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### RESEARCH ARTICLE

## CEO OVERCONFIDENCE AND CORPORATE INNOVATION: THE ROLE OF BUSINESS GROUP AFFILIATION

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### Abstract

This study examines the relation between CEO overconfidence and corporate R&D intensity in an emerging market setting. Drawing on upper echelon's theory and behavioral corporate finance, overconfident CEOs are expected to allocate greater firm resources to innovation activities characterized by uncertainty and long-horizon payoffs. Using a panel of 1,729 nonfinancial firms listed on National Stock Exchange of India from 2009 to 2023, CEO overconfidence is measured using investment- and stock-purchase-based proxies, and its relation with Research and development expenditure, scaled by assets and sales, is analyzed. According to baseline findings, R&D intensity across all possible specifications are positively and strongly related with CEO overconfidence. The findings remain robust to additional firm, board, and CEO controls, alternative scaling measures, and dynamic panel estimation using a two-step system GMM to address endogeneity concerns. Subsample analyses show that the positive relationship is stronger among business group affiliated firms than among standalone firms. The evidence highlights the role of executive cognitive traits in shaping innovation policy and underscores the importance of institutional context in understanding managerial effects on corporate investment decisions.

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### Introduction: -

Executive characteristics play a central role in shaping corporate investment and innovation policy. A growing body of literature in corporate finance and governance demonstrates that managerial traits systematically influence firm-level outcomes beyond traditional firm attributes. According to the upper echelons theory, top executives' values and cognitive foundations are reflected in their strategic decisions (Hambrick & Mason, 1984). Consistent with this view, behavioral corporate finance shows that managerial overconfidence affects corporate investment, financing, and risk-taking decisions (Heaton, 2002; Malmendier & Tate, 2005).

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Overconfident CEOs tend to overestimate expected returns and are more willing to undertake uncertain projects. Empirical evidence indicates that such executives invest more aggressively, particularly when internal resources are available (Guan & Wang, 2024; Koh et al., 2018). Innovation investment represents a setting in which managerial overconfidence may be particularly consequential. Long gestation periods, uncertain payoffs, and significant information asymmetry characterize R&D expenditures. Hirshleifer et al. (2012) show that managerial overconfidence is positively associated with innovative output. More recent studies show that overconfident executives allocate more resources to innovation and take on greater risk (Soon Kim et al., 2021). These findings suggest that CEO overconfidence shapes firms' strategic commitment to innovation. Despite these developments, there are still a number of research gaps. First, much of the existing evidence is drawn from developed markets, primarily the United States, where institutional structures, capital markets, and governance systems differ substantially from those of emerging economies. Second, prior studies have mainly focused on pooled samples, without systematically examining how governance and ownership structures influence the strength of the association between managerial overconfidence and investment outcomes. In particular, limited attention has been paid to the role of business group affiliation, even though internal capital markets and ownership concentration may alter the strength of the association between executive traits and investment decisions. Third, emerging market settings characterized by concentrated ownership and evolving governance frameworks provide an important context for assessing whether behavioral biases operate differently across institutional environments.

India offers a compelling institutional setting to address these gaps. A significant proportion of Indian listed firms are affiliated with diversified business groups characterized by pyramidal ownership structures and internal capital markets. At the same time, standalone firms rely more directly on external capital markets and are subject to regulatory reforms aimed at strengthening corporate governance. These institutional features create meaningful variation in financing arrangements and monitoring structures. In such an environment, CEO overconfidence may exert differential effects on innovation policy across affiliated and standalone firms. Furthermore, understanding the determinants of R&D intensity is particularly relevant for India, where firms face increasing competitive pressures in technology-intensive sectors and where innovation investment remains uneven across industries.

Using a comprehensive panel of nonfinancial firms listed on the National Stock Exchange of India from 2009 to 2023, this study examines the association between CEO overconfidence and R&D intensity. The empirical findings demonstrate a positive, statistically significant relation between CEO overconfidence and R&D expenditure, utilizing two distinct metrics of overconfidence and various indicators of innovation intensity. The findings are robust to alternative specifications, scaling definitions, and dynamic panel estimation using two-step system GMM. Subsample analysis further shows that the positive association is stronger among business-group-affiliated firms than among standalone firms.

This study contributes to the literature in several ways. First, it extends behavioral corporate finance evidence on managerial overconfidence and innovation to a large, emerging-market context. Second, it highlights the moderating role of business group affiliation in shaping the association between executive traits and corporate R&D policy. Third, by employing multiple proxies and dynamic estimation techniques, the study strengthens the empirical identification of the documented relationship. Overall, the findings underscore the importance of executive cognitive characteristics in explaining cross-sectional variation in innovation investment within the Indian institutional context.

