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The Impact of Startups' Dual Learning on Their Green Innovation Capability: The Effects of Business Executives' Environmental Awareness and Environmental Regulations

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Abstract: Under the environment of a green economy, green innovation serves as the only way for enterprises to grow, upgrade their competitiveness and seek continued business. Based on a questionnaire survey of 212 enterprises established within 4 years in the Pearl River Delta of China, this research utilizes structural methods to analyze the impacts of exploratory and applied learning (dual learning) on green innovation capability and verifies the environmental protection awareness of senior executives and the adjustment effects of environmental regulation. The results suggest that (1) exploratory and applied learning have a positively significant impact on green innovation capability; (2) under the regulation of environmental protection awareness of internal executives, there are differences in green innovation capabilities under the dual influences of exploratory and applied learning; and (3) under the adjustment of external environmental regulation, there are differences in green innovation capabilities under the dual influences of exploratory and applied learning. The findings indicate that new start-up ventures should raise awareness of environmental protection among senior executives under dual learning and perceive the changes of the government's environmental regulations to enhance their green innovation capabilities.

Keywords: dual learning; green innovation capability; executive's environmental awareness; environmental regulation

1. Introduction

Green innovation has become one of the most heated topics of enterprises' sustainable development, and all countries around the world are currently formulating environmental regulations to give them a more powerful drive toward green innovation. In response to global climate change and economic recession, enterprises take up green innovation to enhance the value in their products and to promote economic growth, making the green economy a new trend of global economic development. On the other hand, customers are increasingly aware of green products and ethical consumption, and executives are also aware that there is a balance between enterprises' economic pursuits and environmental protection by trying to make their product ecologically compatible.

In China's *Made-in-China 2025* plan, green development is the core of its main direction. State and local governments have issued several environmental regulations to encourage green and low-carbon

production techniques and speed up the pace of green technology innovation and industrialization, green manufacturing, green supply chain management, and much more [1]. Therefore, the growth of the green economy depends on green science and technology and green innovation. In addition, the building up of enterprises' green innovation capability is an inevitable trend of innovation management.

Green innovation is the only way to grow and enhance competitiveness and sustain business in a green economy environment [2,3]. Organizational learning plays a vital role in the process of improving green innovation ability. March divided an organization's dual learning into exploratory and applied learning types [4]. Exploratory learning can acquire new knowledge from the external environment, thus making new innovations. Enterprises are more agile to perceive and grasp external opportunities, make better use of the new knowledge to reorganize enterprise resources, and better integrate and create knowledge [5]. Applied learning can help companies have a deeper understanding of the external environment and their own resources and enhance their ability to perceive opportunities and threats [6]. However, the developments of exploratory and applied learning activities are both internal to the organization. When the influence of senior management's (or executives') environmental awareness is stronger, there will be a greater significant impact of organizational dual learning on green innovation capabilities.

According to the environmental regulation theory, the government can effectively solve the market failure caused by green technology innovation through environmental policies [7]. Porter proposed that environmental regulation can be properly designed to induce innovation [8]. Due to the increasing environmental regulations in the business environment under which companies operate, new innovations must be carried out in response to the rapidly changing market environment. Senior executives also realize that green innovation is a potentially huge business opportunity. Berrone et al. pointed out that policy pressure from government environmental regulation is the main driving force for green innovation in commerce [9]. In other words, the stricter the environmental regulations are, the more enterprises tend to invest in green technologies. Lin et al. focused on internal knowledge resources and capabilities and found that green knowledge sharing enhances green innovation capabilities, thereby promoting green innovation and increasing participation in international competitive advantage [10].

Organizational dual learning and green innovation capability are not only influenced by the pressure resulted from external environmental regulations, but also by the environmental awareness of business executives. The previous literature mainly studied the regulatory relationship between external environment and variables such as dual learning, performance, competitive advantage, etc. Nevertheless, these studies seem to lack an exploration into the role of external environment regulation on dual learning and green innovation ability. In addition, the literature has found that executives' awareness of environmental protection will affect their willingness to approve activities of green innovation, but few studies have studied the regulatory role of executives' awareness of environmental protection in the process of dual learning and the enhancement of green innovation capability. Due to the different characteristics and impacts on organizational growth, exploratory and applied learning activities have different impacts on green innovation capability as well. Therefore, based on the theory of organizational learning, institutional theory, and green innovation theory, this research project aims to explore the impact of dual learning on green innovation capability among startups and then verifies the regulatory effect of environmental awareness of business executives and external environmental regulations. The results contribute to a better way for enterprises to carry out green innovation activities and provide reference for governments to formulate environmental regulations.

2. Literature and Research Hypothesis

2.1. Dual Learning and Green Innovation Capability

Based on the organizational learning theory, March proposed the dual learning concept for the first time in the study of organizational adaptability and development and divided dual learning into two types: applied and exploratory learning [11]. Exploratory learning is essentially a trial-and-error

learning behavior. It mostly explores the internal and external resources of an enterprise, by constantly trying, taking risks and innovating. The basic idea behind applied learning is based on existing knowledge, which the company summarizes and sublimates. Applied learning is the deepening of the knowledge possessed by an organization that is of great significance to its survival. For startups, dual learning is an entrepreneurial learning behavior (a combination of exploratory and applied learning) and is generally related to entrepreneurial activities. New ventures rely on them to continue to grow and develop. To create and accumulate knowledge, dual learning runs through the entire life cycle of a startup.

