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Article

The Effects of Entrepreneurial Orientation and Environmental Uncertainty on Korean Technology Firms' R&D Investment

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Abstract: This study aims to examine the relationship between top managers' entrepreneurial orientation and firms' research and development (R&D) investment and the moderating effects of environmental uncertainty on this relationship. Using a sample of 337 Korean technology firms, we implemented a multiple regression analysis with R&D intensity as a dependent variable, top managers' entrepreneurial orientation as an independent variable, and environmental uncertainty as a moderating variable. The findings reveal that the entrepreneurial orientation of top managers has significant and positive relationships with firms' strategic decisions regarding R&D investment. This implies that the tendencies and characteristics of top managers significantly influence firms' innovation efforts, especially during an economic recession. Furthermore, environmental munificence intensifies the entrepreneurial orientation and R&D investment relationship, while environmental dynamism has a negative moderating effect. On the other hand, environmental hostility does not have any impact on this relationship. The moderating effects of environmental uncertainty imply that firms should carefully consider environmental dynamism and munificence to intensify the positive effect of top managers' entrepreneurial orientation on firms' innovation efforts.

Keywords: entrepreneurial orientation; R&D intensity; innovation; economic recession; environmental uncertainty; open innovation

1. Introduction

When parts of the global market are in economic recession, innovation becomes the most important factor for technology firms to obtain sustainable competitive advantage [1,2]. However, the rapid change attributed to innovation creates new challenges for decision makers in technology firms. As the key decision makers, top managers must integrate technological and market changes into business operations, and promptly reflect them in their strategic decision-making procedures. Innovation requires top managers to possess the intention to accept unprecedented levels of change. However, top managers often reveal an unwillingness to accept changes for innovation. They begin with new ideas and technologies but fail to understand the extent to which the former will be beneficial to their customers. Furthermore, they often intentionally underestimate the impact of innovation due to the high risk associated with it [3–5]. Top managers reveal their tendency of being risk-averse as the agents of owners. Thus, reducing research and development (R&D) investment during economic recession could be considered an agency problem of top managers that reduces the owner's interests. In addition, top managers also have reservations regarding whether the firm's stakeholders understand the benefits of innovation. Therefore, they often fail to involve employees, business partners, and customers in innovation initiatives [6].

Entrepreneurship is widely considered a new strategy in competitive business markets, and the process has been characterized as entrepreneurial orientation. Researchers and practitioners have

attempted to understand how firms can best grasp various innovative opportunities in the market and use them to create sustainable competitive advantages [7]. This effort requires a clear understanding of the entrepreneurial orientation of top managers responsible for innovation. Thus, in the corporate environment, researchers have explored the structure of entrepreneurial orientation, and strategic processes, practices, and behaviors that encourage decision makers to behave in an entrepreneurial manner [8]. Miller [9] introduced and conceptualized the structure of entrepreneurial orientation with three dimensions: Innovativeness, risk taking, and proactiveness. The entrepreneurial orientation of decision makers has become a well-established construct in the field of entrepreneurship research. Several researchers have focused on the entrepreneurial orientation of top managers, who are the key decision makers in firms [10]. A significant implication is that if top managers have a strong entrepreneurial orientation, they invest more in R&D than their competitors to innovate [11]. However, other studies have not found a relationship between top managers' entrepreneurial orientation and the level of firms' R&D investment. They suggest that the strength of the relationship will be influenced by various contingent factors, such as the type of industry and characteristics of the environment [12]. However, the moderating effects of various internal and external factors on this relationship remain unclear [13,14].

This study attempts to address the gap in the innovation management literature. We argue that the entrepreneurial orientation, as characteristics and tendencies of top managers, is likely to increase the R&D investment of Korean technology firms. However, this positive relationship will be modified by environmental uncertainty measured through dynamism, hostility, and munificence. The findings provide useful implications for implementing planned innovation by technology firms in Korea. The rest of this paper is organized as follows. Section 2 is a literature review that includes (1) the debates on the effect of top managers on organizational outcomes, (2) the definition of and previous research on entrepreneurial orientation, and (3) the theoretical arguments regarding the need for innovation during economic recession. Section 3 presents the research model, which describes the relationships among critical variables, and the methodology. Sections 4 and 5 present the results of empirical analysis and the implication of our findings. Finally, concluding remarks are presented in Section 6.

