The Same Wind, Different Sails: CEO Business Education, Stock Overvaluation, and R&D Investment in South Korea

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This study examines how stock overvaluation changes the relation between CEO business educational background and R&D investment. CEO business education may improve capital allocation and financing decisions, but it may also increase caution toward uncertain long-horizon projects such as R&D. Using a sample of Korean listed firms from 2011 to 2023, we find that business-educated CEOs are associated with lower R&D investment when firms are not overvalued, whereas they are associated with higher R&D investment when firms are overvalued. This result supports a reversal hypothesis rather than an amplification or mitigation hypothesis. The finding is robust to dynamic panel estimation, instrumental variable estimation, propensity score matching, alternative R&D measures, alternative overvaluation definitions, positive-R&D sample restrictions, and industry-by-year fixed effects. Mechanism tests show that the positive association between CEO business education and R&D investment among overvalued firms is concentrated among firms with short-horizon investors, regardless of financial constraint status. These findings are difficult to reconcile with a pure equity-financing explanation and are more consistent with a catering-based interpretation. Further tests show that the reversal pattern does not differ significantly by CEO ownership status or Chaebol affiliation. Overall, this study shows that CEO business education does not have a fixed implication for R&D investment. Its effect depends on valuation conditions, and the evidence suggests that the R&D response of business-educated CEOs under overvaluation is more consistent with catering incentives than with financing opportunities alone.

Keyword: CEO business educational background, stock overvaluation, R&D investment, equity financing mechanism, catering mechanism.

I. Introduction

Research and development (R&D) investment is a key source of corporate innovation. Yet such investment is difficult to justify at the time the decision is made. R&D requires current resource commitments, while its expected benefits are uncertain and distant. Unlike many other investments, R&D proj-

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ects often provide limited observable signals about their economic value before resources are committed (Chan et al., 2001; Hottenrott et al., 2016). This creates a difficult managerial problem. Firms must invest before they can know whether the underlying technology will succeed or whether the project will generate future cash flows. For this reason, R&D investment relies heavily on managerial judgment when project value is difficult to verify ex ante (Alzahrani and Rao, 2014; Custódio and Metzger, 2014; Czarnitzki and Toole, 2011).

This reliance on managerial judgment makes CEO characteristics particularly relevant. Upper echelons theory suggests that corporate decisions reflect how top managers interpret the conditions they face (Hambrick, 2007; Hambrick and Mason, 1984). This perspective is especially relevant for R&D investment, where decision makers must evaluate uncertain projects without clear evidence of future value. Among CEO characteristics, educational background is particularly important because it shapes how managers process information and assess investment opportunities. A business educational background is especially relevant in this setting because it can expose managers to concepts related to financing, capital allocation, and valuation (Gupta, 2022). Such training may affect how CEOs approach R&D investment when the economic value of R&D projects is difficult to verify (Kim, 2025; Miller and Xu, 2019).

A business educational background does not imply a single direction for R&D investment. It may help CEOs evaluate investment opportunities and secure financial resources for projects whose value is difficult to verify (Dong et al., 2025; Graham et al., 2013; Gupta, 2022; Gupta et al., 2021). R&D often requires sustained funding before returns become visible. CEOs with business training may therefore be better positioned to assess financing conditions and allocate resources to uncertain projects. At the same time, business education may increase caution toward R&D. It may also make CEOs more attentive to measurable outcomes and short-term performance pressure (Kim, 2025; Loukil and Yousfi, 2022; Miller and Xu, 2019). These concerns matter for R&D because current expenditures are visible, while future benefits remain uncertain. The relation between CEO business educational background and R&D investment is therefore theoretically ambiguous.

Stock overvaluation provides a setting in which this ambiguity becomes especially important. Overvaluation changes both the financing conditions and the market incentives surrounding R&D investment. When a firm is overvalued, external equity becomes less costly, which can ease financing constraints and make it easier to fund un-

certain projects (Baker et al., 2003; McLean and Zhao, 2014; Stein, 1996). At the same time, overvaluation may increase managerial incentives to justify optimistic market expectations and sustain high stock prices (Jensen, 2005; Polk and Sapienza, 2009). R&D investment is particularly relevant under these conditions because investors may view it as a visible commitment to future growth. Thus, stock overvaluation may change how business-educated CEOs apply their training in financing and capital allocation to R&D decisions.

Prior research has paid limited attention to whether the effect of CEO business educational background on R&D investment depends on stock market valuation conditions. Studies on CEO characteristics show that managerial traits affect corporate policies (e.g., Barker and Mueller, 2002; Darmadi, 2013; Graham et al., 2013; Kallias et al., 2023), but they often estimate average trait effects. Studies on stock overvaluation show that misvaluation affects real investment through financing conditions or managerial incentives (Baker et al., 2003; Dang and Xu, 2018; Dong et al., 2021; Duong, 2024; Li, 2026; Shen et al., 2021), but they often treat the managerial response as homogeneous. This leaves an important gap. Stock overvaluation may not translate into R&D investment mechanically. Its effect may depend on who interprets valuation signals and how those signals are converted into investment decisions. This study examines whether stock overvaluation changes the relation between CEO business educational background and R&D investment.

To address this question, we use a sample of Korean listed firms from 2011 to 2023. The baseline results reveal a reversal pattern. Business-educated CEOs are associated with lower R&D investment when firms are not overvalued, whereas they are associated with higher R&D investment than other CEOs among overvalued firms. The reversal pattern remains robust in analyses that account for R&D persistence, mitigate potential reverse causality concerns, address endogenous CEO appointment, and reduce observable selection bias. It also holds under alternative measures of R&D investment, alternative definitions of overvaluation, restrictions to firms with positive R&D expenditure, and industry-by-year fixed effects.

We next examine why this reversal occurs. Stock overvaluation can affect R&D investment by easing equity financing or by strengthening incentives to respond to optimistic market expectations. To distinguish these channels, we examine whether the reversal pattern is concentrated among financially constrained firms or among firms with short-horizon investors. The positive effect of business education among overvalued firms appears only in firms with short-hori-

zon investors, regardless of financial constraint status. The results are more consistent with an interpretation in which investor horizon shapes the R&D response of business-educated CEOs under overvaluation, rather than one in which favorable equity financing opportunities are the primary driver. Taken together, these findings are difficult to reconcile with a pure equity-financing explanation and are more consistent with a catering-based interpretation.

This study makes two main contributions. It shifts the analysis of CEO educational background from an average-effect perspective to a conditional-effect perspective. CEO business education does not have a uniform implication for R&D investment across valuation environments. Its effect depends on whether firms are overvalued. This finding helps explain why the same managerial background can lead to different investment choices under different market conditions. The study also adds a managerial-heterogeneity perspective to the misvaluation-investment literature by showing that valuation signals are filtered through CEO characteristics. Stock overvaluation does not translate into R&D investment in a uniform way. Its effect on R&D investment depends partly on the characteristics of the CEO who interprets valuation signals and converts them into investment decisions.

The remainder of this paper is organized as follows. Section 2 reviews the related literature and develops the testable hypotheses. Section 3 describes the data, variables, and research design. Section 4 presents the empirical results. Section 5 concludes with implications, limitations, and directions for future research.

Ⅱ. Literature Review and Testable Hypotheses

2.1 CEO Business Educational Background and R&D Investment

Upper echelons theory views corporate outcomes as reflecting the individuals who make decisions. Firm policies depend on how CEOs interpret the environment they face (Hambrick, 2007; Hambrick and Mason, 1984). CEOs do not simply react to external information. They interpret signals from their own perspectives and act accordingly. This explains why firms facing similar conditions may adopt different policies (Adner and Helfat, 2003; Bertrand and Schoar, 2003; Driouchi et al., 2022). This perspective is particularly relevant for corporate R&D investment. R&D is among the most uncertain forms of corporate investment. It requires substantial upfront commitments and produces outcomes that are difficult to verify ex ante (Czarnitzki

and Toole, 2011; Hottenrott et al., 2016). These features make R&D decisions highly dependent on managerial judgment (Custódio and Metzger, 2014; Malmendier and Tate, 2005). As a result, CEO characteristics can lead to systematic differences in R&D investment behavior. Firms differ not only in how much they invest, but also in how they finance those investments (Benmelech and Frydman, 2015; Custódio et al., 2019; Graham et al., 2013). The CEO does not merely implement a predetermined policy. The CEO shapes how the firm responds to external conditions.

Among observable CEO traits, educational background is particularly relevant because it reflects how managers are trained to process information, evaluate risk, and make resource-allocation decisions (Barker and Mueller, 2002; Darmadi, 2013; Gottesman and Morey, 2006; Gounopoulos et al., 2021; Kallias et al., 2023). A business-related educational background may support R&D investment for several reasons. First, business education can strengthen managers' ability to evaluate investment opportunities and allocate capital across competing uses. Such capabilities are particularly relevant for R&D because the expected returns from R&D projects are difficult to assess ex ante and often materialize only over long horizons. CEOs with stronger training in valuation and capital allocation may therefore be better equipped to distinguish promising R&D projects from less attractive ones and to commit resources despite uncertainty (Dong et al., 2025; Graham et al., 2013).

Second, business education may facilitate the financing of R&D investment. R&D projects typically require sustained resource commitments before their economic benefits become observable, making access to and management of financial resources particularly important. Prior studies suggest that CEO educational background is related to firms' financing capacity and investment decisions (Gounopoulos et al., 2021; Gupta, 2022; Gupta et al., 2021). If business- educated CEOs are better able to secure external capital and manage internal financial resources, they may be more willing and able to undertake R&D projects that would otherwise be difficult to finance. Korean evidence also suggests that CEO educational characteristics are associated with firms' R&D investment behavior (Ha and Lee, 2014). Taken together, these arguments provide a theoretical basis for a positive relation between CEO business educational background and R&D investment: business education may equip CEOs with the evaluation, resource-allocation, and financing capabilities needed to undertake uncertain, long-horizon R&D projects.

However, a business-related educational background may discourage R&D investment.

Greater emphasis on measurable performance and short-term outcomes can reduce willingness to commit resources to projects with uncertain and delayed returns (Christensen et al., 2007; Miller and Xu, 2019). Because R&D outcomes are difficult to evaluate and may generate short-term earnings pressure, business-trained CEOs may prefer investments with clearer and more immediate financial payoffs (Kim, 2025). Consistent with this view, Loukil and Yousfi (2022) find that CEOs with business degrees are less likely to engage in innovative activities.

Taken together, prior studies point to an ambiguous relation between business-related educational backgrounds and R&D investment. CEO business education may improve capital allocation and access to financing, yet it may also increase reluctance to invest in uncertain long-horizon projects.

2.2 Stock Overvaluation and R&D Investment

Prior research shows that stock overvaluation can influence real corporate decisions, particularly when firms rely on external financing or when managers have incentives to respond to firm valuations (Morck et al., 1990). One prominent explanation is the equity-financing channel. Overvaluation lowers the effective cost of external capital and allows firms to issue equity on favorable terms. This can enable firms to invest beyond what their internal resources would otherwise permit. Stein (1996) argues that stock prices can affect investment when financing frictions are present. Related studies show that investment becomes more sensitive to stock prices among equity-dependent firms and during periods of favorable financing conditions (Baker et al., 2003; McLean and Zhao, 2014; Warusawitharana and Whited, 2016).

A second explanation emphasizes catering incentives. Elevated valuations may give managers stronger incentives to justify optimistic market expectations and sustain high stock prices. Managers may therefore adjust corporate policies in ways that investors view favorably, even when such actions are not fully supported by fundamentals. Jensen (2005) argues that managers may overinvest during high-valuation periods. Polk and Sapienza (2009) show that stock overvaluation can induce overinvestment when managers respond to stock prices. Other studies document that firms are more likely to undertake valuation-sensitive actions during periods of overvaluation (Baker and Wurgler, 2004; Gao, 2010; Jin, 2022).[1)]

1) These two mechanisms are not mutually exclusive. Stock overvaluation may simultaneously relax financing constraints and strengthen incentives to pursue actions viewed favorably by the market. Prior studies suggest that

These mechanisms are also relevant to R&D investment. Easier access to external capital may support R&D projects that would otherwise be delayed or underfunded (Dang and Xu, 2018; Li, 2026). At the same time, R&D can serve as a visible signal of future growth (Platikanova, 2026). Managers may increase R&D spending when such investment is likely to be viewed as consistent with optimistic market expectations (Dong et al., 2021; Duong, 2024; Shen et al., 2021). Taken together, prior studies suggest that stock overvaluation affects both the opportunity to invest and the incentive to do so. The net effect on R&D investment depends on how managers interpret valuation conditions and translate them into investment decisions.

