The driving effect of internal and external environment on green innovation strategy - The moderating role of top management’s environmental awareness

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Abstract

Purpose – Green innovation strategy is not only a new idea to achieve green development but also the inevitable choice for enterprises to upgrade. At present, the research on the driving forces of green innovation strategy mainly focus on direct impact of single factor, lacking the overall consideration of internal and external environment. At the same time, research on the contingency effect of top management’s environmental awareness is scarce. This paper aims to explore how external environment pressures (policy pressures and market pressures) and internal environment driving force (innovation resources and innovation capability) make enterprises to choose green innovation strategy with moderating effect of top management’s environmental awareness.

Design/methodology/approach – Based on the sample of 216 enterprises, this paper explores the relationship between policy pressure, market pressure, innovation resources, innovation capability and the green innovation strategy with moderating effect of top management’s environmental awareness from inside and outside driving angle.

Findings – The results of the hierarchical regression model show, first, the driving effect of factors in the external environment. The coercive policy has an inverted U-shaped impact on the green innovation strategy. The incentive policy and the market pressure both have a significant positive impact on the green innovation strategy. Second, the driving effect of factors in the internal environment. The innovation capability has a significant positive impact on the green innovation strategy. The innovation resources have no significant impact on the green innovation strategy. Third, the moderating effect of top management’s environmental awareness. The relationship between the green innovation strategy and the coercive policy is stronger when the top management’s environmental awareness higher. The relationship between the green innovation strategy and the market pressure is stronger when the top management’s environmental awareness higher. The relationship between the green innovation strategy and the innovation resources is stronger when the top management’s environmental awareness higher. Otherwise, the relationship between the green innovation strategy and the innovation capability is weaker when the top management’s environmental awareness higher. And there is no significant change about the relationship between the green innovation strategy and the incentive policy when the top management’s environmental awareness higher.

Originality/value – First, the authors have promoted the integrated research on the drivers of the enterprise’s green innovation strategy. From the perspective of internal and external environment driving forces, this paper analyzes the key factors influencing the decision-making of the green innovation strategy. Second, the study has contributed to the strategic choice theory. This paper studies the driving mechanism of the green innovation strategy from a new perspective of the strategic choice theory.

Keywords External pressure, Green innovation strategy, Internal driving force, Top management’s environmental awareness

Paper type Research paper
1. Introduction
Green innovation strategy is a strategy in which enterprises reduce environmental impact among business activities actively and incorporate environmental responsibility into the strategic planning (Eiadat et al., 2008). On the one hand, increasingly improving environmental regulations and growing consumers’ environmental awareness have led to increased constraints on enterprises. Only by integrating environmental problems into strategic height can enterprises win unique competitive advantages. On the other hand, the dual externalities (Jaffe et al., 2005; Rennings, 2000), high investment cost and high risk of environmental management have led to the lack of incentive for enterprises to carry out green innovations. This means that the enterprise adopt green innovation strategy will face with both opportunities and challenges. Therefore, how to solve the above paradox conflict, and how to drive enterprises to adopt green innovation strategy, has become one of the core issues in the field of green innovation. Existing literatures mainly discuss the influencing factors of the green innovation strategy from the following two perspectives:

First, the research perspective of external environment mainly analyzed the influencing factors of the green innovation strategy based on stakeholder theory and institutional theory. Buyssse and Verbeke (2003) studied from the angle of stakeholder management and found that employees, shareholders, financial institutions and other stakeholders had played a major role in the process of the adoption of leadership environmental protection strategy. Delgado-ceballos et al. (2012) further expanded the study of stakeholder theory, indicating that enterprises with stronger stakeholder integration ability will better develop positive environmental strategies. Lin et al. (2014) found that environmental regulations and different stakeholders such as customers, suppliers and competitors had a differentiated impact on the green innovation activities of enterprises. Based on the theory of new system, Li and Ye (2011) surveyed data from the 148 manufacturers of Pearl River Delta and showed that institutional pressures coming from government’s common-and-control instruments and competitor had significant positive impacts on environmental innovation practices, while government’s incentive instruments and consumers’ pressure did not have significant impact on environmental innovation practices. Therefore, pressures from environmental regulations and stakeholders are the main source of external pressure.

Second, the research perspective of internal conditions mainly explored the driving mechanism of the green innovation strategy based on the basic theory of natural resources. Liao and Cheng (2014) believed that the background characteristics such as the size, the age and nature of the enterprise, even the industry in which it is located affected the environmental innovation of the enterprise. Ketata et al. (2015) found that the internal absorption capacity played an important role in the sustainable innovation of the company. Lin and Chen (2017) focused on internal knowledge resources and capabilities and found that green knowledge sharing improved the green dynamic capabilities, which in turn promoted enterprises to implement green service innovation and gain green competitive advantages. Compared with reactive and active green innovations, Chen et al. (2012) discovered that only internal sources such as environmental leadership, culture and environmental capabilities can promote proactive green innovations. Sharma’s (2000) research showed that managers consider environmental issues as opportunities or threats will significantly affect green innovation strategic choices of the enterprise. He et al. (2016) pointed out that when managers recognize natural environment issues as a chance, it is more likely to take proactive environmental strategy, which can improve enterprise’s environmental performance and financial performance. Therefore, the enterprise’s background characteristics, resources, capabilities and managers’ attention are the main internal driving forces.
Despite of series valuable research results, the existing literatures on the drivers of the green innovation strategy still has the following deficiencies:

First, previous literatures focused on examining the direct impact of independent explanatory variables on the enterprise’s green innovation strategy, but lacking a comprehensive research on both internal and external levels. On the one hand, enterprises’ strategies are determined by external environmental factors, especially the macro environment and market competition environment. At the same time, resources and capabilities of the internal environment can also affect it. Through the overall analysis from both internal and external environmental factors, it is conducive to gain a comprehensive understanding of the enterprise’s strategic selection mechanism. Second, previous studies have considered the managers’ attention as an internal factor in the organization, neglecting that the top management’s environmental awareness can play a contingency role on the green innovation strategy through external pressure and internal driving force. Third, previous studies mostly used Western developed countries as a sample. However, researches on the drivers of the green innovation strategy for Chinese enterprises are relatively scarce.

