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# How Are Organizational Architectures of Corporate Social Responsibility Related to Corporate Performance? The case of Japanese listed companies[1]

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Abstract

This study examines the relationship between organizational architectures of corporate social responsibility (CSR) and corporate performance ("strategic CSR theory"), using survey and financial data from Japanese listed companies. Specifically, this study highlights the establishment of departments and executives dedicated to CSR activities, and their interactions with various performance indicators, including profitability, value, and productivity. Our empirical results are dependent not only on the variances in such organizational architectures but also on performance indicators, industrial classifications, and time lags since their inception. The main finding is that strategic CSR theory is only partially supported. However, even when departments and executives are not related or negatively related to corporate performance in the short term (1–2 years), they may have positive relationships in the medium term (3–4 years). Thus, although the results of this study cannot be interpreted as a strict causal relationship, they do provide useful implications for the organizational architectures of companies that engage in CSR activities.

Keywords: Corporate Social Responsibility (CSR), Strategic CSR Theory, Organizational Architectures, Corporate Performance

JEL classification: L21, L25, M14



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# 1 Introduction

Corporate social responsibility (CSR) has long been debated regarding the traditional roles in markets and civil societies. With a heightened awareness of environmental issues, such as climate change, contamination of air, marine, and soil, and forest destruction, there has been a resounding call for firms to strengthen their commitment to CSR activities. This voice has gained further momentum due to the recent requirement of poverty reduction, respect for human rights, protection of consumers and employees, and redress of disparities.

Stakeholders' expectations for firms' CSR activities led to the development of international guidelines such as "ISO26000," "OECD Guidelines for Multinational Enterprises," and United Nations' "Guiding Principles on Business and Human Rights." As is common knowledge, the United Nations' "sustainable development goals" (SDGs) formulated in 2015 encourage firms to incorporate the 17 targets into their daily management and operations to achieve a sustainable economy, society, and environment by 2030. [1] Every year, the World Economic Forum announces the "Global 100 Most Sustainable Corporations in the World" ranking, resulting from a significant interest in CSR activities. [2] In the case of Japan that we study, the Japan Business Federation (JBF, Keidanren) revised its corporate behaviour charter in 2017 requiring the member companies to outline proactive SDG attainment. [3]

International institutes and organizations have attempted to establish all-inclusive definitions of CSR, despite researchers and academic disciplines defining it differently. For example, the European Commission (2002) defines CSR as "a concept whereby companies integrate social and environmental concerns in their business operations and in their interactions with their stakeholders on a voluntary basis." Meanwhile, the World Bank documents that "CSR is the commitment of businesses to behave ethically and to contribute to sustainable economic development by working with employees, their families, the local community, and society at large to improve their quality life, in ways that are both good for business and good for international development" (Petkoski and Twose, 2003). However, McWilliams and Siegel's (2001) definition is the most popular among academic researchers: "actions that appear to further some social good, beyond the interests of the firm and that which is required by law." In the CSR literature as a whole, ethical, voluntary, and social aspects without external mandatory forces are frequently emphasized. Then, how can we understand the "economic" aspects of CSR if firms incur CSR expenditures at the expense of profits?

The perspectives of economics and business administration literature have significantly

[1] As for the detailed 17 targets of SDGs, see the following United Nations' website: https://sdgs.un.org/goals

[2] https://www.corporateknights.com/rankings/global-100-rankings/2022-global-100-rankings/

[3] In 2000, the Japan Association of Corporate Executives (JACE, Keizai Doyukai) published the "21st Century Declaration" in 2000 to commit affiliate corporations to social and human value responsibility. The JACE also produced a series of self-assessment CSR reports to increase Japanese companies' CSR awareness and practices. Suto and Takehara (2018) provide additional information on the historical development of CSR in Japan.

diverged into two extremes. One extreme is the so-called "shareholder" rights theory. Friedman (1970), a prominent proponent of this theory, noted that firms' primary responsibility is to increase their profits for the benefit of shareholders. He asserted that although governments are obliged to provide public goods (including those provided by CSR activities), firms engaging in such activities are subject to moral hazard and waste valuable resources trusted by shareholders. By contrast, the other extreme is "stakeholder" rights theory that emphasizes the importance of considering a wide range of stakeholders (Freeman, 1984). This theory posits that business managers must maximize the satisfaction of all stakeholders associated with their companies, including employees, customers, banks, government institutions, local communities and residents, and shareholders in particular. The issue at hand is that CSR activities play a crucial role in attracting and retaining stakeholders to the firms, and that the defection of stakeholders may hinder firms from implementing sound management and operations and achieving long-term competitive advantages. [4] Meanwhile, this theory of stakeholder rights is criticized for placing excessive emphasis on the ethical obligations that firms must fulfill. In other words, the theory tends to understate the "strategic" significance of CSR activities. The question then arises as to why firms engage in CSR activities that waste management resources and reduce profits? The "strategic CSR theory" provides a revealing response to this question (Baron, 2001; McWilliams and Siegal, 2000, 2001; McWilliams et al., 2006). [5] The strategic CSR theory finds a strategic effectiveness of CSR and related investments to maximize long-term firm values through deliberate cost-benefit analyses comparing their short-term costs with long-term benefits. Kitzmueller and Shimshack (2012), who surveyed how strategic CSR activities function, identified the theoretic channels. By employing CSR as a signal of concern for the environment and sustainability, firms can, for instance, attract morally motivated, high-quality employees or provide differentiated products to discerning customers, thereby gaining a competitive edge over rivals. By implementing CSR as a corporate strategy beforehand, firms can eliminate activists' threats that could harm their reputation or incur significant expenses. Moreover, CSR activities, which are excessive compliance, can be used not only as a buffer zone to avoid potential changes in regulation and related adjustment costs but also as a deterrent to consumers' participation in lobbying activities that induce government regulation.

Some mainstream economists have also attempted to establish theoretical foundations for firms' CSR activities. Bénabou and Tirole (2010) explained why firms are willing to engage in CSR based on the corporate finance and behavioral economics theory. First, CSR enables firms to abandon short-termism and to adopt long-term management per-

[4]In this sense, the shareholder rights can approach the stakeholder rights theory with some leeway. Jensen (2001) presented an alternative concept of "enlightened stakeholder theory," according to which firms must coordinate the interests of diverse stakeholders to maximize their long-term firm values.

[5]A similar explanation for CSR activities is the "resource-based theory", which views firms' indispensable and valuable resources as a competitive advantage (Wernerfelt, 1984; Barney, 1991). The subsequent explanation of the strategic CSR theory incorporates the resource-based theory, as the latter theory complements the former.

spectives, which is consistent with the previously discussed strategic CSR theory in terms of maximizing intertemporal profits and long-term firm values, including shareholder values. Second, CSR can be interpreted as delegated philanthropy by stakeholders such as conscientious consumers, who request that corporations engage in philanthropy on their behalf. As stakeholders who demand CSR sacrifice profits, CSR is not necessarily inconsistent with value maximization. Third, in contrast, CSR activities may not be initiated by conscious stakeholders but by insiders, particularly board members, who desire to satisfy self-consciousness by performing philanthropy. Profits are not typically maximized in this third scenario, so corporate governance is an issue. Furthermore, Aoki (2010) examined CSR concerning the corporation and social games and found an intriguing point. He argued that CSR activities contribute to the accumulation of firms' "social capital" based on mutual trusts, norms, and social networks, allowing firms to attract their stakeholders who are interested in social responsibility, increase demand and decrease their capital costs, and thereby improve their long-term competitive advantage and corporate performance.

Although theoretical channels of strategic CSR theory have been cleared through which CSR may positively affect corporate performance, studying empirically how they actually work in corporations is also an important and practical research focus. As the review of empirical studies will be presented in Section 2, a general overview demonstrates that corporate social performance (CSP) generally has a positive relationship with corporate financial performance (CFP) (Orlitzky et al., 2003; Margolis et al., 2009). This result suggests evidence, albeit weak, that CSR may be profitable for businesses. Relative to Japan, which is a focus of this study, any positive causal flow from CSP to CFP has not been observed under endogeneity control (Suto and Takehara, 2018). However, few studies have analyzed the relationship between CSR activities and corporate performance, particularly concerning Japanese companies, from a comprehensive corporate performance perspective. Hence, investigating the relationship using data on corporate performance indicators of Japanese companies is an important research agenda, because they have recently explored their competitive advantage through CSR activities, as JBF's guidance demonstrates.

This study intends to contribute to the empirical literature on CSR by highlighting three distinctive aspects. First, this study focuses on "organizational architectures" rather than "CSR scores." The CSR scores published by private rating agencies are synthesized from various CSR-related indicators by multivariate analysis, but they tend to blur individual significant factors that can affect corporate performance. In addition, it is difficult to evaluate CSR scores over time because questionnaires and calculation methods may vary in different years. In contrast, organizational architectures appear to be more concrete and objective factors that can be linked directly to corporate performance. Among other things, this study sheds light on the establishment of CSR departments and executives within companies (henceforth, abbreviated as "CSR department" and "CSR executive," respectively). Second, this study evaluates corporate performance using three performance indicators: profitability, value, and productivity. Although return on equity (ROE) receives a disproportionate amount of attention in the existing literature, probing other indicators is also important to comprehensively understand corporate performance. Third, this study classifies the industrial category into the R&D-intensive and less R&D-intensive industries (henceforth, abbreviated as "R&D industry" and "non-R&D industry," respectively). As R&D and non-R&D industries have different sources of competitiveness (e.g., market structure, technology, intangible asset), CSR departments and executives may interact with corporate performance differently depending on the industry category.

This study analyzes the relationship between CSR and corporate performance by matching survey data from Japanese listed companies that with financial data. As mentioned previously, this study highlights the organizational architectures of CSR from establishing specialized or dual obligatory departments and executives within firms, which provide objective measures for CSR activities. Our empirical results depend not only on the differences in such organizational architectures, but also on performance indicators, industrial categories (R&D or non-R&D industry), and time lags after the organization's establishment (short or medium-term). The most important finding is that strategic CSR theory is only partially supported. Interestingly, even when CSR departments and executives are not related or negatively related to corporate performance in the short-term (1–2 years), they may have positive relations in the medium-term (3–4 years). For example, the annual profitability growth of ROE and return on assets (ROA) tends to be negatively correlated with CSR departments for the first two years after their establishment. However, their relationships tend to become positive after 3–4 years, particular in R&D industry. This type of time-lag effect is also observed in the relation between the growth of labor productivity and CSR departments, as well as between the growth of total factor productivity (TFP) and CSR executives in non-R&D industries. In fact, these empirical results cannot be interpreted as rigorous causal relations, but as mere correlations, due to the characteristics of observational data. Nevertheless, in the context of the relationship between organizational architectures and corporate performance, we can find both indirect positive and negative evidence supporting strategic CSR theory. Consequently, these results would have implications for how firms should mobilize their organizations as a tool for implementing corporate strategies and simultaneously achieving CSR.

The structure of the paper is as follows. Section 2 reviews related empirical literature on the relationship between CSP and CFP. Section 3 explains the hypotheses and the empirical formulation and describe the data used. Section 4 presents empirical results according to corporate performance indicators. Section 5 concludes the paper and raises future research challenges.

## 2 Related Empirical Literature

Individual empirical research examining the CSR–CFP relationship yields ambiguous results depending on context-specific factors, such as employed data and model parameters.

[6] Among early works that documented the positive relation between the two indicators, Waddock and Graves (1997) used an inclusive index of CSP rated over the US Standard & Poor's (S&P) 500 (i.e., KLD ratings) to demonstrate that CSP has positive associations with prior and future CFP. Following Waddock and Graves (1997), Ruf et al. (2001) confirmed the stakeholder theory by demonstrating that a change in CSP was positively correlated with sales growth in the current and subsequent years, and with the level of ROE and sales three years later. Meanwhile, Jiao (2010) and Jo and Harjoto (2011) also found that CSR participation led to an increase in firm value, as measured by Tobin's q. Considering the reverse causal flow from better corporate performance to undertaking of CSR activities, Erhemjamts et al. (2013) demonstrated that the strength of CSR activities positively affected corporate performance in addition to investments after correcting the endogeneity biases. By regarding CSR awards as a significant CSR barometer, Hou (2019) argued that companies that invest in CSR have more successful CFP than those that do not.

In stark contrast, there are studies that propose a negative relationship between CSR and CFP. For example, Wright and Ferris (1997) discovered a negative reaction of stock prices to disinvestment of assets in South Africa, which managerial action was considered conformed with CSR in the late 1980s. Other authors highlighted intervening variables that could affect both CSR and CFP and blur the relation. McWilliams and Siegel (2001), refuting Waddock and Graves's (1997) positive result, argued that the relationship is inconclusive when R&D investment is included as a control variable. Moreover, Surroca et al. (2010) concluded that the CSR-CFP relationship was fictitious as the mediation effects of firms' intangible assets, such as corporate culture, became effective.

Despite the divergent results of individual studies, meta-analyses provide a comprehensive assessment of empirical results already obtained. Orlitzky et al. (2003) demonstrated, through a meta-analysis of 52 studies, that CSP (and, to a lesser extent, environmental responsibility performance) and CFP exhibited a positive relationship, and that when a reputation indicator of CSP is used, this relationship is stronger than when other indicators are used. Based on a meta-analysis of 251 studies, Margolist et al. (2009) also advocated a positive relationship between CSP and CFP, but found that the numerical significance was rather small (i.e., the correlation coefficient is around 0.1) and that the small result was notable over the past decade. Overall, the authors who conducted the meta-analyses found that CSR activities can benefit firms in terms of CFP, indicating that the strategic CSR theory is supported. [7] However, given that these meta-analyses covered relatively old studies examining companies operating in the US and the EU, we should be cautious as to whether this result would hold true for contemporary Japanese companies.

Notably, empirical studies have yielded a variety of results contingent upon the charac-

[6]Although numerous studies have explored the relationship between corporate environmental performance (CEP) and CFP, Section 2 of the present study focuses on the relationship between CSP and broader corporate activities including CEP.

[7]These analyses appear to be lacking in scope. In other words, although the positive correlation between CSP and CFP is confirmed, it does not necessarily imply a causal relation between CSP to CFP.

teristics of CSR activities or the circumstances in which companies find themselves beyond the simple CSR-CFP relationship. They focused on influential factors such as how relationships are built with primary stakeholders (e.g., customers, employees) and the type of social issue participation (Hillman and Keim, 2001), the level of innovation and product differentiation (Hull and Rothenberg, 2008), the asymmetric effects on CFP between good and bad reputations (Van der Laan et al., 2008), unobservable firm characteristics crucially relevant for CSR (Neiling and Webb, 2009), the non-linearity like the "U-shape" CFP–CSP relationship (Barnett and Salomon, 2012), and the customer awareness proxied by advertising expenditures (Servaes and Tamayo, 2013). As suggested by these studies, when the association between CSR activities and corporate performance is observed, characteristics that are relevant to both variables must be controlled for. On this point, this study explores the relationship by focusing on the organizational architectures of various industrial categories, in which firms may encounter varied circumstances when conducting CSR activities.