2.3 Testable Hypotheses

The preceding discussion suggests that both CEO business educational background and stock overvaluation shape R&D investment decisions. CEO business educational background influences how managers evaluate investment opportunities, manage financing, and respond to capital market conditions. Stock overvaluation, in turn, changes both the resources available for investment and the incentives that guide managerial behavior. These forces jointly determine how firms adjust R&D investment.

The first possibility is that CEO business education is positively associated with R&D investment. As discussed above, business-educated CEOs may be better equipped to evaluate uncertain investment opportunities, allocate financial resources, and obtain financing for long-horizon projects. These capabilities can make R&D investment more feasible and attractive despite its uncertain and delayed payoffs. Under this view, business-educated CEOs are more willing and able to commit resources to R&D even in the absence of stock overvaluation.

Stock overvaluation may reinforce business-educated CEOs' tendency to invest in R&D. One channel operates through financing conditions. When firms are overvalued, access to external equity becomes less costly and financing opportunities expand (Baker et al., 2003; McLean and Zhao, 2014). Business-educated CEOs, who are trained in valuation and capital allocation, may be more likely to recognize these opportunities and channel additional resources into R&D investment. A second channel reflects market responsiveness. Greater attention to capital markets may lead business-educated

financing motives and catering incentives can jointly shape investment responses to stock prices, especially when firms face financing frictions and short-horizon shareholder pressure (Alzahrani and Rao, 2014; Baxamusa, 2011; Kusnadi and Wei, 2017; Mrad et al., 2024).

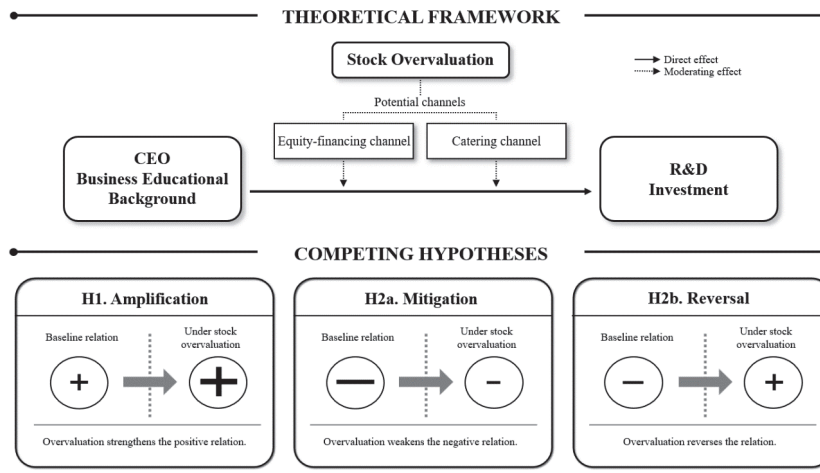
CEOs to align investment decisions with market expectations (Sun et al., 2021). This channel can further strengthen their tendency to increase R&D investment. Taken together, these arguments suggest that stock overvaluation amplifies the positive relation between CEO business educational background and R&D investment.

Hypothesis 1 (Amplification). Stock overvaluation strengthens the positive relation between CEO business educational background and R&D investment.

Stock overvaluation may also weaken the conservative tendency toward R&D investment associated with CEO business educational background. Under normal conditions, business-educated CEOs may be reluctant to invest in R&D because such investment requires large upfront commitments and is difficult to evaluate ex ante (Czarnitzki and Toole, 2011; Hottenrott et al., 2016). These concerns are likely to be more salient for CEOs who emphasize financial discipline and short-term accountability (Kim, 2025; Miller and Xu, 2019). Overvaluation can partially reduce this reluctance through two channels. First, by lowering the effective cost of external equity, overvaluation weakens one financial reason for avoiding R&D (Baker et al., 2003; McLean and Zhao, 2014; Warusawitharana and Whited, 2016). Second, because R&D can serve as a visible signal of future growth, an excessively conservative R&D policy may become less consistent with valuation-related market expectations when firms are overvalued (Dong et al., 2021; Duong, 2024; Shen et al., 2021). Thus, even if business-educated CEOs remain less inclined to invest in R&D, the negative association between CEO business educational background and R&D investment should be weaker under overvaluation.

Hypothesis 2a (Mitigation). Stock overvaluation weakens the negative relationship between CEO business educational background and R&D investment.

This mitigation effect can take a stronger form. Here, the relevant question is not whether overvaluation strengthens an already positive relation, but whether it is strong enough to overturn an initially negative relation. Under this scenario, overvaluation does not merely reduce business-educated CEOs' reluctance toward R&D. It changes the direction of their R&D response. Favorable financing conditions make R&D less costly to undertake, while valuation-related incentives increase the payoff to visible investment in future growth. Prior studies suggest that overvalued firms face incentives to justify optimistic market expectations and sustain high valuations



〈Figure 1〉 Theoretical framework and competing hypotheses

through corporate policies that investors view favorably (Gao, 2010; Jensen, 2005; Jin, 2022; Polk and Sapienza, 2009). When these forces dominate the baseline conservative tendency, business-educated CEOs may move from reduced reluctance to active R&D investment. Accordingly, stock overvaluation may reverse the negative relation between CEO business educational background and R&D investment.

Hypothesis 2b (Reversal). Stock overvaluation reverses the negative relationship between CEO business educational background and R&D investment, such that business-educated CEOs exhibit higher R&D investment than non-business CEOs among overvalued firms.

Figure 1 summarizes the theoretical framework and the three competing hypotheses developed above. The upper panel illustrates how stock overvaluation may modify the relation between CEO business educational background and R&D investment through the potential equity-financing and catering channels, while the lower panel summarizes the amplification, mitigation, and reversal hypotheses.

Ⅲ. Data and Research Design

3.1 Sample and Data

This study uses a sample of Korean listed firms from 2011 to 2023. The sample period

begins in 2011, when Korean listed firms adopted Korean International Financial Reporting Standards, which enhances the comparability of financial statements across firms. The sample ends in 2023 based on the availability of financial and firm-level data. Financial firms (two-digit Korean Standard Industrial Classification (KSIC) codes 64 - 66) are excluded because their accounting structures and regulatory environments differ substantially from those of non-financial firms.

Information on firms' R&D investment, stock prices, and financial statement variables is obtained from DataGuide 6. Information on CEO educational background is hand-collected from firms' annual reports filed with the Financial Supervisory Service and supplemented with data from the TS-2000 database provided by the Korea Listed Companies Association. When information on CEO educational background is not available from these sources, we further supplement it through searches on major online portals, including Naver, Daum, and Google. Observations with missing values for variables are removed. The final sample consists of 2,397 unique firms and 21,618 firm-year observations.

3.2 Variables

3.2.1 R&D Investment

R&D investment is proxied by R&D intensity (*RDI*), which is defined as total R&D expenditure scaled by total sales. Total R&D expenditure includes both R&D expenses recognized in the income statement and R&D expenditures capitalized as intangible assets.

3.2.2 CEO Business Educational Background

We construct our measure of CEO business educational background in two steps. First, we identify the CEO for each firm-year. In this study, the CEO is defined as the individual designated as the representative director in the annual report (e.g., Ryu and Kim, 2020; Yim, 2019). When multiple representative directors are reported (i.e., co-CEO structures), the CEO is identified as the individual whose signature appears first in the report (Yim and Kang, 2024). In the Korean institutional setting, the first signature on the annual report is generally understood to indicate ultimate responsibility for the disclosed information. Using this procedure, we identify 4,975 unique CEOs over the sample period.

Second, we manually collect detailed information on the educational backgrounds of the identified CEOs, including the level and field of each reported degree. Degree levels are classified as bachelor's, master's, and doctoral degrees. We classify CEOs as having a business educational background if at least

one bachelor's, master's, or doctoral degree in a business-related field is identified in the CEO's available educational records (e.g., Mun and Kim, 2021). Business-related fields include business administration, management, finance, accounting, and closely related disciplines. MBA degrees are classified as master's-level business education; this classification indicates that an MBA represents formal business education undertaken at the master's level and does not assume that an MBA is equivalent to an academic master's degree. Accordingly, BUSINESS is defined as an indicator variable equal to one if the CEO holds at least one degree in a business-related field, and zero otherwise. This classification captures whether the CEO has received formal business education at any stage of higher education, rather than assigning the CEO to an educational category based solely on the field of the highest reported degree.

3.2.3 Stock Overvaluation

We measure stock overvaluation using the firm-specific misvaluation component based on the decomposition method of Rhodes-Kropf et al. (2005). This approach decomposes the market-to-book ratio into firm-specific, industry-specific, and long-term components. We focus on the firm-specific component (e.g., Alzahrani and Rao, 2014; Jin, 2022; Mrad et al., 2024), which captures deviations between market value and accounting-based fundamentals that are unique to each firm.

To implement this approach, we estimate cross-sectional regressions of market value on accounting fundamentals within each industry-year:[2)]

$$m_{i,t} = \delta_{0,j,t} + \delta_{1,j,t} b_t + \delta_{2,j,t} \ln\left(NI_{i,t}^{+}\right) + \delta_{3,j,t} I(NI_{i,t} < 0) \bullet \ln\left(NI_{i,t}^{+}\right) + \delta_{4,j,t} LEV_{i,t} + \varepsilon_{i,t} \quad (1)$$

where i, j, and t denote firm, industry, and year, respectively. $m_{i,t}$ is the logarithm of the market value of equity, $b_{i,t}$ is the logarithm of the book value of equity, $NI_{i,t}^{+}$ denotes the absolute value of net income, $I(NI_{i,t} < 0)$ is an indicator for negative earnings, and $LEV_{i,t}$ denotes leverage. Using the estimated coefficients, we obtain the predicted log market value implied by firm fundamentals. Firm-specific misvaluation is calculated as the difference between the observed log market value and the predicted log market value.

To construct a measure of overvaluation, we classify firm-year observations into ter-

2) In the U.S. setting, prior studies typically estimate Eq. (1) using the Fama-French 12 industry classification. However, in the Korean context, we employ the two-digit KSIC codes to define industries. Following Kim (2021), we restrict the estimation to industry-year groups with at least 10 observations to ensure reliable coefficient estimates.

ciles based on the annual distribution of firm-specific misvaluation (e.g., Bonaimé et al., 2014; Mrad et al., 2024). Firms in the highest tercile are defined as overvalued. Based on this classification, we construct an indicator variable, OVER, equal to one if a firm-year observation falls into the highest tercile and zero otherwise.

3.2.4 Control Variables

This study includes CEO age (*CEOAGE*) and CEO ownership (*CEOOWN*) to control for other observable CEO characteristics that may be associated with both CEO educational background and R&D investment decisions (e.g., Mun and Kim, 2021). We then control for a set of firm characteristics that may affect R&D investment. Firm size (*FIRMSIZE*) accounts for the greater resource availability of larger firms, while firm age (*FIRMAGE*) captures organizational maturity that may influence innovation behavior. We include return on assets (*ROA*) to reflect internal funding capacity that can support R&D investment. Leverage (*LEV*) reflects financial risk and may constrain discretionary investment. Asset tangibility (*TANG*) captures differences in asset structure that may affect financing conditions for R&D activities. Cash holdings (*CASH*) are included to capture internal liquidity and financial flexibility that may support R&D investment. Capital expenditure (*CAPEX*) is included to control for firms' general investment activity, allowing us to distinguish R&D investment from broader capital investment decisions. Sales growth (*GROWTH*) captures firms' growth opportunities and expansion prospects.[3] Finally, we control for ownership structure by including foreign ownership (*FOR*) and large shareholdings (*LARGE*), as these factors may influence monitoring intensity and managerial decision-making. Variable definitions are provided in Table A1 in the Appendix.