What factors in the internal and external environment can drive enterprises to adopt green innovation strategy? With different levels of top management’s environmental awareness, how can the drivers in the internal and external environment affecting the green innovation strategy? Based on Child’s strategic choice theory (Child, 1997), this paper constructs a model of the influencing factors of the green innovation strategy and explores how external environment pressures (policy pressures and market pressures) and internal environment driving forces (innovation resources and innovation capability) make enterprises to choose the green innovation strategy under the moderating effect of top management’s environmental awareness.

2. Theories and hypothesis

2.1 Policy pressure and green innovation strategy

The pressure of policy mainly comes from government regulations. Due to the “dual externality” feature of green innovation (Jaffe et al., 2005), enterprises lack the initiative to carry out green innovation. So the government formulates and implements environmental regulations to affect enterprises’ choice of green innovation strategy (Liu et al., 2015).

On the one hand, mandatory environmental regulation mainly relies on its coercive power to force enterprises to choose green innovation strategy (Ford et al., 2014). At first, the pre-control of environmental regulations: Government guides the production behaviors of enterprises through the formulation of environmental planning, assessment of environmental impact, etc., forcing enterprises to take environmental factors into strategic planning and design. Then, the process control of environmental regulations: environmental regulations constrain enterprise behaviors by limiting production technology standards and pollutant emissions. And enterprises make strategic adjustments to meet regulatory mandatory requirements. Last but not the least, the post-control of environmental regulations: Government can exercise the power of punishment by enforing environmental laws and regulations, which increasing the environmental violation costs of the enterprise. So enterprises conduct green innovations to avoid economic penalties and gains cost advantages (Berrone et al., 2013).

On the other hand, market incentive environmental regulation relies on its potential advantages to induce enterprises to adopt green innovation strategies. First, government provides tax incentives, financial subsidies and preferential procurement, which can partially compensate for the costs increase caused by green innovation; at the same time, the
flexibility of market-incentive environmental regulations is conducive for enterprise to surpass the limitations of regulations and take green innovation according to their own advantages (Xu et al., 2013). Furthermore, government guides the flow of green innovation technologies, knowledge and other resources in the industry through incentive-type policies to reduce the uncertainty of green innovation.

Policy pressure from environmental regulations is the main driver of green innovation. Berrone et al. (2013) pointed out that the stricter the government’s environmental regulations are, the more willing enterprises are to adopt green innovation strategies. According to Frondel’s research, market incentive regulations have a more significant impact on green innovation than mandatory regulations (Frondel et al., 2007).

Based on the research of previous literature, we divide the policy pressures into coercive and incentive policies and propose the following assumption:

H1. The policy pressure has a significant positive impact on the green innovation strategy.

2.2 Market pressure and green innovation strategy

China’s governance of the environment is still in its infancy. And insufficient policies have led to the existence of government supervision loopholes. Consumers, suppliers and competitors are in the market mechanism that has the closest relationship with the production and management of enterprises. And their concern for green protection is the main source of market pressure (Lin et al., 2014; Tang and Tang, 2012).

Consumers mainly influence enterprises’ green innovation strategy through their product selection rights. With the growing awareness of environmental protection, consumers prefer to choose environmentally friendly products (Li et al., 2016). On the one hand, enterprises take green innovations (researching low-carbon environment-friendly products, reducing raw material consumption, etc.) to obtain more market opportunities. This action not only meets the needs of consumers but also creates a good green image. At the same time, products can be sold at high prices to form products differentiation advantage (Sarkar, 2013). On the other hand, consumers’ demands for green products or services can not only eliminate the doubts of enterprises about the market’s uncertainty but also help them to enhance the enthusiasm for green innovation.

The more importance suppliers attach to environmental protection, the more they will impact the strategic choices of upstream and downstream enterprises through the supply chain system. First, as an access point for a wider range of supplier networks, suppliers can provide enterprises with knowledge and resources, which is conducive to enterprises’ green innovation. Then, the cooperation between suppliers and enterprises to carry out innovation can effectively reduce the R&D costs of new products. Finally, for enterprises that damage their image and reputation, suppliers have the right to stop the supply (Cao et al., 2014).

Competitors mainly cause environmental pressure on enterprises in the process of competing with enterprises for resources and markets. First, competitors provide green innovative products to win more consumer favors and government resources. To win market competitive advantages and resources, enterprises will follow the competitors to develop green innovation strategies (Menguc et al., 2010; Hojnik and Ruzzier, 2016). Second, a good competitive environment enables enterprises to transfer green innovation technologies and knowledge to increase revenue and reduce the external costs of innovation.

The source of pressure in the market is that enterprises can obtain competitive advantages and potential economic returns by implementing green innovation strategies. Fernando and Wah (2017) pointed out that when enterprises adopt green innovation strategies...
practices, they must consider not only the constraints of environmental regulations but also the market-oriented factors. Montabon et al. (2007) stated that paying attention to the market pressure is an important resource for enterprises to obtain market information, react in a timely manner and gain competitive advantages. Based on this, we propose the following hypotheses:

H2. The market pressure has a significant positive impact on the green innovation strategy.