Few studies have investigated the empirical issue within the context of Japanese companies' CSR efforts. Suto and Takehara (2008) is a seminal work to which this study refers extensively for inspiration. The authors analyzed corporate performance considering characteristics of corporate governance (i.e., internal governance, external governance, and social contribution). Among other things, internal governance deserves special mention concerning this study. Their definition of internal governance for streamlining CSR activities relates to the presence or absence of specialized or dual obligatory CSR departments, special committees, and executive directors who oversee the CSR activities of the companies. Using the Center for Public Resources Development dataset covering the CSR survey in 2006 and financial information from 2001 to 2005, they conducted a simple analysis that regressed corporate performance measured by average and standard deviation of ROE, ROA, Tobin's q, sales growth, assets growth, and stock returns onto the previously mentioned dummy variables. They did not obtain any consistent results except the finding that special committees are negatively related to the standard deviation of stock returns. Subsequently, addressing the endogeneity issue, Suto and Takehara (2018) did not observe any positive effects of CSR on CFP, but they did find a reduction in firm management risk as measured by stock markets. [8]

In summary, although empirical analyses frequently derive a direct CFP–CSP relationship, regardless of whether it is positive or negative, results may also depend on the firms' characteristics and circumstances. Taking this into account, this study intends to be unique in focusing not only on diverse corporate performance indicators but also on corporate governance issues represented by organizational architectures of CSR (Suto and Takehara, 2008, 2018).

[8] Other notable studies have analyzed the CFP–CSP relationship by highlighting various stakeholders (Shinohara, 2014), foreign investor shareholding (Kawamura and Nagata, 2016), and long-term financial performance (Okamoto, 2015).

# 3 Empirical Formulation

This study is based on the empirical formulation specified in this section. Section 3 describes the hypotheses that prescribe the relationship between CSR organizational architectures and corporate performance, and then presents a straightforward estimation model to confirm the hypotheses. In addition, it provides a concise explanation of the unique dataset on CSR collected from Japanese publicly traded companies using survey questionnaires and financial statements.

## 3.1 Hypotheses and estimation model

This study's primary objective is to determine whether CSR, particularly organizational architectures of CSR within Japanese listed companies, have a positive, negative, or neutral relationship with their corporate performance. Indeed, any consequences may depend on the validity of the strategic CSR theory (see Section 1). If CSR activities successfully attract "selective" stakeholders, such as customers, investors, and employees to a firm, thereby enhancing its competitiveness, the firm would enjoy greater corporate performance in market competition. However, if CSR activities fail to attract relevant, significant stakeholders and waste shareholders' valuable resources, then the company's performance may decline.

This study focuses on the concrete organizational architectures of CSR, namely, the establishment of departments and executives related to CSR management and operation. These indicators have the advantage of obtaining objective responses from firms in a questionnaire survey, as opposed to subjective indicators, such as the response to the question "Do your firms respect CSR guidelines or not?" Whether firms contain relevant departments or executives is a potentially reliable fact that firms answer. Moreover, focusing primarily on organizational architectures, such as CSR departments and executives, following the strategic CSR theory would provide us with a useful perspective on how corporate governance should be constructed to achieve both CSR and high corporate performance. [9] Accordingly, the first and most interested empirical hypothesis of this study is summarized as follows.

**Hypothesis 1 (H1).** *CSR departments (or executives) have positive relationships with corporate performance under the assumption of strategic CSR.*

The potential internal mechanisms by which CSR activities affect corporate performance should be briefly discussed. First, profits can be increased in a number of ways. For instance, environmental preservation activities encouraging firms to reduce waste materials could result in increased profitability. In another scenario, firms that expand their CSR activities may be able to attract highly motivated, talented employees, thereby increasing

[9] For general survey of firms' internal structures and incentives, see Milgrom and Roberts (1992) and Besanko et al. (2017).

their profits through market dominance. Second, investors who value CSR activities highly can appreciate the firm's worth. These investors may respond positively to the news that firms intend to or actually establish CSR-related departments or executives. Third, by adhering to environmental and safety regulations as part of CSR efforts, productivity could be improved over time by reducing defective products in production processes. Although these are merely a few examples, numerous other channels link the implementation of CSR through the establishment of organization architectures to corporate performance.

Another conceivable possibility is that CSR departments and executives have reciprocal relationships that influence corporate performance. Specifically, CSR executives are typically expected to collaborate effectively with CSR departments of firms by issuing appropriate managerial directives to affiliated departments. Hence, this study will also confirm the following second hypothesis.

**Hypothesis 2 (H2).** *CSR departments and executives "complement" one another in terms of corporate performance, which means that CSR executives amplify the positive results that CSR departments contribute to corporate performance.*

Lastly, the relevant CSR departments and executives have specialized or dual responsibilities to promote CSR within their firms. Although "specialized" obligations require departments or executives to focus solely on CSR activities, "dual" obligations require them to engage in other corporate activities, such as general and legal affairs and advertising, in addition to CSR. Theoretically, specialized and dual obligations may generate different outcomes based on the level of commitment to CSR activities or managerial resources devoted to such activities.

**Hypothesis 3 (H3).** *CSR departments (or executives) with specialized obligations have different relationships to corporate performance from those with dual obligations.*

With these hypotheses in mind, the simple regression equation is formulated as follows:

$$\Delta \log(Y_{i,t}) = \sum_k \beta_k X_{i,t-m,k} + \sum_l \beta_l Z_{i,t-n_l,l} + \alpha_i + \alpha_t + \alpha_{j,t} + \varepsilon_{i,t}. \tag{1}$$

$Y$ is a performance variable of firms' profitability, value, and productivity. As outlined below, the corporate performance is measured by the log-difference of relevant variables to focus on their year-to-year changes. $X$s are independent variables that represent CSR organizational architectures (i.e., CSR departments, executives, and their composite), which is the primary focus of this study. These independent variables are essentially composed of dummy variables. $Z$s are control variables that capture firm characteristics such as sales, employee count, fixed assets, firm age, firm age squared, and R&D intensity. The variables' detailed data construction will be explained in Subsection 3.2. $\beta_k$ and $\beta_l$ are coefficients to be estimated, and the sign of the former evaluates the hypotheses regarding the relation between organizational architectures of CSR and corporate performance. $i$, $j$, and $t$

represent the firm, industry, and year indices, respectively. Then, the dummy variables $\alpha_i$, $\alpha_t$, and $\alpha_{j,t}$ indicate fixed-effects relevant for firms, years, and industry-year combinations. $\varepsilon_{it}$ is an error term that is normally assumed to be identically independently distributed (i.i.d.). Note that $m$ and $n_l$, which are included in $X$s and $Z$s, respectively, represent the lag time of years. It is assumed that it will take a certain amount of time for the effect of a change in organizational architectures to become evident in corporate performance. Moreover, using time lags has the added benefit of mitigating simultaneous endogeneity between the independent variables and the error term, which will be discussed in greater detail below.

Equation (1), a regression equation, is estimated by using the fixed-effects model that eliminates firm-fixed-effects, $\alpha_i$, through the within-transformation. This fixed-effects model enables us to incorporate both between and within variations while avoiding the endogeneity issue wherein constant unobserved firm characteristics can be correlated with the error term. This is an obvious advantage over Suto and Takehara's (2018) analysis, in which pooled data omits time variations. However, since CSR activities of firms are highly likely to be endogenous variables due to omitted variables or reverse causality, [10] lagged $X_{i,t-m,k}$ may still be correlated with it when being serially correlated across years. In that case, the "strict exogeneity" assumption of independent variables to ensure unbiased estimates may not be satisfied (Wooldridge, 2010). Therefore, estimated coefficients based on the fixed-effects model cannot be interpreted as a strict causal relationship, but rather as a mere correlation. Unfortunately, due to the lack of institutional changes regarding CSR policies in Japan, it is difficult to exploit exogenous variations of CSR-relevant independent variables that allow us to establish a causal relationship. Nevertheless, considering the significance of the hypotheses, the examination of statistical relationships remains an interesting research agenda. [11]

Finally, this study will conduct an analysis by classifying industries. According to the intensity of R&D, the total samples are classified into two distinct categories (see Subsection 3.2). It is reasonable to assume that each industrial category has distinctive competitive advantages, such as intangible assets, technologies, and innovations, and that, as a result, they will yield distinct empirical findings.

[10] Reverse causality is more probable because firms with better corporate performance can afford to engage the establishment of CSR departments and executives.

[11] The propensity score matching (PSM) method, in which firms with CSR departments or executives and those without are matched appropriately, appears to be effective for identifying a causal relationship. However, the PSM method has the drawback that the matched dataset collapses to the repeated "cross-section", implying that the average treatment effect on the treated evaluates "between-variations," but not "within-variations." Furthermore, since the timing of events in which firms introduce CSR departments and executives is not fixed to a specific year, we cannot conduct a difference-in-differences method or event studies.

## 3.2 Data

Two primary datasets are utilized in this study. [12] The first is the "CSR Database" provided by TOYO KEIZAI, INC, which contains information from 2010 to 2020 (11 years). [13] This database collects information about CSR from both Japanese listed and major unlisted companies in the context of environment, society, and governance and human resources. Based on various information in these two perspectives, this database publishes a "Comprehensive List of CSR Companies" that includes the CSR ranking and scores of respondent companies; however, this information is not utilized in this research. Typically, the survey is conducted between June and October, and the results are made public in December. In 2020, for instance, the questionnaire was sent to 3,819 companies, and 1,614 (1,561 listed and 53 unlisted companies) responded, for a response rate of 42.3%. There are questions on the questionnaire that inquire about the existence of CSR departments (and executives) in companies, and respondents choose from the following options: (i) they are specialized; (ii) they have dual obligations; (iii) they do not exist; and (iv) others, including free answers. This study makes a CSR department (and executive) dummy that assigns a value of 1 if the answer is (i) or (ii) and 0 if the answer is (iii) for the aforementioned options. During 2010-2020, most firms report that they keep 1(0) or move from 0 to 1, and the case where firms move from 1 to 0 is very scarce (the ratio is 0.3% for CSR departments and 0.1% for executives all over the samples). These samples are all included in the analysis to evaluate variations of the existence of CSR departments and executives.

Figure 1 depicts the shares of firms with CSR departments and executives during the sample years. It shows that CSR departments have higher shares than CSR executives and that this trend has continued since 2014. Although the shares of CSR departments and executives declined rapidly in 2013–2014, this volatile trend is likely to be absorbed by the year dummy variable when performing estimations. [14]

[Figure 1. Shares of CSR departments and executives]

This study also employs the "Financial Data Digest" dataset, which is also provided by TOYO KEIZAI, INC. It contains basic information regarding non-consolidated financial data (e.g., sales, assets, liabilities, profits, stocks, firm age, and R&D investments) for all companies listed on the Japanese stock markets, such as Tokyo Stock Exchange, NASDAQ Japan, and TSE Mothers. Both dependent and control variables are constructed with the Financial Data Digest as their primary resource. Corporate performance indicators are obtained through concise calculations: (i) profitability (ROE and ROA), (ii) value

[12] See Appendix for more details of data construction.

[13] The CSR Database provides data from 2005 to 2021 as of the writing of this paper. However, this study only covers a portion of full years because the disruptive impacts of the 2008–2009 global financial crisis should be excluded.

[14] The unlisted probit estimation shows that the establishment of CSR departments and executives is strongly correlated. In addition, while the establishment of CSR departments are positively correlated with firm scales such as sales, employee count, and fixed assets, that of CSR executives are so only with fixed assets and capital stocks. This estimation result is provided by the author upon request.

(aggregate market share values and Tobin's q), and (iii) productivity (labor productivity and TFP). [15]

These performance indicator variables may contain outliers and are not be normally distributed. When the shape of their distributions does not conform to the normal distributions, original samples are winsorized, but not trimmed, by the lower and upper 0.5%, respectively (totaling 1.0%), so as not to reduce sample sizes. [16] Importantly, the focus of this study is not the "level" of corporate performance, but rather the "change" (i.e., the year-to-year percent change of dependent variables). As Ruf et al. (2001) indicated, measuring corporate performance by change is preferable to measuring by level due to the time series characteristics of variables, which would also mitigate reverse causality between dependent and independent variables. To approximately calculate the year-to-year percentage change, this study takes first-differences of logarithm of the performance indicator variables. However, as some variables may have negative values, calculating the logarithm for these variables presents a formidable challenge. Hence, before taking logarithm, this study applies the following formula when "$\arg\min Y_{i,t} < 0$" holds:

$$Y_{i,t} + |\arg\min Y_{i,t}| + 1 \ \text{ for all } Y_{i,t} \ \text{ if } \ \arg\min Y_{i,t} < 0. \tag{2}$$

This transformation enables the distribution of $Y_{i,t}$ to keep the same shape, although the evaluation of percentage changes is not necessarily accurate.

The total number of samples for analyses is reduced to the size of CSR Database given that it is easy to match the two datasets with the firm code that is uniquely assigned to each company. Financial institutions (i.e., banks, insurance companies, and securities futures trading companies) are excluded from the analyses because their earning structures differ from those of conventional businesses. The resulting integrated dataset for analytical use consists of 13,350 samples with unbalanced panel data spanning 2010–2020. [17]

Noteworthily, this integrated dataset has a potential sample selection bias. Because up to 24,922 samples over the years are unmatched with the CSR Database, the distributions of unmatched data may differ from those of matched data. Comparing these matched and unmatched data by testing the differences in the average values of the dependent variables reveals that the numerical values of matched data are statistically little different from those of unmatched data except for aggregate market share value and Tobin's q (with these variables, the former is larger than the latter). This finding suggests that respondent firms do not necessarily achieve superior corporate performance in terms of profitability and productivity. Principally, suppose it is assumed that firms' decision to answer the questionnaire survey without reluctance is affected by an unobservable factor

[15] The sample sizes do not always coincide across dependent variables due to the missing values of financial data.

[16] Quantile regression is a possible estimation tool for mitigating the effect of outliers. However, although the methods such as those of Machado and Santos Silva (2019) have been developed, the validity of "fixed-effect" quantile regression is still debatable.

