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Stimulating Green Investment Behaviors for Enterprises at the End of the Value Chain in China

Xianyou Pan
School of Economics and Management, Shanghai University of Electric Power, Shanghai, China
Marxism Research Institute, Shanghai University of Electric Power, Shanghai, China
Email: panxianyou@shiep.edu.cn (Corresponding author)

Jiajia Ma
School of Economics and Management, Shanghai University of Electric Power, Shanghai, China
Email: 18884317152@163.com

Yalin Shu
School of Management, Beijing Institute of Technology, Beijing, China
Email: shuyalin621@163.com

ABSTRACT

Enhancing the green investment (GI) behaviors and leveraging the synergies between enterprises at different value-chain (VC) positions are important guarantees for addressing climate risks and avoiding green overcapacity in developing country. Based on the sample includes 1918 Shanghai and Shenzhen A-share listed companies in China, this paper provides a specific analysis of the impact of VC position on GI. Further, it explores the formation mechanism of differentiated GI effects across different VC positions in terms of internal drivers and external conditions. Using one-way ANOVA and regression analysis, we reveal how the disparity in GI is shaped by key mechanism factors. Overall, the increase of VC position significantly promotes the enterprise GI. The differences of enterprise GI in different VC positions are influenced by factors such as the executive green cognition, the technological innovation ability, the non-controlling shareholders exit threat, and market competition. Specifically, enterprises in high VC positions have stronger GI due to stronger executive green cognition and technological innovation ability, and weaker exit threat and market competition than those of enterprises in low VC positions. Based on the above conclusions, this paper provides scientific suggestions on how to stimulate the willingness of GI and leverage the synergistic effects between enterprises at different VC positions.

Keywords: *corporate green investment, value-chain positions, synergy effect, driving factors, developing country*

1. INTRODUCTION

The global scale of sustainable investment is steadily increasing to effectively mitigate climate risks. The United Nations Industrial Development Organization emphasizes that green investment (GI) is crucial for the green recovery of the economy. Developing countries like South Africa, Morocco and China have issued green sovereign bonds to promote GI. Academic research on the participation motivations of enterprises in low value-chain (VC) positions in developing countries remains insufficient. These enterprises occupy foundational positions in global supply chains, and their lagging green transition may generate systemic risks. Despite the current green practice has shown great potential, it also faces financial, technical challenges, and the difficulty of being locked into low VC positions. The CPC Central Committee and the State Council highlighted the importance of promoting green development on July, 2024. However, China's industrial green development continues to face significant challenges, such as the necking of key green technologies and lock-in at low VC positions (Perez-Aleman and Sandilands, 2008). On the one hand, enterprises in low VC positions are unsure if GI aligns with their operation model (Sun *et al.,* 2019). GI increases short-term costs and crowds out non-profitable projects. These costs are often not offset by improvements in competitive position for an extended period, which leads some enterprises to merely fulfill the minimum legal requirements without a strong GI desire (Chen *et al.,* 2018). Most enterprises in developing countries still occupy low VC positions, and are vulnerable to technological blockades in green development, resulting in low GI rates (Perez-Aleman and Sandilands,2008). On the other hand, enterprises in high VC positions influence the competition intensity and the "prisoner's dilemma" faced by enterprises in low VC positions (Yan *et al.,* 2018). Although theoretical optimization suggests that carbon emission constraints can be managed through supply chain coordination mechanisms like Vendor Managed Inventory (VMI) systems (Nugroho and Wee, 2019), such coordination is difficult to achieve in practice. Enterprises at the core of the VC have not fully leveraged their leadership role, making it difficult to promote coordinate of GI among upstream and downstream supply chain enterprises. Such vertical coordination failures exacerbate green overcapacity from redundant investments,

underscoring the urgency to examine how VC positioning shapes corporate GI motivations. Therefore, this paper mainly answers the following three RQ:

- RQ1: Does the VC position drive differentiated GI behavior?
- RQ2: Why do enterprises at different VC positions exhibit differentiated GI behaviors?
- RQ3: What are the policy tools to promote GI collaboration among enterprises at different VC positions?