Green innovation capability is the result of adapting to changes in the environment during the development of innovation management. Its essence is the ability to integrate internal and external resources and technologies, reduce environmental pollution, and improve environmental performance in order to obtain a sustainable competitive advantage. From the perspective of the resource-based theory, Nehru pointed out that the ways to reduce pollution involve many aspects of a startup's operation, such as product design, equipment utilization, workflow, raw material recycling, etc. [12]. These activities are conducted while creating market demand, while reducing costs, and while preventing pollution. The development of green innovation capability requires the organization to accumulate and acquire knowledge. To a certain extent, it depends on the organization's acquisition and accumulation of knowledge in this process, which also shows that learning is the main mechanism for creating and developing green innovation capability [13]. Through trial and error, improvisation, and imitation of other organizational behaviors, a startup's green innovation capability can be more effectively improved [14].

Compared to mature enterprises, startups with dual learning have more significant performance due to their unique utilization of organizational resources and capabilities. First, the exploration and utilization of external knowledge are very important for startups to upgrade and renew existing resources and to re-engineer new resources. Second, the new characteristics of startups reflect that their existing knowledge may not be enough to meet their current development, and that information and technology acquired through dual learning must be transformed into organizational resources [15]. Exploratory and applied learning, as two different learning modes of an organization, play an important role in improving green innovation capability [16]. Exploratory learning can improve green innovation capability through the acquisition of new knowledge in the field of entrepreneurship from the external environment. Such new knowledge further promotes the perception of opportunities and enhances the startups' own creativity, making new ventures more agile to perceive and grasp external opportunities. Moreover, this contributes to making better use of the acquired knowledge by restructuring it to form resources and knowledge integration and then creation [17]. In this process, organizational change is carried out through repeated trial and error to better adapt to changes in the environment.

The ways to improve enterprises' green innovation capability are as follows. Applied learning emphasizes the upgrading of existing knowledge by expanding the content and depth of that knowledge in accordance with the necessary changes in a timely manner, which is conducive to the promotion of organizations' green innovation ability [18]. Applied learning can help enterprises have a deeper understanding of the external environment and their own resources and enhance their ability to perceive opportunities and threats. In addition, applied learning attaches importance to the further refinement of knowledge and strengthens the understanding of organizational practices and processes, which will help startups to better adapt to environmental changes and enhance their green innovation capabilities. Therefore, in the process of the development of new ventures, exploratory and applied learning are very important to enhance green innovation capability. Therefore, the following hypotheses are proposed:

Hypothesis 1. *Exploratory learning of new ventures has a positive impact on green innovation capability.*

Hypothesis 2. *Applied Learning of new ventures has a positive impact on green innovation capability.*

2.2. Dual Learning and Green Innovation Capability

There are different opinions on the contradiction and complementation of the two kinds of learning. An opposite viewpoint holds that exploratory and applied learning behaviors will compete for the organizations' resources, and the organizations have certain inertia and dependence on applied learning or exploratory learning. Furthermore, the two kinds of learning activities need different organizational mechanisms for support [11]. Exploratory learning and entrepreneurial learning simultaneously may have a negative impact on corporate performance, and so only one kind of learning can be carried out within the organization. The view of complementation holds that exploratory and applied learning activities can be carried out simultaneously, and that organizations can control both kinds of learning activities at the same time [13]. In recent years, more and more scholars have shown that exploratory and applied learning are complementary rather than contradictory.

Exploratory learning essentially refers to the discovery and acquisition of new external knowledge, which is crucial to the future development of enterprises. Applied learning, on the other hand, contributes to upgrading and reform with the existing entrepreneurial knowledge and to improving the current performance. Exploratory learning adds new entrepreneurship knowledge to new ventures and fosters the speed of acquisition of new knowledge. Both are beneficial to the green innovation capability of new ventures. As the environmental issues business organizations are facing nowadays have become more and more turbulent, the knowledge needed to cope will change, and the complementary viewpoint of dual learning is increasingly recognized by academia. Through exploratory and applied learning, knowledge innovation and accumulation can be realized in that new knowledge acquired from outside is transformed into the existing knowledge structure, while tacit knowledge is transformed into explicit knowledge, and knowledge circular development is thus formed [19]. Therefore, dual learning is a cyclical process. Without exploratory learning, applied learning cannot occur, and the use of existing resources must be based on previous exploratory learning. At the same time, for new ventures that are eager at exploring and innovating, they must carry out applied learning to find stable financial support for engaging in high-risk market activities.

In sum, exploratory and applied learning can promote gradual innovation and the breakthrough of innovation in new ventures [20]. This further shows that dual learning is more important for green innovation capability. Ignoring any of them may have a negative impact on corporate development. This research thus argues that, in the context of social networking, dual learning has a positive impact on green innovation capability. The third hypothesis is thus proposed:

Hypothesis 3. *The interaction between exploratory and applied learning has a positive impact on startups' green innovation capability.*

2.3. Mediating Effect on the Environmental Protection Awareness of Business Executives

Executives are the core of business management and have a key role in corporate strategy and green innovation development decisions [21]. Corporate executives are influenced by politics, environmental regulations, and values. Some senior executives know that environmental opportunities may become an important source of real income growth. In other words, theoretically, the stronger an executives' environmental awareness is, the more likely they are to identify the potential benefits of green innovation. On the one hand, environment-oriented executives are more likely to perceive the potential benefits of government regulations and the incentives behind them. On the other hand, they regard consumers, suppliers, and competitors as market opportunities if the correct green innovation is applied in the product or service. The research and development of new products will be more to the point in order to meet consumers' demand, to cooperate with suppliers to share innovation risks, and to focus on competitor strategies. Ultimately, competing for market share this way forms a competitive advantage.