2.3 Innovation resources and green innovation strategy

Drawing on the resource-based theory, heterogeneous resources and organizational capabilities within a firm are the source of improving corporate performance and gaining competitive advantages (Barney et al., 2001). The green innovation strategy has external spillover and high risk. Therefore, fully assessing and understanding the resources and capabilities is a necessary part for the design of the enterprise’s strategy. Rich resources provide the space and foundation for enterprises to choose green innovation strategies. Innovation capabilities determine whether the green innovation strategy can be carried out smoothly. The innovation resource is an important prerequisite for the enterprise to choose a green strategy (Martensson and Westerberg, 2016).

On the one hand, the green innovation strategy is easier to be supported when innovation resources are abundant. In the case of resource shortage, enterprises prefer to select projects that can generate rapid return on investment and enhance production capacity quickly; On the contrary, when resources are abundant, they tend to choose projects that can achieve long-term benefits. The external spillover of green innovation activities determines that it will not have the priority distribution rights of resources. From this perspective, rich innovation resources allow enterprises to have higher autonomy in the selection of projects, avoid resource competition among internal departments and teams, and focus on the green innovation (Leonidou et al., 2017).

On the other hand, different types of resources have different effects on enterprises’ adopting of green innovation strategies. Financial resources play an important role in the R&D investment phase of the green innovation. They are mainly used to purchase advanced production and pollution treatment equipment and carry out green innovation experiments. Human resources play an important role in R&D investment and innovation commercialization phases, making it easier for enterprises to obtain knowledge and skills for green innovations, and design more environmental friendly production processes. Information resources help enterprises capture market opportunities in the field of green innovation quickly, research and develop new products to meet market demands and launch green marketing to gain competitive advantages (Bi et al., 2014).

Many studies have demonstrated the relationship between innovation resources and green innovation strategies. Chan (2005) stated that innovation resources are beneficial for the formation of special organizational capabilities, and then promote the choice of the green innovation strategy. Horbach et al. (2012) differentiated the drivers of innovation and pointed out that the resources owned by enterprises, such as technology, knowledge, infrastructure, and information, have a positive driving effect on the green innovation. Buysse and Verbeke (2003) also pointed out that limited resources can only support enterprises adopting the lowest-level environmental strategy based on environmental regulation requirements, and higher-level pollution prevention and environmental
leadership strategies need to be matched by more abundant resources. Based on this, we propose the following hypotheses:

**H3.** Innovation resources have a significant positive impact on the green innovation strategy.

### 2.4 Innovation capability and green innovation strategy

Environmental issues are becoming increasingly prominent. Enterprises must not only pay attention to the key role of resources but also handle the relationship between the environment and themselves correctly to gain sustainable competitive advantages. Based on this, this article focuses on the impact of innovation capability on the green innovation strategy and defines innovation capability as the ability to effectively acquire information, integrate resources, absorb knowledge and apply it to innovation activities (Zahra and George, 2002).

First, innovation capability can provide an ability foundation for the green innovation strategy. Green innovation can be seen as a combination of static and dynamic evolution. Innovation resources can match materials and technologies in the static evolution phase to achieve the required innovation; during the dynamic phase, innovation capability can absorb effective information, reconfigure and integrate resources to form the combination skills needed for green innovation, adapt to the changing environment and achieve sustainable survival (Huang and Li, 2017).

Second, innovation capability can increase the probability of success in the green innovation strategy. On the one hand, innovation capability can reduce the risk of green innovation. The characteristics of green innovation such as external spillover and long return on investment have determined the high risk of investment in green innovation projects. The stronger the innovation capability of the enterprise is, the more able it is to withstand this risk. On the other hand, innovation capability can eliminate knowledge barriers for green innovation. In the R&D process of green innovation, innovation capability continuously acquires, absorbs, transforms and applies diversified knowledge and stimulates potential innovations through knowledge sharing and inter-sectorial collaboration (Zahra and George, 2002).

Aragón-Correa and Sharma (2003) pointed out that innovation capabilities of the enterprise are the basis of R&D activities, which play a decisive role in the effectiveness of innovation and help the enterprise to obtain competitive advantages. Chen et al. (2012) made an empirical analysis and showed that environmental capability is conducive to the enterprise to achieve environmental management and green innovation and has a positive impact on both reactive and proactive green innovations. Based on this, we propose the following hypotheses:

**H4.** The innovation capability has a significant positive impact on the green innovation strategy.

### 2.5 The moderating effect of top management’s environmental awareness

Child (1997) pointed out in the strategic selection theory that top managements are key players in the decision of the strategy. Influenced by the characteristics of top managements’ attitudes and values, enterprises will adopt different environmental strategies under the same political and economic context. This paper believes that the external pressure and internal driving force influence the green innovation strategy would be moderated by the top management’s environmental awareness. This is because the top management’s
interpretation of external pressure and self-ability will affect the enterprise’s environmental protection strategy (Gadenne et al., 2009).

Top managements who have the higher awareness of the environment will tend to identify the potential benefits and market opportunities of the green innovation (Peng and Wei, 2015). On the one hand, top managements with strong environmental awareness are more likely to perceive the potential benefits brought by the incentive policy of the governments. Enterprises are no longer limited to meeting the minimum requirements for environmental regulations (end-of-pipe governance), but actively strive for government’s market incentive resources to offset the cost of green innovation. On the other hand, top managements with high environmental awareness regard the emphasis that consumers, suppliers and competitors place on the green innovation as a market opportunity, so they research and develop new products to meet consumer demands, cooperate with suppliers to share innovation risks, focus on competitors’ strategies and compete for market share. All the measures above eventually lead to the competitive advantage (Egri and Herman, 2000).