#### **Literature Review and Hypothesis Development: - CEO Overconfidence and R&D Intensity: -**

Corporate innovation decisions involve substantial uncertainty, long gestation periods, and significant information asymmetry. In such settings, managerial characteristics play an important role in shaping investment outcomes. Upper echelons theory posits that organizational strategies and performance outcomes reflect the cognitive bases and values of top executives (Hambrick & Mason, 1984). When projects are complex and future payoffs are challenging to verify, executive discretion increases, allowing managerial traits to influence strategic choices. R&D investment represents a domain in which discretion is particularly pronounced, as innovation projects rely heavily on managerial evaluation of uncertain technological and market opportunities.

Behavioral corporate finance provides a complementary explanation for variation in innovation intensity. Overconfidence refers to a systematic tendency to overestimate the precision of private information and expected returns (Ahmed & Duellman, 2013; Malmendier & Tate, 2005). Heaton (2002) shows that optimistic managers

perceive internal investment opportunities as more profitable than they objectively are and therefore undertake higher levels of investment. Because R&D projects are inherently risky and involve highly skewed return distributions, upwardly biased expectations can lead to greater innovation expenditure. (Wang et al., 2023; Zaveritiaeva et al., 2018) provide empirical evidence that managerial overconfidence is positively associated with innovative output, indicating that executive optimism affects both the scale and direction of corporate investment.

Agency theory further clarifies the mechanism. R&D expenditures are often tricky for external stakeholders to evaluate ex ante, creating scope for managerial discretion. When monitoring is imperfect, and innovation outcomes are difficult to specify in formal contracts, CEOs' subjective assessments can significantly influence capital allocation decisions. Overconfident executives may perceive higher expected net present values for innovative projects, leading to greater R&D intensity than in firms led by less optimistic managers. Recent empirical studies reinforce this perspective. Kraft et al. (2025) show that managerial overconfidence is associated with higher corporate investment and innovation intensity. (Banerjee et al., 2023; Soon Kim et al., 2021; Xia et al., 2023) report similar evidence linking executive optimism to greater risk-taking and strategic investment.

Resource-based theory also suggests that sustained competitive advantage depends on the development of intangible capabilities, including technological knowledge and innovation capacity. If overconfident CEOs exhibit a stronger growth orientation and greater tolerance for uncertainty, they may allocate a larger proportion of firm resources to R&D to build long-term competitive assets (Guan & Wang, 2024; Koh et al., 2018). In environments characterized by limited external monitoring or concentrated ownership structures, managerial traits may exert a more substantial influence on innovation policy.

Taken together, upper echelons theory, behavioral corporate finance, agency theory, and resource-based arguments predict a positive association between CEO overconfidence and R&D intensity. Overconfident CEOs are expected to allocate more resources to innovation activities because of upward-biased expectations about project outcomes and a greater willingness to undertake uncertain investments. Accordingly, the study proposes following hypothesis:  
***H1: CEO overconfidence is positively associated with research and development intensity.***

### **CEO Overconfidence and R&D Intensity in Group firms Vs Standalone firms: -**

The relation between CEO overconfidence and innovation investment is largely contingent upon the institutional and ownership context in which companies' function. Upper echelons theory suggests that executive traits influence strategic outcomes when managerial discretion is substantial (Hambrick & Mason, 1984). However, the extent to which such traits affect observable corporate policies depends on governance structures and financing arrangements. A substantial percentage of publicly traded companies in India are associated with business groups that exhibit concentrated ownership, pyramidal structures, and internal capital markets. These features create a distinct institutional setting for examining how CEO characteristics influence R&D intensity (Gao et al., 2024; Guzzini & Iacobucci, 2014).

Internal capital market theory posits that business groups facilitate the reallocation of financial resources across affiliated firms. In the Indian context, where external capital markets are evolving and informational asymmetries remain pronounced, internal capital allocation mechanisms can play an important role in financing long-term projects (Purkayastha et al., 2018). Empirical evidence indicates that internal capital markets influence investment patterns within business groups and modify firms' sensitivity to external financing conditions (Belenzon & Berkovitz, 2010). Given that R&D projects involve uncertain payoffs and require sustained funding, group affiliation may give overconfident CEOs greater capacity to pursue innovation investments (Guzzini & Iacobucci, 2014).

Behavioral corporate finance predicts that overconfident CEOs overestimate expected project returns and are more willing to invest in risky activities (Malmendier and Tate 2005). In group-affiliated firms, where ownership is concentrated and monitoring is mediated through controlling shareholders, managerial discretion over strategic investment may be stronger. In such an environment, the positive association between CEO overconfidence and R&D intensity may be more pronounced. Recent evidence shows that executive traits interact with governance environments and ownership structures to shape corporate investment decisions (Dick et al., 2021; Hsieh et al., 2010; Soon Kim et al., 2021).