The stronger executives' environmental awareness is, the more responsible they would feel about green innovation, and the more willing they are to invest resources and capabilities in it. In the case of limited resources, the ratio of return on investment is the most important factor for enterprises to consider in project investment. Green innovation requires more investment resources, high market risk, and many instances of uncertainty in R&D. Only when senior managers incorporate green innovation into the scope of corporate responsibility can they invest resources and make it more accessible at the strategic level.

If executives have a high awareness of environmental protection and are open minded about green innovation, then they would be good at exploratory learning, encoding the information they get and integrating it with enterprise resources, as well as absorbing internal and external knowledge and applying it to green innovation. More importantly, executives having a strong awareness of environmental protection can actively respond to environmental problems their products have caused. They can utilize applied learning to promote their enterprises to identify market opportunities from outside. This is conducive to the rational allocation of internal resources and management capabilities. Sharma analyzed the process of strategic choice from the perspective of opportunities and threats perceived by managers [22], believing that managers who regard environmental issues as opportunities tend to choose proactive environmental strategies. Burki et al. pointed out that executives' attitudes and commitments to the environment affect the achievement of green innovation, which is conducive to building an excellent environment for business collaboration [23].

Previous studies have revealed that organizational learning behavior can aid enterprises in becoming sensitive to and capturing external opportunities, thus improving their competitive advantage. However, the development of learning activities alone cannot make enterprises achieve this. As a learning attitude, senior executives' environmental awareness can more clearly reflect the value of the learning activities. Additionally, business executives' interpretation of external environmental regulatory pressure and their own capabilities will affect their company's environmental protection policies. At this rate, the impact of external pressure and internal driving forces of green innovation is mediated by the executives' environmental awareness. Therefore, this paper proposes that senior executives' environmental awareness has mediating effects on both exploratory and applied learning and green innovation capability of a startup. Therefore, the following hypotheses are proposed:

Hypothesis 4a. *The stronger executives' environmental awareness is, the stronger is the positive impact of exploratory learning on green innovation capability.*

Hypothesis 4b. *The stronger executives' environmental awareness is, the stronger is the positive impact of applied learning on green innovation capability.*

Hypothesis 4c. *The stronger executives' awareness of environmental protection is, the stronger is the positive impact of dual learning interaction on green innovation capability.*

2.4. Mediating Effect of Environmental Regulation

Green innovation driven by environmental regulation has been widely recognized throughout the world and has become a very popular research topic in developing countries. Chen et al. conducted an empirical analysis, and their results show that environmental regulation is conducive to environmental management and green innovation and has a positive impact on responsive green innovation strategy and proactive green innovation [24]. Zhang et al. noted that the policy pressure of environmental regulation is the main driving force for an enterprise to adopt green innovation [25]. In other words, the stricter the environmental regulation is, the more enterprises would feel compelled to adopt green innovation. Previous studies have also shown that environmental regulation can promote enterprise development and diffusion of green technology, because of the compensation effect of innovation. In this sense, environmental regulation has an incentive effect on enterprise green innovation technology

and green innovation performance [26–28]. Domestically, there are also empirical studies that confirm the same effect [29,30].

Environmental regulation can be divided into command control type and market incentive type, which have different effects on green innovation capability. Frondel et al. showed that market incentive regulation has a more significant impact on green innovation than mandatory regulation [31]. In today's market environment, most enterprises are no longer confined to meeting the minimum requirements of environmental regulation (also known as 'terminal governance'), but actively strive to comply with the government's market incentive resources to offset the cost of green innovation. On the contrary, some studies suggest that environmental regulation hinders green technological innovation by increasing the cost of pollution control and by crowding out the investment in green innovation [1,26]. Judging from these two arguments, the impact of environmental regulation on green technology innovation is uncertain. The impact of different environmental policies and intensity on green technology innovation is obviously different. Therefore, the theory of environmental regulation holds that environmental regulation, as a kind of government policy, will lead to the re-allocation of innovation factors and changes in the direction, focus, and scale of innovation. As a result, there will be differences in the choice of innovation strategies to cope with environmental regulations.

A change in the regulation of the external environment brings opportunities and threats to the development of new ventures. Startups face more uncertainties in the process of development as a result. Through continuous learning, they can enhance their level of know-how so that they can more acutely perceive the external environment and seize opportunities in time. In addition, they might be better able to enhance their green innovation capability. Under the condition of mandatory environmental regulation (command-control type), the resources and abilities of new ventures may not be enough for fast growth, and competition pressure can turn increasing sharply. In this scenario, the new knowledge and new resources acquired through dual learning and the old knowledge developed may have a very outward impact on the operation and development of new enterprises.