3.3 Research Design

We estimate the following baseline regression model:

$$RDI_{i,t+1} = \alpha + \beta_1 BUSINESS_{i,t} + \beta_2 OVER_{i,t}$$

3) As an alternative proxy for growth opportunities, Tobin's Q is commonly used in the literature. However, we use sales growth instead for two reasons. First, Tobin's Q is closely related to firm valuation (Alzahrani and Rao, 2014; Baker et al., 2003), and may introduce mechanical overlap with our measure of stock overvaluation. Second, because the Rhodes-Kropf et al. (2005) decomposition is based on the market-to-book ratio, Tobin's Q is structurally linked to our measure of misvaluation, which may lead to a high correlation between the two variables. Consistent with this concern, we find that Tobin's Q is strongly correlated with firm-specific misvaluation in our sample (correlation ≈ 0.65). Using sales growth allows us to capture firms' expansion opportunities without conflating growth prospects with stock misvaluation.

$$+\beta_3(BUSINESS_{i,t}\times OVER_{i,t})+\gamma X_{i,t}+\mu_i+\lambda_t+\varepsilon_{i,t+1} \quad (2)$$

RDI denotes R&D investment, *BUSINESS* is an indicator variable for CEO business educational background, and *OVER* denotes stock overvaluation. *X* represents a vector of control variables. We include firm and year fixed effects (μ_i and λ_t) to control for time-invariant firm characteristics and time trends. $\varepsilon_{i,t+1}$ is the error term. Standard errors are clustered at the firm level.

The coefficient of interest is β_3, which captures how stock overvaluation modifies the relation between CEO business educational background and R&D investment. Specifically, β_3 reflects the difference in the effect of *BUSINESS* between overvalued firms (*OVER* = 1) and non-overvalued firms (*OVER* = 0). The conditional effect of *BUSINESS* on *RDI* is given by β_1 when *OVER* = 0, and by $\beta_1 + \beta_3$ when *OVER* = 1. Thus, β_3 represents how the effect of CEO business educational background changes when firms are overvalued.

The interpretation of β_3 depends on both the sign of β_1 and the conditional effect of CEO business educational background among overvalued firms, $\beta_1 + \beta_3$. Under Hypothesis 1 (Amplification), stock overvaluation strengthens the positive relation between CEO business educational background and R&D investment. This pattern requires both β_1 and β_3 to be positive. Under Hypothesis 2a (Mitigation), stock overvaluation attenuates, but does not reverse, the negative relation between CEO business educational background and R&D investment. This pattern requires a negative β_1, a positive β_3, and a non-positive $\beta_1 + \beta_3$. Hypothesis 2b (Reversal) represents a stronger case in which stock overvaluation reverses the negative relation, such that business-educated CEOs increase R&D investment when firms are overvalued. This pattern requires a negative β_1, a positive β_3, and a positive $\beta_1 + \beta_3$.

Table 1 summarizes how the estimated coefficients correspond to the testable hypotheses. All three hypotheses can involve a positive interaction coefficient, but they differ in the baseline relation between CEO business educational background and R&D investment and in the conditional relation among over-

〈Table 1〉 Testable hypotheses and expected coefficient patterns

Hypotheses	Effect of CEOs' business educational background		Expected coefficient pattern
	Non-overvalued firms	Overvalued firms	
Amplification	Positive	More positive	$\beta_1 > 0$, $\beta_3 > 0$
Mitigation	Negative	Less negative	$\beta_1 < 0$, $\beta_3 > 0$, $\beta_1 + \beta_3 \leq 0$
Reversal	Negative	Positive	$\beta_1 < 0$, $\beta_3 > 0$, $\beta_1 + \beta_3 > 0$

valued firms. Thus, the empirical separation between Hypothesis 2a and Hypothesis 2b requires testing whether $\beta_1 + \beta_3$ is statistically greater than zero.

3.4 Summary Statistics

Table 2 presents the distribution of CEO business education and the descriptive statistics for the variables used in the main analysis. Panel A shows that, among the 4,975 CEOs identified in our sample, 2,178 have at least one business-related degree. Of these CEOs, 1,590 hold a business-related bachelor's degree, 1,685 hold a business-related master's degree, and 29 hold a business-related

〈Table 2〉 Distribution of CEO business education and descriptive statistics

Panel A reports the distribution of CEOs with business educational backgrounds by degree level. The degree-level categories are not mutually exclusive because a CEO may hold business-related degrees at multiple levels. Degree-level counts are based on degrees identified in the available educational records and do not imply that an unreported degree was not obtained. Panel B reports summary statistics for the variables used in the baseline regressions. All continuous variables are winsorized at the 1st and 99th percentiles. Variable definitions are provided in Table A1.

Panel A. Distribution of CEO business education					
Business education				No. of CEOs	
All CEOs				4,975	
Business-educated CEOs				2,178	
Business-related bachelor's degree				1,590	
Business-related master's degree				1,685	
Business-related doctoral degree				29	
Panel B. Descriptive statistics					
Variables	Mean	Std. Dev.	Min	Median	Max
RDI	0.033	0.079	0.000	0.010	0.374
BUSINESS	0.443	0.497	0.000	0.000	1.000
OVER	0.333	0.471	0.000	0.000	1.000
CEOAGE	4.020	0.142	3.638	4.043	4.317
CEOOWN	0.125	0.138	0.000	0.053	0.545
FIRMSIZE	26.117	1.476	23.474	25.845	31.080
FIRMAGE	3.241	0.614	1.386	3.219	4.344
ROA	0.025	0.085	−0.315	0.032	0.228
LEV	0.420	0.204	0.054	0.416	0.887
TANG	0.293	0.185	0.004	0.283	0.747
CASH	0.110	0.101	0.002	0.080	0.527
CAPEX	0.042	0.049	0.000	0.025	0.254
GROWTH	0.120	0.448	−0.641	0.049	1.903
FOR	0.063	0.098	0.000	0.022	0.517
LARGE	0.398	0.166	0.007	0.391	0.790

doctoral degree. These degree-level categories are not mutually exclusive because a CEO may hold business-related degrees at more than one level.

Panel B presents the summary statistics for the variables used in the main analysis. The mean value of *RDI* is 0.033, indicating that, on average, R&D expenditure accounts for 3.3% of total sales. The mean value of *BUSINESS* is 0.443, indicating that 44.3% of firm-year observations are led by CEOs with business educational backgrounds. The mean value of *OVER* is 0.333, which is consistent with the classification of overvalued firms based on the top tercile of firm-specific misvaluation.[4] The average of the natural logarithm of CEO age (*CEOAGE*) is 4.020, and the average CEO ownership (*CEOOWN*) is 2.5%. Regarding firm characteristics, the mean values of *FIRMSIZE* and *FIRMAGE*, both measured in natural logarithms, are 26.117 and 3.241, respectively. The mean values of return on assets (*ROA*), leverage (*LEV*), cash holdings (*CASH*), capital expenditure (*CAPEX*), and sales growth (*GROWTH*) are 0.025, 0.420, 0.110, 0.042, and 0.120, respectively. The average foreign ownership (*FOR*) is 6.3%, while the average ownership by large shareholders (*LARGE*) is 39.8%.[5]

Ⅳ. Empirical Results

4.1 Baseline Regressions

Table 3 reports the baseline regression results. In the regression analyses, *RDI* is multiplied by 100 for ease of interpretation. Column (1) includes only the main variables, column (2) adds CEO characteristics (CEO age (*CEOAGE*) and CEO ownership (*CEOOWN*)), and column (3) includes the full set of control variables. Across all specifications, the coefficient on *BUSINESS* is negative and statistically significant.

In column (3), the coefficient on *BUSINESS* is −0.469 and significant at the 5% level, indicating that business-educated CEOs are associated with R&D intensity that is 0.469 percentage points lower among non-overvalued firms. This finding is consistent with the view that business-educated CEOs may be more cautious about R&D investment (Miller and Xu, 2019), especially when firms are not overvalued and R&D involves uncertain outcomes and short-term performance

4) The mean and median values of firm-specific misvaluation are 0.003 and −0.012, respectively.
5) In untabulated analyses, pairwise correlations among the explanatory variables do not indicate serious multicollinearity concerns. Consistent with this, all variance inflation factor (VIF) values are below 5, suggesting that multicollinearity is not a serious concern in our regression models.

〈Table 3〉 Baseline regressions

This table reports the baseline regression results. Definitions of the remaining variables are provided in Table A1. Values in parentheses are *t*-statistics based on standard errors clustered at the firm level. The row "$\beta_1 + \beta_3$" reports the estimated sum of the coefficients on *BUSINESS* and *BUSINESS* × *OVER*. The value in parentheses for this row is the *t*-statistic from testing the null hypothesis that $\beta_1 + \beta_3 = 0$. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

		Dependent variable = RDI_{t+1} (%)		
		(1)	(2)	(3)
BUSINESS	β_1	−0.625***	−0.557***	−0.469**
		(−4.30)	(−3.80)	(−2.33)
OVER	β_2	2.693***	1.303***	0.987***
		(8.45)	(5.25)	(4.53)
BUSINESS × *OVER*	β_3	1.376***	0.913***	0.775***
		(5.42)	(3.59)	(3.15)
CEOAGE	γ_1		−0.428*	−0.430*
			(−1.70)	(−1.92)
CEOOWN	γ_2		0.210**	0.208**
			(2.30)	(2.17)
FIRMSIZE	γ_3			0.555***
				(7.21)
FIRMAGE	γ_4			−1.277***
				(−7.60)
ROA	γ_5			9.144***
				(9.80)
LEV	γ_6			−5.811***
				(−5.21)
TANG	γ_7			0.980
				(1.19)
CASH	γ_8			2.233*
				(1.70)
CAPEX	γ_9			−5.203***
				(−3.63)
GROWTH	γ_{10}			0.735***
				(3.51)
FOR	γ_{11}			1.533
				(1.33)
LARGE	γ_{12}			−4.055***
				(−7.16)
Constant	α	−1.243***	−0.411***	−0.344***
		(−5.23)	(−3.46)	(−2.76)
Firm FE		Yes	Yes	Yes
Year FE		Yes	Yes	Yes
Observations		21,618	21,618	21,618
Within R^2		0.085	0.130	0.254
$\beta_1 + \beta_3$		0.751***	0.356***	0.306**
(*t*-statistics)		(4.40)	(2.59)	(2.50)

pressure. The coefficient on *BUSINESS* × *OVER* is 0.775 and significant at the 1% level. This estimate indicates that the association between CEO business educational background and R&D intensity is 0.775 percentage points higher among overvalued firms than among non-overvalued firms.

To assess the effect of CEO business educational background among overvalued firms, we report the linear combination ($\beta_1 + \beta_3$) of the coefficients on *BUSINESS* and *BUSINESS* × *OVER* at the bottom of the table. The linear combination is positive and statistically significant in all specifications. In Column (3), the linear combination is 0.306 and significant at the 5% level. This finding indicates that, among overvalued firms, business-educated CEOs are associated with a 0.310 percentage point higher R&D intensity than non-business CEOs. Thus, the negative relation between CEO business educational background and R&D investment is not merely attenuated under overvaluation. It becomes positive.[6)]

Taken together, the baseline results support Hypothesis 2b. Business-educated CEOs are associated with lower R&D investment when firms are not overvalued, but the association becomes positive among overvalued firms.

4.2 Endogeneity

4.2.1 R&D Persistence and Reverse Causality

Although the baseline results are consistent with the reversal hypothesis, several endogeneity concerns may affect the interpretation of the findings. The first concern relates to the persistence of R&D investment and potential reverse causality. R&D investment is likely to be persistent because firms' current R&D decisions depend on accumulated technological capabilities and prior investment commitments (e.g., Yim and Kang, 2024). If firms' prior R&D trajectories are correlated with CEO educational background or valuation conditions, the baseline estimates may partly reflect persistent R&D patterns rather than the effect of CEO business education under overvaluation. In addition, firms with high levels of past R&D investment may receive higher market valuations (Li, 2026), raising concerns that stock overvaluation reflects market expectations about future R&D.