2. Literature Review

2.1. Top Managers and Organizational Outcomes

Do top managers possess sufficient power to have a significant influence on organizational outcomes such as strategic choices and performance? It should be noted that historically, there has been a debate in various management disciplines on the role of executives and top managers in organizational outcomes. Pfeffer [15–17] suggested the "all-powerless view," which argues that market and organizational constraints prevent top managers hands that they were as much the captive, not a maker, of their history. Thus, he expressed the doubt that leadership has any discernable impact on organizational outcomes and argued that leadership of firms' top managers is a phenomenon of social attribution used to provide a causal explanation of organizational outcomes. Meindl et al. [18] also subscribed to this view of leadership by adopting the term "romance of leadership." The argument here is that the concept of leadership is a perception that plays a part in the way people attempt to make sense of organizationally relevant phenomena. They argued that the leadership of top managers is perhaps best viewed as an explanatory category that can account for organizational activities and outcomes. In fact, causality may constitute attributional inferences rather than actual causal determinants of events and occurrences. Specifically, they argued that the romanticized concept of leadership results from a biased preference to understand important but causally indeterminant and ambiguous organizational events and occurrences in terms of the leadership of top managers. In addition, some organization theorists suggested the limited roles of managers in organizational outcomes, including the strategic

choices and performance of the firm. Specifically, they argued that top managers have relatively little influence on organizational outcomes due to environmental and inertial forces [19–22].

On the other hand, the central roles played by managers and management teams in determining strategic choices and firm success have been interesting research topics in the strategic management literature [23–25]. In general, the literature agrees that managers play the leading role in choosing a firm's direction, the combination of resources it will deploy and nurture, and the markets in which it will participate [26,27]. Senior executives shape the vision and mobilize the ranks. Moreover, they make the difference between success and failure [28]. Senior executives are thus an essential resource for firms seeking to formulate and implement strategies effectively [29,30]. Because strategic leaders' decisions are intended to help the firm gain competitive advantage, how top managers exercise discretion when determining appropriate strategic actions has been suggested as a critical factor of firm success [31]. Top managers often use their discretion when making strategic decisions regarding the effective implementation of strategies [32–34], including influencing the behaviors, thoughts, and feelings of their colleagues [35,36].

While concern for the role of top managers is not new [37], the recent perspective goes beyond earlier prescriptions for effective top managers. In particular, this new approach emphasizes the importance of understanding the background, experiences, and values of top managers in explaining their strategic choices and performance outcomes. Hambrick and Mason's [38] upper-echelons theory is particularly relevant to this perspective. Specifically, this theory suggests that both strategic choice and organizational performance are associated with managerial background characteristics such as age, functional track, career experience, formal education, socioeconomic background, financial position, and group heterogeneity. This theory is based on the premise that top managers make decisions to fit their worldview. As a result, a central requirement for understanding organizational behavior is to identify factors that direct or orient top managers' attention. The logic of this view relies on early work by theorists of the Carnegie School, who argued that complex decisions are largely the result of behavioral factors rather than of perfectly rational analysis based on complete information [39,40]. In their view, bounded rationality, multiple and conflicting goals, and varying aspiration levels and, in turn, actions or inactions, are all derived from beliefs, knowledge, assumptions, and values that decision makers bring to the administrative setting. Building largely on the conceptual arguments of March and Simon [40], Cyert and March [39], and Hambrick and Mason [38], researchers have found considerable empirical support for the view that organizational profiles reflect the characteristics and tendencies of top managers [41–43].

2.2. Entrepreneurial Orientation

Entrepreneurial orientation refers to the "management philosophies that are adventurous in nature" [44]. It encourages an organizational decision-making process that favors risk-taking activities even under environmental uncertainty [45–47]. As such, the degree of top managers' entrepreneurial orientation is likely to affect firms' level of R&D investment. Technology firms with top managers with high levels of entrepreneurial orientation are more active in seeking trend changes and opportunities in the environment to leverage their tangible and intangible resources faster than their competitors [48–50]. They are more accepting of uncertainty in the markets while pioneering new opportunities. Thus, the possibility of a firm grasping and enthusiastically pursuing the exploitation of new product market opportunities is significantly affected by the degree of top managers' entrepreneurial orientation [51,52]. Furthermore, such orientation positively moderates the relationship between the tendency for open innovation and corporate performance [53,54], and it strengthens the positive performance effects of open innovation significantly more than customer and resource orientation [55,56].