By contrast, standalone firms in India rely more heavily on external capital markets and are subject to scrutiny from investors, creditors, and market intermediaries. Greater exposure to market-based monitoring may limit the extent to which managerial overconfidence is associated with higher R&D intensity (Cui & Meng, 2024; Gao et al., 2024). Consequently, the financing and governance differences between business group-affiliated and standalone firms in India provide a meaningful setting to examine heterogeneous effects (Purkayastha et al., 2018). Overall, the upper echelons theory, internal capital market theory, and behavioral corporate finance indicate that the positive correlation between CEO overconfidence and R&D intensity is likely to be more pronounced in business group-affiliated enterprises than in independent firms in India. Accordingly, hypothesis is proposed as:

**H2:** *The relation between CEO overconfidence and research and development intensity is more positive in business group-affiliated companies than to standalone firms in India.*

## Data and Methodology: -

### Sample: -

The sample includes all companies listed on the National Stock Exchange of India. Firms operating in banking and financial services, utilities, and government firms are not considered due to regulatory frameworks and operational structures. Observations lacking data on CEO characteristics are also removed from the analysis. The final sample consists of 23,985 firm-year data covering the period from 2009 to 2023 and covers 1,729 nonfinancial and non-government Indian firms. Data on CEO specific attributes are manually compiled from official corporate websites, annual reports, and CEOs' LinkedIn profiles. When a firm does not formally designate a CEO, the managing director is treated as the chief executive for empirical purposes. Firm-level financial and governance variables are sourced from the Prowess IQ database.

### Variable Description: -

Descriptions of all the variables are given in Table 1 below.

Table 1: Variable description	
Variables	Description of the variables
R&D Assets	Research and development expenses are scaled by Assets.
R&D Sales	Research and development expenses are scaled by Sales.
Overconfidence_Capex	A dummy variable = 1 if the ratio of capital expenditure to lag of total assets is greater than its industry median in the specific year, otherwise 0. (Ahmed & Duellman, 2013; Chyz et al., 2019).
Overconfidence_Netbuyer	A dummy variable = 1 if the CEO purchases/acquires additional stock of the company, and his stock purchase exceeds the stock sale of the company in the specific year; otherwise, it is 0. (Malmendier and Tate, 2005)
CEO Compensation	CEO compensation is the log of the total executive's salary, current bonuses, perquisites, and payouts from long-term incentive plans.
Roa	ROA is computed by dividing the earnings before interest, tax, depreciation, and amortization (EBITDA) by the book value of total assets.
Firm Size	Natural log (Total Assets).
Leverage	Total borrowings to assets ratio in a specific year.
Board size	Natural log of (The total number of executive (including CEO) and non-executive directors sitting on a board).
IND	Number of independent directors divided by Board size.
M/B	Ratio of Market value to book value.

CEO age	Natural log of (Age of CEO)
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**Empirical Model Estimation: -**

Using multivariate panel data regression, we first examine the relationship between CEO overconfidence and compensation. The model specifications are outlined in Equations 1 and 2 below:

$$R\&DAssets_{i,t} = \alpha_0 + \beta_1 * Overconfidence\_Capex_{i,t} + X_{i,t} + Industry\ effects + Year\ effects + e_{i,t} \dots \dots \dots (1)$$

$$R\&DAssets_{i,t} = \alpha_0 + \beta_1 * Overconfidence\_Netbuyer_{i,t} + X_{i,t} + Industry\ effects + Year\ effects + e_{i,t} \dots \dots \dots (2)$$

$$R\&DSales_{i,t} = \alpha_0 + \beta_1 * Overconfidence\_Capex_{i,t} + X_{i,t} + Industry\ effects + Year\ effects + e_{i,t} \dots \dots \dots (3)$$

R&D Intensity is the dependent variable in our study, and we have used two measures: R&D scaled by assets and R&D scaled by Total sales. Independent variables are CEO Overconfidence, measured using two methods: Capex and Netbuyer. The vector X includes control variables such as firm size, Roa, leverage, Tobin’s Q, board size, percentage of independent directors, CEO compensation, and CEO age. The models use both industry and year fixed effects to mitigate unobserved variability.

To mitigate any endogeneity issues in the baseline specifications, we utilize the two-step system Generalized Method of Moments (GMM) estimator. R&D intensity is highly persistent over time, and omitting the lagged dependent variable can bias conventional fixed-effects estimates (Arellano and Bond 1991). Moreover, CEO overconfidence may be endogenous if firms with greater innovation intensity attract certain types of executives or if unobserved firm characteristics jointly influence managerial traits and R&D policy. The system GMM framework by Blundell and Bond 1998 addresses these concerns by combining equations in levels and first differences and using internal instruments constructed from lagged values of the variables. This approach mitigates biases arising from unobserved firm-specific heterogeneity, simultaneity, and dynamic feedback effects. It is particularly appropriate for panels with a large cross-section and a shorter time dimension (Roodman, 2009). The two-step system GMM estimator improves the identification of the correlation between CEO overconfidence and R&D intensity by explicitly modelling persistence and instrumenting potentially endogenous variables.