Under the influence of environmental regulation (command-control type), dual learning may have a significant impact on the operation and development of enterprises [32]. Dual learning is conducive to discovering and understanding changes in customer needs and coping successfully with the changes brought by environmental regulations. In a relatively stable regulation environment (market incentive type), enterprises face less pressure from competitors, and their insight ability is relatively weak. Hence, incorporating dual learning activities cannot bring obvious results to enterprises. Nonetheless, dual learning is still a necessary premise for an enterprise to grow and develop within an uncertain environment. Through exploratory and applied learning, an enterprise can better improve its ability to discover new opportunities and resources in a changing environment [33]. This paper proposes that environmental regulation has a mediating effect on the exploratory, applied learning and green innovation capability in new ventures. Thus, the following hypotheses are proposed.

Hypothesis 5a. *The stronger the environmental regulation is, the stronger is the positive impact of exploratory learning on green innovation capability.*

Hypothesis 5b. *The stronger the environmental regulation is, the stronger is the positive impact of applied learning on green innovation capability.*

Hypothesis 5c. *The stronger the environmental regulation is, the stronger is the positive impact of dual learning interaction on green innovation capability.*

To summarize, based on the organizational learning theory, institutional theory, and green innovation theory, this paper sets out to explore the impact of dual learning on green innovation capability of new ventures and verifies the mediating effect of environmental awareness and external environmental regulation of executives. The research framework is shown in Figure 1.

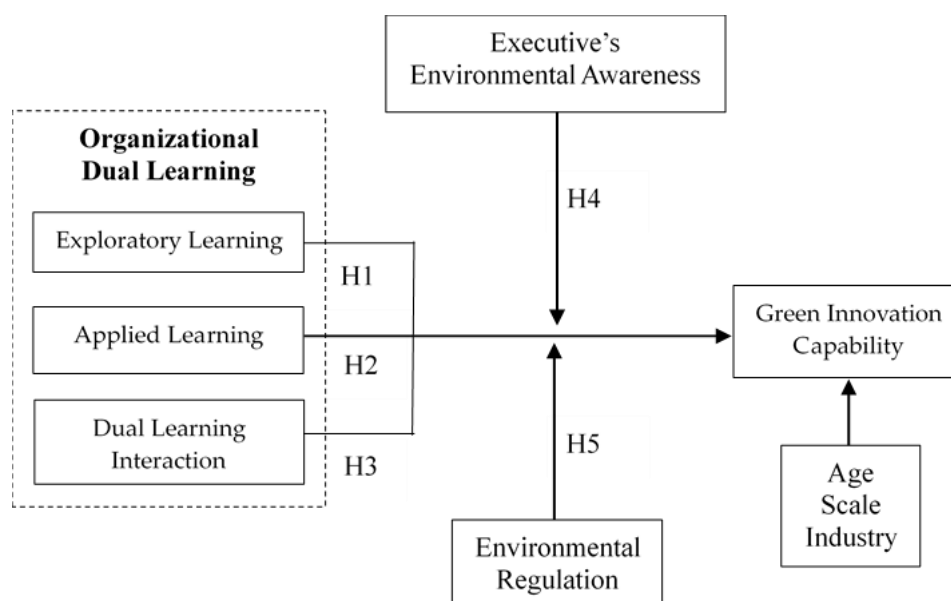


Figure 1. Research framework for startups' dual learning and green innovation capability.

3. Research Design

3.1. Sample and Data Collection

The data of this study come from new ventures (startups) in the Pearl River Delta, that are within their fourth year of establishment. According to reports of GEM the 42-month-old new ventures are in the growth stage. Questionnaire participants are mainly senior and middle managers of enterprises. In total, 500 questionnaires were sent out, and 268 questionnaires were retrieved. Fifty-six questionnaires were found to have incomplete information, which makes them invalid. The remaining 212 questionnaires were valid for a validity rate of 42.40%. Samples consist of companies with 1–10 employees (10.31%), 11–50 employees (16.14%), 51–100 employees (12.56%), and 100 or more employees (60.99%). In terms of age, 6.84% are within one year old, 27.00% 1–2 years old, 18.70% 2–3 years old, and 47.46% 3–4 years old. In terms of industry, 38.00% are manufacturing, 19% information transmission, software, and information technology services, 16.70% finance, 9.3% logistics, 8.20% retail, 8.10% construction, and 0.70% from other industries.

3.2. Measurement of Variables

The development of the questionnaire items in this study mainly is based on the theories and findings of the relevant previous literature. In order to obtain a rigorous questionnaire, after it had been designed, scholars, professors, and practitioners in relevant fields were invited to provide guidance for improvement. After several revisions of the items and grammar, the questionnaire first selected 30 enterprises for pre-test. After statistical analysis of the preliminary data, the accuracy of the questionnaire items was ensured. Moreover, after repeated revision of inappropriate semantics, the formal questionnaire for this study was finalized. The questionnaire uses the Likert 7-point scale, which means the higher the number selected by the participants is, the more that they agree with the description of the question (1 for highly disagree, 3 for normal, 7 for highly agree). The questionnaire mainly contains five dimensions: exploratory learning, applied learning, green innovation capability, executives' environmental awareness, and environmental regulation. The operational definitions of variables in the research framework and the basis of the research scale are described as follows.