Moreover, as an individual-level strategic position, entrepreneurial orientation motivates and supports top managers to absorb the knowledge-based resources from the external environment and leverage these into value-creating internal resource bundles [57,58]. Acquiring and leveraging various types of resources in the market is critical for technology firms to enhance the quality of strategic

decision-making and financial returns. Technology firms with top managers who have a high-level of entrepreneurial orientation tend to be creative resource bundlers. They are more likely to embrace untested resources in the market and seek the highest possible returns from them. With a more proactive strategic orientation, firms could be more responsive to externally acquired knowledge and opportunities [59]. Additionally, with higher levels of entrepreneurial orientation, technology firms can improve their level of financial performance through intense information utilization efforts [60,61]. However, it should be noted that the preference of top managers for R&D investment affected by their entrepreneurial orientation may be adjusted by the characteristics and intensity of environmental uncertainty [62,63].

2.3. Recession and Innovation

Although there is a lack of consensus on the fact that the current economic situation meets an official definition of an economic recession, it is true that most firms in the global market are currently focusing on retrenchment [64,65]. An economic recession increases the level of environmental uncertainty. It strengthens the importance of disruptive innovation, and therefore the R&D investment decisions of technology firms [66–68]. Although there are certain arguments that it is hasty of top managers to invest more resources in R&D during periods of recession, many scholars and practitioners now insist that firms should invest more in innovative activities [56]. The worst decision to take in an economic recession could be to lose the growth engine in the future by diminishing R&D investment. Innovation is a critical lever for technology firms to achieve sustainable competitive advantages in the long-term [69,70].

However, technology firms must be cautious about their R&D investment decisions. Several scholars and practitioners believe that firms face certain constraints during a recession [9]. However, ironically, these constraints encourage and enable firms to innovate more [71]. For example, Amazon expanded its online discounting E-commerce model to a broad range of products and services. Environmental scarcity during an economic downturn challenged Amazon's basic model, in addition to inducing organizational members' creativity to engage in open innovation considering their business models [72]. Thus, open environmental constraints during an economic recession often encourage firms to take significant risks that inspire innovation [73]. Specifically, firms in which top managers have a high level of entrepreneurial orientation implement innovation strategies more efficiently than their competitors.

Corporates are challenged by rapid changes in the business environment, shorter product cycles, and more connected businesses, leading to the need for new and more efficient innovation methods [74]. Thus, open innovation, which comprises internal and external ideas and ways to market, has become more important [75]. A variety of innovation styles, such as open source, crowdsourcing, and service and user innovation, are based on this theory and are referred to as open innovation [76]. Not only has this phenomenon been introduced in high-tech sectors and large international corporations, but the trend of open innovation has entered the mainstream and is common in small and medium-sized enterprises [77]. In addition, top managers have learned that companies can be a potential source of open innovation through collaboration with external innovation [78]. The relationship between a company and its community still raises questions if the resulting output does not meet the company's expectations [79]. To innovate openly and to cope with future economic difficulties, it is essential that the goals and needs of the top managers and firms concerned are properly understood [80,81].

In fact, during an economic recession, top managers are inclined toward spending more money on short-term investments with immediate returns over longer-term investments with more questionable returns. Furthermore, R&D investment is undoubtedly a natural option to consider when searching for areas to reduce costs, and thus, to meet tightened budgets during an economic recession [82]. However, it should be noted that a sterile innovation environment restricts firms from exploiting opportunities to achieve sustainable competitive advantages. Accordingly, many scholars and practitioners recommend that top managers consider options for innovation proactively, and as a minimum, maintain R&D

investments during an economic recession [83]. They argue that curtailing R&D investment can be a significant strategic error in the long-term.

In summary, the economic climate during a recession is more likely to tighten budgets, cut resources, and reduce long-term investments. However, in terms of R&D investments, negligent firms often face more challenges to compete in the market as the economy recovers. Therefore, an appropriate investment in innovation should be rationalized by a significantly challenging economic situation [84]. This is not to suggest that technology firms should simply invest more in R&D during an economic recession. On the contrary, they should safeguard their efforts with their R&D investments by carefully considering various internal and external factors. Continuing to emphasize the importance of innovation and investing in R&D activities sufficiently during an economic recession requires strong leadership by top managers [59].