[17] Quite naturally, the sample size to be used is reduced to less than 13,350, after taking log-difference of variables of corporate performance indicators.

(i.e., selection equation). In that case, this factor is likely to be positively correlated with corporate performance (i.e., structural equation), which may result in possible upward biases. However, from the above comparison, such upward biases do not seem serious overall. Therefore, it is still substantial to examine whether organizational architectures of CSR are related to corporate performance even if only respondent firms are used for analyses. [18]

The matched database enumerates the 23 industries according to the classification made by the Japan Standard Industry Classification formulated by the Ministry of Internal Affairs and Communications and TOYO KEIZAI, INC. [19] Table 1 presents the sample sizes of each industry and the classification of the industrial categories. Specifically, the industries can be classified from the perspective of how intensively firms conduct their R&D investments relative to their sales, that is, the R&D intensity. By averaging the R&D intensity of firms over the years according to the individual industries before matching the two datasets, this study establishes the "R&D industry" (1–2, 4, 6–7, 9–13, 17, 19) if the average industry-level R&D intensity is above the median and "non-R&D industry" (3, 5, 8, 14–16, 18, 20–23) if it is below the median. Then, this study categorizes sample firms into those belonging to the industry whose R&D intensity is high (firms in the R&D industry) and those not (firms in the non-R&D industries), respectively. [20]

[Table 1. Classification of industries]

The descriptive statistics, that is, simple means and standard errors, used for empirical analyses are presented in Table 2. Note that sales, fixed assets, and labor productivity are deflated by the year-base industrial GDP deflators of the Japanese Cabinet Office's national economic accounting. [21] As shown in Table 2, several distinctions exist between the R&D and non-R&D industries. The R&D industry has a higher growth of ROA and TFP than the non-R&D industry, but a lower growth of aggregate market share value. [22] Additionally, the former firms record the larger shares of establishing CSR departments and executives than the latter firms. This result may be because the former firms typically produce manufacturing goods, and as a result, are more concerned about how these goods may affect the environment, consumer confidence, and so on. Finally, the former firms are

[18] Suto and Takehara (2008) reported that Japanese companies aggressively engaging in CSR activities are large and stable, such as those in the apparatus and utility industries, and that these companies exhibit superior corporate performance. This study must therefore control for firm sizes and industrial categories to partially correct selection biases.

[19] Since CSR information is voluntarily gathered from companies for the CSR Database, some years lack CSR data. Consequently, the dataset contains an unbalanced panel.

[20] The (non-)manufacturing and (non-)R&D industries are nearly identical: the (non-)manufacturing industry index ranges 1–13 (14–23). The results using the classification of the manufacturing and non-manufacturing industries are provided upon request from the author.

[21] When industrial deflators that are exactly matched with the industrial categories of the dataset do not exist, they are created by synthesizing relevant deflators with weights of real GDP in each industry.

[22] Although the ROE of the R&D industry is significantly higher than that of the non-R&D industry, the standard error of the R&D industry is so large that the mean appears to be affected by outliers. When conducting subsequent analyses, we must exclude outliers in certain instances.

larger in terms of employment and older than the latter firms, which is indicative of their manufacturing characteristics. Because of these various factors, each industrial category is expected to demonstrate typical estimation results.

[Table 2. Descriptive statistics]

# 4 Empirical Results

Section 4 explains the empirical results of testing the three hypotheses (H1–H3) that were presented in Section 3. Using cluster-robust standard errors across firms, this study applied the same fixed-effects model independently to various dependent variables. This study intends to check the signs of the following dummy variables and their cross-terms, that is, $X_{i,t-m,k}$ in Equation (1): (i) *Dep* and *Exe* (CSR department and executive dummies; H1), (ii) $Dep \times Exe$ (cross-term of CSR department and executive dummies; H2), and (iii) *Deps*, *Depd*, *Exes*, and *Exed* (specialized or dual obligatory CSR department or executive dummies, respectively; H3). If the estimates are positive, CSR departments or executives are positively related to individual corporate performance indicators. This study utilizes 1- to 4-year lags of the relevant dummy variables, assuming that the effects of CSR departments and executives appear with time lags of years. The purpose of lagged estimations is to observe the relatively short- (i.e., 1–2 years) or medium-term (i.e., 3–4 years) relations, but not long-term relations, because the 11-year time dimension does not permit long-term evaluations due to insufficient sample size.

Control variables are included in estimations to account for firm-specific characteristics such as firm size, age, and R&D intensity. Altough sales, employment, fixed assets, firm age, and firm age squared are concurrent with the dependent variables, R&D intensity is included with a 1-year lag on the assumption that its effect would emerge after at least a year. [23] The firm, year, and industry-year dummies should also be included to eliminate unobservable variables that may be correlated with the establishment of CSR departments and executives.

The most serious concern when conducting the aforementioned estimations is reverse causality, which may bias estimates affected by the correlation between independent variables and error term despite eliminating unobservable firm characteristics by fixed-effect estimation. This bias primarily reflects the possibility that firms with high corporate performance can afford to establish CSR departments and executives through affluent managerial resources. To alleviate this concern of reverse causality, this study attempts to conduct the "reverse regression" of Equation (1), in which the dependent variables, $X_{i,t,k}$, are regressed on the concurrent corporate performance indicators, $\Delta \log(Y_{it})$, and other control variables, $Z_{i,t,l}$. The summary of these estimation results is presented in Table A1. Given that the estimated coefficient is significantly positive only in the relationship between the

[23] McWilliams and Siegel (2001) emphasized that R&D intensity should be included in control variables to adequately explain corporate performance by eliminating biases due to omitted variables.

CSR department dummy and Tobin's q, the assumption of reverse causality appears to be less of a concern for the other corporate performance indicators.

## 4.1 Profitability

Tables 3 and 4 present the estimation results of ROE and ROA, respectively. This section verifies the estimates of CSR department and executive dummies in Estimations (1), (4), and (7) and of their cross-terms in Estimations (3), (6), and (9). Before undertaking estimations, the upper and lower samples of ROE and ROA are winsorized by 0.5%, respectively, given the substantial standard deviation of ROE in the R&D industry. In addition, the levels of ROE and ROA are transformed according to Equation (2) so that they can be interpreted as year-to-year growth for analytical convenience.

Profitability is measured by ROE and ROA, both of which evaluate how effectively firms leverage their capitals and assets, respectively, to generate profits. Thus, these corporate performance indicators are the focus of investors' attention. Specifically, ROE is a crucial metric for shareholders who invest in a company and expect a return on their shares. If a firm's ROE or ROA is low, investors typically view it as an unworthy investment destination. It is common knowledge that the ROE and ROA of Japanese listed companies are lower than those of the US and EU companies. [24]

Table 3 shows that the estimate of CSR departments with a 2-year lag ($Dep_{-2}$, particularly $Depd_{-2}$) for the total industry is negative at the 5% significance level. However, the estimates with a three-year lag ($Dep_{-3}$) for the R&D industry (in addition, specialized CSR departments [$Deps_{-3}$] for the total and R&D industries) are positive at the 10% significance level, suggesting that ROE of the R&D industry is expected to increase three years after its inception. The relationship between CSR departments and the growth of ROE is positive in the medium-term, but negative in the short-term, particularly for the R&D industry. In contrast, Table 3 demonstrates that the estimate of CSR executives with a 4-year lag ($Exe_{-4}$, particularly $Exed_{-4}$) for the R&D industry is negative at the 5% significance level, whereas the estimates with a 3-year lag ($Exed_{-3}$) for the total and R&D industries are negative at the 10% significance level. This finding suggests that the negative relationship between CSR executives and the growth of ROE in the R&D sector appears over the medium-term. Meanwhile, no positive or negative relationships of CSR departments and executives with the growth of ROE are observed for the non-R&D industry, except for CSR dual obligatory executives with a 1-year lag at the 10% significance level.

[Table 3. Estimation results: ROE]

In Table 4, the aforementioned relations of CSR departments are more distinct in

[24] According to METI of Japan (2019), the average ROE (ROA) of representative Japanese, US, and European companies in 2018 was 9.4% (4.2%), 18.4% (5.7%), and 11.9% (5.0%), respectively.

the case of ROA. [25] Put precisely, on the one hand, the estimates of CSR departments with a 2-year lag ($Dep_{-2}$) in addition to their subcomponents ($Depd_{-2}$ and $Deps_{-2}$) are significantly negative for the total and non-R&D industries (more significant for the non-R&D industry at the 5% level), and on the other hand, those with a 3-year lag ($Dep_{-3}$, $Depd_{-3}$, and $Deps_{-3}$) for the R&D industry are highly significantly positive at the 1% level (the estimate of $Dep_{-4}$ for the total industry is also positive at the 10% significance level). Moreover, significant negative estimates are observed as for specialized CSR executives with a 3-year lag ($Exes_{-3}$) for the total and non-R&D industries (at the 5% significance level for the total industry). This indicates that specialized CSR executives are likely to be associated with slower ROA growth over the medium-term. These findings suggest that CSR departments (executives) are positively (negatively) associated with profitability growth over the medium-term.

[Table 4. Estimation results: ROA]

## 4.2 Value

Firm values are analyzed in terms of aggregate market share values and Tobin's q, respectively (Tables 5 and 6). The aggregate market share values, calculated by multiplying share prices by the number of outstanding shares, indicate a firm's value, including investors' expectations regarding its growth potential. Tobin's q is a criterion for investment decisions and is defined as firms' market values (i.e., aggregate market share values plus aggregate liabilities) divided by capital values. Hence, if a firm's Tobin's q is greater (lesser) than 1, the firm's market value exceeds (falls below) reacquisition costs of capitals, indicating that it is reasonable to invest (not invest) in such a firm.

Table 5 demonstrates that the estimates of CSR executives with a 2-year lag ($Exe_{-2}$, particularly $Exed_{-2}$) and CSR departments with a 3-year lag ($Dep_{-3}$, particularly $Deps_{-3}$) are negative at the 10% significance level for the non-R&D industry, respectively. These organizational architectures of CSR are neither relevant to nor negatively associated with the growth of aggregate market share values, contrary to commonly held belief that CSR activities of firms would lead to higher market values reflecting positive investor responses. Even after one year, there is no evidence that they tend to enhance aggregate market share values for any industrial categories.

[Table 5. Estimation results: aggregate market share value]

Table 6 exhibits a different result regarding Tobin's q; the estimate of (dual obligatory) CSR departments with a 1-year lag ($Dep_{-1}$ and $Depd_{-1}$) is positive at the 10% significance level for the total industry. However, the estimate of specialized CSR departments with a 3-year lag ($Deps_{-3}$) are negative at the 5% significance level for the non-R&D industry,

[25] If the definition of ROA is applied to business profits rather than current profits as the numerator, the same results are obtained.

whereas the estimate of overall CSR departments is insignificant. This latter result for the non-R&D industry is partially consistent with that of aggregate market share values. That is, it is suggested that CSR departments have a negative relationship with the growth of firm values in the non-R&D industry over the medium-term.

[Table 6. Estimation results: Tobin's q]

## 4.3 Productivity

This subsection examines the relationship of labor productivity and TFP. Labor productivity focuses on labor forces among production factors put into production activities, whereas TFP considers all production factors that are not explained by labor and capital inputs. Specifically, TFP growth evaluates improvements in operational and productive efficiencies that do not rely on physical inputs; thus, it can be viewed as an indicator of technological development and innovation. This study does not calculate TFP using production function approaches due to a lack of stock data for capital and R&D inputs in the financial dataset. Therefore, the growth of TFP utilized in this study is obtained using the following simplified method (see Appendix for details):

$$\ln(TFP) = \ln\left(\frac{Q}{Emp}\right) - \frac{1}{3}\ln\left(\frac{K}{Emp}\right). \tag{3}$$

In Equation (3), $Q$, $K$, and $Emp$ denote sales, physical fixed assets, and year-end employees, respectively (where sales and physical fixed assets are deflated by the industrial deflators). [26] This calculation yields "approximate TFP growth" derived from the "Solow residuals," but it is widely employed in existing literature (e.g., Tomiura, 2007).

Table 7 displays the estimation results of labor productivity. Note that because labor productivity is measured by values added, the financial basis includes negative values. This study does not arbitrarily eliminate negative values, but instead winsorizes the upper and lower samples by 0.5%, respectively, to avoid the influence of outliers, especially in the R&D industry (see Table 2). The level of labor productivity is then transformed using Equation (2), followed by a logarithmic difference. The relationship between CSR departments and labor productivity growth appears in the medium-term. Specifically, the estimate with a 3-year lag ($Dep_{-3}$) is significantly positive at the 5% level for the total industry, primarily due to the effect of the R&D industry, especially the specialized CSR department ($Deps_{-3}$). This medium-term relation also appears with a 4-year lag for the non-R&D industry, as the estimate ($Dep_{-4}$), 0.103, is large and significant at the 5% level. Meanwhile, the positive relation between CSR executives and labor productivity growth is weakly observed in the short-term. The estimates of CSR executives with 1–2 year lags ($Dep_{-1}$ and $Dep_{-2}$) are positive at the 10% significance level (the estimate of $Depd_{-2}$ is

[26] Regarding outputs, $Q$, sales, or value added are typically employed when calculating TFP. Since the financial dataset contains numerous negative values of value added, this study employs sales.

significant at the 5% level, in particular), while they are insignificant at all for both the R&D and non-R&D industries. More notably, concerning the medium-term, the estimate of specialized CSR executives with a 4-year lag ($Exes_{-4}$) is negative, despite the statistical significance being only at the 10% level. These findings imply that the effect of establishing CSR executives on labor productivity growth may be weakly positive in the short-term and may disappear or become negative in the medium-term, which is essentially opposite of the case for CSR departments.

[Table 7. Estimation results: labour productivity]

Let us move on to Table 8 that shows the estimation results of TFP. The log-level of TFP is also winsorized by both the upper and lower 0.5%, and then the growth of TFP is obtained by differencing according to Equation (3). First, the estimate of CSR departments is positive only for the R&D industry and with a 1-year lag ($Dep_{-1}$, particularly $Deps_{-1}$). In addition, the statistical significance is weak at the 10% level. In the medium-term, it is suggested that CSR departments may not be as effective in accelerating TFP growth. Second, the relationships between CSR executives and the growth of TFP over the medium-term vary significantly between R&D and non-R&D industries. The estimates of CSR executives with a 3-year lag ($Exe_{-3}$, $Exes_{-3}$, and $Exed_{-3}$) for the R&D industry are negative at the 10% significance level, whereas those ($Exe_{-3}$ and $Exed_{-3}$) for the non-R&D industry are strongly positive at the 1% significance level. Interestingly, only the estimate of dual obligatory CSR executives ($Exed_{-3}$) is statistically significant, but not the estimate of specialized CSR executives ($Exes_{-3}$), for the non-R&D industry. Furthermore, the estimate of specialized CSR executives with a 4-year lag for the total industry is negative, despite a statistical significance level of 10%. These results indicate that specialized CSR executives may not be related to TFP growth but have a negative relationship with it. Third, some cross-term estimates are significantly negative. In other words, the estimates with a 1-year lag ($Dep_{-1} \times Exe_{-1}$) for the non-R&D industry and with a 3-year lag ($Dep_{-3} \times Exe_{-3}$) for the total and R&D industries are negative at the significance levels of 10% and 5%, respectively. This finding suggests that CSR departments and executives may not reciprocally complement the growth of TFP, but may sometimes reduce it.