Top management who has the higher awareness of the environment is more willing to take the responsibility for green innovation and invest resources and capabilities in green innovation. In the case of limited resources, investment income ratio is the primary consideration for enterprises to invest in projects. Green innovation has the characteristics of high market risk and significant R&D uncertainty, requiring more investment resources. Therefore, only if top managements put green innovations within the scope of corporate responsibility, will them be invested resources and incorporated into the strategic height (He et al., 2016). Top managements with high environmental awareness have an open and supportive attitude toward green innovation. At the same time, they are good at coding the acquired information and integrating them with corporate resources, absorbing internal and external knowledge of organizations and applying them to green innovation and responding to environmental issues actively (Tseng et al., 2013).

Top managements with high environmental awareness can not only promote enterprises to identify market opportunities from the outside but also help enterprises to allocate internal resources or capabilities rationally and incorporate green innovation into strategic heights. Sharma analyzed the process of corporate strategic choice from the perspective of opportunities and threats perceived by managers. He believed that managers who regard environmental issues as opportunities tend to choose active environmental strategies (Sharma, 2000). Burki and Dahlstrom (2017) pointed out that the attitudes and commitments of top managements for the environment affect the green innovation, which in turn helps to establish a good surrounding for cooperation. Based on this, we propose the following hypotheses:

H5a. The higher the top management’s environmental awareness is, the stronger the influence of the policy pressure on the green innovation strategy would have.

H5b. The higher the top management’s environmental awareness is, the stronger the influence of the market pressure on the green innovation strategy would have.

H5c. The higher the top management’s environmental awareness is, the stronger the influence of innovation resources on the green innovation strategy would have.

H5d. The higher the top management’s environmental awareness is, the stronger the influence of innovation capability on the green innovation strategy would have.
2.6 Conceptual framework

According to Child’s strategic choice theory, strategic choice refers to the decision-making process of strategic action by rights holders in the organization. Conducted in a specific environment, strategic choices are subject to the constraints of the internal and external environments of the enterprises. So they are the result of interactions between the strategy makers and the internal and external environments of the organization. Strategic Choice Theory believes that the strategic choices of enterprises are mainly influenced by three factors: first, the types of agents and choices; second, the characteristics of the environment; and third, the relationship between agents and the environment.

The strategic choice theory focuses on the influencing factors hidden in top managements’ decisions, providing an appropriate theoretical basis for the study of the green innovation strategy. This article explores the driving factors of the enterpriser’s green innovation strategy from the perspective of internal and external environments. The conceptual framework is shown in Figure 1.

The strategic choice theory defines the main factors that influence the choice of green innovation strategy of the enterprise from three aspects: Top managements of the enterprise, the internal and external environment and the relationship between the top management and the environment:

1. From the perspective of top managements of the enterprise, top managements are the core of corporate strategic choices and their environmental awareness directly drives the entire process of strategic choices.

2. From the perspective of internal and external environmental characteristics: when enterprises adopt green innovation strategies, they will be subject to the constraints of the internal and external environments. So policies and market pressures from the external, resources and capabilities from the internal are all factors that must be considered.

3. From the perspective of the relationship between the top management and the environment: The top management’ environmental awareness influences their interpretation of external pressures and internal driving forces.
Enterprise who tends to choose the green innovation strategy generally has top managements with high environmental awareness. So the relationship between the top management and the environment can be seen as a binding for strategic decision.

3. Research methods
3.1 Questionnaire design
The first step, collect relevant literature for reference and sort out survey questionnaires initially. The second step, the initial scale is revised and improved by seeking expert opinions and interviewing enterprises. The third step, select 10 companies in Qingdao to conduct a small sample of pre-research and make improvements based on their opinions to form a final questionnaire. The measurement of the questionnaire items is by means “seven-point Likert scale from 1 to 7” rating from strongly disagreement to strongly agreement.

3.2 Variable design and index measurement
3.2.1 Dependent variable. Green innovation strategy. This study learns from Chan (2005) to measure the green innovation strategy from the performance at the level of enterprise behavior. There are seven items in total.

3.2.2 Independent variables.
(1) Policy pressure. Drawing on the studies of Jaffe et al. (2004), Li and Ye (2011), this article divides the policy pressure into two types: The coercive and incentive policy. The coercive policy mainly includes relevant laws and regulations from views of pre-event, process-event and post-event. There are four items in total. The incentive policy mainly includes taxation, finance and finance. There are four items in total.

(2) Market pressure. This article learns from the measurement indicators for social responsibility of stakeholders by Wang et al. (2010) and Tang (2012) and divides the market pressure into three dimensions: customer, supplier and competitor. There are four items in total.

(3) Innovation resource. This article learns from the researches of Chan (2005) and Bi et al. (2014) and measures the innovation resources in terms of human, finances, materials and technologies. There are four items in total.

(4) Innovation capability. This article learns from Romijn’s research (Romijn and Albaladejo, 2002) and selects two items from the perspective of input and output: the research funding and the number of patents applications.

3.2.3 Moderator variable. Top management’s environmental awareness. This article refers to the research of Eiadat et al. (2008) and Gadenne et al. (2009). There are three items in total.

3.2.4 Control variables. This study selects the size, the age, the industry and the nature of the enterprise as control variables. Based on the number of employees, the scale of the firm is divided into three categories: large, medium and small. The company’s age is divided into four types: 3 years, 3-5 years, 5-10 years and 10 years or more. The industry of the enterprise is measured according to whether it belongs to a highly polluting industry. The nature of enterprises is divided into state-owned, private and other three kinds. The above variables are measured by assigning dummy variables.
3.3 Research samples
This study selects the more polluting manufacturing enterprises from Shandong, Jiangsu, Zhejiang, Guangdong and Shanxi provinces. Questionnaires are collected through the following channels: First, they are distributed through the government’s scientific research institutions and corporate information platforms. Second, they are distributed to alumnus, EMBA and MBA students based on university platforms such as Ocean University of China and Shandong University. Third, they are distributed through the author’s personal social network. The questionnaire survey was used in the period from 1 January 2016 to 31 April 2016. A total of 550 questionnaires were distributed and 327 were recovered. The rate of return was 59.5 per cent. Excluding incomplete and content contradictory questionnaires, 216 valid questionnaires were retained, and the effective rate was 39.3 per cent.