To mitigate this concern, we estimate a dynamic panel model using the two-step system generalized method of moments (GMM) estimator (Arellano and Bover, 1995; Roodman, 2009). We include the lagged dependent variable as an additional regressor to account

6) As a supplementary check, Table A2 in the Appendix reports subsample regressions by valuation status. The coefficient on *BUSINESS* changes from negative in the undervalued and fairly valued subsamples to positive in the overvalued subsample, consistent with the reversal hypothesis.

〈Table 4〉 Endogeneity checks (1) system GMM

This table reports the system GMM estimation results. Definitions of the remaining variables are provided in Table A1. Values in parentheses are t-statistics based on Windmeijer-corrected robust standard errors with finite-sample adjustment. The row "$\beta_1 + \beta_3$" reports the estimated sum of the coefficients on *BUSINESS* and *BUSINESS* × *OVER*. The value in parentheses for this row is the t-statistic from testing the null hypothesis that $\beta_1 + \beta_3 = 0$. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

		Dependent variable = RDI_{t+1} (%)
RDI	ρ	0.317***
		(8.20)
BUSINESS	β_1	−0.877*
		(−1.93)
OVER	β_2	3.163***
		(3.99)
BUSINESS × *OVER*	β_3	2.175**
		(2.50)
CEOAGE	γ_1	−0.530**
		(−2.00)
CEOOWN	γ_2	0.157*
		(1.90)
FIRMSIZE	γ_3	0.150***
		(4.34)
FIRMAGE	γ_4	−0.495*
		(−1.89)
ROA	γ_5	4.880***
		(2.90)
LEV	γ_6	−2.745***
		(−5.41)
TANG	γ_7	0.051
		(0.05)
CASH	γ_8	1.977**
		(2.24)
CAPEX	γ_9	−2.290**
		(−2.42)
GROWTH	γ_{10}	0.341**
		(2.40)
FOR	γ_{11}	0.850
		(1.13)
LARGE	γ_{12}	−2.873***
		(−4.91)
Constant	α	1.422
		(0.89)
Year FE		Yes
Observations		21,618
Diagnostic test		
AR(1) test (p-value)		0.000
AR(2) test (p-value)		0.275
Hansen J test (p-value)		0.539
$\beta_1 + \beta_3$		1.298**
(t-statistics)		(2.10)

for the persistence of R&D investment. By using internal instruments based on lagged values of the variables, system GMM helps mitigate biases arising from unobserved firm-specific effects, the inclusion of the lagged dependent variable, and the potential endogeneity of *BUSINESS* and *BUSINESS* × *OVER*. This approach allows us to test whether the baseline reversal pattern remains robust in a dynamic panel setting.[7)]

Table 4 reports the results. The diagnostic tests support the validity of the system GMM specification. The AR (1) test is significant, while the AR (2) test is insignificant, indicating no evidence of second-order serial correlation. The Hansen J test is also insignificant, suggesting no evidence against the validity of the instruments. The coefficient on *RDI* is positive and statistically significant, confirming the persistence of R&D investment. More importantly, the coefficient on *BUSINESS* remains negative, whereas the coefficient on *BUSINESS* × *OVER* remains positive and statistically significant. The linear combination of the coefficients on *BUSINESS* and *BUSINESS* × *OVER* is also positive and statistically significant, indicating that business-educated CEOs are associated with higher R&D investment than non-business CEOs among overvalued firms. These results suggest that the reversal pattern documented in the baseline regressions persists after accounting for R&D persistence and addressing concerns about potential reverse causality.

4.2.2 Endogenous CEO Appointments

The second concern relates to the endogenous appointment of CEOs with business educational backgrounds. Firms with different innovation environments may appoint CEOs with different educational backgrounds. For instance, He and Hirshleifer (2022) note that CEOs with Ph.D. degrees are concentrated in innovative industries, suggesting that CEO educational background may be systematically related to firms' innovation environments. If unobserved firm characteristics affect both the appointment of business-educated CEOs and subsequent R&D investment, the estimated relation between CEO business educational background and R&D investment may be biased.

To address this concern, we employ an instrumental variable (IV) approach. Following

7) In the estimation, we treat *BUSINESS* and *BUSINESS* × *OVER* as endogenous variables. This accounts for the possibility that CEO educational background is related to unobserved firm characteristics that also affect R&D investment. *OVER* is treated as an observed valuation condition rather than as the primary endogenous treatment variable, because the analysis focuses on whether the effect of *BUSINESS* differs across valuation conditions. As a robustness check, we also treat *OVER* as predetermined, allowing it to reflect past firm conditions but not contemporaneous shocks to R&D investment.

〈Table 5〉 Endogeneity checks (2) IV estimation for endogenous CEO appointment

This table reports the instrumental variable estimation results. Columns (1) and (2) report the first-stage regressions for *BUSINESS* and *BUSINESS* × *OVER*, respectively. Column (3) reports the second-stage regression results. *BUSINESS* is instrumented by *BUS_IND*, and *BUSINESS* × *OVER* is instrumented by *BUS_IND* × *OVER*. Definitions of the remaining variables are provided in Table A1. Values in parentheses are *t*-statistics for the first-stage regressions and *z*-statistics for the second-stage regression, based on robust standard errors. The row "$\beta_1 + \beta_3$" reports the estimated sum of the coefficients on *BUSINESS* and *BUSINESS* × *OVER*. The value in parentheses for this row is the *z*-statistic from testing the null hypothesis that $\beta_1 + \beta_3 = 0$. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

		First stage		Second stage
		(1)	(2)	(3)
		BUSINESS	*BUSINESS* × *OVER*	RDI_{t+1} (%)
BUS_IND		0.800***	0.240*	
		(12.76)	(1.88)	
BUS_IND × *OVER*		0.155***	0.209***	
		(3.35)	(5.27)	
BUSINESS (instrumented)	β_1			−0.293*
				(−1.91)
OVER	β_2			1.205***
				(4.11)
BUSINESS × *OVER (instrumented)*	β_3			0.689**
				(2.40)
CEOAGE	γ_1	−0.044***	0.001	−0.325***
		(−2.92)	(0.50)	(−2.60)
CEOOWN	γ_2	0.080**	0.040	0.027
		(1.98)	(0.75)	(1.40)
FIRMSIZE	γ_3	0.007***	0.010***	0.411***
		(3.92)	(2.89)	(4.19)
FIRMAGE	γ_4	0.097***	0.018***	−0.227**
		(8.99)	(2.95)	(−2.15)
ROA	γ_5	0.162***	0.187***	1.677***
		(3.21)	(2.69)	(3.81)
LEV	γ_6	−0.055	−0.010	−5.550***
		(−0.70)	(−1.03)	(−8.04)
TANG	γ_7	0.211***	0.098***	0.711
		(2.99)	(4.22)	(0.22)
CASH	γ_8	0.150***	−0.020	2.097
		(4.50)	(−0.90)	(0.49)
CAPEX	γ_9	0.197***	−0.035	−4.318**
		(3.15)	(−0.73)	(−2.10)
GROWTH	γ_{10}	−0.011**	−0.003*	1.205*
		(−2.10)	(−1.80)	(1.74)
FOR	γ_{11}	0.049***	0.044	1.762
		(2.99)	(1.12)	(0.39)
LARGE	γ_{12}	0.111***	−0.015	−1.097***
		(7.15)	(−0.70)	(−3.28)
Firm FE		Yes	Yes	Yes
Year FE		Yes	Yes	Yes
Observations		21,618	21,618	21,618
Diagnostic test				
Sanderson-Windmeijer *F* statistic		21.86***	24.13***	
Kleibergen-Paap rk *F* statistic				19.31***
$\beta_1 + \beta_3$				0.396**
(z-statistics)				(2.49)

the intuition of Mun and Kim (2021), we use the industry-level proportion of business-educated CEOs (*BUS_IND*), excluding the focal firm, as an IV for CEO business educational background. Industries are defined based on two-digit KSIC codes. The relevance of this instrument rests on the idea that firms are more likely to appoint business-educated CEOs when such CEOs are more prevalent in the same industry. This industry-level prevalence reflects the managerial labor market and CEO appointment patterns within the industry (Kallias et al., 2023). The exclusion restriction rests on the assumption that, conditional on firm characteristics, firm fixed effects, and year fixed effects, the industry-level prevalence of business-educated CEOs affects subsequent R&D investment mainly through the appointment of a business-educated CEO (Mun and Kim, 2021).

Because CEO business educational background enters the model both directly and through its interaction with stock overvaluation, we treat both *BUSINESS* and *BUSINESS* × *OVER* as endogenous regressors. *BUSINESS* is instrumented by *BUS_IND*, and *BUSINESS* × *OVER* is instrumented by the interaction between *BUS_IND* and *OVER*. This approach follows the standard IV principle that when an endogenous variable is interacted with an observed conditioning variable, the interaction term should also be instrumented (e.g., Balli and Sørensen, 2013; Bun and Harrison, 2019).[8)]

Table 5 reports the IV estimation results. Columns (1) and (2) present the first-stage regressions for *BUSINESS* and *BUSINESS* × *OVER*, respectively, and column (3) presents the second-stage results. The first-stage results show that *BUS_IND* is positively and significantly associated with *BUSINESS*, and *BUS_IND* × *OVER* is positively and significantly associated with *BUSINESS* × *OVER*. The Sanderson-Windmeijer F statistics are 21.86 and 24.13 for the two endogenous regressors, respectively, and the Kleibergen-Paap rk F statistic is 19.31. These statistics suggest that weak instrument concerns are unlikely to drive the results.[9)]

The second-stage results are consistent with the baseline findings. The coefficient on *BUSINESS* is negative and statistically significant, while the coefficient on *BUSINESS* × *OVER* is positive and statistically significant. More importantly, the linear combination of the coefficients on *BUSINESS* and *BUSINESS*

8) In this IV specification, *OVER* is treated as an observed valuation condition rather than as the primary endogenous treatment variable. Our objective is not to estimate the standalone causal effect of stock overvaluation, but to examine whether the effect of CEO business educational background differs across valuation conditions.

9) The model is exactly identified because the two endogenous regressors, *BUSINESS* and *BUSINESS* × *OVER*, are instrumented by two excluded instruments, *BUS_IND* and *BUS_IND* × *OVER*. Therefore, overidentification tests such as the Sargan or Hansen J test are not available. We instead report the Sanderson-Windmeijer F statistics

× *OVER* is positive and statistically significant. These results indicate that, even after addressing concerns about endogenous CEO appointment, business-educated CEOs are associated with higher R&D investment than non-business CEOs among overvalued firms. Thus, the IV results continue to support the reversal hypothesis.

4.2.3 Observable Selection Bias

The third concern relates to observable selection bias. Firms led by business-educated CEOs may differ from firms led by non-business CEOs in observable characteristics (Dong et al., 2025). Similarly, overvalued firms may differ from non-overvalued firms in financial conditions or investment capacity (Mrad et al., 2024; Yim, 2025). These differences may affect subsequent R&D investment independently of CEO educational background or valuation status. If firms with certain observable characteristics are more likely to appoint business-educated CEOs or to be classified as overvalued, the estimated interaction effect may partly reflect differences in firm composition rather than the effect of CEO business educational background among overvalued firms.

To address this concern, we employ propensity score matching (PSM) to construct more comparable samples. We conduct two separate matching procedures. First, the treatment group consists of firm-year observations led by CEOs with business educational backgrounds (*BUSINESS* = 1), and the control group consists of firm-year observations led by CEOs without such backgrounds (*BUSINESS* = 0). We refer to this sample as the business-matched sample. Second, the treatment group consists of overvalued firm-year observations (*OVER* = 1), and the control group consists of non-overvalued firm-year observations (*OVER* = 0). We refer to this sample as the overvaluation-matched sample. The propensity scores are estimated using the full set of control variables included in the baseline regression model. We perform one-to-one nearest-neighbor matching with replacement under a common-support restriction and then re-estimate the baseline model using each matched sample. Table A3 in the Appendix reports covariate balance tests, showing that the matching procedure substantially reduces observable differences between treated and control observations.