[Table 8. Estimation results: TFP]

## 4.4 Summary and discussions

The findings so far in Section 4 are boldly summarized in what follows.

1. **Profitability.** (i) While CSR departments are negatively related to the growth of profitability (both ROE and ROA) in the short-term (H1 is rejected), they are positively related in the medium-term, especially for the R&D industry (H1 is supported); (ii) In the medium-term, (dual obligatory) CSR executives are negatively related to the growth of ROE for the R&D industry (H1 is rejected), and that of specialized

CSR executives is negatively related to the growth of ROA for the R&D industry (H1 is rejected; H3).

2. **Value.** (i) CSR executives and departments have negative relationships with the growth of aggregate market share values in the short- and medium-term for the non-R&D industry, respectively (H1 is rejected); (ii) Although CSR departments are positively related to the growth of Tobin's q in the short-term (H1 is supported), specialized CSR departments are negatively related in the medium-term (H1 is rejected; H3).

3. **Productivity.** (i) CSR departments are positively related to the growth of labor productivity in the medium-term (H1 is supported); (ii) CSR executives are positively related to the growth of labor productivity in the short-term (H1 is supported), but this relationship disappears in the medium-term. (iii) CSR departments are positively related to the growth of TFP in the short-term for the R&D industry (H1 is supported), but this relationship disappears in the medium-term; (iv) CSR executives are negatively related to the growth of TFP in the medium-term for the R&D industry (H1 is rejected), but they (particularly dual obligatory CSR executives) are positively related for the non-R&D industry (H1 is supported); (v) The combination of both CSR departments and executives is negatively related to the growth of TFP in the short-term for the non-R&D industry and in the medium-term for the total and R&D industries, respectively (H2 is rejected); (vi) Specialized CSR executives are negatively related to the growth of labor productivity and TFP in the medium-term (H1 is rejected; H3).

These results indicate four discussion points. First, the validity of the strategic CSR theory is dependent on corporate performance indicators (i.e., profitability, value, productivity), organizational architectures (i.e., CSR departments or executives), industrial categories (i.e., R&D or non-R&D industry), and time lags (i.e., short- or medium-term). For instance, H1 regarding the relationship between CSR departments and short-term profit growth is categorically rejected. This result is striking considering the meta-analysis studies (Orlitzky et al., 2003; Margolist et al., 2009), which demonstrate a positive correlation between CSP and CFP. Therefore, the results of this study provide some counter-evidence to the strategic CSR theory. However, even when CSR departments and executives have negative short-term relationships with corporate performance, these relationships may become positive in the medium-term. The example of profitability shows that CSR departments have a positive association particularly for the R&D industry in the medium-term. In addition, the positive relationship between CSR departments and labor productivity growth takes a moderate amount of time to become evident. One important lesson derived from these findings is that establishing CSR organizational architectures may not have immediate positive effects; rather, they may become available gradually as their potentials permeate daily management and operations. On the contrary, it has been observed that the "negative" relationships can occasionally emerge in the medium-term (e.g., CSR executives and profitability, CSR departments and value, CSR executives and TFP for the R&D industry). See Figure 2 that depicts the time trends of the estimated coefficients according to the industrial category. Firms confronted with such challenges would be required to mitigate inefficiencies associated with CSR activities led by their organizational architectures and generate positive effects on management and operations.

[Figure2. Confidence interval of the coefficients]

Second, it is demonstrated that the estimation results for the R&D and non-R&D industries differ significantly. The R&D industry experiences a positive relationship between CSR departments and the growth of ROA in the medium-term, whereas the non-R&D industry experiences a negative relationship in the short-term. Moreover, CSR executives have a negative relationship with the growth of TFP over the medium-term in the R&D industry, but a positive relationship in the non-R&D industry. Although it is difficult to infer concrete mechanisms from robust evidence, the difference generated between the two industrial categories appears to be related to organizational architectures as well as industrial characteristics. In terms of competitive advantages, it is evident that the R&D industry is completely distinct from the non-R&D industry. Specifically, since the competitive advantage of firms in the R&D industry is primarily determined by technologies, innovations, and intangible assets that are typically embodied in accumulations of R&D and knowledge stocks (Haskel and Westlake, 2017), CSR characterized by regular activities, particularly of specific departments, may successfully enhance such a competitive advantage, and the positive effects may manifest themselves in the growth of profitability and TFP. Intuitively, CSR departments of the R&D industry continuously engage in activities such as reducing waste materials, developing products that reflect the environmental consciousness of consumers, and improving working conditions for corporate researchers.

Conversely, firms in the non-R&D industry do not have a competitive advantage in technologies and innovations, but rather in human capitals. CSR activities enhancing human capitals, for example, employment of women and minorities and improvement of the work–life balance, may positively correlate with increased corporate performance. On this point, corporate executives are the most crucial human capitals that should be allocated to the efficient management and operations of the corporation. Notably, in the medium-term, CSR executives have a negative relationship with the growth of TFP (and ROE) in the R&D industry, but a positive relationship in the non-R&D industry. As suggested by this finding, firms in the R&D industry may sacrifice or waste valuable human resources of executives by hindering them from paying their attention to other important corporate management issues than CSR, whereas firms in the non-R&D industry may be able to increase TFP with the leadership of CSR executives who make efforts to link CSR activities with higher efficiency of corporate practices. CSR executives from the non-R&D industry are more important than those from the R&D industry because the non-R&D industry tend to rely on human capitals, including executives, to bolster their corporate performance.

Third, the result that H2, which points to the complementarity between CSR departments and executives, is not positively supported is disappointing in terms of the strategic CSR theory. To make matters worse, the combination may harm the growth of TFP in the medium-term particularly in the R&D industry, which suggests that the organizational architectures of CSR may include wasteful duplication. Although it is difficult to identify the details of the negative mechanism, firms must consider the synergistic effects that CSR executives have on CSR departments in promoting corporate performance while performing CSR.

Lastly, the estimation results reveal no discernible trend concerning H3, which postulates a distinction between specialized and dual obligatory CSR departments or executives. Nevertheless, specialized CSR executives have been observed to have extreme, and frequently negative, effects on corporate performance. Specialized CSR executives have negative relationships with the growth of ROA, labor productivity, and TFP in the medium-term. Of course, this study does not intend to deny that Japanese companies vigorously engage in CSR through the efforts of corporate executives. However, from the perspective of corporate strategies, the CSR executives issue warrants further consideration. Given the small number of specialized CSR executives compared to dual obligatory executives (4.2% vs. 50.6% in Table 2), corporate managers must design more reasonable incentive mechanisms for multitasking (i.e., commercial and CSR activities) to balance the two tasks among executives (Holmstrom and Milgrom, 1991). If incentives for CSR (e.g., the number of stakeholder communications) are too strong, companies must develop a different incentive system that emphasizes commercial activities more. Nevertheless, this is an inferential proposal for corporate strategy, so extensive research into the role of CSR executives should be conducted.

# 5 Concluding Remarks

This study attempted to reveal the relationship between CSR organizational architectures and corporate performance, focusing on establishing CSR departments and executives by the Japanese listed companies. Although many existing studies have paid attention to CSP, this study covered various corporate performance indicators, including profitability, value, and productivity. Recently, CSR activities have been supported by the theoretical concept of strategic CSR, which is expected to generate competitive advantages for firms by satisfying the expectations of influential stakeholders. In light of the results that the relationships are contingent on performance indicators, types of organizational architectures (departments or executives), industrial categories (R&D or non-R&D industry), and time lags (short- or medium-term), the strategic CSR theory does not simply hold. Even when CSR departments and executives are not or negatively related to corporate performance in the short-term, they may positively affect corporate performance in the medium-term for some industrial categories. This indicates that it takes time for CSR organizational architectures to positively impact corporate performance. Accordingly, when firms intend to introduce CSR activities into their organizational portfolios in establishing corporate objectives, they should consider the competitive advantages attached to industrial characteristics and time spans.

Section 5 concludes with a discussion of additional research directions. First, the results derived from the fixed-effects model indicate a correlation, but not a strict causal relationship, based on observational data. The instrumental variable approach with panel is more preferable to control endogeneity between CSR activities and corporate performance, whereas it appears difficult to find such exogenous variables regarding the establishment of CSR departments and executives. Second, the findings that CSR departments and executives have a positive or negative relationship with corporate performance should be further theorized and empirically examined. In this study, the mechanisms that determine whether the strategic CSR theory partially holds or not remains a "black box." Third, long-term (e.g. 10 years) relationships between CSR activities and corporate performance should be analyzed in addition to short- and medium-term relationships. Finally, this study has the limitation of focusing on a subset of Japanese listed companies. In order to demonstrate the differences between Japanese and foreign companies and large listed and small unlisted companies, additional research and a new dataset are needed.

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# Appendix

This appendix describes how this study constructs the variables and the points that require attention in implementing the analyses.

## Dependent variables

*Return on equity (ROE)* (%) is defined as [(current net profit)/(equity capital)]×100.

*Return on total assets (ROA)* (%) is defined as [(current profit)/(total asset)]×100. Other variables, such as operating profits and current net profits, are added to the numerator to modify the definition. These various types of ROA are used to assess the robustness of the empirical analysis.

*Aggregate market share values* are defined as (number of shares issued)×(closing share price) at the fiscal term end.

*Tobin's q* is defined as (total debt+aggregate market share value)/(total asset). Note that this is not the *marginal* Tobin's q, but the *average* one. Due to the data restriction, the marginal Tobin's q is unavailable.

*Labor productivity* is defined as (value added)/(average of the beginning and end of employees). It can also be interpreted as value added per employee. When data on the beginning and end of an employee's term is unavailable, data on the employee's current term employees is used. The value added includes total employment costs, labor costs, taxes and dues, rental costs, financial costs, patent fee costs, corporate income taxes, residential taxes, business taxes, depreciation expenses, and current net profits.

*Total factor productivity (TFP)* is obtained by simplified calculation in a logarithm form according to Equation (3). This equation is derived from the Cobb-Douglas production function, $Q = AK^{\frac{1}{3}}Emp^{\frac{2}{3}}$, where $Q$, $A$, $K$, $Emp$ are sales, TFP level, physical fixed assets, and year-end employees, respectively. Note that $Q$ is measured by sales, but not value added, because the latter includes many negative values. The capital and labor shares to income distribution are simply assumed to be 1/3 and 2/3, respectively, in a conventional way.

## Independent variables

*CSR department dummy* is assigned a value of 1 if a company responded that it had already established a specialized (option 1) or dual obligatory (option 2) department that engages in CSR activities, and a value of 0 if it responded that it had not yet established or had no plans to establish such a department (option 3). Meanwhile, there are numerous responses from others (option 4), a category that frequently accompanies textual comments written freely by the company. In consideration of these comments, as many category (option 4) responses as possible are manually re-classified into the aforementioned categories (options 1–3), whereas the answers that cannot be re-classified are treated as missing values. If a department responsible for CSR activities is reported to have been established within an associated company (parent or subsidiary company), the company is also considered to have the relevant department, and the CSR department dummy takes 1.

*Specialized CSR department dummy* is assigned a value of 1 if a company answered category (option 1) as mentioned above in the item of *CSR department dummy*, implying that it had already established a specialized CSR department that dedicated its mission or task only to CSR activities, and 0 otherwise.

*Dual obligatory CSR department dummy* is assigned a value of 1 if a company answered category (option 2) as mentioned in the item of *CSR department dummy*, implying that it had already established a dual obligatory CSR department that engaged in CSR activities and other crucial missions and tasks, such as general affairs, corporate planning, and publicity. If comments show that a CSR department is under direct control of a president, a president office, or a CSR committee, it is regarded as a dual obligatory CSR department.

*CSR executive dummy* is assigned a value of 1 if a company responded that it had already appointed specialized (option 1) or dual obligatory (option 2) executives engaged in CSR activities, and a value of 0 if it responded that it had not yet appointed or had no plans to appoint such a executive (option 3). In consideration of comments, as many responses of others (option 4) as possible are manually re-classified into the aforementioned categories (options 1–3), whereas the answers that cannot be re-classified are treated as missing values. If an executive responsible for CSR activities is reported to have been appointed within an associated company (parent or subsidiary company), the company is also considered to have the relevant executive, and thus the CSR executive dummy takes 1.

*Specialized CSR executive dummy* is assigned a value of 1 if a company answered category (option 1) as mentioned above in the item of *CSR executive dummy*, implying that it had already appointed a specialized CSR executive that dedicated his/her mission or task only to CSR activities, and 0 otherwise.