This paper uses SPSS 20.0 software to analyze the sample data. The descriptive statistics of the sample are shown in Table I:

3.4 Reliability and validity of the measurement
3.4.1 Reliability. It is generally believed that if Cronbach’s \( \alpha \) coefficient is above 0.7, the reliability is good. By examining the scale we find that Cronbach’s \( \alpha \) coefficient of all construct dimensions are all greater than 0.8; CITC values of all items are greater than 0.4. Deletion of any item can’t make a significant increase in Cronbach’s \( \alpha \) coefficient of each scale. This indicates that the scales have high reliability and internal consistency.

3.4.2 Validity. The content validity of the questionnaire is ensured through literature collection, expert interviews and pre-testing in enterprises. The construct validity of the questionnaire is tested through exploratory factor analysis by SPSS 20.0. At first, the KMO and Bartlett’s test of sphericity are performed. The KMO values of all scales are greater than 0.6 and the \( p \)-values of Bartlett’s test of sphericity are all less than 0.001. Then the principal component analysis method was used for factor analysis. As the results shown in Table II, the factor loading of each item is greater than 0.7, indicating that the scale has good construct validity.
Constructs | Items | \( \lambda \) | Cronbach’s \( \alpha \) |
---|---|---|---|
Green innovation strategy | The enterprise adjusts its business practices or operations to reduce the damage to the ecological environment. | 0.977 | 0.945 |
| Although the government does not require, the enterprise still takes environmental remedial actions. | 0.917 | |
| The enterprise adjusts its business practices or operations to reduce wastes and emissions. | 0.913 | |
| The enterprise adjusts its business practices or operations to recycle non-renewable raw materials, chemicals and components. | 0.898 | |
| The enterprise reduces the use of traditional fuels by the substitution of some less polluted energy sources. | 0.899 | |
| The enterprise adjusts its business practices or operations to reduce energy consumption. | 0.748 | |
| The enterprise adjusts its business practices or operations to reduce the environmental impacts of its products. | 0.858 | |
Coercion policy | Relevant laws, regulations or rules stipulate strict pollutant discharge standards (such as concentration or total amount of the pollutant discharge). | 0.975 | 0.961 |
| Relevant laws, regulations or rules stipulate strict production technical standards. | 0.912 | |
| For enterprises that fail to meet the environmental standards, the relevant laws, regulations or rules stipulate strict pollution control period, charge the rectification within a time limit or adopt compulsory measures such as closing and stopping production. | 0.948 | |
| The environmental protection department formulates detailed environmental plans according to relevant laws, regulations or rules. | 0.953 | |
Incentive policy | The local government establishes a complete tax incentive system for green innovative enterprises (tax reduction or return). | 0.973 | 0.938 |
| The local government provides special fund subsidies for green innovation projects. | 0.975 | |
| The local government provides project loan interest discounts or loan concessions for green innovative enterprises. | 0.963 | |
| The local government adopts a sewage charging system. | 0.788 | |
| Most customers of the enterprise have high demand for green products. | 0.98 | 0.961 |
| Most customers of the enterprise are very concerned about the enterprise’s green innovation behaviors. | 0.964 | |
| Most suppliers of the enterprise have high green requirements. | 0.892 | |
| Most suppliers of the enterprise regard green innovation as an important indicator for evaluating corporate reputation. | 0.885 | |
| Most competitors of the enterprise have a high degree of focus on the green innovation strategy. | 0.978 | |
| Most competitors of the enterprise pay great attention to green innovation in their operations. | 0.841 | |
| Compared with other enterprises in the same industry, the funds owned by the enterprise is at a high level. | 0.933 | 0.909 |
| Compared with other enterprises in the same industry, the technology owned by the enterprise is at a high level. | 0.957 | |

Table II.
Analysis of core construct factors and reliability analysis

(continued)
4. Data and results

4.1 Correlation analysis

The mean, standard deviation and correlation analysis for each variable are shown in Table III. The green innovation strategy and coercion policy, incentive policy, market pressure, innovation resources, innovation capability and top management’s environmental awareness are significantly correlated ($P < 0.01$).

4.2 Multi-level regression analysis

This paper uses SPSS 20.0 to perform the hierarchical regression analysis on the data and centralizes the variables to obtain cross terms in the examination of top management’s environmental awareness moderating effect. The regression results are shown in Tables IV and V.

<table>
<thead>
<tr>
<th>Constructs</th>
<th>MEAD</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1. Green innovation strategy</td>
<td>4.007</td>
<td>1.261</td>
<td>1</td>
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<td>2. Coercion policy</td>
<td>3.419</td>
<td>1.607</td>
<td>0.766**</td>
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<td>3. Incentive policy</td>
<td>4.054</td>
<td>1.407</td>
<td>0.886**</td>
<td>0.764**</td>
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<tr>
<td>4. Market pressure</td>
<td>3.939</td>
<td>1.427</td>
<td>0.813**</td>
<td>0.752**</td>
<td>0.762**</td>
<td>1</td>
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<tr>
<td>5. Innovation resources</td>
<td>3.963</td>
<td>1.413</td>
<td>0.504**</td>
<td>0.397**</td>
<td>0.475**</td>
<td>0.434**</td>
<td>1</td>
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<tr>
<td>6. Innovation capability</td>
<td>4.012</td>
<td>1.355</td>
<td>0.838**</td>
<td>0.647**</td>
<td>0.800**</td>
<td>0.663**</td>
<td>0.504**</td>
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<tr>
<td>7. Top management’s environmental</td>
<td>4.023</td>
<td>1.518</td>
<td>0.449**</td>
<td>0.323**</td>
<td>0.483**</td>
<td>0.457**</td>
<td>0.244**</td>
<td>0.490**</td>
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<tr>
<td>Awareness</td>
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Note: **Significant correlation at 0.01 level (bilateral)
4.2.1 Impact of external pressure and internal driving force on the green innovation strategy. Table IV shows the regression results of external pressure and internal driving force with the green innovation strategy. Model 2 verifies the role of external pressure and internal driving force on the green innovation strategy. To further verify the inverted U-shaped relationship between external pressure, internal driving force and the green innovation strategy, we put squared terms of the coercive policy, the incentive policy, the market pressure, the innovation resources and the innovation capability into Model 3. The results show that only the square of the coercive policy has a significant negative impact on the green innovation strategy ($\beta = -0.316, p < 0.001$). To sum up, there is an inverted U-shaped relationship between the coercive policy and the green innovation strategy. When the coercive policy is too loose, enterprises lack the initiative to carry out green innovation; when the environmental regulation is too stringent, it may exceed the scope of the enterprise’s capabilities and the enterprise can only take expedient measures; maybe the