**Empirical results and discussion: -**

**Descriptive Statistics: -**

Table 2 reports summary statistics for the variables employed in the empirical analysis. R&D Assets has a mean of 0.305 and a standard deviation of 2.534, indicating substantial cross-sectional dispersion in innovation intensity. R&D Sales reports a mean of 1.776 and a standard deviation of 13.194, consistent with greater heterogeneity in R&D expenditure relative to revenue. The Overconfidence\_Capex indicator has a mean of 0.542, signifying that 54.2% of firm-year observations are categorized as overconfident according to this metric. Overconfidence\_Netbuyer exhibits a mean of 0.202, indicating a reduced occurrence under the alternate proxy. Firm Size averages 8.337 with a standard deviation of 2.068. ROA has a mean of 3.855 and a standard deviation of 8.416, while Leverage averages 0.267. Market-to-book is 1.317 on average. Board size has a mean of 8.034 directors, and board independence averages 0.453. CEO compensation reports a mean of 16.264, and CEO age averages 55.255 years, indicating a mature executive cohort in the sample.

Variables	Observations	Mean	Std. Dev.	p1	p99
R&D Assets	23,985	0.305	2.534	0.000	4.144
R&D Sales	7,305	1.776	13.194	0.004	14.933
Overconfidence_Capex	25,815	0.542	0.498	0.000	1.000
Overconfidence_Netbuyer	13,926	0.202	0.401	0.000	1.000
Firm Size	24,020	8.337	2.068	1.705	12.965
Roa	25,935	3.855	8.416	-28.71	29.140
Leverage	24,020	0.267	0.230	0.000	1.173
M/B	23,961	1.317	1.626	0.000	9.788
Board Size	22,942	8.034	3.170	1.000	16.000
IND	22,942	0.453	0.201	0.000	0.800
CEO compensation	18,007	16.264	1.587	12.297	19.619
CEO age	17,948	55.255	10.748	31.000	80.000

**Note:** This table summarizes all variables.

**Pairwise Correlation: -**

Table 3 reports pairwise correlations among the principal variables. R&D Assets is positively correlated with Overconfidence\_Capex (0.024) and Firm Size (0.039), indicating a modest association among innovation intensity, managerial overconfidence, and firm scale. R&D Assets shows stronger correlations with Market to Book at 0.157, and CEO compensation at 0.160, suggesting that firms with higher growth opportunities and higher executive pay allocate relatively more resources to R&D. Overconfidence\_Capex is positively associated with ROA at 0.179 and CEO compensation at 0.142, consistent with the relation between investment behavior, firm performance, and compensation. Firm Size exhibits strong correlations with CEO compensation (0.647) and Board Size (0.516), reflecting scale-related governance structures. The correlation between Board Size and IND equals 0.589, indicating substantial overlap in board characteristics. All reported coefficients remain below conventional multicollinearity benchmarks, supporting the inclusion of these variables in subsequent regression analyses.

**Table 3: Pairwise Correlations**

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) R&D Assets	1.000									
(2) Overconfidence_Capex	0.024	1.000								
(3) Firm Size	0.039	0.061	1.000							
(4) Roa	-0.031	0.179	0.098	1.000						
(5) Leverage	-0.033	0.078	0.035	-0.305	1.000					
(6) M/B	0.157	0.055	0.235	0.327	-0.244	1.000				
(7) Board Size	0.029	0.031	0.516	0.077	-0.050	0.223	1.000			
(8) IND	0.037	-0.084	0.336	-0.013	-0.048	0.171	0.589	1.000		
(9) CEO compensation	0.160	0.142	0.647	0.263	-0.152	0.265	0.335	0.099	1.000	
(10) CEO Age	0.035	-0.007	0.090	0.038	-0.031	0.026	0.127	0.099	0.165	1.000

**Note:** This table shows the correlation matrix.

**T-test using the CEO Overconfidence (Using the Capex measure): -**

Table 4 reports mean comparisons between firms led by non-overconfident CEOs and overconfident CEOs, where overconfidence is proxied by the Capex-based measure. The results indicate statistically significant differences across several firm characteristics and investment outcomes. R&D Assets is higher for firms with overconfident CEOs, with a mean of 0.364 compared to 0.241 for non-overconfident CEOs. The mean difference of negative 0.123 is significant at the 1 percent level, indicating greater R&D intensity under overconfident leadership. In contrast, R&D Sales does not differ significantly across the two groups, as reflected by a mean difference of 0.029. Firms with overconfident CEOs are larger on average, with Firm Size equal to 8.462 relative to 8.209, and the mean difference of negative 0.253 is statistically significant at the 1 percent level. Profitability also differs markedly. ROA equals 5.242 for overconfident CEOs compared to 2.222 for non-overconfident CEOs, yielding a mean difference of -3.021, significant at the 1 percent level.