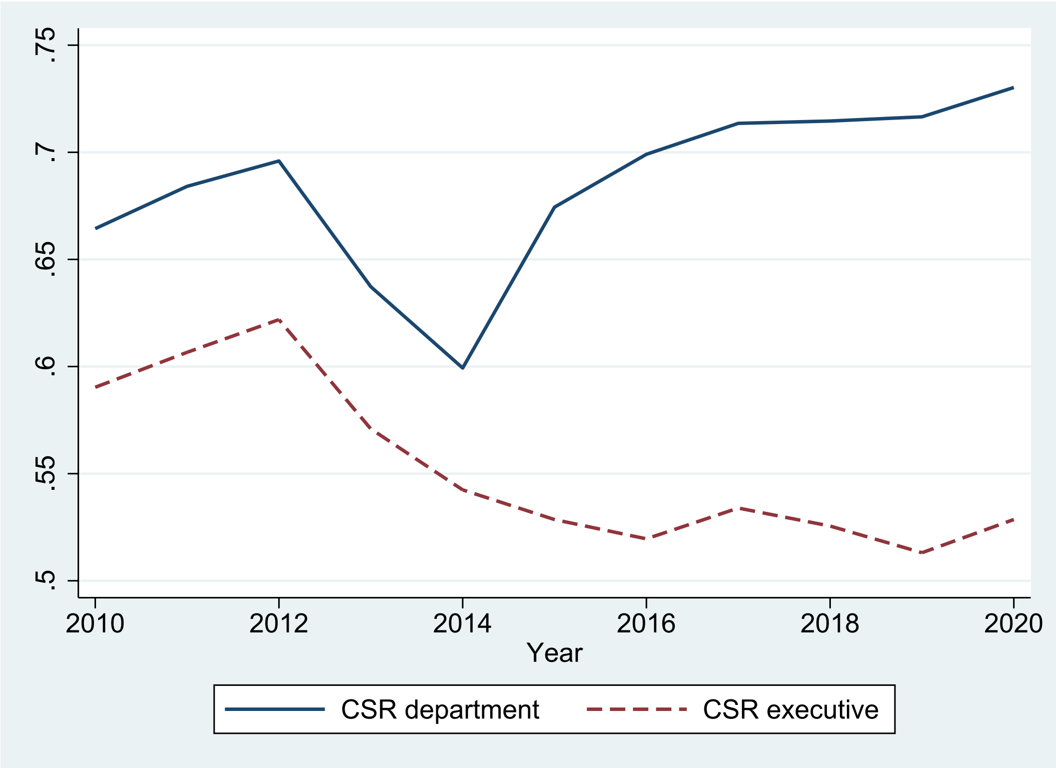
*Dual obligatory CSR executive dummy* is assigned a value of 1 if a company answered category (option 2) as mentioned in the item of *CSR executive dummy*, implying that it had already appointed a dual obligatory CSR executive that engaged in CSR activities and other crucial missions and tasks, such as general affairs, corporate planning, and publicity. If comments show that a president performs an executive responsible for CSR, dual obligatory CSR executive dummy takes 1.

## Control variables

*Firm age* is calculated as the reference year minus the year it was established. The established year is calculated by bringing forward one year if the established month is July or after and not otherwise. For example, if a firm is founded in July 1970, the year of establishment is considered to be 1971. In addition, if the reference and established years are the same (i.e., the firm's age is zero), the natural logarithm of the firm's age is obtained by adding 1 to the firm's age.

*R&D intensity* is calculated as (R&D investment)/(sales). Since there are numerous missing values R&D investment values in the dataset, they are conventionally treated as 0.

**Figure 1. Shares of CSR departments and executives**




Note: The shares are calculated as the sum of the CSR department and executive dummies equal to 1 divided by the sample size for each year.

**Figure 2. Confidence intervals of the coefficients**

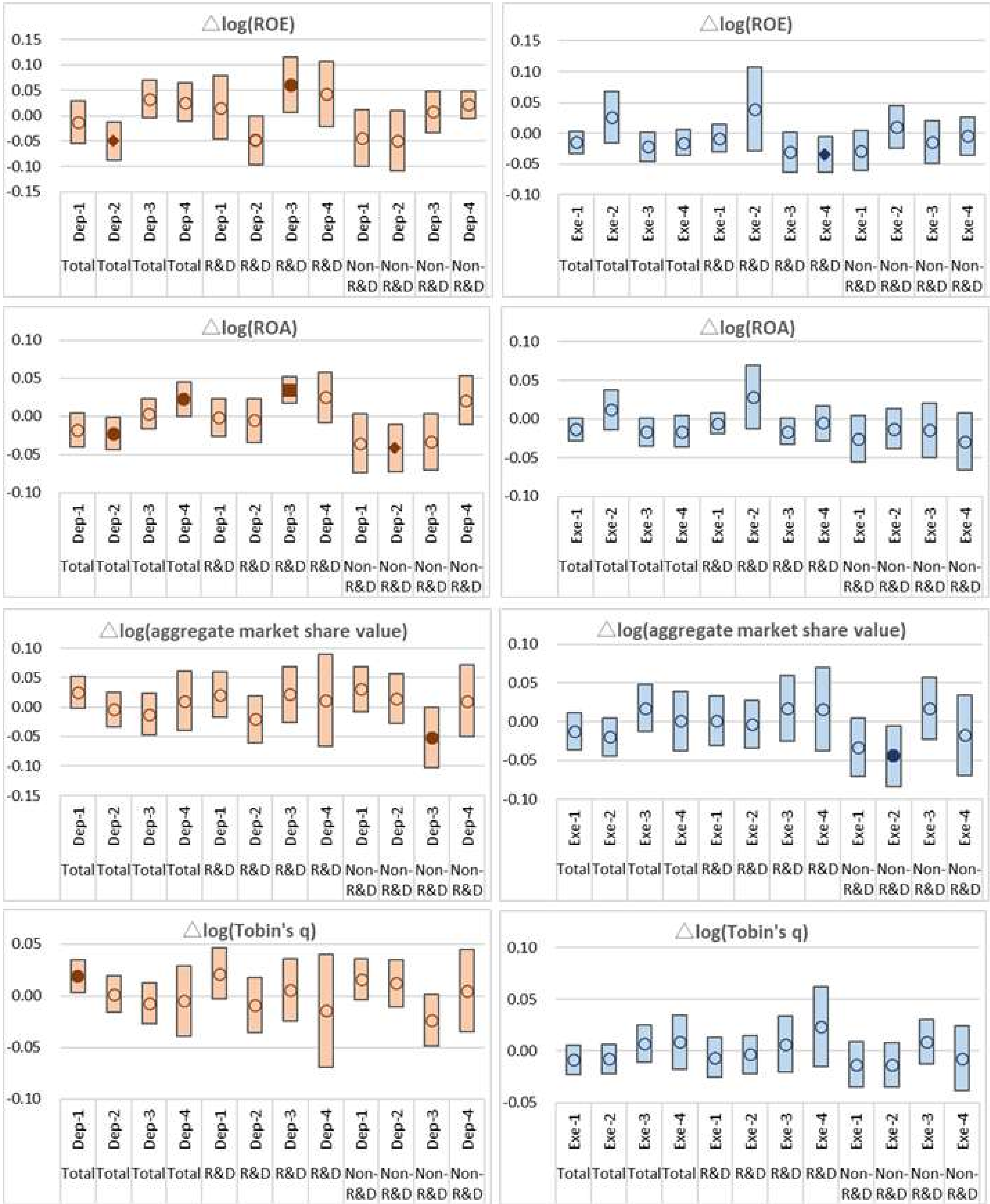
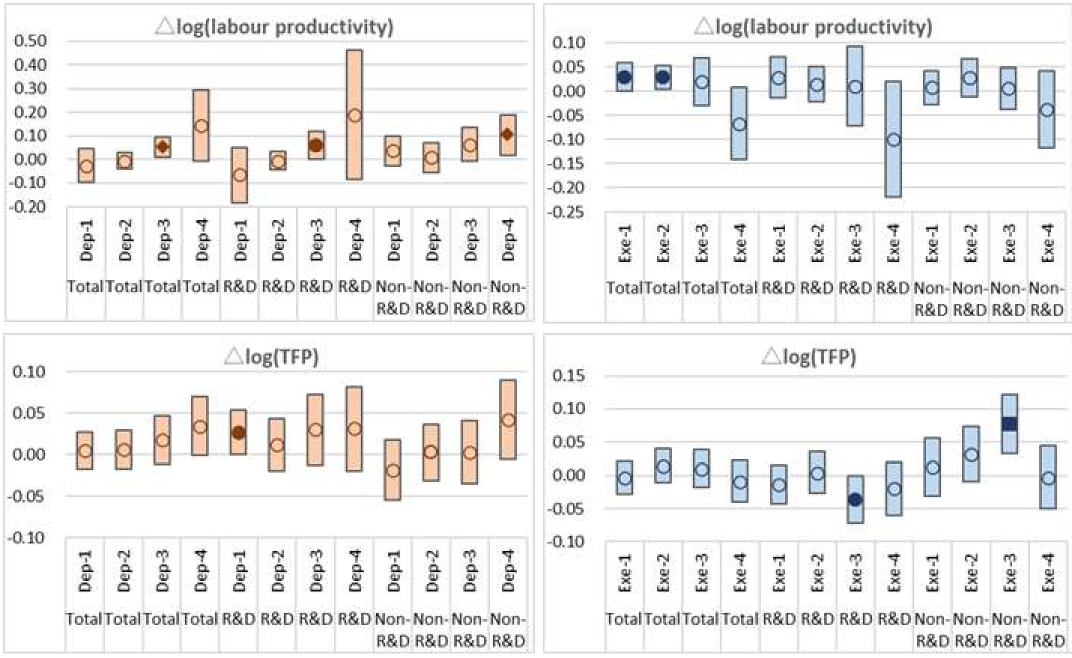


**Figure 2. Confidence intervals of the coefficients (continued)**




Note: 1. "Dep-i" and "Exe-i" ($i = 1, 2, 3, 4$) represent the i-year lag of the CSR department and executive dummies, respectively.

2. The confidence intervals of 90% level are presented.

3. ■, ♦, •, and ◦ represent "significant at the 1% level," "significant at the 5% level," "significant at the 10% level," and "insignificant at the 10% level," respectively.

**Table 1. Classification of industries**

| Index | Name | R&D or Non-R&D | Samples |
|---|---|---|---|
| 1 | Food | R&D | 586 |
| 2 | Textile | R&D | 261 |
| 3 | Pulp and paper | Non-R&D | 103 |
| 4 | Chemical and medical | R&D | 1,373 |
| 5 | Petroleum and coal | Non-R&D | 43 |
| 6 | Glass, soil, and stone | R&D | 163 |
| 7 | Primary metal | R&D | 328 |
| 8 | Metal products | Non-R&D | 289 |
| 9 | Machinery | R&D | 881 |
| 10 | Electric equipment | R&D | 1,241 |
| 11 | Transport equipment | R&D | 596 |
| 12 | Precision equipment | R&D | 202 |
| 13 | Other products | R&D | 564 |
| 14 | Agriculture, forestry, and fisheries | Non-R&D | 38 |
| 15 | Mining | Non-R&D | 21 |
| 16 | Construction | Non-R&D | 702 |
| 17 | Electricity and gas | R&D | 142 |
| 18 | Transportation | Non-R&D | 482 |
| 19 | Information and communications | R&D | 1,127 |
| 20 | Wholesale | Non-R&D | 1,396 |
| 21 | Retailing | Non-R&D | 1,187 |
| 22 | Real estate | Non-R&D | 359 |
| 23 | Service | Non-R&D | 1,266 |
| | R&D | | 7,322 |
| | Non-R&D | | 6,028 |
| | Total | | 13,350 |

Note: The samples are aggregated over the years.

## Table 2. Descriptive statistics

| | Total | R&D | Non-R&D | Difference |
|---|---|---|---|---|
| *Dependent variables* | | | | |
| **Profitability** | | | | |
| ROE (%) | 9.067 | 12.985 | 4.310 | 8.676 |
| | (5.461) | (9.950) | (0.506) | (10.973) |
| Δlog(ROE) | −0.001 | −0.002 | −0.0001 | −0.002 |
| | (0.001) | (0.002) | (0.0001) | (0.002) |
| ROA (%) | 5.110 | 5.284 | 4.899 | 0.385*** |
| | (0.061) | (0.083) | (0.090) | (0.122) |
| Δlog(ROA) | −0.001 | −0.0005 | −0.003 | 0.002* |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **Values** | | | | |
| Aggregate share market value (million yen) | 303,836 | 401,616 | 184,861 | 216,755*** |
| | (8,975) | (15,263) | (6,831) | (17,939) |
| Δlog(Aggregate share market value) | 0.072 | 0.067 | 0.078 | −0.011* |
| | (0.003) | (0.004) | (0.004) | (0.006) |
| Tobin's q | 1.486 | 1.561 | 1.394 | 0.167*** |
| | (0.013) | (0.019) | (0.016) | (0.026) |
| Δlog(Tobin's q) | 0.021 | 0.023 | 0.018 | 0.005 |
| | (0.002) | (0.003) | (0.003) | (0.004) |
| **Productivities** | | | | |
| Labor productivity (thousand yen) | 30,599 | 26,231 | 35,898 | −9,667*** |
| | (1,542) | (2,658) | (1,119) | (3,099) |
| Δlog(Labor productivity) | −0.001 | −0.002 | −0.0002 | −0.002 |
| | (0.002) | (0.003) | (0.0002) | (0.003) |
| log(TFP) | 3.376 | 3.214 | 3.575 | −0.361*** |
| | (0.007) | (0.008) | (0.013) | (0.015) |
| Δlog(TFP) | −0.007 | 0.002 | −0.019 | 0.021*** |
| | (0.003) | (0.003) | (0.004) | (0.005) |
| *Independent variables* | | | | |
| **CSR department** | | | | |
| CSR department dummy (1 or 0) | 0.687 | 0.733 | 0.632 | 0.100*** |
| | (0.004) | (0.005) | (0.006) | (0.008) |
| Specialisation dummy (1 or 0) | 0.280 | 0.332 | 0.216 | 0.116*** |
| | (0.004) | (0.005) | (0.005) | (0.008) |
| Dual obligation dummy (1 or 0) | 0.407 | 0.400 | 0.416 | −0.015* |
| | (0.004) | (0.006) | (0.006) | (0.009) |
| **CSR executive director** | | | | |
| CSR executive director dummy (1 or 0) | 0.549 | 0.617 | 0.465 | 0.152*** |
| | (0.004) | (0.006) | (0.006) | (0.009) |
| Specialisation dummy (1 or 0) | 0.042 | 0.052 | 0.031 | 0.021*** |
| | (0.002) | (0.003) | (0.002) | (0.004) |
| Dual obligation dummy (1 or 0) | 0.506 | 0.565 | 0.434 | 0.131*** |
| | (0.004) | (0.006) | (0.006) | (0.009) |
| *Control variables* | | | | |
| Sales (million yen) | 217,408 | 221,816 | 212,054 | 9,762 |
| | (5,751) | (8,015) | (8,211) | (11,556) |
| Employment (persons) | 2,022 | 2,426 | 1,531 | 895*** |
| | (42.0) | (65.0) | (48.2) | (83.9) |
| Fixed assets (million yen) | 231,494 | 232,980 | 229,690 | 3,290 |
| | (6,743) | (9,249) | (9.839) | (13,550) |
| Firm age (years) | 58.0 | 63.1 | 51.9 | 11.2*** |
| | (0.231) | (0.301) | (0.340) | (0.453) |
| R&D intensity | 0.037 | 0.066 | 0.002 | 0.065*** |
| | (0.007) | (0.013) | (0.0001) | (0.014) |

Note: 1. Sales, fixed assets, and labor productivity are deflated by the industrial deflators.
2. Δlog(ROE), Δlog(ROA), and Δlog(Labor productivity) are calculated by using Equation (2).
3. The first and second rows of variables present the simple means and standard errors for all samples, respectively.
4. ***, **, and * represent 1%, 5%, and 10% statistical significance, respectively.