<table>
<thead>
<tr>
<th>Table IV.</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small enterprises</td>
<td>-0.107</td>
<td>-0.036</td>
<td>-0.036</td>
<td>-0.041</td>
<td>-0.060</td>
</tr>
<tr>
<td>Medium-sized enterprises</td>
<td>-0.098</td>
<td>-0.041</td>
<td>-0.046*</td>
<td>-0.048</td>
<td>-0.067*</td>
</tr>
<tr>
<td>&lt;3 years</td>
<td>-0.099</td>
<td>-0.073**</td>
<td>-0.080***</td>
<td>-0.072**</td>
<td>-0.049**</td>
</tr>
<tr>
<td>3-5 years</td>
<td>-0.106</td>
<td>-0.120***</td>
<td>-0.098***</td>
<td>-0.115***</td>
<td>-0.076**</td>
</tr>
<tr>
<td>5-10 years</td>
<td>-0.114</td>
<td>-0.076**</td>
<td>-0.032</td>
<td>-0.074**</td>
<td>-0.059**</td>
</tr>
<tr>
<td>Highly polluting industry</td>
<td>-0.013</td>
<td>-0.003</td>
<td>-0.006</td>
<td>-0.002</td>
<td>-0.017</td>
</tr>
<tr>
<td>State-owned enterprises</td>
<td>0.076</td>
<td>0.008</td>
<td>0.007</td>
<td>0.008</td>
<td>-0.012</td>
</tr>
<tr>
<td>Private enterprises</td>
<td>0.097</td>
<td>-0.005</td>
<td>0.008</td>
<td>0</td>
<td>0.008</td>
</tr>
<tr>
<td>Coercion policy</td>
<td>0.087*</td>
<td>0.442***</td>
<td>0.079†</td>
<td>0.063</td>
<td></td>
</tr>
<tr>
<td>Incentive policy</td>
<td>0.353***</td>
<td>0.203***</td>
<td>0.360***</td>
<td>0.362***</td>
<td></td>
</tr>
<tr>
<td>Market pressure</td>
<td>0.264***</td>
<td>0.239***</td>
<td>0.270***</td>
<td>0.254***</td>
<td></td>
</tr>
<tr>
<td>Innovation resources</td>
<td>0.038</td>
<td>0.047†</td>
<td>0.037</td>
<td>0.024</td>
<td></td>
</tr>
<tr>
<td>Innovation capability</td>
<td>0.298***</td>
<td>0.195***</td>
<td>0.309***</td>
<td>0.361***</td>
<td></td>
</tr>
<tr>
<td>(Coercion policy)$^2$</td>
<td></td>
<td></td>
<td>-0.316***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Incentive policy)$^2$</td>
<td></td>
<td></td>
<td>0.055</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Market pressure)$^2$</td>
<td></td>
<td></td>
<td>-0.018</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Innovation resources)$^2$</td>
<td></td>
<td></td>
<td>0.013</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Innovation capability)$^2$</td>
<td></td>
<td></td>
<td>0.053</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top management’s environmental awareness</td>
<td></td>
<td>-0.032</td>
<td>-0.047</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coercion policy × top management’s environmental awareness</td>
<td></td>
<td></td>
<td></td>
<td>-0.042</td>
<td></td>
</tr>
<tr>
<td>Incentive policy × top management’s environmental awareness</td>
<td></td>
<td></td>
<td>0.043</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market pressure × top management’s environmental awareness</td>
<td></td>
<td></td>
<td>0.134**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation resources × Top management’s environmental awareness</td>
<td></td>
<td></td>
<td>0.083**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation capability × Top management’s environmental awareness</td>
<td></td>
<td></td>
<td>-0.188***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.035</td>
<td>0.881</td>
<td>0.921</td>
<td>0.881</td>
<td>0.898</td>
</tr>
<tr>
<td>$F$</td>
<td>0.938</td>
<td>114.720***</td>
<td>126.835***</td>
<td>106.662***</td>
<td>90.654***</td>
</tr>
<tr>
<td>$\Delta R^2$</td>
<td>0.046</td>
<td>0.04</td>
<td>0.001</td>
<td>0.016</td>
<td></td>
</tr>
<tr>
<td>$\Delta F$</td>
<td>286.430***</td>
<td>19.768***</td>
<td>1.107</td>
<td>6.319***</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ***, * p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.10
can attract enterprises to carry out green innovations initiatives.

In the past in China, the motivation of the green innovation strategy largely comes from external regulations. The unique flexibility and diversity of incentive policies can attract enterprises to carry out green innovations initiatives. H1 is partially supported.