Table 6 reports the regression results using propensity score-matched samples. Column

and the Kleibergen-Paap rk *F* statistic. The Sanderson-Windmeijer F statistics are appropriate because the model includes multiple endogenous regressors and they assess the conditional relevance of the excluded instruments for each endogenous regressor (Sanderson and Windmeijer, 2016). The Kleibergen-Paap rk *F* statistic is appropriate under heteroskedasticity-robust inference (Kleibergen and Paap, 2006).

〈Table 6〉 Endogeneity checks (3) propensity score matching

This table reports regression results using propensity score-matched samples. Column (1) reports the results based on the business-matched sample, where firms led by CEOs with business educational backgrounds are matched with firms led by CEOs without such backgrounds. Column (2) reports the results based on the overvaluation-matched sample, where overvalued firms are matched with non-overvalued firms. Definitions of the remaining variables are provided in Table A1. Values in parentheses are *t*-statistics based on standard errors clustered at the firm level. The row "$\beta_1 + \beta_3$" reports the estimated sum of the coefficients on *BUSINESS* and *BUSINESS* × *OVER*. The value in parentheses for this row is the *t*-statistic from testing the null hypothesis that $\beta_1 + \beta_3 = 0$. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

		Dependent variable = RDI_{t+1} (%)	
		(1)	(2)
		Business-matched sample	Overvaluation-matched sample
BUSINESS	β_1	−0.393**	−0.443**
		(−2.30)	(−2.35)
OVER	β_2	1.003***	0.920***
		(4.29)	(3.88)
BUSINESS × *OVER*	β_3	0.758***	0.776***
		(3.15)	(3.20)
CEOAGE	γ_1	−0.390*	−0.463*
		(−1.79)	(−1.91)
CEOOWN	γ_2	0.230**	0.225**
		(2.43)	(2.20)
FIRMSIZE	γ_3	0.680***	0.680***
		(6.79)	(6.30)
FIRMAGE	γ_4	−1.466***	−0.953***
		(−7.50)	(−5.61)
ROA	γ_5	8.940***	8.755***
		(8.90)	(8.30)
LEV	γ_6	−6.711***	−7.081***
		(−7.90)	(−8.65)
TANG	γ_7	0.133	0.176
		(0.59)	(1.30)
CASH	γ_8	1.200	2.601**
		(1.49)	(2.30)
CAPEX	γ_9	−4.977***	−4.333**
		(−3.03)	(−2.34)
GROWTH	γ_{10}	0.780***	0.549**
		(3.30)	(2.13)
FOR	γ_{11}	1.160	1.313
		(0.97)	(1.52)
LARGE	γ_{12}	−4.433***	−4.580***
		(−6.70)	(−6.46)
Constant	α	−0.423***	−0.370*
		(−2.99)	(−1.89)
Firm FE		Yes	Yes
Year FE		Yes	Yes
Observations		19,120	14,370
Within R^2		0.233	0.229
$\beta_1 + \beta_3$		0.365***	0.333**
(*t*-statistics)		(2.80)	(2.17)

(1) presents the results based on the business-matched sample, and Column (2) presents the results based on the overvaluation-matched sample. In both columns, the coefficient on *BUSINESS* remains negative, whereas the coefficient on *BUSINESS* × *OVER* remains positive and statistically significant. The sum of the coefficients, $\beta_1 + \beta_3$, is positive and statistically significant. These findings indicate that the reversal pattern remains after reducing observable differences related to the two components of the interaction term, CEO business educational background and stock overvaluation status.[10)]

4.3 Robustness Checks

We conduct several robustness checks to examine whether the baseline reversal pattern is sensitive to alternative variable definitions, sample restrictions, and fixed-effect structures. Table 7 reports the results. Columns (1) and (2) examine whether the baseline results are sensitive to the measurement of R&D investment. In Column (1), we use *RDA (%)*, measured as R&D expenditure scaled by lagged total assets and multiplied by 100. In Column (2), we use *LnRD*, measured as the natural logarithm of R&D expenditure. In both specifications, *BUSINESS* remains negative, *BUSINESS* × *OVER* remains positive and statistically significant, and the linear combination of the two coefficients remains positive and statistically significant. These results indicate that the reversal pattern is not driven by the choice of sales-scaled R&D intensity as the baseline dependent variable.

Column (3) restricts the sample to firms with positive R&D expenditure. This test addresses the possibility that the baseline results are driven by firms that report zero R&D expenditure. The results remain consistent with the baseline findings. The coefficient on *BUSINESS* is negative and statistically significant, the coefficient on *BUSINESS* × *OVER* is positive and statistically significant, and the linear combination, $\beta_1 + \beta_3$, is positive and statistically significant. This finding suggests that the reversal pattern also holds among firms that engage in R&D investment.

Column (4) redefines *OVER* using the highest quintile of firm-specific misvaluation, providing a more restrictive definition of overvaluation (e.g., Alzahrani and Rao, 2014). The results remain unchanged. BUSINESS is negative and statistically significant, *BUSINESS*

10) Although PSM helps mitigate observable selection bias, it does not directly eliminate the potential endogeneity of the interaction term itself. Because the main coefficient of interest is *BUSINESS* × *OVER*, the matching analyses should be interpreted as complementary evidence that reduces observable differences in the two components of the interaction term, CEO business educational background and stock overvaluation status.

〈Table 7〉 Robustness checks

This table reports robustness check results. The dependent variables in Columns (1) and (2) are *RDA* (%) and *LnRD*, respectively. In Columns (3) to (6), the dependent variable is *RDI* (%). Column (3) restricts the sample to firms with positive R&D expenditure. In Column (4), *OVER* is redefined as an indicator equal to one for firm-year observations in the highest quintile of firm-specific misvaluation (FSE). Column (5) replaces the indicator measure of overvaluation with the continuous FSE component derived from the Rhodes-Kropf et al. (2005) decomposition and includes its interaction with *BUSINESS*. Column (6) includes industry-by-year fixed effects. Definitions of the remaining variables are provided in Table A1. Values in parentheses are *t*-statistics based on standard errors clustered at the firm level. Within R^2 is reported for Columns (1) to (5), and adjusted R^2 is reported for Column (6). The row "$\beta_1 + \beta_3$" reports the estimated sum of the coefficients on *BUSINESS* and *BUSINESS* × *OVER*. The value in parentheses for this row is the *t*-statistic from testing the null hypothesis that $\beta_1 + \beta_3 = 0$. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

		(1) *RDA* (%)	(2) *LnRD*	(3) Positive R&D sample only	(4) *OVER* based on top quintile of FSE	(5) Continuous FSE	(6) Industry × Year FE
BUSINESS	β_1	−0.361** (−2.23)	−0.060* (−1.79)	−0.477** (−2.13)	−0.379* (−1.83)	−0.404** (−2.05)	−0.125** (−2.11)
OVER	β_2	0.835*** (5.43)	0.293*** (4.67)	1.225*** (6.37)	1.295*** (6.50)		0.997*** (3.69)
BUSINESS × *OVER*	β_3	0.606*** (2.80)	0.121** (2.32)	0.655*** (2.73)	0.813*** (2.99)		0.414** (2.38)
FSE	β_4					0.197*** (8.45)	
BUSINESS × *FSE*	β_5					0.098*** (4.70)	
Control variables		Yes	Yes	Yes	Yes	Yes	Yes
Constant		Yes	Yes	Yes	Yes	Yes	Yes
Firm FE		Yes	Yes	Yes	Yes	Yes	No
Year FE		Yes	Yes	Yes	Yes	Yes	No
Industry × Year FE		No	No	No	No	No	Yes
Observations		21,618	21,618	13,109	21,618	21,618	21,618
R^2		0.209	0.172	0.195	0.221	0.151	0.189
$\beta_1 + \beta_3$ (*t*-statistics)		0.245* (1.93)	0.061** (2.01)	0.178** (2.00)	0.434*** (3.49)	–	0.289** (2.30)

× *OVER* is positive and statistically significant, and the linear combination is positive and significant at the 1% level. This result indicates that the baseline conclusion is not sensitive to the tercile cutoff used to define overvalued firms.

Column (5) replaces the indicator measure of overvaluation with the continuous firm-specific misvaluation component (FSE). The coefficient on *BUSINESS* remains negative, while the coefficient on *BUSINESS* × *FSE* is positive and statistically significant. Thus,

the relation between CEO business education and R&D becomes more positive as FSE increases, indicating that the baseline interaction result is not driven by the discrete cutoff used to define overvalued firms.[11)]

Column (6) includes industry-by-year fixed effects. This specification absorbs time-varying industry-level shocks that may affect firms within the same industry-year. The coefficient on *BUSINESS* remains negative, whereas the coefficient on *BUSINESS* × *OVER* remains positive and statistically significant. The linear combination is also positive and statistically significant. Thus, the reversal pattern persists even after controlling for time-varying industry-level factors.

4.4 Mechanism Tests

Having established the reversal pattern across the baseline, endogeneity, and robustness analyses, we next examine the mechanisms through which stock overvaluation changes the relation between CEO business educational background and R&D investment. The baseline results show that business-educated CEOs are associated with lower R&D investment when firms are not overvalued, but higher R&D investment when firms are overvalued. This pattern may arise through different channels.

One possible channel is the equity-financing mechanism. Stock overvaluation may provide firms with favorable equity financing opportunities (Baker et al., 2003; McLean and Zhao, 2014; Warusawitharana and Whited, 2016), and business-educated CEOs may be more likely to recognize and use these opportunities to support R&D investment. Another possible channel is the catering mechanism. Stock overvaluation may increase incentives to respond to market expectations (Gao, 2010; Jensen, 2005; Jin, 2022; Polk and Sapienza, 2009), and business-educated CEOs may respond by increasing visible growth-oriented investments such as R&D. These mechanisms are not necessarily mutually exclusive.

To distinguish these mechanisms, we jointly consider financial constraints and investor horizons. Financial constraints capture the extent to which favorable equity financing opportunities are valuable to the firm. If the reversal pattern is driven by the equity financing mechanism, the positive conditional effect of CEO business educational background among overvalued firms should be more pronounced among financially con-

11) As an additional untabulated robustness check, we redefine *OVER* as an indicator equal to one when firm-specific misvaluation is greater than zero. The results remain consistent with the baseline findings: *BUSINESS* remains negative, *BUSINESS* × *OVER* remains positive and statistically significant, and the conditional effect of *BUSINESS* among overvalued firms remains positive and statistically significant.

strained firms. Investor horizons capture the extent to which firms are exposed to investors with shorter trading horizons, which may intensify valuation-related market pressure. If the reversal pattern is driven by the catering mechanism, the positive conditional effect should be more pronounced among firms with short-horizon investors. We therefore divide the sample into four groups based on financial constraint status and investor horizon.

We measure financial constraints using a modified KZ index following Baker et al. (2003). Because the conventional KZ index includes Tobin's Q, it may mechanically overlap with our stock overvaluation measure. We therefore exclude Tobin's Q from the index and calculate the modified KZ index as follows:

$$KZindex_{i,t} = -1.002 \times \frac{CF_{i,t}}{A_{i,t-1}} - 39.368 \times \frac{DIV_{i,t}}{A_{i,t-1}} - 1.315 \times \frac{C_{i,t}}{A_{i,t-1}} + 3.139 \times LEV_{i,t} \quad (3)$$

In Eq. (3), CF denotes cash flow, DIV denotes cash dividends, C is cash holdings, A denotes total assets, and LEV is leverage. Firms with modified KZ index values above the annual median are classified as financially constrained, and the remaining firms are classified as financially unconstrained. Following Alzahrani and Rao (2014), we measure investor horizon using stock turnover. Specifically, the turnover ratio is calculated as the average monthly ratio of shares traded to shares outstanding over the fiscal year. A higher turnover ratio indicates that shares change hands more frequently and is therefore interpreted as reflecting a shorter investor horizon. Firms with turnover ratios above the annual median are classified as short-horizon investor firms, and the remaining firms are classified as long-horizon investor firms.