## Table 3. Estimation results: ROE

| | Dependent variable: Δlog(ROE) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | | | R&D | | | Non-R&D | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| $Dep_{-1}$ | −0.013 | −0.031 | | 0.016 | −0.013 | | −0.044 | −0.046 | |
| | (0.026) | (0.021) | | (0.038) | (0.021) | | (0.034) | (0.036) | |
| $Exe_{-1}$ | −0.015 | −0.095 | | −0.008 | −0.107 | | −0.028 | −0.042 | |
| | (0.011) | (0.066) | | (0.014) | (0.093) | | (0.020) | (0.038) | |
| $Dep_{-1} \times Exe_{-1}$ | | 0.094 | | | 0.120 | | | 0.016 | |
| | | (0.070) | | | (0.100) | | | (0.034) | |
| $Deps_{-1}$ | | | 0.016 | | | 0.037 | | | −0.003 |
| | | | (0.037) | | | (0.057) | | | (0.036) |
| $Depd_{-1}$ | | | −0.018 | | | 0.012 | | | −0.049 |
| | | | (0.024) | | | (0.034) | | | (0.034) |
| $Exes_{-1}$ | | | 0.005 | | | −0.004 | | | 0.020 |
| | | | (0.027) | | | (0.038) | | | (0.036) |
| $Exed_{-1}$ | | | −0.019 | | | −0.011 | | | −0.036* |
| | | | (0.012) | | | (0.015) | | | (0.022) |
| $F$-statistics | 3.26 | 2.94 | 2.73 | 2.36 | 2.26 | 1.99 | 2.15 | 1.92 | 1.84 |
| Observations | 10,613 | 10,613 | 10,613 | 5,915 | 5,915 | 5,915 | 4,698 | 4,698 | 4,698 |
| $Dep_{-2}$ | −0.050** | −0.032 | | −0.048 | −0.005 | | −0.050 | −0.057 | |
| | (0.023) | (0.025) | | (0.030) | (0.030) | | (0.036) | (0.039) | |
| $Exe_{-2}$ | 0.026 | 0.103 | | 0.039 | 0.175 | | 0.011 | −0.031 | |
| | (0.025) | (0.112) | | (0.041) | (0.164) | | (0.021) | (0.035) | |
| $Dep_{-2} \times Exe_{-2}$ | | −0.091 | | | −0.169 | | | 0.047 | |
| | | (0.107) | | | (0.156) | | | (0.042) | |
| $Deps_{-2}$ | | | −0.043 | | | −0.036 | | | −0.059 |
| | | | (0.036) | | | (0.043) | | | (0.061) |
| $Depd_{-2}$ | | | −0.051** | | | −0.051* | | | −0.048 |
| | | | (0.022) | | | (0.029) | | | (0.033) |
| $Exes_{-2}$ | | | −0.007 | | | −0.035 | | | 0.055 |
| | | | (0.036) | | | (0.052) | | | (0.048) |
| $Exed_{-2}$ | | | 0.027 | | | 0.040 | | | 0.009 |
| | | | (0.026) | | | (0.042) | | | (0.023) |
| $F$-statistics | 3.04 | 2.91 | 2.76 | 2.09 | 1.94 | 2.10 | 2.25 | 2.02 | 1.86 |
| Observations | 8,673 | 8,673 | 8,673 | 4,915 | 4,915 | 4,915 | 3,758 | 3,758 | 3,758 |
| $Dep_{-3}$ | 0.033 | 0.034 | | 0.061* | 0.065 | | 0.008 | 0.009 | |
| | (0.022) | (0.026) | | (0.033) | (0.043) | | (0.025) | (0.026) | |
| $Exe_{-3}$ | −0.022 | −0.016 | | −0.030 | −0.016 | | −0.014 | −0.008 | |
| | (0.014) | (0.020) | | (0.020) | (0.028) | | (0.021) | (0.040) | |
| $Dep_{-3} \times Exe_{-3}$ | | −0.007 | | | −0.017 | | | −0.006 | |
| | | (0.026) | | | (0.044) | | | (0.040) | |
| $Deps_{-3}$ | | | 0.074* | | | 0.099* | | | 0.041 |
| | | | (0.040) | | | (0.059) | | | (0.030) |
| $Depd_{-3}$ | | | 0.026 | | | 0.053 | | | 0.004 |
| | | | (0.022) | | | (0.033) | | | (0.025) |
| $Exes_{-3}$ | | | −0.002 | | | −0.027 | | | 0.028 |
| | | | (0.025) | | | (0.029) | | | (0.057) |
| $Exed_{-3}$ | | | −0.028* | | | −0.035* | | | −0.021 |
| | | | (0.015) | | | (0.021) | | | (0.021) |
| $F$-statistics | 2.30 | 2.09 | 2.41 | 2.19 | 2.14 | 1.90 | 1.70 | 1.52 | 1.55 |
| Observations | 7,145 | 7,145 | 7,145 | 4,122 | 4,122 | 4,122 | 3,023 | 3,023 | 3,023 |
| $Dep_{-4}$ | 0.026 | 0.023 | | 0.043 | 0.038 | | 0.022 | 0.020 | |
| | (0.023) | (0.026) | | (0.039) | (0.047) | | (0.017) | (0.017) | |
| $Exe_{-4}$ | −0.015 | −0.030 | | −0.035** | −0.049 | | −0.005 | −0.016 | |
| | (0.013) | (0.031) | | (0.018) | (0.044) | | (0.019) | (0.038) | |
| $Dep_{-4} \times Exe_{-4}$ | | 0.018 | | | 0.018 | | | 0.013 | |
| | | (0.037) | | | (0.057) | | | (0.040) | |
| $Deps_{-4}$ | | | 0.037 | | | 0.034 | | | 0.059 |
| | | | (0.027) | | | (0.041) | | | (0.038) |
| $Depd_{-4}$ | | | 0.025 | | | 0.045 | | | 0.017 |
| | | | (0.023) | | | (0.039) | | | (0.016) |
| $Exes_{-4}$ | | | 0.055 | | | 0.047 | | | 0.047 |
| | | | (0.059) | | | (0.080) | | | (0.062) |
| $Exed_{-4}$ | | | −0.019 | | | −0.036** | | | −0.011 |
| | | | (0.013) | | | (0.018) | | | (0.019) |
| $F$-statistics | 2.42 | 2.16 | 2.07 | 2.32 | 2.14 | 2.02 | 1.16 | 1.03 | 1.11 |
| Observations | 5,857 | 5,857 | 5,857 | 3,430 | 3,430 | 3,430 | 2,436 | 2,436 | 2,436 |

Note: 1. The estimation of the fixed-effects model utilizes cluster-robust standard errors calculated across firms. The control variables, year dummies, and industry-year dummies are included in the regressions.
2. The samples are winsorized by both the upper and lower 0.5% and transformed by using Equation (2).
3. The first and second rows of the independent variables present the estimated coefficients and standard errors, respectively.
4. ***, **, and * represent 1%, 5%, and 10% statistical significance, respectively.

## Table 4. Estimation results: ROA

| Dependent variable: Δlog(ROA) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | | | R&D | | | Non-R&D | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| $Dep_{-1}$ | −0.018 | −0.022 | | −0.002 | −0.009 | | −0.035 | −0.034 | |
| | (0.014) | (0.015) | | (0.015) | (0.017) | | (0.023) | (0.025) | |
| $Exe_{-1}$ | −0.014 | −0.030* | | −0.006 | −0.031* | | −0.026 | −0.017 | |
| | (0.009) | (0.016) | | (0.008) | (0.017) | | (0.018) | (0.033) | |
| $Dep_{-1} \times Exe_{-1}$ | | 0.019 | | | 0.030 | | | −0.010 | |
| | | (0.017) | | | (0.020) | | | (0.032) | |
| $Deps_{-1}$ | | | −0.008 | | | 0.002 | | | −0.014 |
| | | | (0.013) | | | (0.015) | | | (0.022) |
| $Depd_{-1}$ | | | −0.020 | | | −0.003 | | | −0.038 |
| | | | (0.014) | | | (0.015) | | | (0.024) |
| $Exes_{-1}$ | | | −0.018 | | | −0.012 | | | −0.031 |
| | | | (0.011) | | | (0.011) | | | (0.023) |
| $Exed_{-1}$ | | | −0.015 | | | −0.006 | | | −0.028 |
| | | | (0.009) | | | (0.008) | | | (0.019) |
| $F$-statistics | 5.39 | 4.82 | 4.62 | 4.33 | 3.91 | 3.56 | 2.87 | 2.65 | 2.59 |
| Observations | 10,636 | 10,636 | 10,636 | 5,926 | 5,926 | 5,926 | 4,710 | 4,710 | 4,710 |
| $Dep_{-2}$ | −0.023* | −0.007 | | −0.005 | 0.024 | | −0.042** | −0.039** | |
| | (0.013) | (0.013) | | (0.017) | (0.018) | | (0.019) | (0.020) | |
| $Exe_{-2}$ | 0.012 | 0.076 | | 0.028 | 0.120 | | −0.013 | 0.008 | |
| | (0.016) | (0.071) | | (0.025) | (0.102) | | (0.016) | (0.038) | |
| $Dep_{-2} \times Exe_{-2}$ | | −0.076 | | | −0.114 | | | −0.023 | |
| | | (0.067) | | | (0.098) | | | (0.037) | |
| $Deps_{-2}$ | | | −0.024* | | | −0.008 | | | −0.043* |
| | | | (0.014) | | | (0.019) | | | (0.022) |
| $Depd_{-2}$ | | | −0.022* | | | −0.005 | | | −0.042** |
| | | | (0.013) | | | (0.017) | | | (0.019) |
| $Exes_{-2}$ | | | −0.002 | | | 0.013 | | | −0.022 |
| | | | (0.017) | | | (0.026) | | | (0.019) |
| $Exed_{-2}$ | | | 0.013 | | | 0.029 | | | −0.012 |
| | | | (0.016) | | | (0.025) | | | (0.016) |
| $F$-statistics | 5.16 | 4.61 | 4.47 | 4.09 | 3.63 | 3.69 | 2.91 | 2.63 | 2.34 |
| Observations | 8,688 | 8,688 | 8,688 | 4,926 | 4,926 | 4,926 | 3,762 | 3,762 | 3,762 |
| $Dep_{-3}$ | 0.004 | 0.004 | | 0.034*** | 0.040*** | | −0.033 | −0.034 | |
| | (0.012) | (0.013) | | (0.011) | (0.013) | | (0.022) | (0.023) | |
| $Exe_{-3}$ | −0.017 | −0.016 | | −0.016 | 0.001 | | −0.015 | −0.023 | |
| | (0.011) | (0.016) | | (0.010) | (0.012) | | (0.022) | (0.042) | |
| $Dep_{-3} \times Exe_{-3}$ | | −0.001 | | | −0.021 | | | 0.010 | |
| | | (0.014) | | | (0.016) | | | (0.036) | |
| $Deps_{-3}$ | | | 0.017 | | | 0.038*** | | | −0.003 |
| | | | (0.012) | | | (0.014) | | | (0.020) |
| $Depd_{-3}$ | | | 0.001 | | | 0.033*** | | | −0.038* |
| | | | (0.012) | | | (0.010) | | | (0.023) |
| $Exes_{-3}$ | | | −0.032** | | | −0.023 | | | −0.047* |
| | | | (0.015) | | | (0.016) | | | (0.026) |
| $Exed_{-3}$ | | | −0.018 | | | −0.016 | | | −0.016 |
| | | | (0.011) | | | (0.010) | | | (0.022) |
| $F$-statistics | 3.83 | 3.41 | 3.56 | 4.74 | 4.24 | 3.83 | 2.42 | 2.15 | 2.32 |
| Observations | 7,157 | 7,157 | 7,157 | 4,132 | 4,132 | 4,132 | 3,025 | 3,025 | 3,025 |
| $Dep_{-4}$ | 0.023* | 0.020 | | 0.025 | 0.021 | | 0.021 | 0.019 | |
| | (0.014) | (0.016) | | (0.020) | (0.024) | | (0.020) | (0.022) | |
| $Exe_{-4}$ | −0.016 | −0.028* | | −0.005 | −0.017 | | −0.029 | −0.044 | |
| | (0.012) | (0.016) | | (0.013) | (0.017) | | (0.022) | (0.041) | |
| $Dep_{-4} \times Exe_{-4}$ | | 0.014 | | | 0.015 | | | 0.018 | |
| | | (0.020) | | | (0.025) | | | (0.044) | |
| $Deps_{-4}$ | | | 0.033** | | | 0.025 | | | 0.046 |
| | | | (0.016) | | | (0.020) | | | (0.029) |
| $Depd_{-4}$ | | | 0.021 | | | 0.025 | | | 0.017 |
| | | | (0.014) | | | (0.020) | | | (0.020) |
| $Exes_{-4}$ | | | −0.025 | | | −0.012 | | | −0.047 |
| | | | (0.017) | | | (0.019) | | | (0.034) |
| $Exed_{-4}$ | | | −0.017 | | | −0.005 | | | −0.030 |
| | | | (0.012) | | | (0.014) | | | (0.023) |
| $F$-statistics | 2.37 | 2.33 | 2.14 | 2.04 | 2.00 | 1.82 | 1.52 | 1.43 | 1.44 |
| Observations | 5,869 | 5,869 | 5,869 | 3,439 | 3,439 | 3,439 | 2,430 | 2,430 | 2,430 |

Note: 1. The estimation of the fixed-effects model utilizes cluster-robust standard errors calculated across firms. The control variables, year dummies, and industry-year dummies are included in the regressions.
2. The samples are winsorized by both the upper and lower 0.5% and transformed by using Equation (2).
3. The first and second rows of the independent variables present the estimated coefficients and standard errors, respectively.
4. ***, **, and * represent 1%, 5%, and 10% statistical significance, respectively.