Leverage is less negative for overconfident CEOs at negative 2.014 relative to negative 2.288, with a mean difference of negative 0.274 that is statistically significant. Market-to-Book is higher for overconfident CEOs at 1.402 than for non-overconfident CEOs at 1.224, with a significant mean difference of -0.178. Board Size is slightly larger under overconfident CEOs at 1.994, compared with 1.961, while board independence is lower at 0.437, compared with 0.471. CEO compensation is higher for overconfident CEOs (16.478) than for less confident CEOs (16.027), with a significant mean difference of -0.451. CEO age does not differ significantly across groups.

	Observations (non-Overconfident CEOs)	Observations (Overconfident CEOs)	Mean (non- Overconfident CEOs)	Mean (Overconfident CEOs)	Mean difference
R&D Assets	11,436	12,504	0.241	0.364	-0.123***
R&D Sales	2,990	4,315	1.793	1.764	0.029
Firm Size	11,413	12,492	8.209	8.462	-0.253***
Roa	11,817	13,998	2.222	5.242	-3.021***
Leverage	11,413	12,492	-2.288	-2.014	-0.274***
M/B	11,386	12,474	1.224	1.402	-0.178***
Board Size	10,982	11,846	1.961	1.994	-0.033***
IND	10,982	11,846	0.471	0.437	0.034***
CEO compensation	8,422	9,502	16.027	16.478	-0.451***
CEO age	8,410	9,467	3.994	3.991	0.003

**Note:** Table 4 includes the Mean and Mean difference for all variables for non-overconfident CEOs and overconfident CEOs, as per the Education Level binary measure.

#### **Impact of CEO Overconfidence (using Capex measure) on R&D Intensity: -**

Table 5 reports panel regressions of R&D intensity scaled by total assets on CEO overconfidence measured using the Capex proxy. The coefficient for Overconfidence\_Capex in column 1 is 0.114. It is statistically significant at the 1 percent level, suggesting that enterprises overseen by overconfident CEOs commit greater resources to research and development. The relationship persists in column 2, with a coefficient of 0.083, significant at the 1 percent level after accounting for firm characteristics. In column 3, with board controls included, the coefficient equals 0.092 and is significant at one percent level. In column 4, after incorporating CEO level controls, the coefficient equals 0.093 and remains significant at the 1 percent level. The stability of the coefficient across specifications indicates that the relation is not driven by observable firm, board, or executive characteristics.

These findings align with behavioral corporate finance theory, which asserts that overconfident managers overrate project returns and exhibit increased risk tolerance in innovative ventures. Recent empirical evidence documents that managerial overconfidence is associated with higher investment and innovation intensity (Hirshleifer et al., 2020). R&D projects involve long horizons and uncertain payoffs, making them particularly sensitive to managerial beliefs about future outcomes.

Among the controls, Firm Size is positive and significant at the 1 percent level in columns 2-4, with coefficients ranging from 0.042 to 0.030. ROA is positive and significant, with a p-value of 0.005 in column 4 at the 1 percent level. Leverage is negative and significant across models, consistent with debt overhang constraining risky investment. Market-to-Book is positive and significant at the 1 percent level. Board independence is positive and significant at the 1 percent level in columns 3 and 4. CEO compensation is positive and significant at the 1 percent level in column 4. In comparison, CEO age is negative and significant at the 1 percent level, consistent with lifecycle arguments on executive risk preferences Serfling, 2020.

	(1)	(2)	(3)	(4)
VARIABLES	R&D Assets	R&D Assets	R&D Assets	R&D Assets
Overconfidence_Capex	0.114*** (0.014)	0.083*** (0.016)	0.092*** (0.017)	0.093*** (0.013)
Firm Size		0.042*** (0.004)	0.039*** (0.005)	0.030*** (0.006)
Roa		0.002* (0.001)	0.002** (0.001)	0.005*** (0.001)
Leverage		-0.017*** (0.006)	-0.015** (0.006)	-0.022*** (0.005)
M/B		0.042*** (0.005)	0.038*** (0.006)	0.024*** (0.004)

Board Size			-0.010 (0.021)	-0.011 (0.018)
IND			0.190*** (0.051)	0.274*** (0.044)
CEO compensation				0.033*** (0.006)
CEO age				-0.094*** (0.031)
Constant	0.182** (0.201)	-0.145* (0.207)	-0.203*** (0.213)	-0.281*** (0.191)
Industry Effect	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES
Observations	23,940	22,062	20,910	15,687
R-squared	0.817	0.825	0.826	0.280
<b>Note:</b> This table shows the relationship between CEO Overconfidence and R&D. Dependent variable is R&D scaled by Assets, and independent variable is CEO Overconfidence, measured as the Capex measure. Control variables include Firm-specific, Board-specific, and CEO-specific indicators.				