This paper forms a complete framework for studying the position of enterprise VC and GI from both theoretical and empirical perspectives. We explain the inherent logic of differentiated GI behavior of enterprises in different VC positions. Moreover, we extract the main factors driving differentiated GI behavior among enterprises at different VC positions in terms of internal drivers and external conditions. These factors mainly include executive green cognition, technological innovation ability, non-controlling shareholders exit threat and market competition. To verify the theoretical inference, this paper selects Chinese A-share listed companies in the Shanghai and Shenzhen stock exchanges as the research subjects. We established a basic effects model and designed a series of robust experiments to confirm the relationship between corporate VC position and GI. Moreover, this study employs a mechanism analysis to examine those factors influencing the relationship between VC position and GI.

The main conclusions include the following aspects: The rise in the position of the industry VC has significantly increased the GI of enterprises. Based on the characteristics of enterprises at different VC positions, this research further found that GI behaviors vary due to factors such as executive green cognitions, technological innovation abilities, non-controlling shareholders exit threat, and market competition. Enterprises in high VC positions tend to have stronger green cognitions and technological innovation abilities. They also face weaker exit threats and less market competition, which leads to a stronger tendency to invest in green initiatives compared to those in low VC positions. Based on the above conclusions, this paper provides scientific suggestions on how to stimulate the willingness of GI and leverage the synergistic effects between enterprises at different VC positions in developing country.

The marginal contributions of this study are as follows: First of all, a large number of literatures have studied the driving factors of corporate GI from a balanced perspective and the research mainly focuses on green finance (Javeed *et al.,* 2024), practical benefits (Wang *et al.,* 2022) and competition strategy (McFarland *et al.,*2008). This paper provides an effective supplement to the theoretical research results on the driving factors of corporate GI by explaining the relationship between the position of the VC and corporate GI. In addition, the main responsibility for promoting the green transformation of enterprises and improving the efficiency of green resource allocation lies in leveraging the synergies between enterprises at different positions in the VC. This study examines the internal drivers and external conditions shaping GI differentiation across enterprises in different VC positions. The conclusion provides theoretical reference for understanding the GI behavior at different positions in the VC, and also provides practical direction for achieving GI synergy among enterprises and avoiding redundant construction in developing countries.

The following is the remaining structure of this study. Section 2 reviews GI and VC based on existing studies. The paper presents a theoretical analysis and explains the functional paths of the promoting effect of VC on the GI in Section 3. Section 4 outlines the research design involving the establishment of an empirical model, sample selection, and variable descriptions. Section 5 uses the sample data of the selected corporations for empirical analysis, robustness tests. The paper examines the promotion paths of VC's impact on GI in Section 6. Finally, the paper concludes the findings and put forward policy implications in Section 7.

2. LITERATURE REVIEW

2.1 Research on Enterprise GI

Pearce *et al.* (1989) first proposed the concept of "green economy" in the " Blueprint for a Green Economy", setting the stage for a global transition toward sustainable development. Adapted to the green economy, the investment in green economic development is called GI. In the IMF report, Eyraud *et al.* (2011) pointed out that GI is needed to reduce greenhouse gas and air pollutant emissions without significantly reducing the production and consumption of non-energy products".

The drivers of enterprises' GI can be broadly grouped into internal drivers and external conditions. Internally, GI is affected by factors such as manager gender (Atif *et al.,* 2020), executive background (Jia *et al.,* 2021), and risk preference (Peng *et al.,* 2023). Sharfman (2008) believes that if an enterprise actively implements environmental management strategies, it will actively participate in GI behavior and promote its performance improvement. In addition, studies have found that manufacturing flexibility can effectively promote a company's environmental performance (Yu and Lee, 2023). The GI undertaken by an enterprise will increase the production cost in the short term, and return period is long. However, in the long run, GI can produce significant social and environmental benefits. These efforts can also obtain the support of environmental stakeholders who prefer green consumers. Saunila *et al.* (2018) pointed out that if enterprises pay more attention to economic, institutional and social sustainability, they are more likely to make GI; According to the peer effect, McFarland *et al.* (2008) believed that changes in behavior and strategy occur in the competitive market. These changes in the social network composed of enterprises affect the actions of other members. When an enterprise obtains consumers ' favor and competitive advantage due to GI behavior, it will attract the attention of competitors and imitate and implement GI behavior. Further, Aghion *et al.* (2023) believed that in a high degree of product market competition, the pro-social attitude of enterprises has a positive role in promoting GI. It can help enterprises get rid of competition and improve their competitive advantage by attracting consumers with social responsibility. Feng *et al.* (2022) found that digital transformation, as an important change in the internal management and production and operation of enterprises, can also significantly improve the