## Table 5. Estimation results: aggregate market share value

| Dependent variable: $\Delta\log$(aggregate market share value) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | | | R&D | | | Non-R&D | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| $Dep_{-1}$ | 0.025 | 0.028 | | 0.021 | 0.027 | | 0.030 | 0.029 | |
| | (0.017) | (0.018) | | (0.023) | (0.026) | | (0.024) | (0.025) | |
| $Exe_{-1}$ | −0.013 | −0.0001 | | 0.001 | 0.020 | | −0.034 | −0.044 | |
| | (0.015) | (0.035) | | (0.019) | (0.044) | | (0.023) | (0.054) | |
| $Dep_{-1} \times Exe_{-1}$ | | −0.015 | | | −0.023 | | | 0.012 | |
| | | (0.036) | | | (0.048) | | | (0.055) | |
| $Deps_{-1}$ | | | 0.028 | | | 0.018 | | | 0.042 |
| | | | (0.021) | | | (0.027) | | | (0.033) |
| $Depd_{-1}$ | | | 0.024 | | | 0.022 | | | 0.029 |
| | | | (0.017) | | | (0.023) | | | (0.023) |
| $Exes_{-1}$ | | | −0.006 | | | 0.018 | | | −0.041 |
| | | | (0.023) | | | (0.029) | | | (0.038) |
| $Exed_{-1}$ | | | −0.013 | | | 0.001 | | | −0.034 |
| | | | (0.015) | | | (0.020) | | | (0.023) |
| $F$-statistics | 5.36 | 4.81 | 4.31 | 5.64 | 5.15 | 4.59 | 1.12 | 1.01 | 0.94 |
| Observations | 10,780 | 10,780 | 10,780 | 6,026 | 6,026 | 6,026 | 4,754 | 4,754 | 4,754 |
| $Dep_{-2}$ | −0.004 | −0.0005 | | −0.021 | −0.019 | | 0.015 | 0.018 | |
| | (0.018) | (0.020) | | (0.024) | (0.029) | | (0.026) | (0.028) | |
| $Exe_{-2}$ | −0.020 | −0.004 | | −0.003 | 0.002 | | −0.045* | −0.025 | |
| | (0.015) | (0.029) | | (0.019) | (0.035) | | (0.024) | (0.054) | |
| $Dep_{-2} \times Exe_{-2}$ | | −0.018 | | | −0.007 | | | −0.022 | |
| | | (0.032) | | | (0.040) | | | (0.056) | |
| $Deps_{-2}$ | | | −0.005 | | | −0.034 | | | 0.037 |
| | | | (0.023) | | | (0.032) | | | (0.034) |
| $Depd_{-2}$ | | | −0.004 | | | −0.018 | | | 0.012 |
| | | | (0.018) | | | (0.024) | | | (0.025) |
| $Exes_{-2}$ | | | −0.027 | | | −0.007 | | | −0.051 |
| | | | (0.024) | | | (0.031) | | | (0.037) |
| $Exed_{-2}$ | | | −0.020 | | | −0.001 | | | −0.047* |
| | | | (0.015) | | | (0.019) | | | (0.024) |
| $F$-statistics | 3.31 | 2.99 | 2.66 | 3.19 | 2.87 | 2.61 | 0.78 | 0.72 | 0.74 |
| Observations | 8,797 | 8,797 | 8,797 | 5,013 | 5,013 | 5,013 | 3,784 | 3,784 | 3,784 |
| $Dep_{-3}$ | −0.012 | −0.022 | | 0.022 | 0.013 | | −0.052* | −0.057* | |
| | (0.022) | (0.024) | | (0.029) | (0.034) | | (0.031) | (0.033) | |
| $Exe_{-3}$ | 0.018 | −0.024 | | 0.017 | −0.011 | | 0.017 | −0.015 | |
| | (0.018) | (0.034) | | (0.026) | (0.041) | | (0.024) | (0.066) | |
| $Dep_{-3} \times Exe_{-3}$ | | 0.049 | | | 0.034 | | | 0.035 | |
| | | (0.038) | | | (0.047) | | | (0.069) | |
| $Deps_{-3}$ | | | −0.017 | | | 0.023 | | | −0.074* |
| | | | (0.028) | | | (0.036) | | | (0.042) |
| $Depd_{-3}$ | | | −0.011 | | | 0.022 | | | −0.049 |
| | | | (0.022) | | | (0.029) | | | (0.031) |
| $Exes_{-3}$ | | | 0.012 | | | 0.010 | | | 0.021 |
| | | | (0.029) | | | (0.038) | | | (0.045) |
| $Exed_{-3}$ | | | 0.019 | | | 0.017 | | | 0.019 |
| | | | (0.019) | | | (0.026) | | | (0.025) |
| $F$-statistics | 4.37 | 4.01 | 3.50 | 4.67 | 4.23 | 3.74 | 1.62 | 1.46 | 1.33 |
| Observations | 7,244 | 7,244 | 7,244 | 4,207 | 4,207 | 4,207 | 3,037 | 3,037 | 3,037 |
| $Dep_{-4}$ | 0.011 | 0.017 | | 0.012 | 0.010 | | 0.010 | 0.025 | |
| | (0.031) | (0.034) | | (0.048) | (0.056) | | (0.037) | (0.037) | |
| $Exe_{-4}$ | 0.0007 | 0.027 | | 0.016 | 0.011 | | −0.018 | 0.086 | |
| | (0.023) | (0.059) | | (0.033) | (0.071) | | (0.032) | (0.119) | |
| $Dep_{-4} \times Exe_{-4}$ | | −0.031 | | | 0.006 | | | −0.117 | |
| | | (0.065) | | | (0.084) | | | (0.121) | |
| $Deps_{-4}$ | | | 0.024 | | | 0.036 | | | 0.001 |
| | | | (0.037) | | | (0.052) | | | (0.052) |
| $Depd_{-4}$ | | | 0.008 | | | 0.007 | | | 0.012 |
| | | | (0.031) | | | (0.048) | | | (0.037) |
| $Exes_{-4}$ | | | −0.0008 | | | 0.023 | | | −0.038 |
| | | | (0.035) | | | (0.046) | | | (0.050) |
| $Exed_{-4}$ | | | −0.0009 | | | 0.012 | | | −0.016 |
| | | | (0.023) | | | (0.032) | | | (0.032) |
| $F$-statistics | 2.61 | 2.35 | 2.12 | 3.13 | 2.78 | 2.65 | 2.35 | 2.37 | 2.00 |
| Observations | 5,942 | 5,942 | 5,942 | 3,497 | 3,497 | 3,497 | 2,445 | 2,445 | 2,445 |

Note: 1. The estimation of the fixed-effects model utilizes cluster-robust standard errors calculated across firms. The control variables, year dummies, and industry-year dummies are included in the regressions.
2. The first and second rows of the independent variables present the estimated coefficients and standard errors, respectively.
3. ***, **, and * represent 1%, 5%, and 10% statistical significance, respectively.

## Table 6. Estimation results: Tobin's q

| Dependent variable: Δlog(Tobin's q) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | | | R&D | | | Non-R&D | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| $Dep_{-1}$ | 0.019* | 0.022** | | 0.022 | 0.028* | | 0.016 | 0.016 | |
| | (0.010) | (0.011) | | (0.015) | (0.017) | | (0.012) | (0.013) | |
| $Exe_{-1}$ | −0.009 | 0.007 | | −0.006 | 0.017 | | −0.013 | −0.015 | |
| | (0.009) | (0.019) | | (0.012) | (0.025) | | (0.013) | (0.028) | |
| $Dep_{-1} \times Exe_{-1}$ | | −0.018 | | | −0.028 | | | 0.002 | |
| | | (0.020) | | | (0.028) | | | (0.029) | |
| $Deps_{-1}$ | | | 0.020 | | | 0.021 | | | 0.019 |
| | | | (0.012) | | | (0.017) | | | (0.018) |
| $Depd_{-1}$ | | | 0.019* | | | 0.022 | | | 0.015 |
| | | | (0.010) | | | (0.015) | | | (0.012) |
| $Exes_{-1}$ | | | −0.016 | | | −0.011 | | | −0.022 |
| | | | (0.015) | | | (0.019) | | | (0.023) |
| $Exed_{-1}$ | | | −0.008 | | | −0.006 | | | −0.013 |
| | | | (0.009) | | | (0.012) | | | (0.014) |
| $F$-statistics | 4.34 | 3.91 | 3.52 | 3.77 | 3.47 | 3.03 | 1.35 | 1.23 | 1.10 |
| Observations | 10,780 | 10,780 | 10,780 | 6,026 | 6,026 | 6,026 | 4,754 | 4,754 | 4,754 |
| $Dep_{-2}$ | 0.002 | 0.002 | | −0.009 | −0.014 | | 0.013 | 0.017 | |
| | (0.011) | (0.012) | | (0.016) | (0.019) | | (0.014) | (0.015) | |
| $Exe_{-2}$ | −0.008 | −0.007 | | −0.003 | −0.190 | | −0.014 | 0.012 | |
| | (0.009) | (0.019) | | (0.011) | (0.024) | | (0.013) | (0.029) | |
| $Dep_{-2} \times Exe_{-2}$ | | −0.001 | | | 0.019 | | | −0.029 | |
| | | (0.020) | | | (0.027) | | | (0.029) | |
| $Deps_{-2}$ | | | −0.003 | | | −0.022 | | | 0.025 |
| | | | (0.015) | | | (0.020) | | | (0.020) |
| $Depd_{-2}$ | | | 0.003 | | | −0.006 | | | 0.011 |
| | | | (0.011) | | | (0.016) | | | (0.014) |
| $Exes_{-2}$ | | | −0.015 | | | −0.004 | | | −0.028 |
| | | | (0.014) | | | (0.019) | | | (0.020) |
| $Exed_{-2}$ | | | −0.007 | | | −0.002 | | | −0.014 |
| | | | (0.009) | | | (0.012) | | | (0.014) |
| $F$-statistics | 3.29 | 2.92 | 2.79 | 2.21 | 2.01 | 1.95 | 1.66 | 1.56 | 1.55 |
| Observations | 8,797 | 8,797 | 8,797 | 5,013 | 5,013 | 5,013 | 3,784 | 3,784 | 3,784 |
| $Dep_{-3}$ | −0.007 | −0.011 | | 0.005 | 0.004 | | −0.023 | −0.025 | |
| | (0.012) | (0.013) | | (0.018) | (0.020) | | (0.015) | (0.016) | |
| $Exe_{-3}$ | 0.007 | −0.008 | | 0.007 | 0.001 | | 0.009 | −0.005 | |
| | (0.011) | (0.024) | | (0.017) | (0.032) | | (0.013) | (0.032) | |
| $Dep_{-3} \times Exe_{-3}$ | | 0.018 | | | 0.006 | | | 0.016 | |
| | | (0.025) | | | (0.033) | | | (0.034) | |
| $Deps_{-3}$ | | | −0.015 | | | 0.006 | | | −0.051** |
| | | | (0.016) | | | (0.023) | | | (0.021) |
| $Depd_{-3}$ | | | −0.006 | | | 0.005 | | | −0.020 |
| | | | (0.012) | | | (0.018) | | | (0.015) |
| $Exes_{-3}$ | | | −0.006 | | | −0.004 | | | −0.010 |
| | | | (0.018) | | | (0.024) | | | (0.025) |
| $Exed_{-3}$ | | | 0.009 | | | 0.007 | | | 0.013 |
| | | | (0.011) | | | (0.017) | | | (0.013) |
| $F$-statistics | 2.05 | 1.93 | 1.85 | 1.19 | 1.08 | 0.97 | 3.47 | 3.11 | 3.41 |
| Observations | 7,244 | 7,244 | 7,244 | 4,207 | 4,207 | 4,207 | 3,037 | 3,037 | 3,037 |
| $Dep_{-4}$ | −0.005 | −0.001 | | −0.014 | −0.015 | | 0.005 | 0.011 | |
| | (0.021) | (0.024) | | (0.033) | (0.040) | | (0.024) | (0.026) | |
| $Exe_{-4}$ | 0.009 | 0.023 | | 0.024 | 0.022 | | −0.007 | 0.038 | |
| | (0.016) | (0.035) | | (0.023) | (0.051) | | (0.019) | (0.037) | |
| $Dep_{-4} \times Exe_{-4}$ | | −0.017 | | | 0.002 | | | −0.051 | |
| | | (0.039) | | | (0.059) | | | (0.043) | |
| $Deps_{-4}$ | | | −0.006 | | | −0.009 | | | −0.006 |
| | | | (0.024) | | | (0.036) | | | (0.030) |
| $Depd_{-4}$ | | | −0.005 | | | −0.016 | | | 0.006 |
| | | | (0.021) | | | (0.033) | | | (0.024) |
| $Exes_{-4}$ | | | −0.007 | | | 0.018 | | | −0.045 |
| | | | (0.022) | | | (0.030) | | | (0.032) |
| $Exed_{-4}$ | | | 0.009 | | | 0.023 | | | −0.004 |
| | | | (0.016) | | | (0.023) | | | (0.019) |
| $F$-statistics | 1.14 | 1.11 | 1.06 | 1.98 | 1.81 | 1.58 | 1.35 | 1.35 | 1.60 |
| Observations | 5,942 | 5,942 | 5,942 | 3,497 | 3,497 | 3,497 | 2,445 | 2,445 | 2,445 |

Note: 1. The estimation of the fixed-effects model utilizes cluster-robust standard errors calculated across firms. The control variables, year dummies, and industry-year dummies are included in the regressions.
2. The first and second rows of the independent variables present the estimated coefficients and standard errors, respectively.
3. ***, **, and * represent 1%, 5%, and 10% statistical significance, respectively.