### Impact of CEO Overconfidence (using Netbuyer measure) on R&D Intensity: -

Table 6 presents panel regressions of R&D intensity scaled by total assets on CEO overconfidence measured using the Netbuyer proxy. In column 1, the coefficient for Overconfidence\_Netbuyer is 0.043. It is significant at the 10 percent level, suggesting that companies managed by CEOs who consistently purchase their firm's equity demonstrate greater R&D intensity. In column 2, the coefficient is 0.043 and is significant at the 10 percent threshold. In column 3, the coefficient increases to 0.047 and is significant at the 10 percent level. In column 4, the coefficient equals 0.048 and is significant at the 5 percent level. The magnitude and statistical significance across specifications indicate a consistent positive relation between CEO overconfidence and R&D investment.

This finding supports the behavioral corporate finance theory, which holds that managers who are overconfident tend to overestimate project returns and give less probability to unfavorable outcomes, which encourages them to invest more in initiatives that are risky. The Netbuyer measure captures managerial optimism, as reflected in personal equity trading behavior, and is associated with higher corporate investment (Banerjee et al., 2021). Because R&D projects involve long gestation periods and uncertain payoffs, the positive and statistically significant coefficients are consistent with the view that CEO overconfidence shapes firms' innovation decisions.

**Table 6: R&D and CEO overconfidence (Net buyer measure)**

	(1)	(2)	(3)	(4)
VARIABLES	R&D Assets	R&D Assets	R&D Assets	R&D Assets
Overconfidence_Netbuyer	0.043* (0.027)	0.043* (0.029)	0.047* (0.031)	0.048** (0.021)
Firm Size		0.033*** (0.007)	0.028*** (0.009)	0.015* (0.008)
Roa		0.003* (0.002)	0.004** (0.002)	0.007*** (0.001)
Leverage		-0.008 (0.009)	-0.006 (0.009)	-0.019*** (0.006)
M/B		0.047*** (0.009)	0.044*** (0.009)	0.021*** (0.006)
Board Size			0.022 (0.033)	0.025 (0.024)
IND			0.142* (0.081)	0.216*** (0.061)
CEO compensation				0.038*** (0.008)
CEO age				-0.139***

				(0.042)
Constant	0.265	-0.040	-0.130	-0.095
	(0.254)	(0.266)	(0.274)	(0.237)
Industry Effect	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES
Observations	13,121	12,123	11,580	8,871
R-squared	0.857	0.861	0.862	0.297
<b>Note:</b> This table shows the relationship between CEO Overconfidence and R&D. Dependent variable is R&D scaled by Assets, while the independent variable is the alternative measure of CEO Overconfidence, known as the Netbuyer measure. Control variables encompass Firm-specific, Board-specific, and CEO-specific indicators.				

### Impact of CEO Overconfidence on R&D intensity for Business group firms and Standalone firms: -

Table 7 reports subsample regressions of R&D intensity scaled by total assets on CEO overconfidence, separately for business-group-affiliated firms and standalone firms. Columns 1 and 2 utilize the Capex-based proxy for overconfidence, whereas columns 3 and 4 apply the Netbuyer proxy. All specifications include industry and year fixed effects along with the complete set of controls.

In column 1, for business group firms, the coefficient on *Overconfidence\_Capex* equals 0.096 and is significant at the 1 percent level. In column 2, for standalone firms, the coefficient equals 0.023 and is significant at the 10 percent level. The coefficient among group enterprises is significantly greater, suggesting that the relation between CEO overconfidence and R&D intensity is significantly stronger in these entities. Columns 3 and 4 present more evidence utilizing the Netbuyer metric. For group enterprises, the coefficient for *Overconfidence\_Netbuyer* is 0.069 and is statistically significant at the 1 percent level. For standalone firms, the coefficient equals -0.014 and is statistically insignificant. The absence of statistical significance in standalone firms under the alternative proxy reinforces the view that the positive association between CEO overconfidence and R&D is concentrated in business groups.

These findings are consistent with internal capital market theory, which suggests that affiliated firms operate within networks that facilitate intra group resource allocation. Such arrangements can influence corporate investment decisions by reducing reliance on external capital markets and modifying monitoring structures. Recent empirical studies indicate that internal capital allocation within business groups affects investment sensitivity and financing patterns (Belenzon et al. 2020). Within this framework, managerial overconfidence appears more closely associated with innovation spending in group settings than in standalone firms. Overall, the evidence indicates that business group affiliation conditions the strength of the relation between CEO overconfidence and R&D intensity, with the effect being economically larger and statistically stronger in affiliated firms across both measures of overconfidence.