We first examine financial constraints and investor horizons separately before examining their joint classification. If the equity-financing mechanism is the primary explanation, the reversal should be more evident among financially constrained firms, for which favorable equity-financing conditions are particularly valuable. By contrast, if the catering mechanism is more relevant, the reversal should be more evident among firms with short-horizon investors, where pressure to respond to market expectations is likely to be stronger. We then combine the two dimensions in a 2 × 2 classification to examine whether the investor-horizon pattern persists across financial constraint status.

Table 8 reports the mechanism test results. Panel A presents the separate subsample analyses. Columns (1) and (2) divide the sample by financial constraint status, while Columns (3) and (4) divide the sample by investor horizon. In both the constrained

〈Table 8〉 Mechanism tests

This table reports the mechanism test results based on subsamples classified by financial constraint status and investor horizon. Financial constraints are measured using the modified KZ index following Baker et al. (2003), excluding Tobin's Q from the conventional KZ index. Firms with modified KZ index values above the annual median are classified as financially constrained, and the remaining firms are classified as financially unconstrained. Investor horizon is measured using stock turnover following Alzahrani and Rao (2014). Firms with turnover ratios above the annual median are classified as short-horizon investor firms, and the remaining firms are classified as long-horizon investor firms. Panel A reports separate subsample analyses by financial constraint status and investor horizon. Columns (1) and (2) divide the sample into financially constrained and unconstrained firms, respectively, while Columns (3) and (4) divide the sample into short- and long-horizon investor firms, respectively. Panel B reports the joint 2 × 2 classification based on both financial constraint status and investor horizon. Definitions of the remaining variables are provided in Table A1. Values in parentheses are *t*-statistics based on standard errors clustered at the firm level. The row "$\beta_1 + \beta_3$" reports the estimated sum of the coefficients on *BUSINESS* and *BUSINESS* × *OVER*. The value in parentheses for this row is the *t*-statistic from testing the null hypothesis that $\beta_1 + \beta_3 = 0$. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

		Dependent variable = RDI_{t+1} (%)			
Panel A. Separate subsample analysis					
		(1) Constrained	(2) Unconstrained	(3) Short-horizon	(4) Long-horizon
BUSINESS	β_1	−0.455**	−0.469**	−0.445**	−0.493**
		(−2.25)	(−2.40)	(−2.11)	(−2.53)
OVER	β_2	0.949***	0.935***	0.943***	1.000***
		(5.60)	(5.59)	(5.44)	(5.59)
BUSINESS × *OVER*	β_3	0.703***	0.713***	0.889***	0.572
		(2.83)	(2.90)	(3.45)	(1.60)
Control variables		Yes	Yes	Yes	Yes
Constant		Yes	Yes	Yes	Yes
Firm FE		Yes	Yes	Yes	Yes
Year FE		Yes	Yes	Yes	Yes
Observations		10,809	10,809	10,809	10,809
Within R^2		0.211	0.215	0.224	0.221
$\beta_1 + \beta_3$		0.248**	0.244**	0.444***	0.079
(*t*-statistics)		(2.03)	(2.03)	(3.52)	(1.05)
Panel B. Joint financial-constraint × investor-horizon analysis					
		(1) Constrained × Short-horizon	(2) Constrained × Long-horizon	(3) Unconstrained × Short-horizon	(4) Unconstrained × Long-horizon
BUSINESS	β_1	−0.503**	−0.492***	−0.489***	−0.469***
		(−2.33)	(−2.70)	(−2.69)	(−2.61)
OVER	β_2	0.905***	1.111***	0.965***	0.935***
		(5.57)	(6.76)	(5.99)	(5.50)
BUSINESS × *OVER*	β_3	0.776***	0.621*	0.851***	0.555
		(3.29)	(1.69)	(3.70)	(1.37)
Control variables		Yes	Yes	Yes	Yes
Constant		Yes	Yes	Yes	Yes
Firm FE		Yes	Yes	Yes	Yes
Year FE		Yes	Yes	Yes	Yes
Observations		5,184	5,625	5,614	5,195
Within R^2		0.193	0.200	0.208	0.194
$\beta_1 + \beta_3$		0.273**	0.129	0.362***	0.086
(*t*-statistics)		(2.15)	(1.19)	(2.70)	(1.09)

and unconstrained subsamples, BUSINESS is negative and statistically significant, while *BUSINESS* × *OVER* is positive and statistically significant. The interaction coefficients are also very similar in magnitude, at 0.703 and 0.713, respectively. The conditional effects of *BUSINESS* among overvalued firms, $\beta_1 + \beta_3$, are 0.248 for constrained firms and 0.244 for unconstrained firms. Thus, the relation between CEO business education and R&D under overvaluation does not appear to be concentrated among financially constrained firms.

The results differ more clearly when the sample is divided by investor horizon. In the short-horizon subsample, *BUSINESS* is negative and significant, whereas *BUSINESS* × *OVER* is positive and significant. The corresponding conditional effect of *BUSINESS* among overvalued firms is 0.444 (t = 3.52). In the long-horizon subsample, *BUSINESS* remains negative and significant, but *BUSINESS* × *OVER* is statistically insignificant, and the corresponding conditional effect is only 0.079 (t = 1.05). These results provide more direct evidence that the reversal pattern is associated with investor horizon rather than financial constraint status.

Panel B further examines the two dimensions jointly. The results reinforce the pattern in Panel A. The conditional effect of *BUSINESS* among overvalued firms is positive and statistically significant for financially constrained firms with short-horizon investors (0.273) and for financially unconstrained firms with short-horizon investors (0.362). By contrast, the corresponding effects are statistically insignificant for constrained firms with long-horizon investors (0.129) and unconstrained firms with long-horizon investors (0.086). Thus, the reversal is observed in both financial constraint groups when investor horizons are short, but not when investor horizons are long.

Taken together, the separate and joint subsample analyses point to investor horizon, rather than financial constraint status, as the dimension more closely associated with the reversal pattern. If favorable equity financing were the primary mechanism, the reversal would be expected to be concentrated among financially constrained firms. Instead, it appears across both constrained and unconstrained firms when investor horizons are short. This pattern is difficult to reconcile with a pure equity-financing explanation and is more consistent with a catering-based interpretation.

Additional analysis in Table A4 of the Appendix shows that business-educated CEOs are more likely to issue equity under overvaluation, but equity issuance itself is not significantly associated with subsequent R&D investment. This finding suggests that business-educated CEOs may use favorable equity market conditions, but such financing be-

havior does not appear to explain the reversal pattern in R&D investment.

4.5 Further Tests

CEO ownership status and Chaebol affiliation may provide alternative explanations for the documented relation between CEO business education and R&D investment. Prior Korean evidence suggests that owner-managers and professional managers differ in their R&D investment behavior. For example, Kim and Song (2011) find that firms managed by professional CEOs exhibit significantly lower R&D intensity than firms managed by owner CEOs. In addition, the Chaebol structure represents an important feature of the Korean corporate environment. Ryu and Cho (2021) argue that the distinctive ownership and control structure of Korean Chaebols can affect firms' R&D expenditure behavior beyond governance characteristics at the individual-firm level. We therefore examine whether the baseline reversal varies systematically with CEO ownership status and Chaebol affiliation.

Following the Korean literature, we identify owner CEOs using the CEO's relationship with the firm's largest shareholder. Specifically, *OWNERCEO* equals one if the identified CEO is reported as the largest shareholder or a related party of the largest shareholder, and zero otherwise. This approach is consistent with prior Korean research that uses information on the largest shareholder, relatives, and related parties to distinguish owner-managers from professional managers (Kim and Kim, 2025). *CHAEBOL* equals one if the firm belongs to a designated business group in year t, and zero otherwise. We estimate separate three-way interaction models for *OWNERCEO* and *CHAEBOL* and include all corresponding lower-order interaction terms. This specification allows us to test directly whether the positive interaction between *BUSINESS* and *OVER* varies with CEO ownership status or Chaebol affiliation.

Table 9 reports the results. Column (1) examines CEO ownership status. The coefficient on *OWNERCEO* is positive and statistically significant, whereas *BUSINESS* × *OWNERCEO* is insignificant. More importantly, *BUSINESS* × *OVER* remains positive and significant, whereas *BUSINESS* × *OVER* × *OWNERCEO* is statistically insignificant. Thus, there is no evidence that the reversal in the relation between CEO business education and R&D under overvaluation differs systematically between owner and professional CEOs.

Column (2) examines Chaebol affiliation. The coefficient on *CHAEBOL* is positive and statistically significant, and the coefficient on *BUSINESS* × *CHAEBOL* is also positive and significant. However, the coefficient on *BUSINESS* × *OVER* × *CHAEBOL* is statisti-

〈Table 9〉 CEO ownership status, Chaebol affiliation, and the reversal effect

This table examines whether the relation between CEO business education, stock overvaluation, and subsequent R&D investment varies with CEO ownership status and Chaebol affiliation. Column (1) reports the results using CEO ownership status. *OWNERCEO* equals one if the CEO is identified as the largest shareholder or a related party of the largest shareholder, and zero otherwise. Column (2) reports the results using Chaebol affiliation. *CHAEBOL* equals one if the firm belongs to a designated business group in year t, and zero otherwise. Each specification includes all corresponding lower-order interaction terms. The coefficients on *BUSINESS* × *OVER* × *OWNERCEO* and *BUSINESS* × *OVER* × *CHAEBOL* test whether the interaction between *BUSINESS* and *OVER* differs by CEO ownership status and Chaebol affiliation, respectively. Definitions of the remaining variables are provided in Table A1. Values in parentheses are t-statistics based on standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable = RDI_{t+1} (%)	
	(1) Owner status	(2) Chaebol affiliation
BUSINESS	−0.443** (−2.03)	−0.453** (−2.17)
OVER	0.915*** (3.78)	0.945*** (3.80)
BUSINESS × *OVER*	0.707*** (2.87)	0.743*** (2.90)
OWNERCEO	0.167** (2.03)	
BUSINESS × *OWNERCEO*	−0.033 (−0.45)	
OVER × *OWNERCEO*	0.063 (0.89)	
BUSINESS × *OVER* × *OWNERCEO*	−0.005 (−0.13)	
CHAEBOL		0.323*** (5.27)
BUSINESS × *CHAEBOL*		0.208*** (3.02)
OVER × *CHAEBOL*		−0.049 (−0.38)
BUSINESS × *OVER* × *CHAEBOL*		−0.015 (−0.16)
Control variables	Yes	Yes
Constant	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	21,618	21,618
Within R^2	0.266	0.259

cally insignificant. Thus, although Chaebol affiliation is associated with the baseline relation between CEO business education and R&D, it does not significantly alter the reversal associated with overvaluation. Taken together, these results provide no evidence that the documented reversal differs systematically by CEO ownership status or Chaebol affiliation, suggesting that the baseline finding is unlikely to be attributable solely to these ownership and governance characteristics.

Ⅴ. Conclusion

This study examines how CEO business educational background shapes R&D investment under stock overvaluation. Using Korean listed firms from 2011 to 2023, we find a reversal in the relation between CEO business educational background and R&D investment. CEOs with business educational backgrounds are associated with lower R&D investment when firms are not overvalued. However, this negative relation reverses when firms are overvalued. Among overvalued firms, business-educated CEOs are associated with higher R&D investment than other CEOs. This evidence supports the reversal hypothesis rather than the amplification or mitigation hypothesis. More broadly, the pattern suggests that stock overvaluation shapes how business-educated CEOs translate their training in financing and capital allocation into R&D investment decisions. This finding remains robust in analyses that account for R&D persistence, mitigate concerns about potential reverse causality, address endogenous CEO appointment, and reduce observable selection bias. It also persists across alternative measures of R&D investment, alternative definitions of overvaluation, restrictions to firms with positive R&D expenditure, and industry-by-year fixed effects.