## Table 7. Estimation results: labor productivity

| Dependent variable: Δlog(labor productivity) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | | | R&D | | | Non-R&D | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| $Dep_{-1}$ | −0.027 | −0.028 | | −0.067 | −0.078 | | 0.036 | 0.040 | |
| | (0.043) | (0.050) | | (0.070) | (0.085) | | (0.038) | (0.041) | |
| $Exe_{-1}$ | 0.029* | 0.022 | | 0.029 | −0.012 | | 0.008 | 0.038 | |
| | (0.018) | (0.030) | | (0.026) | (0.038) | | (0.021) | (0.061) | |
| $Dep_{-1} \times Exe_{-1}$ | | 0.008 | | | 0.049 | | | −0.034 | |
| | | (0.046) | | | (0.068) | | | (0.068) | |
| $Deps_{-1}$ | | | 0.021 | | | 0.002 | | | 0.039 |
| | | | (0.062) | | | (0.081) | | | (0.101) |
| $Depd_{-1}$ | | | −0.035 | | | −0.081 | | | 0.037 |
| | | | (0.043) | | | (0.072) | | | (0.033) |
| $Exes_{-1}$ | | | 0.032 | | | −0.018 | | | 0.105 |
| | | | (0.037) | | | (0.033) | | | (0.095) |
| $Exed_{-1}$ | | | 0.023 | | | 0.021 | | | 0.001 |
| | | | (0.019) | | | (0.025) | | | (0.025) |
| $F$-statistics | 2.19 | 2.02 | 1.82 | 1.92 | 1.76 | 1.78 | 1.41 | 1.41 | 1.20 |
| Observations | 10,692 | 10,692 | 10,692 | 5,965 | 5,965 | 5,965 | 4,727 | 4,727 | 4,727 |
| $Dep_{-2}$ | −0.007 | −0.011 | | −0.006 | −0.015 | | 0.008 | 0.003 | |
| | (0.021) | (0.024) | | (0.023) | (0.028) | | (0.038) | (0.042) | |
| $Exe_{-2}$ | 0.028* | 0.008 | | 0.014 | −0.015 | | 0.028 | −0.004 | |
| | (0.015) | (0.027) | | (0.022) | (0.034) | | (0.024) | (0.067) | |
| $Dep_{-2} \times Exe_{-2}$ | | 0.024 | | | 0.035 | | | 0.036 | |
| | | (0.032) | | | (0.036) | | | (0.076) | |
| $Deps_{-2}$ | | | −0.061 | | | −0.051 | | | −0.089 |
| | | | (0.041) | | | (0.047) | | | (0.079) |
| $Depd_{-2}$ | | | 0.003 | | | 0.004 | | | 0.023 |
| | | | (0.022) | | | (0.024) | | | (0.041) |
| $Exes_{-2}$ | | | 0.026 | | | −0.035 | | | 0.120 |
| | | | (0.051) | | | (0.043) | | | (0.142) |
| $Exed_{-2}$ | | | 0.035** | | | 0.020 | | | 0.032 |
| | | | (0.016) | | | (0.023) | | | (0.026) |
| $F$-statistics | 2.23 | 1.99 | 1.89 | 2.03 | 1.82 | 1.86 | 0.77 | 0.70 | 0.68 |
| Observations | 8,716 | 8,716 | 8,716 | 4,958 | 4,958 | 4,958 | 3,758 | 3,758 | 3,758 |
| $Dep_{-3}$ | 0.053** | 0.060* | | 0.060* | 0.070 | | 0.064 | 0.062 | |
| | (0.027) | (0.031) | | (0.035) | (0.046) | | (0.043) | (0.042) | |
| $Exe_{-3}$ | 0.020 | 0.050 | | 0.011 | 0.045 | | 0.006 | −0.005 | |
| | (0.030) | (0.043) | | (0.050) | (0.061) | | (0.026) | (0.058) | |
| $Dep_{-3} \times Exe_{-3}$ | | −0.036 | | | −0.041 | | | 0.012 | |
| | | (0.050) | | | (0.075) | | | (0.065) | |
| $Deps_{-3}$ | | | 0.081* | | | 0.102** | | | 0.016 |
| | | | (0.042) | | | (0.048) | | | (0.072) |
| $Depd_{-3}$ | | | 0.048* | | | 0.051 | | | 0.068 |
| | | | (0.028) | | | (0.037) | | | (0.046) |
| $Exes_{-3}$ | | | −0.018 | | | 0.046 | | | −0.195 |
| | | | (0.054) | | | (0.064) | | | (0.121) |
| $Exed_{-3}$ | | | 0.018 | | | 0.004 | | | 0.024 |
| | | | (0.030) | | | (0.049) | | | (0.027) |
| $F$-statistics | 1.92 | 1.75 | 1.64 | 2.39 | 2.14 | 2.08 | 0.64 | 0.58 | 0.67 |
| Observations | 7,171 | 7,171 | 7,171 | 4,157 | 4,157 | 4,157 | 3,014 | 3,014 | 3,014 |
| $Dep_{-4}$ | 0.143 | 0.160 | | 0.189 | 0.219 | | 0.103** | 0.104* | |
| | (0.092) | (0.109) | | (0.166) | (0.210) | | (0.052) | (0.055) | |
| $Exe_{-4}$ | −0.067 | 0.004 | | −0.099 | −0.005 | | −0.038 | −0.035 | |
| | (0.045) | (0.053) | | (0.073) | (0.102) | | (0.049) | (0.064) | |
| $Dep_{-4} \times Exe_{-4}$ | | −0.084 | | | −0.118 | | | −0.004 | |
| | | (0.098) | | | (0.190) | | | (0.069) | |
| $Deps_{-4}$ | | | 0.155* | | | 0.205 | | | 0.074 |
| | | | (0.093) | | | (0.160) | | | (0.081) |
| $Depd_{-4}$ | | | 0.141 | | | 0.186 | | | 0.107* |
| | | | (0.094) | | | (0.170) | | | (0.060) |
| $Exes_{-4}$ | | | −0.097* | | | −0.094 | | | −0.121 |
| | | | (0.055) | | | (0.076) | | | (0.091) |
| $Exed_{-4}$ | | | −0.067 | | | −0.102 | | | −0.031 |
| | | | (0.045) | | | (0.072) | | | (0.046) |
| $F$-statistics | 1.70 | 1.52 | 1.52 | 2.42 | 2.15 | 1.98 | 0.84 | 0.75 | 0.88 |
| Observations | 5,882 | 5,882 | 5,882 | 3,456 | 3,456 | 3,456 | 2,426 | 2,426 | 2,426 |

Note: 1. The estimation of the fixed-effects model utilizes cluster-robust standard errors calculated across firms. The control variables, year dummies, and industry-year dummies are included in the regressions.
2. The samples are winsorized by both the upper and lower 0.5% and transformed by using Equation (2).
3. The first and second rows of the independent variables present the estimated coefficients and standard errors, respectively.
4. ***, **, and * represent 1%, 5%, and 10% statistical significance, respectively.

## Table 8. Estimation results: TFP

| Dependent variable: Δlog(TFP) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | | | R&D | | | Non-R&D | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| $Dep_{-1}$ | 0.005 | 0.013 | | 0.027* | 0.028 | | −0.019 | −0.004 | |
| | (0.014) | (0.015) | | (0.016) | (0.019) | | (0.022) | (0.022) | |
| $Exe_{-1}$ | −0.003 | 0.031 | | −0.013 | −0.007 | | 0.013 | 0.111** | |
| | (0.015) | (0.025) | | (0.018) | (0.019) | | (0.027) | (0.053) | |
| $Dep_{-1} \times Exe_{-1}$ | | −0.040 | | | −0.007 | | | −0.109* | |
| | | (0.028) | | | (0.025) | | | (0.057) | |
| $Deps_{-1}$ | | | 0.017 | | | 0.036* | | | −0.005 |
| | | | (0.017) | | | (0.020) | | | (0.030) |
| $Depd_{-1}$ | | | 0.004 | | | 0.025 | | | −0.019 |
| | | | (0.014) | | | (0.017) | | | (0.023) |
| $Exes_{-1}$ | | | 0.018 | | | −0.018 | | | 0.085 |
| | | | (0.027) | | | (0.026) | | | (0.063) |
| $Exed_{-1}$ | | | −0.006 | | | −0.014 | | | 0.006 |
| | | | (0.015) | | | (0.018) | | | (0.027) |
| $F$-statistics | 36.84 | 34.43 | 31.90 | 26.34 | 23.41 | 21.50 | 20.71 | 19.04 | 21.34 |
| Observations | 10,661 | 10,661 | 10,661 | 5,971 | 5,971 | 5,971 | 4,690 | 4,690 | 4,690 |
| $Dep_{-2}$ | 0.007 | 0.011 | | 0.012 | 0.020 | | 0.003 | 0.004 | |
| | (0.014) | (0.016) | | (0.019) | (0.022) | | (0.021) | (0.022) | |
| $Exe_{-2}$ | 0.014 | 0.033 | | 0.004 | 0.029 | | 0.032 | 0.038 | |
| | (0.015) | (0.029) | | (0.019) | (0.037) | | (0.025) | (0.042) | |
| $Dep_{-2} \times Exe_{-2}$ | | −0.022 | | | −0.030 | | | −0.007 | |
| | | (0.030) | | | (0.040) | | | (0.043) | |
| $Deps_{-2}$ | | | 0.006 | | | 0.009 | | | 0.006 |
| | | | (0.018) | | | (0.023) | | | (0.029) |
| $Depd_{-2}$ | | | 0.006 | | | 0.013 | | | 0.001 |
| | | | (0.014) | | | (0.020) | | | (0.021) |
| $Exes_{-2}$ | | | −0.020 | | | −0.025 | | | −0.024 |
| | | | (0.032) | | | (0.030) | | | (0.083) |
| $Exed_{-2}$ | | | 0.016 | | | 0.005 | | | 0.035 |
| | | | (0.015) | | | (0.019) | | | (0.026) |
| $F$-statistics | 34.83 | 30.97 | 31.57 | 24.11 | 21.43 | 21.41 | 17.60 | 15.98 | 17.18 |
| Observations | 8,703 | 8,703 | 8,703 | 4,968 | 4,968 | 4,968 | 3,735 | 3,735 | 3,735 |
| $Dep_{-3}$ | 0.018 | 0.033* | | 0.031 | 0.057* | | 0.003 | 0.010 | |
| | (0.018) | (0.019) | | (0.026) | (0.029) | | (0.023) | (0.023) | |
| $Exe_{-3}$ | 0.010 | 0.075** | | −0.036* | 0.049 | | 0.077*** | 0.124* | |
| | (0.017) | (0.037) | | (0.022) | (0.046) | | (0.027) | (0.070) | |
| $Dep_{-3} \times Exe_{-3}$ | | −0.076** | | | −0.104** | | | −0.052 | |
| | | (0.038) | | | (0.049) | | | (0.070) | |
| $Deps_{-3}$ | | | 0.021 | | | 0.029 | | | 0.016 |
| | | | (0.025) | | | (0.033) | | | (0.038) |
| $Depd_{-3}$ | | | 0.017 | | | 0.031 | | | 0.001 |
| | | | (0.018) | | | (0.025) | | | (0.024) |
| $Exes_{-3}$ | | | −0.012 | | | −0.053* | | | 0.026 |
| | | | (0.031) | | | (0.032) | | | (0.070) |
| $Exed_{-3}$ | | | 0.011 | | | −0.035* | | | 0.079*** |
| | | | (0.017) | | | (0.021) | | | (0.028) |
| $F$-statistics | 31.63 | 28.51 | 26.12 | 23.16 | 20.57 | 21.00 | 15.61 | 14.02 | 13.41 |
| Observations | 7,169 | 7,169 | 7,169 | 4,172 | 4,172 | 4,172 | 2,997 | 2,997 | 2,997 |
| $Dep_{-4}$ | 0.034 | 0.038 | | 0.031 | 0.047 | | 0.042 | 0.034 | |
| | (0.022) | (0.024) | | (0.031) | (0.038) | | (0.029) | (0.030) | |
| $Exe_{-4}$ | −0.009 | 0.005 | | −0.020 | 0.029 | | −0.003 | −0.059 | |
| | (0.019) | (0.040) | | (0.024) | (0.049) | | (0.029) | (0.060) | |
| $Dep_{-4} \times Exe_{-4}$ | | −0.017 | | | −0.061 | | | 0.064 | |
| | | (0.043) | | | (0.057) | | | (0.062) | |
| $Deps_{-4}$ | | | 0.032 | | | 0.019 | | | 0.051 |
| | | | (0.029) | | | (0.036) | | | (0.050) |
| $Depd_{-4}$ | | | 0.035 | | | 0.034 | | | 0.040 |
| | | | (0.022) | | | (0.031) | | | (0.029) |
| $Exes_{-4}$ | | | −0.050* | | | −0.043 | | | −0.091 |
| | | | (0.027) | | | (0.030) | | | (0.060) |
| $Exed_{-4}$ | | | −0.007 | | | −0.018 | | | 0.001 |
| | | | (0.019) | | | (0.024) | | | (0.029) |
| $F$-statistics | 36.73 | 32.66 | 31.95 | 19.61 | 17.55 | 16.28 | 18.94 | 16.85 | 16.86 |
| Observations | 5,880 | 5,880 | 5,880 | 3,472 | 3,472 | 3,472 | 2,408 | 2,408 | 2,408 |

Note: 1. The estimation of the fixed-effects model utilizes cluster-robust standard errors calculated across firms. The control variables, year dummies, and industry-year dummies are included in the regressions.
2. The samples are winsorized by both the upper and lower 0.5% and transformed by using Equation (2).
3. The first and second rows of the independent variables present the estimated coefficients and standard errors, respectively.
4. ***, **, and * represent 1%, 5%, and 10% statistical significance, respectively.

**Table A1. Reverse regression**

| | Dependent variable: *Dep* | | | Dependent variable: *Exe* | | |
|---|---|---|---|---|---|---|
| | Total | R&D | Non-R&D | Total | R&D | Non-R&D |
| (1) ΔROE | −0.005 | −0.001 | −0.011 | −0.007 | 0.002 | −0.016* |
| | (0.004) | (0.002) | (0.008) | (0.004) | (0.003) | (0.008) |
| (2) ΔROA | −0.020** | −0.005 | −0.038** | −0.007 | 0.008 | −0.025 |
| | (0.009) | (0.010) | (0.016) | (0.009) | (0.007) | (0.017) |
| (3) ΔAMSV | 0.008 | 0.009 | 0.007 | 0.001 | 0.007 | −0.008 |
| | (0.006) | (0.008) | (0.009) | (0.007) | (0.009) | (0.011) |
| (4) ΔTQ | 0.014** | 0.021** | 0.003 | 0.002 | 0.007 | −0.009 |
| | (0.007) | (0.009) | (0.011) | (0.008) | (0.010) | (0.015) |
| (5) ΔLP | −0.001 | −0.002 | 0.001 | −0.0004 | −0.001 | −0.001 |
| | (0.001) | (0.002) | (0.001) | (0.0004) | (0.001) | (0.001) |
| (6) ΔTFP | −0.006 | 0.014 | −0.022* | 0.002 | 0.012 | −0.006 |
| | (0.008) | (0.010) | (0.012) | (0.010) | (0.013) | (0.016) |

Note: 1. AMSV: aggregate market share value, TQ: Tobin's q, LP: labor productivity.
2. The estimation of the fixed-effects model utilizes cluster-robust standard errors calculated across firms. The control variables, year dummies, and industry-year dummies are included in the regressions.
3. The samples of Estimations (1), (2), (5), and (6) are winsorized by both the upper and lower 0.5% and transformed by using Equation (2) in the same manner as the original regressions.
4. The first and second rows of the independent variables present the estimated coefficients and standard errors, respectively.
5. ***, **, and * represent 1%, 5%, and 10% statistical significance, respectively.