**Table 7: CEO Overconfidence and R&D for Business Groups vs Standalone firms**

VARIABLES	R&D Assets			
	(Group firms)	(Standalone firms)	(Group firms)	(Standalone firms)
Overconfidence_Capex	0.096*** (0.016)	0.023* (0.012)		
Overconfidence_Netbuyer			0.069*** (0.026)	-0.014 (0.020)
Firm Size	0.046*** (0.007)	0.003 (0.005)	0.025** (0.010)	0.002 (0.008)
Roa	0.008*** (0.001)	0.001 (0.001)	0.009*** (0.002)	0.001 (0.001)
Leverage	-0.033*** (0.006)	-0.016*** (0.005)	-0.033*** (0.007)	-0.008 (0.007)
M/B	0.018*** (0.006)	0.044*** (0.004)	0.012 (0.008)	0.038*** (0.007)
Board Size	-0.026 (0.023)	0.083*** (0.016)	0.011 (0.032)	0.057** (0.023)
IND	0.437*** (0.056)	-0.283*** (0.039)	0.377*** (0.079)	-0.264*** (0.053)

CEO compensation	0.024*** (0.007)	0.016*** (0.006)	0.032*** (0.010)	0.013 (0.008)
CEO age	-0.112*** (0.039)	0.038 (0.029)	-0.189*** (0.053)	0.184*** (0.041)
Constant	-0.258 (0.226)	-0.380*** (0.132)	0.019 (0.287)	-0.961*** (0.190)
Industry Effect	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES
Observations	12,070	3,617	6,815	2,056
R-squared	0.309	0.188	0.318	0.164

**Note:** This table shows the relationship between CEO Overconfidence and R&D in Business group firms (specifications 1 and 3) vs. Standalone firms (specifications 2 and 4). Dependent variable is R&D scaled by assets, while independent variable is CEO overconfidence (Capex). Control variables encompass Firm-specific, Board-specific, and CEO-specific indicators.

### Robustness Test: -

#### Impact of CEO overconfidence on R&D Intensity using an alternative measure (R&D Sales): -

Table 8 reports robustness tests using R&D scaled by sales as dependent variable. In column 1, the coefficient for Overconfidence\_Capex is 0.023 and is statistically significant at the ten percent level. In column 2, the coefficient is 0.444 and retains significance at the ten percent level. In column 3, coefficient equals 0.441 and is significant at the ten percent level. In column 4, coefficient is 0.136 and is statistically significant at 5% level. In all specifications, coefficient for independent variable Overconfidence\_Capex remains positive and statistically significant, demonstrating that relationship between CEO overconfidence and R&D intensity endures when R&D is normalized by sales instead of assets.

The consistency in sign and statistical significance across specifications suggests that the dependent variable's scaling choice does not drive the main inference. R&D scaled by sales captures innovation effort relative to operating activity, thereby addressing potential concerns that asset-based scaling of research and development expenses may mechanically influence results. The positive, statistically significant coefficients indicate that CEO overconfidence correlates with increased innovation intensity according to the alternative measurement. This robustness evidence strengthens empirical validity of main findings. It indicates that the documented relation between managerial overconfidence and R&D investment is not sensitive to operationalization of innovation intensity.

**Table 8: Robustness Test: CEO overconfidence and R&D intensity using an alternative measure**

	(1)	(2)	(3)	(4)
VARIABLES	R&D Sales			
Overconfidence_Capex	0.023* (0.206)	0.444* (0.230)	0.441* (0.234)	0.136** (0.067)
Firm Size		0.049 (0.077)	0.088 (0.085)	0.168*** (0.031)
Roa		-0.148*** (0.018)	-0.155*** (0.018)	-0.047*** (0.006)
Leverage		-0.362*** (0.079)	-0.372*** (0.081)	-0.081*** (0.023)
M/B		0.087 (0.075)	0.106 (0.077)	0.063*** (0.022)
Board Size			-0.281 (0.344)	-0.397*** (0.106)
IND			-0.630	0.885***

			(0.807)	(0.247)
CEO compensation				-0.025
				(0.033)
CEO age				-0.145
				(0.163)
Constant	0.143	-1.073	-0.484	0.247
	(1.631)	(1.792)	(1.873)	(0.845)
Industry Effect	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES
Observations	7,305	6,746	6,612	5,674
R-squared	0.592	0.597	0.598	0.287
<b>Note:</b> This table shows robustness of relationship between CEO Overconfidence and R&D using an alternative measure of R&D.				