level of GI of enterprises. Externally, Sharfman *et al.* (2008) pointed out that the environmental negative externalities generated by the economic activities of enterprises generally require the intervention of government environmental policies to be effectively controlled. The behavior of enterprises in the field of GI can be summarized as a "passive response" to government environmental policies and "active investment" in pursuit of their own sustainable development and market competitiveness. Wang *et al.* (2022) began to explore the relationship between public demands, environmental regulation, and GI of enterprises. They found that environmental regulation has a positive impact on GI. Consistently, Benjamin *et al.* (2023) demonstrated that external institutional pressures are fundamental drivers for small and medium-sized enterprises to implement green supply chain initiatives, which subsequently leads to improved environmental and economic performance. They believed that environmental regulation and technological innovation can promote GI of enterprises. Some researchers believe that environmental regulation does not promote GI of enterprises, and that technological innovation alone promotes GI (Sinn, 2008; Acemoglu *et al.,* 2012).

2.2 Research on VC and Enterprise GI

The concept of VC has experienced significant development and evolution since it was proposed by Michael Porter in the 1980s. Porter divides enterprise activities into basic activities and support activities, forming an interrelated and mutually supportive system, namely 'VC'. Webber and Labaste (2009) focused more on VC linkages. These linkages not only covered all the vertical linkages and interdependence processes that created value for consumers, but also included horizontal linkages with other VCs that provided intermediate goods and services. Bell (2013) defined the VC as a group of ' interdependent economic activities ' and ' a group of vertically connected economic entities'; The idea of VC marked a systematic thinking on how internal processes promote value creation and competitive advantage (Mac Clay, 2019). It is worth noting that for the external VC, enterprises in the same industry can use a variety of ways to achieve a win-win situation. They can achieve resource sharing and maximize the efficiency of inter-enterprise collaboration.

The investment strategy of the VC has also expanded from the inside of the VC to the whole chain. Jennifer Pellet (2003) found that the VC runs through all the links from product development to market entry. To make a reasonable investment, it is necessary to optimize the VC and grasp its core links. Kolstad and Wiig (2012) found that there is a significant causal relationship between the VC position of enterprises and their OFDI decision-making. Enterprises can enhance their division of labor in the global VC through OFDI, and the benefits will increase over time. Taking the VC theory as the theoretical basis of enterprise investment strategy means that enterprises need to measure the requirements of investment and competition to maximize the value of enterprises. Different from the foreign investment of enterprises, Tran (2020) comprehensively summarizes the power sources of enterprises' GI, including responding to government supervision, obtaining economic benefits and competitive advantages, maintaining corporate reputation, corporate citizenship responsibility, and spontaneous environmental awareness. The classical VC theory holds that the higher the VC position of the enterprise, the more the enterprise can obtain profits. Therefore, considering the highly irrational characteristics of enterprise decision-makers, the behavior of enterprise decision-makers in different VC positions will show differences in GI.

3. THEORETICAL ANALYSIS AND RESEARCH HYPOTHESIS

The VC theory refers to the different but related value activities generated in the value creation process of a firm, emphasizing that firms create value through activities such as product front-end design, production, sales, and service (Kano *et al.,* 2020). Specifically, the VC position in this study represents an enterprise's economic standing and value-added capability within the production network. A high VC position is characterized by high-value-added activities such as research and development (R&D), core component design, and sophisticated services, which typically possess higher technological barriers. In contrast, a low VC position involves labor-intensive assembly or primary resource processing with lower profit margins. It is important to clarify that VC position differs from the 'upstream and downstream' concepts in a supply chain: while the latter describes the physical flow of materials, the VC position emphasizes the distribution of economic value. For instance, some downstream activities like brand marketing are high VC positions due to their high value-added nature, despite being at the end of the physical supply chain.