3. Research

As previously discussed, when firms are confronted with an uncertain business environment, they are required to undertake proactive R&D investments to create and maintain their competitive advantage. Thus, decision-making for destructive innovation is considered a significant factor in corporate management during an economic recession [85–87]. However, top managers often reveal a reluctance to invest resources in R&D activities as there is a high potential for risk of failure. Thus, there is a dilemma regarding how to make top managers invest more in innovation. To resolve this, the empirical model (see Figure 1) of this study is designed to explore the relationship between top managers' entrepreneurial orientation and firms' R&D investment, and the moderating effects of environmental uncertainty on this relationship.

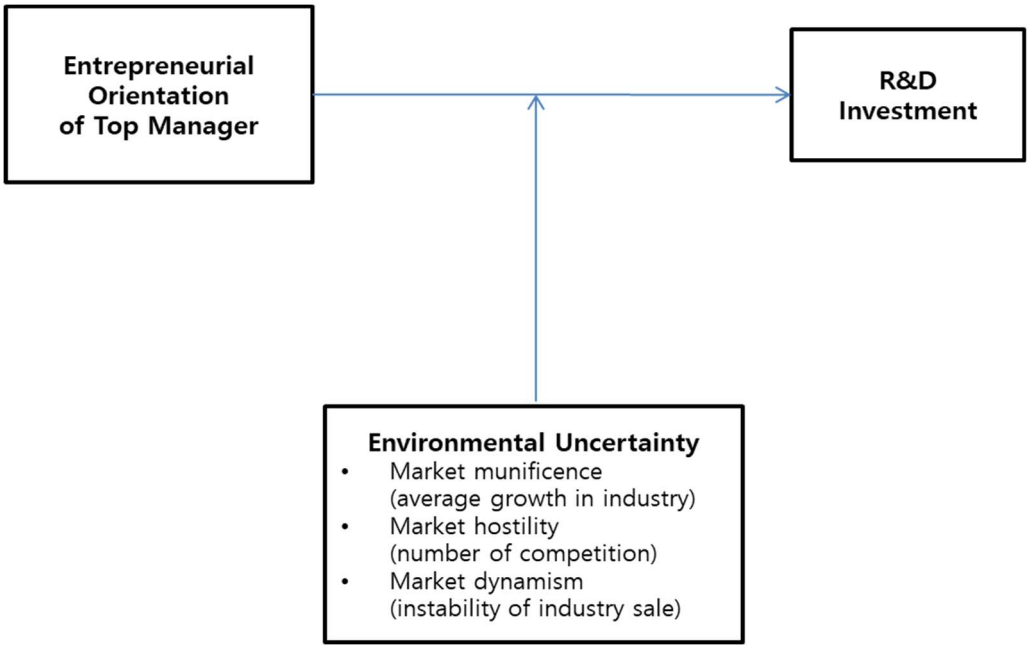

Figure 1. The research model.

The empirical setting of this study is the technology industries in the Korean market. Particularly, sample firms in technology industries were selected from 4075 firms reported on the "Korean Innovation Survey 2014 (KIS 2014)" conducted by the Science and Technology Policy Institute (STEPI) of Korea. Korea Innovation Survey (KIS), a survey of corporate-level innovation activities, has been implemented to identify the current status and characteristics of innovation activities in the manufacturing and service sectors in Korea and to secure basic data for the establishment and research of national innovation policies. This survey, which began in 1996 and is being conducted every two years, was designated

as 'National Accreditation Statistics No. 39501' by the National Statistical Office in recognition of its high objectivity and accuracy of the information provided. This study selected a sample that are the firms in technology-intensive manufacturing sectors from KIS 2014. Specifically, based on OECD classification for high-tech manufacturing industry, this study includes the firms from aircraft, pharmaceuticals, communication equipment, electrical machinery and apparatus, motor vehicles, and chemicals industries, where innovative activities based on entrepreneurial orientation of top managers could have a significant impact on firms' performance. This procedure reduced the sample date set to 337 from 4075 firms.

The data of the entrepreneurial orientation of top managers were collected through a structural content analysis [73]. We selected several key words in Table 1 that represent the entrepreneurial orientation of top managers to undertake a structural content analysis. Then, we searched and counted these words in the annual reports and chief executive officers' (CEO) messages on company websites [88].

Table 1. Entrepreneurial orientation keywords.