The mechanism tests suggest that this reversal pattern is difficult to reconcile with a pure equity-financing explanation and is more consistent with a catering-based interpretation. If favorable equity financing opportunities were the main channel, the positive effect of CEO business educational background among overvalued firms should be stronger among financially constrained firms. However, the results show that this effect is significant only among firms with short-horizon investors, regardless of financial constraint status. The effect is insignificant among firms with long-horizon investors, even when they are financially constrained. Additional analysis further shows that business-educated CEOs are more likely to issue equity when firms are overvalued, but equity issuance itself is not significantly associated with subsequent R&D investment. These

findings do not provide strong support for the view that easier equity financing is the primary explanation for the reversal pattern. Although business-educated CEOs appear to use favorable equity market conditions under overvaluation, their R&D response does not appear to be primarily financing-driven. Rather, it is more consistent with catering incentives that may become more salient when market expectations matter more.

Taken together, the findings indicate that the effect of CEO business educational background on R&D investment is not fixed. It depends critically on stock market valuation conditions. Business education appears to be associated with a more conservative approach to R&D investment when firms are not overvalued. Yet, under overvaluation, the same educational background is associated with a stronger R&D response, especially among firms with short-horizon investors. This evidence is consistent with the view that short-horizon investor environments strengthen the association between CEO business education and R&D investment under overvaluation. Thus, this study shows that corporate R&D investment is shaped not only by CEO characteristics, but also by the valuation conditions under which those characteristics operate.

5.1 Research Implications

This study extends the upper echelons literature by showing that CEO educational background does not have a uniform effect on R&D investment. Rather, its effect depends on the valuation conditions under which CEOs make investment decisions. This finding suggests that CEO business education should be understood not only as a proxy for managerial ability or preference, but also as a factor that shapes how CEOs interpret and respond to valuation-related market signals. In this sense, CEO educational background functions as a context-dependent managerial attribute rather than as a fixed predictor of R&D investment.

The findings also have implications for how the relation between stock misvaluation and corporate investment should be interpreted. Prior studies show that overvaluation can affect real investment through financing opportunities or catering incentives. Our results suggest that this relation should not be viewed as a purely firm-level response to valuation conditions. Rather, the investment response to overvaluation may depend on the characteristics of the CEO who interprets valuation signals and translates them into investment decisions. Thus, overvaluation does not mechanically translate into R&D investment. Its effect on real investment should be understood in conjunction with

managerial characteristics.

The findings also have practical implications for how R&D investment is interpreted. Increases in R&D spending are often viewed as evidence of stronger innovation commitment. Our results suggest that this interpretation may be incomplete when firms are overvalued. In such settings, R&D investment may reflect a response to valuation-related market pressure, particularly when firms are exposed to short-horizon investors. This distinction is important because increases in R&D investment among firms led by business-educated CEOs under overvaluation should not be interpreted simply as the result of improved financing capacity. They may also reflect responses to market expectations that become more salient in short-horizon investor environments. This does not imply that R&D investment under overvaluation is necessarily inefficient or value-destroying. Rather, it suggests that such investment should be interpreted in relation to the valuation environment and investor horizon in which it occurs.

The findings further suggest that investors, boards, and innovation evaluators should look beyond the amount of R&D spending. Investors and analysts should consider whether R&D increases among overvalued firms reflect sustained innovation plans or market-responsive behavior. Boards should assess the continuity and technological rationale of R&D projects, rather than focusing only on the amount of spending. More broadly, innovation evaluation frameworks should distinguish between R&D investment driven by long-term technological objectives and R&D investment induced by market pressure.

5.2 Limitations and Future Research

This study has several limitations that provide opportunities for future research. First, the analysis focuses on R&D investment rather than innovation outcomes or innovation quality. Although the results show that business-educated CEOs increase R&D investment when firms are overvalued, this study does not directly examine whether such investment leads to greater innovation output, higher-quality innovation, greater R&D efficiency, or long-term firm value. This limitation is important because R&D spending captures resource commitment, but not necessarily the economic or technological value generated by that commitment. Future research could examine whether the R&D increases documented in this study translate into patents, citation-weighted innovation outcomes, R&D efficiency, or subsequent firm performance.

A further limitation relates to the measurement of stock overvaluation. This study relies primarily on the misvaluation decom-

position approach of Rhodes-Kropf et al. (2005) to identify firm-specific overvaluation. Although this approach is widely used and allows us to separate firm-specific valuation deviations from broader valuation components, overvaluation can also be measured using alternative frameworks, such as residual income models, fundamental cash-flow-based valuation measures, or forecast-based intrinsic value estimates (e.g., Bonaimé et al., 2014; Dong et al., 2021; Jin, 2022; Shen et al., 2021). Due to data limitations, this study does not fully examine whether the results hold across these alternative measures. Future research could use richer valuation data to test whether the reversal pattern documented in this study is robust across different approaches to measuring stock overvaluation.

Finally, although this study conducts several analyses to mitigate endogeneity concerns, including dynamic panel estimation, instrumental variable estimation, and propensity score matching, the findings should be interpreted cautiously in causal terms. CEO appointment decisions, valuation conditions, and R&D investment may still be jointly influenced by unobservable firm characteristics or market expectations. In addition, the mechanism tests provide evidence consistent with the catering mechanism, but they do not directly observe managerial intentions or the specific expectations imposed by investors. Future research could use exogenous shocks to valuation conditions, investor horizons, or CEO appointments to provide sharper causal evidence. Future research could also use textual disclosures, conference calls, or R&D project-level information to examine more directly how CEOs justify R&D investment decisions under stock overvaluation.

References

Adner, R., and Helfat, C. E. (2003). "Corporate effects and dynamic managerial capabilities," *Strategic Management Journal*, 24(10), pp.1011-1025.

Alzahrani, M., and Rao, R. P. (2014). "Managerial behavior and the link between stock mispricing and corporate investments: Evidence from market-to-book ratio decomposition," *The Financial Review*, 49(1), pp.89-116.

Arellano, M., and Bover, O. (1995). "Another look at the instrumental variable estimation of error-components models," *Journal of Econometrics*, 68(1), pp.29-51.

Baker, M., Stein, J. C., and Wurgler, J. (2003). "When does the market matter? Stock prices and the investment of equity-dependent firms," *The Quarterly Journal of Economics*, 118(3), pp.969-1005.

Baker, M., and Wurgler, J. (2004). "A catering theory of dividends," *The Journal of Finance*,

59(3), pp.1125-1165.

Balli, H. O., and Sørensen, B. E. (2013). "Interaction effects in econometrics," *Empirical Economics*, 45, pp.583-603.

Barker, V. L., and Mueller, G. C. (2002). "CEO characteristics and firm R&D spending," *Management Science*, 48(6), pp.782-801.

Baxamusa, M. (2011). "How well do market timing, catering, and classical theories explain corporate decisions?" *The Journal of Financial Research*, 34(2), pp.217-239.

Benmelech, E., and Frydman, C. (2015). "Military CEOs," *Journal of Financial Economics*, 117(1), pp.43-59.

Bertrand, M., and Schoar, A. (2003). "Managing with style: The effect of managers on firm policies," *The Quarterly Journal of Economics*, 118(4), pp.1169-1208.

Bonaimé, A. A., Öztekin, Ö., and Warr, R. S. (2014). "Capital structure, equity mispricing, and stock repurchases," *Journal of Corporate Finance*, 26, pp.182-200.

Bun, M. J. G., and Harrison, T. D. (2019). "OLS and IV estimation of regression models including endogenous interaction terms," *Econometric Reviews*, 38(7), pp.814-827.

Chan, L. K. C., Lakonishok, J., and Sougiannis, T. (2001). "The stock market valuation of research and development expenditures," *The Journal of Finance*, 56(6), pp.2431-2456.

Christensen, L. J., Peirce, E., Hartman, L. P., Hoffman, W. M., and Carrier, J. (2007). "Ethics, CSR, and sustainability education in the Financial Times Top 50 Global Business Schools: Baseline data and future research directions," *Journal of Business Ethics*, 73, pp.347-368.

Custódio, C., Ferreira, M. A., and Matos, P. (2019). "Do general managerial skills spur innovation?" *Management Science*, 65(2), pp.459-476.

Custódio, C., and Metzger, D. (2014). "Financial expert CEOs: CEO's work experience and firm's financial policies," *Journal of Financial Economics*, 114(1), pp.125-154.

Czarnitzki, D., and Toole, A. A. (2011). "Patent protection, market uncertainty, and R&D investment," *The Review of Economics and Statistics*, 93(1), pp.147-159.

Dang, T. V., and Xu, Z. (2018). "Market sentiment and innovation activities," *Journal of Financial and Quantitative Analysis*, 53(3), pp.1135-1161.

Darmadi, S. (2013). "Board members' education and firm performance: Evidence from a developing economy," *Review of International Business and Strategy*, 23(2), pp.113-135.

Dong, M., Hirshleifer, D., and Teoh, S. H. (2021). "Misvaluation and corporate inventiveness," *Journal of Financial and Quantitative Analysis*, 56(8), pp.2605-2633.

Dong, Z., Jianxin, Z., and Shahzad, U. (2025). "CEO with a business educational background and corporate resilience," *Journal of Management Analytics*, 12(3), pp.552-581.

Driouchi, T., Chen, M., Lyu, Z., Bennett, D. J., and So, R. H. Y. (2022). "Ambiguity, managerial ability, and growth options," *British Journal of Management*, 33(3), pp.1323-1345.

Duong, L. Q. (2024). "Stock mispricing and firm innovation: Evidence from an emerging equity market," *Operations Research Forum*, 5, 112.

Gao, H. (2010). "Market misvaluation, managerial horizon, and acquisitions," *Financial Management*, 39(2), pp.833-850.

Gottesman, A. A., and Morey, M. R. (2006). "Manager education and mutual fund performance," *Journal of Empirical Finance*, 13(2), pp.145-182.

Gounopoulos, D., Loukopoulos, G., and Loukopoulos, P. (2021). "CEO education and the ability to raise capital," *Corporate Governance: An International Review*, 29(1), pp.67-99.

Graham, J. R., Harvey, C. R., and Puri, M. (2013). "Managerial attitudes and corporate actions," *Journal of Financial Economics*, 109(1), pp.103-121.

Gupta, G. (2022). "CEO's educational background, economic policy uncertainty, and investment-cash flow sensitivity: Evidence from India," *Applied Economics*, 54(5), pp.568-579.

Gupta, G., Mahakud, J., and Verma, V. (2021). "CEO's education and investment-cash flow sensitivity: An empirical investigation," *International Journal of Managerial Finance*, 17(4), pp.589-618.

Ha, Y. B., and Lee, S. H. (2014). "The effects of CEO characteristics on firm R&D investment," *Korea International Accounting Review*, 58, pp.103-125.

Hambrick, D. C. (2007). "Upper echelons theory: An update," *Academy of Management Review*, 32(2), pp.334-343.

Hambrick, D. C., and Mason, P. A. (1984). "Upper echelons: The organization as a reflection of its top managers," *Academy of Management Review*, 9(2), pp.193-206.

He, Z., and Hirshleifer, D. (2022). "The exploratory mindset and corporate innovation," *Journal of Financial and Quantitative Analysis*, 57(1), pp.127-169.

Hottenrott, H., Hall, B. H., and Czarnitzki, D. (2016). "Patents as quality signals? The implications for financing constraints on R&D," *Economics of Innovation and New Technology*, 25(3), pp.197-217.

Jensen, M. C. (2005). "Agency costs of overvalued equity," *Financial Management*, 34(1), pp.5-19.

Jin, Y. (2022). "Firm misvaluation and corporate social responsibility," *Asia-Pacific Journal of Financial Studies*, 51(4), pp.517-540.

Kallias, A., Kallias, K., Tsalkamas, I., and Zhang, S. (2023). "One size does not fit all: The conditional role of CEO education on IPO performance," *Journal of Business Research*, 157, 113560.

Kim, E. (2025). "MBA CEOs and innovation," SSRN Working Paper No.5143016.

Kim, H. (2021). "The effect of equity valuation on external financing," *Korean Management Review*, 50(4), pp.959-980.

Kim, H., and Kim, Y. M. (2025). "Co-CEOs and R&D investment efficiency," *Korean Management Review*, 54(1), pp.133-161.

Kim, H., and Song, J. (2011). "The impact of corporate ownership structure on R&D investment in Korea," *Journal of Strategic Management*, 14(2), pp.93-112.