The market pressure (β = 0.264, p < 0.001) has a significant positive impact on the green innovation strategy. The market pressure mainly comes from consumers, suppliers and competitors: The “green consume” consciousness and the favor of environmentally friendly products of consumers drive the enterprise’s green innovation strategy. Suppliers can cooperate with enterprises in innovation and reduce the cost of innovation. Meanwhile, they can provide enterprises with knowledge and resources and affect their strategic choices. If competitors in the industry gain market advantages by implying green innovation strategies, the enterprise will adopt a green innovation strategy to compete for market share and acquire core competitiveness. H2 is supported.

The innovation resources (β = 0.038) have no significant impact on the green innovation strategy. This is different from the previous research conclusions, indicating that innovation resources can not only provide a material basis for the enterprise to choose the green innovation strategy but also enable the enterprise to establish a buffer mechanism to resist pressures from regulations and markets. H3 is not supported.

### Table V. Regression results of the moderating effects of top management’s environmental awareness on the relationship between the coercion policy and the green innovation strategy

<table>
<thead>
<tr>
<th>Dependent variable = Green innovation strategy</th>
<th>Model 1</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
<th>Model 9</th>
<th>Model 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small enterprises</td>
<td>−0.107</td>
<td>0.026</td>
<td>−0.02</td>
<td>0.002</td>
<td>−0.001</td>
<td>0.002</td>
</tr>
<tr>
<td>Medium-sized enterprises</td>
<td>−0.098</td>
<td>−0.043</td>
<td>−0.063</td>
<td>−0.02</td>
<td>−0.019</td>
<td>−0.019</td>
</tr>
<tr>
<td>&lt;3 years</td>
<td>−0.099</td>
<td>−0.115**</td>
<td>−0.099**</td>
<td>−0.101**</td>
<td>−0.110**</td>
<td>−0.112**</td>
</tr>
<tr>
<td>3-5 years</td>
<td>−0.106</td>
<td>−0.126**</td>
<td>−0.074</td>
<td>−0.100**</td>
<td>−0.108**</td>
<td>−0.105**</td>
</tr>
<tr>
<td>5-10 years</td>
<td>−0.114</td>
<td>−0.083†</td>
<td>−0.006</td>
<td>−0.02</td>
<td>−0.035</td>
<td>−0.037</td>
</tr>
<tr>
<td>Highly polluting industry</td>
<td>−0.013</td>
<td>−0.011</td>
<td>−0.008</td>
<td>−0.013</td>
<td>−0.016</td>
<td>−0.016</td>
</tr>
<tr>
<td>State-owned enterprises</td>
<td>0.076</td>
<td>−0.05</td>
<td>−0.048</td>
<td>−0.041</td>
<td>−0.041</td>
<td>−0.038</td>
</tr>
<tr>
<td>Private enterprises</td>
<td>0.097</td>
<td>−0.023</td>
<td>0.016</td>
<td>−0.007</td>
<td>−0.01</td>
<td>−0.01</td>
</tr>
<tr>
<td>(Coercion policy)^2</td>
<td>0.774**</td>
<td>1.018***</td>
<td>0.951**</td>
<td>0.950**</td>
<td>0.958**</td>
<td></td>
</tr>
<tr>
<td>Top management’s environmental awareness</td>
<td>−0.512***</td>
<td>−0.484***</td>
<td>−0.492***</td>
<td>−0.499***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coercion policy × Top management’s environmental awareness</td>
<td>0.055†</td>
<td>0.070*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Coercion policy)^2 × Top management’s environmental awareness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: ***, p < 0.001; **, p < 0.01; *, p < 0.05; †, p < 0.10

The cost is too high for the enterprise to take measures to meet environmental regulations, so the enterprise would rather accept punishment than invest in environmental protection. This is related to the over-exploitation of economic efficiency and the lack of accumulation of green innovation in the past in China. The incentive policy (β = 0.353, p < 0.001) has a significant positive impact on the green innovation strategy. It shows that the greater the incentive degree of the incentive-type policy is, the more the enterprise tends to choose the green innovation strategy. Now in China, the motivation of the green innovation strategy largely comes from external regulations. The unique flexibility and diversity of incentive policies can attract enterprises to carry out green innovations initiatives. H1 is partially supported.
The innovation capability ($\beta = 0.298, p < 0.001$) has a significant positive impact on the green innovation strategy. The green innovation activities have high risk characteristics such as external spillover and long investment return period. The stronger the enterprise’s green innovation capability is, the more able it is to withstand this risk. The innovation capability can provide a foundation for the green innovation strategy and improve its probability of success. Therefore, the stronger the enterprise’s capability of innovation, the more likely it is to choose a green innovation strategy. $H4$ is supported.

4.2.2 The moderating effect of the top management’s environmental awareness. The top management’s environmental awareness has no significant moderating effect on the incentive policy and the green innovation strategy. This shows that the connection between the incentive policy and the green innovation strategy is both close and significant. No matter the level of the environmental awareness of the top management, enterprises will consider the impact of the incentive policy on financial indicators based on their own interests. At the same time, be affected by the mentality of “seeking quick success and instant benefits”, enterprises capture and use the incentive policy for government resources and recognition. As the coercive policy has an inverted U-shaped impact on the green innovation strategy, the moderating effect of the top management’s environmental awareness on the square of the coercive policy and the green innovation strategy is further analyzed. The results are shown in Table V: The top management’s environmental awareness has a positive moderating effect on the coercive policy (not the square of the coercive policy) and the green innovation strategy ($\beta = 0.070, p < 0.05$). It shows that top managements who have a strong sense of environmental protection and can promote the perception of regulatory pressures. $H5a$ is not supported.