The scales of exploratory and applied learning incorporate the ones developed by Atuahene-Gima and Murray [34] and Su et al. [35], and we use three measurement items respectively. Green innovation capability has a multi-structure, and the measurement indicators of it include at least green product

innovation, green technique innovation, green R&D innovation, green sales, etc. from Bi, Yang and Sui [36]. The measurement of the variables of environmental awareness of senior executives is based on the research of Eiadat et al. [37] and Gadenne et al. [38,39], including three items. Moreover, the variables of environmental regulation (mandatory and incentive types) are environmental policies, pollution control costs, pollution emissions, direct subsidies, and indirect subsidies [40]. There are nine items linked with the subsidies in the questionnaire, which are green product subsidies, technology subsidies, R&D subsidies, preferential taxation, and talent incentives. The control variables are enterprise's age, scale, and the industry in which it operates. As these three variables of new ventures allegedly have different degrees of impact, controlling them can have an impact on senior executives' environmental awareness, environmental regulation, dual learning, and green innovation capability.

4. Empirical Results and Analysis

4.1. Descriptive Statistical Analysis

This study uses SPSS23.0 statistical analysis software (IBM SPSS, Chicago, IL, USA) for descriptive statistical analysis of the sampled data. Table 1 lists the mean, standard deviation, and correlation coefficient of each variable, showing that the correlation coefficients of exploratory learning, applied learning, green innovation capability, executives' environmental awareness, and environmental regulation are between 0.16 and 0.70, all of which reach a significant level. This reflects a moderate positive correlation between each variable and green innovation capability. Considering that each questionnaire was filled out by the same participant, there may be common method deviation (CMV) in the data sources. Thus, we adopt the Harman single factor method to solve it, subsequently seeing that the first factor explains 32.6% of the variance without rotation, which does not account for much of the variance. This indicates CMV does not affect the statistical results.

4.2. Confirmatory Factor Analysis

This study employs Mplus 7.0 to test the reliability, convergence validity, and differential validity of the questionnaire by means of confirmatory factor analysis (CFA), presenting the results in Table 1. The Cronbach's alpha coefficient of each research variable is greater than 0.7, and those of exploratory learning and applied learning are 0.76 and 0.84, respectively. Moreover, the Cronbach's alpha coefficient of green innovation capability is 0.86, and those of executives' environmental awareness and environmental regulation are 0.92 and 0.76, respectively. The combined reliability value is greater than 0.7, and the average variant extraction quantity reaches 0.5. The convergence validity reached the standard recommended by scholars. In addition, the confidence interval test is used to verify discriminant validity. The test results show that the correlation coefficients between the constructions do not include 1 after adding or subtracting two standard errors, which agrees with the standard of good discriminant validity. The results of CFA ($df = 1.98 < 3$, $p < 0.001$; standardized root mean square residual [SRMR] = 0.05 < 0.08; comparative fit index [CFI] = 0.91 > 0.90; incremental fit index [IFI] = 0.91 > 0.90; root mean square error of approximation [RMSEA] = 0.06 < 0.08) show that the questionnaire has good reliability and validity and the scale used has satisfactory quality in measurement [41].

Table 1. Descriptive statistics and correlation coefficients of variables.

Variable	Mean	Std	1	2	3	4	5	6	7	8
1. Exploratory learning	3.92	0.52	1							
2. Applied learning	3.56	0.73	0.62 **	1						
3. Green innovation capability	3.54	0.72	0.53 **	0.63 **	1					
4. Executive's environmental awareness	3.76	0.65	0.69 **	0.70 **	0.68 **	1				
5. Environmental regulation	2.83	0.79	0.27 *	0.31 **	0.35 **	0.23 **	1			
6. Age	3.85	2.86	0.06	0.03	−0.12	−0.04	−0.01	1		
7. Scale	3.54	1.02	−0.15 **	−0.22 **	−0.18 **	−0.20 **	0.01	−0.10	1	
8. Industry	3.50	0.83	−0.08	−0.07	−0.11	−0.08	−0.09	−0.16 *	0.68 **	1
CR			0.87	0.75	0.83	0.91	0.78			
AVR			0.58	0.62	0.67	0.53	0.55			

Note: N = 212; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed test).

4.3. Hypothesis Verification

This study utilizes SPSS23.0 and Hayes's (2013) Process system [42] to verify the hypothesis based on the sample data. First, senior managers' awareness of environmental protection is treated to regulate exploratory learning, applied learning, and green innovation. For example, Model 2 in Table 2 shows that exploratory learning has a significantly positive impact on green innovation capability ($\beta = 0.56, p < 0.001$). Thus, Hypothesis 1 is supported. On the other hand, applied learning has a significantly positive impact on green innovation capability ($\beta = 0.35, p < 0.001$). Thus, Hypothesis 2 is supported as well. Model 3 shows that the interactive items of exploratory and applied learning have no significant effect on green innovation capability ($\beta = 0.05, p > 0.05$). Thus, Hypothesis 3 is rejected. The interaction between executives' environmental awareness and exploratory learning has no significantly positive impact on green innovation capability ($\beta = -0.02, p > 0.05$). Thus, Hypothesis 4a is not supported. Finally, executives' environmental awareness and applied learning interaction has no significantly positive impact on green innovation ability ($\beta = -0.07, p > 0.05$). Therefore, Hypothesis 4b is not supported.

Table 2. Hypothesis testing results.