Dimension	Content Analysis Keywords
Innovation	Discovery, Dream, Think out, Predict, Visible, Envision, Shape, Occurrence, Find out, Come up with, Creative, Imagine, Draw, Impromptu, Originality, Creativity, Proactiveness, founder, innovation, Inspiration, Encourage, Excellence, Invent, Originative, Creator, Temperament, Construct, Change, Transformation, Slick, Smart, Change, Creation, New, Novelty, Originate, Derive, Start
Proactiveness	Predict, look ahead, Expect, Exploration, Research, Prediction, Discovery, Predict, Think, Foresee, Prophesy, Progressive, Inquire, Research, Search, Investigation, Lead, Study, Carefully, Inspection,
Risk Sensitivity	Adventurous, Progressive, Bold, Confident, Courage, Possibility, Opportunity, Uncertain, Dangerous, Brave, Danger, Challenge, Strong, Rash, Bold, Indomitable, Equivocal, Enterprise, Brash, Reckless, Slump, Instability, Indiscreet, Risk factor, Interest, Unidentified

Source: Author's Elaboration based Short et al. [88].

The data on firms' R&D investment and environmental uncertainty were collected from Data Analysis, Retrieval and Transfer System (DART), provided by the Financial Supervisory Service and CRETOP corporate information system. As the dependent variable, R&D intensity was calculated by dividing the total R&D investment by the firm's total assets [89–91]. Environmental uncertainty was measured using three different dimensions of environmental characteristics: Dynamism, hostility, and munificence. Market munificence was assessed as the average growth in industry sales. Market hostility was estimated as the number of competitors in the industry. Finally, market dynamism was calculated as the instability of industry sales [92,93]. Each dimension was included in the regression analysis as separate variables to explore the moderating effects of environmental uncertainty.

In the analysis, we included four control variables: Firm age, firm size, industry type, and listing status. Firm age was measured by the number of years since the firm's foundation. We calculated firm size as the log of the total asset. The industry type variable was operationalized using a dummy variable. Finally, the listing status variable was also operationalized as a dummy variable, taking 1 for a listed company and 0 for a non-listed company. To explore the research questions, a multiple regression analysis, with R&D intensity as the dependent variable, top managers' entrepreneurial orientation as the independent variable, and environmental uncertainty as the moderating variable, was implemented.

4. Findings and Discussion

Table 2 presents the means, standard deviations, and correlations of the key variables. We examined the variance inflation factors (VIFs) to detect multicollinearity. All VIF scores were found to be below 3.

Since a common rule of thumb for multicollinearity is a figure of 10 or less, our analysis is unlikely to have a serious multicollinearity problem [91].

Table 2. Means, standard deviations, variance inflation factors (VIF), and Pearson correlations [a].

Variable	Mean	SD	VIF	1	2	3	4	5	6	7	8
1. R&D Investment	0.016	0.05	1.53								
2. Firm Age	22.98	13.56	1.18	−0.12							
3. Firm Size	2.17	0.49	1.41	0.03	0.33						
4. Type of Industry	0.24	0.42	1.19	−0.11	−0.02	−0.05					
5. Listing Status	0.70	0.45	1.41	−0.15	−0.35	−0.34	0.20				
6. Entrepreneurial Orientation	4.47	3.35	1.07	0.11	0.06	0.28	−0.13	−0.19			
7. Dynamism	4.32	3.36	1.04	−0.18	−0.07	0.01	0.05	0.06	−0.06		
8. Hostility	3.07	2.43	1.02	−0.08	0.06	−0.05	0.01	0.04	−0.03	0.01	
9. Munificence	3.53	1.43	1.06	0.16	−0.07	−0.04	−0.21	−0.01	−0.01	−0.05	0.06

[a] Correlations greater than 0.08 are significant at the 0.05.

Table 3. The results of hierarchical regression analysis (N = 337) [a].