The top management’s environmental awareness has a significant moderating effect on the market pressure and the green innovation strategy ($\beta = 0.134, p < 0.01$). This shows that top managements who have a high awareness of environmental are more willing to identify market opportunities of the green innovation and regard the emphasis that consumers, suppliers and competitors place on the green innovation as a market opportunity. They usually develop the green innovation strategy to gain competitive advantages. $H5b$ is supported.

The top management’s environmental awareness has a significant moderating effect on innovation resources and the green innovation strategy ($\beta = 0.083, p < 0.01$). This shows that whether an enterprise can effectively exploit the supportive role of innovative resources for the green innovation strategy depends on the level of the top management’s environmental awareness. The characteristics of the green innovation such as external spillover and uncertainty make it not have the priority distribution rights of resources. So the starting mechanism for resources to play a role in the green innovation strategy depends on the top management’s environmental awareness. Top managements with high environmental awareness not only tend to identify market opportunities of the green innovation but also are more willing to invest resources in the field of green innovation, so as to give full play to the role of resources in supporting the green innovation strategy. $H5c$ is supported.

The top management’s environmental awareness has a negative moderating effect on the innovation capability and the green innovation strategy ($\beta = -0.188, p < 0.001$). One possible explanation is that the green innovation can be divided into two stages: pollution prevention and cleaner production. At present, most enterprises in China are in the primary stage of green innovation and achieve environmental protection goals through pollution prevention. The higher the top management’s environmental awareness is, the more their enterprises tend to adopt the cleaner production measures. From the prevention and control
of pollution to the implementation of technological transformation and upgrading to achieve cleaner production, there is a lag in strategic timeliness. That is the reason for the negative moderating effect. H5d is not supported.

5. Conclusions and implications
Through theoretical construction and empirical analysis, this paper draws the following conclusions:

5.1 Research conclusion
(1) The impact of the external environmental pressure on the green innovation strategy: The coercive policy has an inverted U-shaped impact on the green innovation strategy. This is inconsistent with the previous conclusion that the relationship between the two is linear, indicating that a moderately coercive policy promote the green innovation strategy, while too high or low coercive policies are not conducive for enterprise to choose a green innovation strategy. The incentive policy and the market pressure both have a significant positive impact on the green innovation strategy.

(2) The impact of the internal environmental driving force on the green innovation strategy: The innovation capability has a significant positive impact on the green innovation strategy. The innovation resources have no significant impact on the green innovation strategy.

(3) The moderating effect of the top management’s environmental awareness on the relationship between the internal, external factors and the green innovation strategy: The relationship between the coercive policy (not the square of the coercive policy) and the green innovation strategy is stronger when the top management’s environmental awareness higher. The relationship between the market pressure and the green innovation strategy is stronger when the top management’s environmental awareness higher. The relationship between the innovation resources and the green innovation strategy is stronger when the top management’s environmental awareness higher. Otherwise, the relationship between the innovation capability and the green innovation strategy is weaker when the top management’s environmental awareness higher. And there is no significant change about the relationship between the incentive policy and the green innovation strategy when the top management’s environmental awareness higher. This shows that the interpretation of external pressures and internal driving forces depends on the level of the top management’s environmental awareness. The higher the top management’s environmental awareness, on the one hand, the easier it is to perceive, the pressure of the environmental regulations, identify potential benefits and market opportunities in the green innovation; on the other hand, the more conducive for the enterprise to allocate internal resources rationally, put the green innovation into the strategic height. These are conducive to realize the organic combination of external opportunities and internal resources and promote the formation and implementation of green innovation strategies.

5.2 Theoretical contributions
The theoretical contributions of this study are: First, we have promoted the integrated research on the drivers of the enterprise’s green innovation strategy. In the past, most of the
studies were conducted from a single perspective of the external institutional pressure or the internal organizational structure. From the perspective of internal and external environment driving forces, this paper analyzes the key factors influencing the decision-making of the green innovation strategy. We propose that the policy and market pressure from outside and the innovation resources and capability from inside have a comprehensive effect on the green innovation strategy, and the top management’s environmental awareness plays an important moderating role. This research discovery will help us better understand the root causes of the enterprise’s green innovation strategic choice, and it will also provide useful reference value for the enterprise to choose the green innovation strategic model more effectively.

Second, the study has contributed to the strategic choice theory. This article studies the driving mechanism of the green innovation strategy from a new perspective of the strategic choice theory. Whether the enterprise can make full use of the internal innovation resources and capabilities and translate the external policy and market pressures into opportunities for the green innovation strategy depends on the level of the top management’s environmental awareness. When making strategic choices, enterprises should make comprehensive trade-offs and considerations of the top management’s environmental awareness, the internal and external environment and the relationship between them, so as to achieve the matching and consistency of multiple strategic elements, which can lay a solid foundation for achieving high performance relying on the green innovation strategy.

5.3 Policy suggestions and management inspirations
Policy suggestions to the government:
- When formulating environmental regulations, the government should pay attention to the combination of the coercion regulation and the incentive regulation.
- The government should increase the supporting for the enterprise’s green innovation.
- Create a concept of green production and consumption.

Inspiration to the management:
- Make reasonable use of innovation resources and capabilities.
- Business managers should pay full attention to the national environmental protection policy, the green consumer orientation of consumers, the dynamics and direction of suppliers and the environmental protection strategies of competitors, so as to adjust their own strategies timely.
- Emphasize the cultivation of the managers’ green environmental awareness.

5.4 Limitations and prospects
First, there are limitations on the sample source of this article. Due to energy and resource constraints, the research sample mainly comes from Shandong, Zhejiang, Shanxi and other places. In the future, data information can be collected in a wider range to enhance the generalizability of the research results. Furthermore, this study is a cross-sectional static study, and enterprises in different stages of development may face different internal and external driving forces. In the future, vertical data tracking can be used to study the differences in the choice of green innovation strategies for enterprises in different stages of development.
References


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