#### Endogeneity Test using Two-step system GMM: -

Table 9 reports two-step system GMM estimations to address potential endogeneity arising from dynamic persistence and reverse causality in R&D intensity. The dependent variable is R&D scaled by total assets. In column 1, the coefficient on the lagged dependent variable equals 0.582 and is significant at the one percent level, indicating strong persistence in R&D investment. In column 2, the coefficient is 0.616 and is significant at the 1% level, confirming the dynamic nature of innovation spending.

Coefficient for Overconfidence\_Capex in column 1 is 0.082 and is significant at one percent level. In column 2, the coefficient for Overconfidence\_Netbuyer is 0.043 and is statistically significant at the ten percent level. Positive and statistically significant coefficients indicate that the association between CEO overconfidence and R&D intensity persists after accounting for dynamic adjustment and potential simultaneity. The diagnostic statistics support the validity of the specification. The AR1 test reports a p-value of 0.000 in both columns, consistent with expected first-order serial correlation in differences. The AR2 test reports p-values of 0.705 and 0.310, indicating no evidence of second-order serial correlation. The Hansen test p-values equal 0.230 and 0.368, suggesting that the instrument set is not rejected. System GMM results affirm that the strong correlation between CEO overconfidence and R&D intensity remains robust against issues of endogeneity and dynamic persistence.

**Table 9: Endogeneity Test: Two-step system GMM**

VARIABLES	R&D Assets	
	(1)	(2)
Lag_ R&D Assets	0.582***	0.616***
	(0.079)	(0.096)
Overconfidence_Capex	0.082***	
	(0.024)	
Overconfidence_Netbuyer		0.043*
		(0.030)
Firm Size	0.301***	0.273***
	(0.069)	(0.088)
Roa	0.010***	0.016***
	(0.003)	(0.005)
Leverage	-0.030	-0.011
	(0.018)	(0.024)
M/B	0.034**	0.025
	(0.016)	(0.019)
Board Size	0.019	0.062
	(0.078)	(0.096)
IND	-0.196	-0.122
	(0.167)	(0.189)

CEO compensation	0.049** (0.021)	0.051* (0.029)
CEO age	-0.321** (0.146)	-0.260 (0.166)
Constant	-0.988 (0.684)	-1.131 (0.875)
AR1	0.000	0.000
AR2	0.705	0.310
Hansen P-value	0.230	0.368
Observations	5,099	2,948
Number of firms	604	399
<b>Note:</b> This table shows the robustness of the relationship between CEO Overconfidence and R&D.		

### Conclusion and Policy Implications: -

This study examines the relation between CEO overconfidence and corporate R&D intensity in the Indian context. Using a comprehensive panel of nonfinancial firms listed on the National Stock Exchange of India from 2009 to 2023, the analysis employs two different measures of CEO overconfidence and multiple specifications of R&D intensity. The empirical results consistently indicate that CEO overconfidence is positively and significantly related to innovation investment. This relation remains robust after controlling for firm, board, and CEO characteristics, using alternative R&D scaling measures, and addressing endogeneity concerns through two-step system GMM estimation. The dynamic panel results confirm that the positive coefficient on CEO overconfidence persists even after accounting for the strong persistence of R&D intensity.

The subsample analysis shows that the positive relationship between CEO overconfidence and R&D intensity is stronger in business-group-affiliated firms than in standalone firms. This finding highlights the importance of ownership and governance structures in shaping how executive traits influence strategic investment decisions. In business groups, internal capital markets and concentrated ownership strengthen the link between managerial characteristics and innovation spending. The findings extend evidence on behavioral corporate finance and innovation to a major emerging market. They demonstrate that executive cognitive traits are relevant determinants of corporate R&D policy in environments characterized by concentrated ownership and evolving governance frameworks. The results underscore that institutional context plays a significant role in explaining cross-sectional variation in innovation investment.

From a policy perspective, the evidence has implications for boards, investors, and regulators. Boards may recognize that executive behavioral traits influence long-term innovation strategy. While higher R&D investment may support long-term competitiveness, it may also reflect optimistic bias rather than purely value-maximizing decisions. Stronger board oversight and structured evaluation of major innovation projects can enhance governance quality. For investors, incorporating CEO characteristics into firm analysis can improve the assessment of innovation strategy and risk exposure. For regulators in emerging markets such as India, enhanced transparency and governance standards can improve monitoring of discretionary investment decisions. Overall, the study highlights the importance of integrating behavioral considerations into corporate governance and innovation policy discussions.

### Limitations: -

Some limitations of the study are: First, CEO overconfidence is proxied using observable measures that may not fully capture underlying cognitive traits. Second, R&D intensity reflects expenditure rather than innovation outcomes. Finally, the findings are specific to the listed Indian firms.

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