Kleibergen, F., and Paap, R. (2006). "Generalized reduced rank tests using the singular value decomposition," *Journal of Econometrics*, 133(1), pp.97-126.

Kusnadi, Y., and Wei, K. C. J. (2017). "The equity-financing channel, the catering channel, and corporate investment: International

evidence," *Journal of Corporate Finance*, 47, pp.236-252.

Li, K. (2026). "Valuation driven innovation," *Asia-Pacific Financial Markets*, 33, pp.589-631.

Loukil, N., and Yousfi, O. (2022). "Do CEO's traits matter in innovation outcomes?" *Journal of International Entrepreneurship*, 20, pp.375-403.

Malmendier, U., and Tate, G. (2005). "CEO overconfidence and corporate investment," *The Journal of Finance*, 60(6), pp.2661-2700.

McLean, R. D., and Zhao, M. (2014). "The business cycle, investor sentiment, and costly external finance," *The Journal of Finance*, 69(3), pp.1377-1409.

Miller, D., and Xu, X. (2019). "MBA CEOs, short-term management and performance," *Journal of Business Ethics*, 154, pp.285-300.

Morck, R., Shleifer, A., and Vishny, R. W. (1990). "The stock market and investment: Is the market a sideshow?" *Brookings Papers on Economic Activity*, 21(2), pp.157-216.

Mrad, S., Hamza, T., and Manita, R. (2024). "Corporate investment sensitivity to equity market misvaluation," *Review of Accounting and Finance*, 23(1), pp.1-38.

Mun, S., and Kim, H. J. (2021). "CEO educational background and external financing choices: Evidence from Korea," *Asian Review of Financial Research*, 34(4), pp.79-124.

Platikanova, P. (2026). "Do financial markets provide direction for future innovation? The feedback effect on patenting activities," SSRN Working Paper No.6346441.

Polk, C., and Sapienza, P. (2009). "The stock market and corporate investment: A test of catering theory," *The Review of Financial Studies*, 22(1), pp.187-217.

Rhodes-Kropf, M., Robinson, D. T., and Viswanathan, S. (2005). "Valuation waves and merger activity: The empirical evidence," *Journal of Financial Economics*, 77(3), pp.561-603.

Roodman, D. (2009). "How to do Xtabond2: An introduction to difference and system GMM in Stata," *The Stata Journal*, 9(1), pp.86-136.

Ryu, J. H., and Cho, S. P. (2021). "The effects of CEO type and ownership structure of the Chaebol on the behavior of R&D expenditures," *Korean Accounting Review*, 46(1), pp.245-288.

Ryu, J. H., and Kim, H. (2020). "CEO turnover and R&D investment," *Korean Management Review*, 49(6), pp.1415-1452.

Sanderson, E., and Windmeijer, F. (2016). "A weak instrument F-test in linear IV models with multiple endogenous variables," *Journal of Econometrics*, 190(2), pp.212-221.

Shen, H., Zheng, S., Xiong, H., Tang, W., Dou, J., and Silverman, H. (2021). "Stock market mispricing and firm innovation based on path analysis," *Economic Modelling*, 95, pp.330-343.

Stein, J. C. (1996). "Rational capital budgeting in an irrational world," *The Journal of Business*, 69(4), pp.429-455.

Sun, H., Zhu, J., Wang, T., and Wang, Y. (2021). "MBA CEOs and corporate social responsibility: Empirical evidence from China," *Journal of Cleaner Production*, 290, 125801.

Warusawitharana, M., and Whited, T. M. (2016). "Equity market misvaluation, financing and investment," *The Review of Financial Studies*, 29(3), pp.603-654.

Yim, J. (2019). "Do younger CEOs drive firm innovation?" *Korean Management Review*, 48(5), pp.1331-1362.

Yim, J. (2025). "Catering or signaling? Valuation-driven green patenting: Evidence from Korea," KASBA Convergence Conference Paper.

Yim, J., and Kang, M. (2024). "CEO age and firm innovation: Evidence from IT industry in Korea," *Eurasian Business Review*, 14(2), pp.345-367.

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Appendix

〈Table A1〉 Variable definitions

Variables	Definitions
Panel A: Variables used in the baseline regression	
RDI	R&D intensity. Total R&D expenditures divided by total sales.
BUSINESS	CEO business educational background. Indicator variable equal to one if the CEO holds at least one bachelor's, master's, or doctoral degree in a business-related field, and zero otherwise.
OVER	Stock overvaluation. Indicator variable equal to one if the firm-year observation belongs to the highest tercile of the annual distribution of firm-specific misvaluation, and zero otherwise.
CEOAGE	CEO age. Natural logarithm of CEO age.
CEOOWN	CEO ownership. Proportion of shares owned by the CEO.
FIRMSIZE	Firm size. Natural logarithm of total assets.
FIRMAGE	Firm age. Natural logarithm of firm age.
ROA	Return on assets. Earnings before interest, taxes, depreciation, and amortization divided by total assets.
LEV	Leverage. Total debt divided by total assets.
TANG	Asset tangibility. Tangible assets divided by total assets.
CASH	Cash holdings. Cash and cash equivalents divided by total assets.
CAPEX	Capital expenditures. Capital expenditures divided by total assets.
GROWTH	Sales growth. Annual growth rate of total sales.
FOR	Foreign ownership. Proportion of shares owned by foreign investors.
LARGE	Large shareholder ownership. Proportion of shares owned by the largest shareholder and related parties.
Panel B: Variables used in additional tests	
RDA	Total R&D expenditures divided by lagged total assets.
LnRD	Natural logarithm of total R&D expenditures.
BUS_IND	Proportion of CEOs with business educational backgrounds in the same two-digit KSIC industry-year, excluding the focal firm.
EQUITY	Net equity issuance scaled by total assets. Net equity issuance is calculated as cash proceeds from seasoned equity offerings plus proceeds from the disposal of treasury shares, minus cash outflows associated with equity redemption and the acquisition of treasury shares.
Modified KZ	Modified KZ index following Baker et al. (2003), calculated after excluding Tobin's Q from the conventional KZ index.
Turnover	Average monthly ratio of shares traded to shares outstanding over the fiscal year.
OWNERCEO	Indicator variable equal to one if the CEO is identified as the largest shareholder or a related party of the largest shareholder, and zero otherwise.
CHAEBOL	Indicator variable equal to one if the firm belongs to a designated business group, and zero otherwise.

〈Table A2〉 Subsample tests by valuation status

This table reports subsample regression results by valuation status. Firms are classified into undervalued, fairly valued, and overvalued groups based on the annual terciles of firm-specific misvaluation. *BUSINESS* is an indicator variable equal to one if the CEO has a business educational background, and zero otherwise. Definitions of the remaining variables are provided in Table A1. Values in parentheses are *t*-statistics based on standard errors clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1) Undervalued firms	(2) Fairly valued firms	(3) Overvalued firms
BUSINESS	−0.397*** (−5.66)	−0.162* (−1.75)	0.283** (2.52)
Controls and constant	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	7,211	7,205	7,202
Within R^2	0.205	0.194	0.197

〈Table A3〉 Matching quality based on covariate balance

This table reports matching quality based on covariate balance for the propensity score matching analyses. Panel A reports the balance test for matching based on CEO business educational background. The treated group consists of firm-year observations led by CEOs with business educational backgrounds, and the control group consists of firm-year observations led by CEOs without such backgrounds. Panel B reports the balance test for matching based on stock overvaluation. The treated group consists of overvalued firm-year observations, and the control group consists of non-overvalued firm-year observations. Diff denotes the difference in covariate means between treated and control observations. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Before matching			After matching		
	Treated	Control	Diff.	Treated	Control	Diff.
Panel A: Matching based on CEO business educational background						
CEOAGE	4.037	4.007	0.030*	4.037	4.030	0.007
CEOOWN	0.025	0.024	0.001	0.025	0.024	0.001
FIRMSIZE	25.749	26.410	−0.661**	25.748	25.772	−0.024
FIRMAGE	3.126	3.332	−0.206**	3.132	3.122	0.010
ROA	0.015	0.032	−0.017**	0.015	0.014	0.001
LEV	0.405	0.431	−0.026**	0.404	0.407	−0.003
TANG	0.253	0.324	−0.071**	0.253	0.251	0.002
CASH	0.125	0.099	0.026***	0.125	0.120	0.004
CAPEX	0.039	0.044	−0.005	0.038	0.037	0.001
GROWTH	0.136	0.108	0.028**	0.136	0.145	−0.008
FOR	0.051	0.072	−0.021**	0.050	0.054	−0.004
LARGE	0.376	0.415	−0.039**	0.377	0.370	0.008
Observations	9,566	12,052		9,560	9,560	
Panel B: Matching based on stock overvaluation						
CEOAGE	4.060	4.000	0.060*	4.059	4.049	0.010
CEOOWN	0.025	0.024	0.001	0.025	0.024	0.001
FIRMSIZE	26.380	25.985	0.395***	26.380	26.408	−0.028
FIRMAGE	3.181	3.271	−0.090**	3.180	3.175	0.005
ROA	0.026	0.024	0.002	0.026	0.023	0.003
LEV	0.521	0.369	0.152***	0.521	0.521	0.000
TANG	0.303	0.288	0.015**	0.302	0.300	0.002
CASH	0.105	0.112	−0.007	0.105	0.106	−0.001
CAPEX	0.050	0.038	0.012**	0.050	0.051	−0.001
GROWTH	0.172	0.095	0.077***	0.173	0.179	−0.006
FOR	0.075	0.057	0.018**	0.075	0.076	−0.001
LARGE	0.378	0.408	−0.030**	0.377	0.378	−0.001
Observations	7,202	14,416		7,185	7,185	

〈Table A4〉 Additional analysis of the equity-financing mechanism

This table reports additional analyses of the equity-financing mechanism. Column (1) examines whether business-educated CEOs are more likely to issue equity when firms are overvalued. Column (2) additionally includes *EQUITY* to examine whether equity issuance is associated with subsequent R&D investment. Definitions of the remaining variables are provided in Table A1. Values in parentheses are *t*-statistics based on standard errors clustered at the firm level. The row "$\beta_1 + \beta_3$" reports the estimated sum of the coefficients on *BUSINESS* and *BUSINESS* × *OVER*. The value in parentheses for this row is the *t*-statistic from testing the null hypothesis that $\beta_1 + \beta_3 = 0$. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

		(1) *EQUITY*	(2) RDI_{t+1} (%)
BUSINESS	β_1	0.010 (0.77)	−0.470** (−2.33)
OVER	β_2	0.043*** (4.92)	0.965*** (4.52)
BUSINESS × *OVER*	β_3	0.040*** (3.15)	0.770*** (3.14)
CEOAGE	γ_1	−0.011*** (−2.66)	−0.440* (−1.93)
CEOOWN	γ_2	−0.021** (−2.05)	0.205** (2.26)
FIRMSIZE	γ_3	−0.010*** (−4.15)	0.566*** (7.28)
FIRMAGE	γ_4	−0.008** (−2.11)	−1.267*** (−7.59)
ROA	γ_5	−0.255*** (−10.15)	9.150*** (9.81)
LEV	γ_6	−0.030*** (−6.29)	−5.822*** (−5.15)
TANG	γ_7	−0.060*** (−5.40)	0.975 (1.17)
CASH	γ_8	0.008 (0.80)	2.244* (1.76)
CAPEX	γ_9	0.070* (1.83)	−5.315*** (−3.70)
GROWTH	γ_{10}	0.066*** (5.50)	0.736*** (3.50)
FOR	γ_{11}	−0.045*** (−4.10)	1.544 (1.34)
LARGE	γ_{12}	−0.015** (−2.15)	−4.111*** (−7.20)
EQUITY	γ_E		0.330 (0.62)
Constant	a	0.188*** (6.44)	−0.322** (−2.40)
Firm FE		Yes	Yes
Year FE		Yes	Yes
Observations		21,618	21,618
Within R^2		0.108	0.256
$\beta_1 + \beta_3$		0.050*	0.300**
(*t*-statistics)		(1.78)	(2.49)