In the field of corporate GI, policymakers focus on reducing and controlling the emission of various pollutants, such as greenhouse gases (Eyraud *et al.,* 2011). This is done without significantly reducing the production and consumption of non-energy products. An example of this is investment in the research and development of energy-saving and renewable energy technologies (Zhang *et al.,* 2024). GI behavior refers to the dual goal of achieving both environmental and economic benefits. Enterprises can achieve these benefits by investing resources in environmentally friendly and sustainable projects. The essence of GI behavior is to enhance the market competitiveness of enterprises. It also helps improve the social responsibility image of enterprises by reducing the negative impact of enterprises on the environment (Ibikunle and Steffen, 2017). It is worth noting that the decision-making system of corporate GI is immature and characterized by high irrationality (Nagy *et al.,* 2021). Based on the assumption of the independence of individual decision makers, in the context of corporate GI affected by internal financial costs, risk management and external environmental spillover effects, long-term social well-being enhancement and policy-oriented investment dependence, the environmental and economic values obtained by individuals show significant heterogeneity (Liao, 2018).

By establishing a risk-sharing mechanism, enterprises can reduce financial pressure and investment risks. Additionally, creating a technology-sharing platform enables enterprises to develop collaborative partnerships. These partnerships help achieve complementary advantages. As a result, the value distribution of GI can be optimized, helping to equalize the heterogeneity of GI benefits. Further, according to the perspective of VC theory, the location of an

enterprise determines its access to resources, the market environment it faces and its technological innovation ability. As a result, firms in different VC positions may exhibit significant differences in their GI behaviors.

3.1 Enterprises at Different Positions in the VC Exhibit Different GI Behaviors

In the social production system, enterprises are the primary sources of energy consumption and environmental pollution. Their strategies and actions are crucial for driving green environmental development. In China, enterprises emit up to 80% of the pollutants. Therefore, it is clear that enterprises should take responsibility for environmental governance and actively participate in GI activities. The Guiding Opinions on Accelerating the Establishment of a Sound Green, Low-Carbon and Circular Development Economic System (Guo Fa 2021 No. 4) suggests that a series of green practices, such as GI will be pursued in an all-encompassing manner. These practices will be implemented throughout the entire process. The opinions also emphasize strengthening the main responsibility of enterprises for transformation. This will support their green innovation and transformation. The GI behavior of enterprises includes the research, development, and application of environmental protection technology. It also involves resource conservation, energy efficiency improvement, waste reduction, and recycling. The purpose is to promote the repair of resource and environmental depletion and achieve ecological balance. However, the short-term economic benefits are small and accompanied by uncertainty. Rational entrepreneurs, who prefer certainty of return, may not actively utilize their capital for GI. This is especially true under the constraint of limited resources (D'Angelo *et al.,* 2023). Whether an enterprise considers investing capital in green technologies depends on the cost of the investment versus the magnitude of the resulting emission reduction benefits (Cui *et al.,* 2024). Enterprises at different VC positions face uncertainties and risks associated with investment. These risks arise due to environmental regulations and new technologies. As a result, most enterprises are hesitant to invest in green projects. The scale of such investments is often limited. The reasons for this hesitation are largely intrinsic to their VC position. Depending on the positioning of the enterprise in the VC, decision makers choose whether or not to develop a corresponding GI strategy to achieve the dual goals of economic and environmental benefits (Nagy *et al.,* 2021). Based on this, Hypothesis 1 is formulated in this research:

H1: Differences in the position of enterprises in the VC will create differentiated GI behaviors.

3.2 Analysis of the Formation Mechanism of Differentiated GI at Different Positions of the VC

While H1 establishes the existence of a GI gap across the value chain, it is essential to explore the underlying formation mechanism of this differentiation. The VC position is not merely an economic indicator but a structural context that shapes a firm's internal drivers and external conditions. Specifically, the disparity in GI between high and low VC positions is manifested through four critical dimensions that transform structural positioning into specific investment behaviors. Internally, the subjective driving mechanism reflected in the strategic awareness of the board and the resource-based mechanism represented by R&D capabilities determine the firm's willingness and ability to innovate. Externally, the governance constraint mechanism manifested as pressures from non-controlling shareholders and the external incentive mechanism embodied by the competitive landscape define the institutional boundaries and market motivations for green transformation. By examining these integrated factors, we can uncover how the structural advantages or constraints of a value chain position are converted into differentiated corporate green investment outcomes.