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Firm Age	−0.160 (−3.868) ***	−0.168 (−4.157) ***	−0.157 (−3.766) ***	−0.153 (−3.703) **	−0.156 (−3.853) ***
Firm Size	0.164 (3.624) ***	0.147 (3.327) ***	0.158 (3.478) ***	0.153 (3.406) ***	0.128 (2.882) **
Type of Industry	0.023 (0.337)	0.008 (−0.206)	0.015 (0.367)	0.008 (0.184)	0.012 (0.299)
Listing Status	−0.251 (−5.555) ***	−0.236 (−5.555) ***	−0.246 (−5.408) ***	−0.248 (−5.514) ***	−0.224 (−5.078) ***
EO	0.103 (2.611) **	0.073 (1.875) †	0.104 (2.606) **	0.104 (2.649) **	0.078 (1.997) *
Dynamism		−0.195 (−5.127) ***			−0.192 (−5.077) ***
Hostility			−0.041 (−1.065)		−0.057 (−1.518)
Munificence				0.216 (3.215) ***	0.208 (3.012) **
EO × Dynamism		−0.136 (−3.545) ***			−0.141 (−3.635) ***
EO × Hostility			−0.021 (−0.539)		−0.049 (−1.298)
EO × Munificence				0.097 (2.347) *	0.091 (2.235) *
R^2	0.086	0.132	0.089 ***	0.103 ***	0.152 ***
F-Statistic	11.911 ***	13.707 ***	8.725 ***	10.292 ***	10.193 ***
ΔR^2		0.046	0.003	0.017	0.066
Change in F		16.714 ***	0.780	5.793 ***	8.092 ***

† $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. [a] Standardized regression coefficient are reported; *t* test results are in parentheses. EO refers to entrepreneurial orientation.

The results of hierarchical regression analysis are presented in Table 3. Model 1 includes the control and main variables only. The results indicate that top managers' entrepreneurial orientation has a significant and positive impact on the strategic R&D investment decisions of sample firms ($\beta = 0.103$, $p < 0.001$). As expected, this finding implies that the tendencies and characteristics of top managers significantly influence the strategic choice of technology firms during an economic recession. Furthermore, the findings in Models 2, 3, and 4 indicate that some dimensions of environmental uncertainty reveal moderating effects on the relationship between top managers' entrepreneurial orientation and technology firms' R&D investment. In particular, they reveal that environmental

munificence, measured by the average growth in industry sales, intensifies the entrepreneurial orientation and R&D intensity relationship ($\beta = 0.097$, $p < 0.05$), while environmental dynamism, measured by the instability of industry sales, negatively moderates it ($\beta = -0.136$, $p < 0.001$).

On the other hand, environmental hostility was not found to have any significant impact on the relationship between top managers' entrepreneurial orientation and technology firms' R&D intensity. Model 5 simultaneously analyzes the effects of all independent and moderating variables in a model. The results do not reveal any significant difference in comparison with them in other models. They reveal a positive relationship between top managers' entrepreneurial orientation and firms' strategic decisions regarding R&D investment. They also reveal a negative moderating effect of environmental dynamism but a positive moderating effect of environmental munificence on the relationship between top managers' entrepreneurial orientation and firms' R&D intensity. Thus, the results of Model 5 confirm the findings in Models 1 to 4, which examine the effect of each independent and moderating variable separately.

The findings on the moderating effects of environmental uncertainty imply that the effects of top managers' entrepreneurial orientation on strategic decision-making regarding R&D investment are strengthened as the instability of industry sales decreases and average growth of industry sales increases. Considering the relationships of the four control variables with the dependent variable, firm age presents a negative and significant relationship with firms' R&D intensity. This finding implies that as a firm becomes older, it tends to reduce its R&D intensity. On the other hand, firm size reveals a significant and positive relationship with R&D intensity. Furthermore, the listing status of a firm reveals a significant and negative relationship with R&D intensity. Finally, the type of industry does not have a statistically significant relationship with the R&D intensity of technology firms in Korea.

5. Implications

We develop theoretical arguments concerning how top managers' entrepreneurial orientation affects the long-term R&D investment of Korean technology firms and how this relationship can be modified by the three different dimensions of environmental uncertainty. The findings reveal that top managers' entrepreneurial orientation is useful to reduce the agency problem of top managers in the relationship with owners, especially during economic recession. As previously mentioned, top managers often reveal a tendency to spend more money on a short-term investment with immediate returns to reduce their employment risk. They instead reduce long-term R&D investment despite knowing it is important to strengthen innovation and, ultimately, to achieve sustainable competitive advantage. This agency problem could occur when the interests of top managers differ from those of owners. The finding indicates that the entrepreneurial orientation of top managers in Korean technology firms positively affects firms' R&D investment during economic recession regardless of the specific industry type in which they conduct business. This implies that entrepreneurial orientation, as the willingness of top managers to be proactive, innovative, and endure risk during an economic recession, can be an effective means to reduce the agency problem that arises from the separation of ownership and control in the organization. The results of this study suggest some practical implications for managers and policy makers by emphasizing the importance of business judgment rule that encourages top managers in technology firms to have a more entrepreneurial orientation. The business judgment rule is defined as a case of law-derived doctrine in corporate law that courts defer to the business judgment of top managers of firms. Under weak protection for this rule, top managers may not make long-term investments due to the risk and uncertainty associated with them, although they know it is important for the growth and survival of firms. Instead, they will more likely focus on the pressures for short-term profitability and thus make firms lose global competitiveness. Therefore, it is important for policymakers in the Korean government to realize that, depending on the national policy for business judgment rule, top managers of technology firms could have a different impact on long-term investment decisions including R&D.