Variable	Green Innovation Capability				
	Model 1	Model 2	Model 3	Model 4	Model 5
Control					
Industry	-0.08	-0.02	-0.02	-0.07	-0.01
Scale	-0.26 **	-0.03	-0.02	0.01	-0.03
Age	0.08	0.01	0.01	-0.01	0.02
Two-way interactions					
Exploratory learning		0.56 ***	0.56 ***	0.32 ***	0.36 ***
Applied learning		0.35 ***	0.35 ***	0.24 ***	0.27 ***
Exploratory learning \times Applied learning			0.05	0.03	0.02
Executives' environmental awareness				0.38 ***	
Exploratory learning \times Executives' environmental awareness				-0.02	
Applied learning \times Executives' environmental awareness				-0.07	
Environmental regulation					0.03
Exploratory learning \times Environmental regulation					-0.01
Applied learning \times Environmental regulation					-0.01
Three-way Interaction					
Exploratory learning \times Applied learning \times Executives' environmental awareness				-0.08 **	
Exploratory learning \times Applied learning (Low) \times Executives' environmental awareness (Low)				0.28 ***	
Exploratory learning \times Applied learning (High) \times Executives' environmental awareness (Low)				0.38 ***	
Applied learning (High) \times Executives' environmental awareness (Low)				0.39 ***	
Applied learning (High) \times Executives' environmental awareness (High)				0.37 ***	
Exploratory learning \times Applied learning \times Environmental regulation					0.16 ***
Exploratory learning \times Applied learning (Low) \times Environmental regulation (market incentive type)					0.45 ***
Exploratory learning \times Applied learning (High) \times Environmental regulation (market incentive type)					0.35 ***
Exploratory learning \times Applied learning (Low) \times Environmental regulation (Command Type)					0.27 ***
Exploratory learning \times Applied learning (High) \times Environmental regulation (Command Type)					0.42 ***
R^2	0.05	0.57	0.57	0.80	0.77
ΔR^2	0.04	0.56	0.56	0.64	0.59
F	3.98 *	57.40 **	49.23 ***	56.78 ***	44.47 ***

Note: N = 212; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Second, with regards to the influence of external environmental regulation on exploratory learning, applied learning, and green innovation ability, the results do not show a significant effect on green innovation capability ($\beta = -0.01, p > 0.05$). Thus, Hypothesis 5a is rejected. It also shows that environmental regulation has no mediating effect on the relationship between exploratory learning and green innovation capability. Furthermore, the interaction between environmental regulation and applied learning has no significant effect on green innovation capability ($\beta = -0.01, p > 0.05$). Thus, Hypothesis 5b is not supported, and environmental regulation has no mediating effect on the relationship between applied learning and green innovation capability. However, from Table 2 the three interactions of executives' environmental awareness and exploratory and applied learning have a significant impact on green innovation capability ($\beta = -0.08, p < 0.01$). The three individual interactions of environmental regulation and exploratory and applied learning have a significant impact on green innovation capability ($\beta = 0.16, p < 0.01$).

Third, the three interaction effects are put to test, dividing the environmental awareness of executives and applied learning into low and high levels. The results are in model 4 in Table 2, showing that the interaction between exploratory learning and low-level applied learning has a significantly positive impact on green innovation capability ($\beta = 0.28, p < 0.001$), while the interaction between exploratory learning and high-level applied learning has a significantly positive impact ($\beta = 0.38, p < 0.001$). Similarly, the interaction between exploratory learning and low-level applied learning has a significantly positive impact on green innovation capability ($\beta = 0.39, p < 0.001$), and so does the interaction between exploratory learning and high-level applied learning ($\beta = 0.37, p < 0.001$). Hypothesis 4c is supported.

The analysis results are drawn in Figure 2, in which we illustrate when executives' awareness of environmental protection is low that the simultaneous existence of exploratory learning and high-intensity applied learning has a stronger effect on promoting green innovation capability than that of exploratory learning and low-intensity applied learning. It implies when the initiative of environmental protection of executives in new ventures is low that application innovation should be carried out to meet the market demand quickly by imitating and replicating products. In contrast, when executives' awareness of environmental protection is at a high level, the simultaneous existence of exploratory learning and low-intensity applied learning has a stronger effect on promoting green innovation capability than that of exploratory learning and high-intensity applied learning. It seems that new ventures should spur exploratory innovation when their executives are highly aware of environmental protection, which can be undertaken as an attempt to lead the market by developing new products and inventions in order to meet the needs of customers.

Finally, environmental regulation and applied learning are divided into low and high levels. Model 5 in Table 2 shows under environmental regulation (market-oriented type) that the interaction between exploratory learning and low-level applied learning has a significantly positive impact on green innovation capability ($\beta = 0.45, p < 0.001$). The interaction between exploratory learning and high applied learning has a significantly positive impact on green innovation capability ($\beta = 0.35, p < 0.001$). Under environmental regulation (command type), the interaction between exploratory learning and low-level applied learning has a significantly positive impact on green innovation capability ($\beta = 0.27, p < 0.001$), the interaction between exploratory learning and highly applied learning has a significant impact on green innovation capability ($\beta = 0.42, p < 0.001$). Hypothesis 5c is supported.

The analysis results are drawn in Figure 3, which shows when environmental regulation (market-oriented type) exists that the simultaneous existence of exploratory learning and low-intensity applied learning has a stronger effect on green innovation capability than that of exploratory learning and high applied learning. It denotes that new ventures should spur exploratory innovation through the development of new products and inventions under external environmental regulation (market-oriented type) in order to meet the needs of customers and lead the market. Under environmental regulation (command type), the simultaneous existence of exploratory learning and high-intensity applied learning has a stronger effect on the promotion of green innovation capability than that of exploratory learning and low applied learning. This indicates new ventures should carry out applied innovation under external environmental regulation (command type) to quickly satisfy market demand by imitating products.

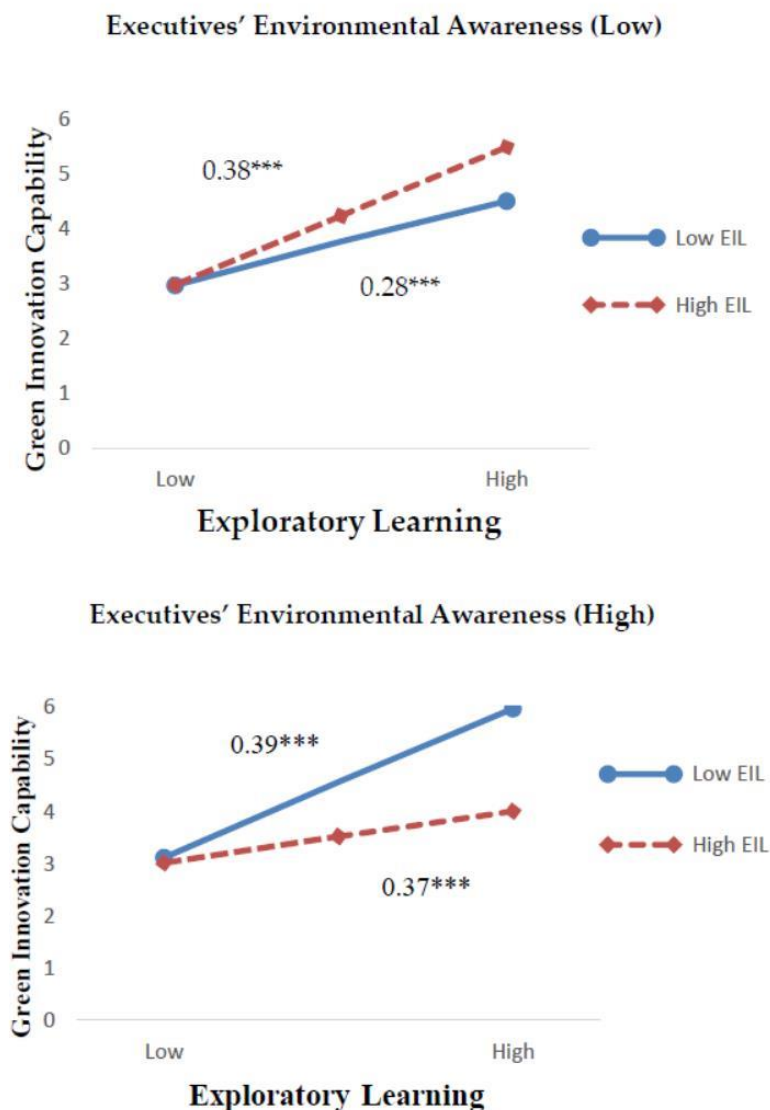


Figure 2. Impact of executives' environmental awareness, exploratory learning, and applied learning on green innovation capability.