This study also reveals that the relationship between top managers' entrepreneurial orientation and Korean technology firms' R&D investment is modified by the two different dimensions of environmental uncertainty. These findings contribute to the entrepreneurial orientation literature by introducing environmental uncertainty as the boundary condition for the role of top managers' entrepreneurial orientation in firms' R&D investment. Specifically, the findings indicate that environmental dynamism negatively modifies the positive relationship between entrepreneurial orientation and R&D investment. This suggests that the effect of top managers' entrepreneurial orientation on firms' R&D investment could be weakened as the instability of industry sales increases. It implies that the risk-taking tendency of top managers weakens when the average industry sales volume fluctuates. On the other hand, environmental munificence intensifies the entrepreneurial orientation and R&D investment relationship. This suggests that the effect of top managers' entrepreneurial orientation on firms' R&D investment could be strengthened as the average growth in industry sales increases. It implies that the risk-taking tendency of top managers strengthens when the industry grows. However, environmental hostility, measured by the number of competitors in the industry, does not reveal any impact on the relationship between top managers' entrepreneurial orientation and firms' R&D investment. These findings indicate that the entrepreneurial orientation of top managers can help explain the managerial processes that strengthen R&D investment and ultimately firms' innovation to respond to environmental uncertainty. Furthermore, they imply that distinguishing the indirect effects of different types of environmental uncertainty is instrumental in enhancing policymakers' and managers' understanding of the relationship between top managers' entrepreneurial orientation and technology firms' R&D investment. Thus, our findings imply that practitioners should carefully consider environmental dynamism and munificence to strengthen the positive effect of top managers' entrepreneurial orientation on firms' innovation. This addresses the call for research on the contingent effect of external factors on the relationship between the entrepreneurial orientation of top managers and firms' strategic decisions [76].

6. Conclusions

This study contributes to both the entrepreneurial orientation and innovation literature by using an emerging market sample and incorporating variables related to environmental uncertainty. We focus on the effect of entrepreneurial orientation on R&D. Environmental uncertainty was set as a control variable. We focus on entrepreneurship and the environment as there is a significant body of research on each of these factors, but studies on the relationship between them are rare. Furthermore, it is important to cultivate an entrepreneurial spirit to promote R&D. It outlines the theoretical research model that explains how top managers' entrepreneurial orientation helps a firm to maintain and intensify innovation as their growth engine during an economic recession and how different dimensions of environmental uncertainty can change this effect. We believe our theoretical research model allows for greater exploration of the effect of entrepreneurial orientation. This study is limited in that it examines only Korean companies. However, despite this limitation, it encourages future research that focuses on the discovery and exploitation of opportunity in the market by using top managers' psychological characteristics in combination with internal and external contingency factors.

The theoretically derived research model, which links top managers' entrepreneurial orientation, firms' R&D investment, and environmental uncertainty, was empirically validated by an analysis of 337 Korean technology firms. Thus, this study demonstrates that CEOs' entrepreneurial orientation has a significant relationship with corporate strategic decisions regarding R&D investment. These results mean that the propensity and nature of CEOs have a significant impact on the company's innovation efforts, especially during economic recession. Moreover, environmental munificence reinforces the relationship between entrepreneurial orientation and R&D investment, while environmental dynamics has a negative effect. On the other hand, environmental hostility does not affect this relationship. The result of mitigating the impact of environmental uncertainty is that companies must carefully consider environmental changes and superiority to enhance the positive effects of the CEO's corporate

orientation on the company's innovation efforts. The results provide guidelines for Korean technology firms undertaking R&D management, especially during economic recession. In addition, we hope that this research presents a suitable direction for the government regarding the corporate R&D activation policy. When the government establishes policies to reduce economic dynamism, companies may produce a wide range of goods and services, and when many of these companies are created, the country will have higher GDP per capita.

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