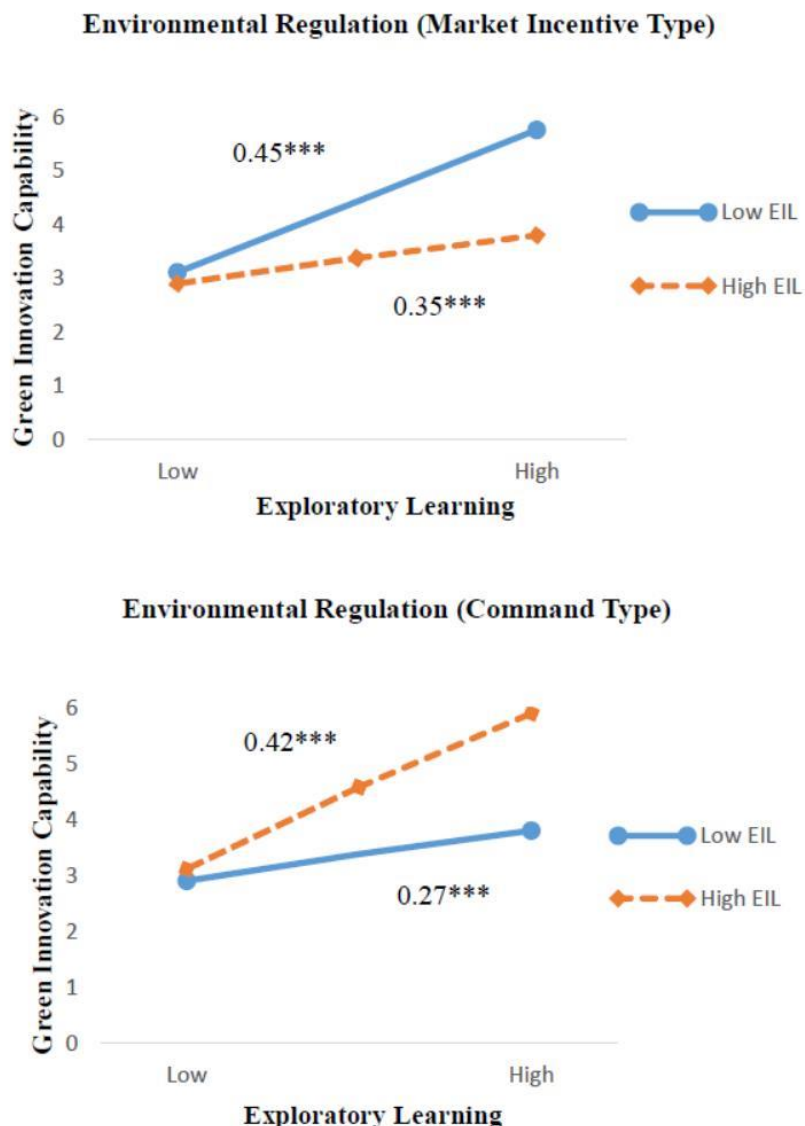


Figure 3. Impact of environmental regulation, exploratory learning, and applied learning on green innovation capability.

5. Research Conclusions and Recommendation for Future Research

5.1. Research Conclusions

Through empirical analysis, this paper explores the relationship between dual learning and green innovation capability of startups and further investigates how to adjust the relationship between environmental awareness of executives and environmental regulation. There are three conclusions, as follows.

First, exploratory and applied learning can promote the improvement of green innovation capability, respectively. However, the interaction between dual learning does not have a significant impact on green innovation capability. This shows that two kinds of entrepreneurial learning behaviors can improve green innovation capability, but the effect of this complementary effect may be influenced by the proportion of these two learning behaviors in the company and other minor factors.

Second, executives’ environmental awareness has no mediating effect on the relationship between exploratory and applied learning and green innovation capability, but the relationship between dual learning interaction and green innovation capability has a significant mediating effect. This means that the impact of dual learning interaction on green innovation capability seems to be affected by

the environmental awareness of senior executives within the organization, which also implies the importance of senior executives' environmental awareness in new ventures' life span.

When executives' environmental awareness is at a low level, exploratory learning and high applied learning play a stronger role in promoting green innovation capability than low-level applied learning. The main reason is that when their environmental awareness is low, it is difficult for enterprises to precisely perceive external opportunities, so that they can make use of and upgrade existing knowledge or imitate the experience of other companies. To a large extent, they can uplift their own development needs and capabilities in this way. When the environmental awareness of senior executives is high, they are less easy to be satisfied with the use of existing resources. On the contrary, they are more willing to actively obtain new external information, daring to take risks in exchange for new knowledge and experience. In sum, the combination of exploratory learning and low-intensity applied learning is more conducive to the green innovation capability of the enterprise.

Third, environmental regulation has no mediating effect on the relationship between exploratory and applied learning and green innovation capability, but the relationship between dual learning interaction and green innovation capability has a significant mediating effect. When environmental regulation (market incentive type) is present, the enterprise can improve green innovation more markedly by carrying out low-level applied and exploratory learning than by high-level applied learning. When environmental regulation of the command type is in the picture, the enterprise seems to improve its green innovation ability more significantly by using high-level applied and exploratory learning than low-level applied learning. This denotes that the change of external environmental regulation is very important for enhancing green innovation capability. The change of external environment regulation brings opportunities and challenges at the same time. The joint development of high-intensity applied and exploratory learning enables the enterprise to perceive opportunities in time, so as to be ready to obtain resources and restructure their own resources. This often serves to better adapt to the changing environment regulation. However, when environmental regulation of the market incentive type is adopted, the enterprise is more likely face fewer less threats. In this case, low-intensity applied and exploratory learning are more suitable for new ventures considering their characteristics. Therefore, the government should optimize the combination of environmental regulation and implement differential regulation in different industries in order to achieve the best effect in promoting sustainable development of green innovation. From the perspective of enterprises, they should carry out dual learning to better adapt to environmental regulation and create a market niche.

5.2. Theoretical Contributions

This study not only enriches the existing research model, but also provides theoretical support for how new ventures can better enhance their green innovation capability. The main theoretical contributions are as follows. First, in using the theory of organizational learning and the application of entrepreneurship, the impact of exploratory and applied learning on green innovation capability has been discussed, and the dual learning mechanism explained. Developing green innovation is key to the development of enterprises. Second, exploratory learning, applied learning, and the interaction between them have been introduced. At the same time, executives' environmental awareness and environmental regulations are explained in connection with the mediating variables, and the different effects of new ventures in the internal and external environment are discussed. These actions enrich the theories on dual learning and green innovation capabilities. The study of the mechanism has profound guiding significance for the growth of a green innovation capability for new ventures.

In the same way, the environmental awareness of top executives in startup enterprises will regulate the improvement of green innovation ability by dual learning. More importantly, this study argues that under different degrees of external environmental regulation, enterprises' dual learning helps to improve green innovation capability through different ways. This further illustrates that when the external environment is different, the growth of green innovation capability of new ventures will travel

a unique path as well. Enterprises need to improve the environmental awareness of senior executives, timely perceive the degree of change in the external environment, and take appropriate measures to promote their own development more effectively.

5.3. Research Limitations and Future Research

This study only involves the environmental awareness of internal executives and external environmental regulation variables. Future research can consider introducing more entrepreneurial context variables to study their impact on the growth of green innovation capability among new ventures. At the same time, due to the limited sample size, there may be some errors in the research results due to the constrained time for the author to assemble a bigger data sample. We suggest that future research should expand the sample size to avoid the same errors.

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