3.2.1 Executive Green Cognition as an Internal Driver

The board of directors is an important component of a company's internal governance mechanism. It plays a key role in managerial and strategic supervision, and it has been pointed out that board executives can influence a series of investment decision-making behaviors of enterprises (Li *et al.,* 2022). Organizational legitimacy theory states that enterprises must maintain their organizational legitimacy to grow. To do so, they need to improve and regulate their behavior in order to gain recognition from external markets and society (Skelcher and Smith, 2015). In order to improve organizational legitimacy and corporate environmental responsibility performance, enterprises need to increase their level of GI (Stucki *et al.,* 2019). It has been noted that engaging in GIs requires substantial resources from an enterprise. This, in turn, cuts the financial budget of the enterprise and reduces the discretionary cash flow available to executives (Weche, 2015). Therefore, the analysis concludes that enterprises need not only the support of resources to make GIs, but also the support of executives on the board of directors of the enterprises. For enterprises with a higher level of green awareness among executives, their executive structure can help the enterprises to develop green strategies and create a good public image. An executive structure with higher levels of green cognition reflects stronger decision support from the enterprise's board of directors. Analyzing from the perspective of VC position, enterprises in different VC positions have different value addition in the whole production process of their products, which leads to differences in the strategic level of their enterprises. Enterprises in high VC positions are driven by high value-added innovation, design, and high-end manufacturing activities. They have stronger strategic resource control in the production process. These enterprises view green development as one of their core strategies, focusing on sustainable development, and they continue to invest in green technology to promote the green transformation of the enterprise and improve their branding strategy. The executives of their enterprise boards have a higher level of cognition regarding green issues. As a result, they actively promote enterprise GI and green brand building. On the contrary, enterprises in low VC positions, such as resource-processing enterprises and labor-intensive processors, are primarily engaged in the initial processing of raw materials. These enterprises have a strong dependence on labor and resources, which creates a path dependency. Accordingly, they are often "captured" and locked into low VC positions. This leads to higher costs from daily operations, green products, and environmental protection packaging. Due to limited profit margins (Hart and Ahuja, 1996), enterprises in low VC positions have clear profit-

seeking characteristics in their investments. The level of green awareness among board executives in these enterprises is significantly lower than that of enterprises in high VC positions. Hence, they generally pay less attention to green issues and focus more on short-term financial goals. In their decision-making, executives are more likely to put their investments on hold or to make "passive" GIs due to government environmental regulations (Berrone *et al.,* 2013), rather than out of green preferences. Based on this, the hypothesis 2a is presented:

H2a: The level of executive green cognitions determines the differentiated GI behaviors of enterprises at different VC positions.

3.2.2 Technological Innovation Ability as an Internal Driver

Technological innovation ability refers to the overall strength of an enterprise to innovate in the field of technology. The strategic role of green technological innovation is becoming increasingly important in the framework of sustainable development for enterprises (Triguero *et al.,* 2013). Based on this, organizations are able to develop new products and services or improve the performance, quality and efficiency of existing ones (Liu *et al.,* 2023). Technological innovation not only lowers the cost threshold of green solutions but also optimizes their performance. This dual effect significantly enhances the incentives for enterprises to adopt green technologies (Li *et al.,* 2022). In addition, technological innovations also energize enterprises to achieve sustainable development. An enterprise's investment in green technology innovation can form a key resource that is highly valued and difficult to replace, and become an endogenous source of competitive advantage (Ning *et al.,* 2023). Enterprises with strong R&D abilities in the VC tend to face lower financial risks and higher returns on assets (Wang *et al.,* 2023). Through continuous technological innovation, these enterprises develop new green products or improve existing one, resulting in a leading position in the market. As mentioned earlier, enterprises in high VC positions gain a first-mover advantage in GI through innovation. They benefit not only by being the first to meet market demand but also by setting market trends through technological innovation. Enterprises with weak R&D ability in the VC are often constrained by factors such as a weak industrial base, lack of core technology, and difficulties in market financing. These constraints make it difficult for enterprises to realize economies of scale. Green development also crowds out production costs, and technical barriers remain at the innovation and R&D stage (Gollop and Roberts, 1983). This limits sustained investment in and development of green technology. Based on this, the hypothesis 2b is presented:

H2b: Differences in technological innovation abilities influence the GI behavior of enterprises at different VC positions.

3.2.3 Non-Controlling Shareholder's Exit Threat as an External Condition

The non-controlling shareholder exit threat refers to the risk that shareholders, who are not involved in day-to-day operations and management, may choose to exit the enterprise. They do this by selling their shares based on their assessment of the enterprise's future earnings prospects, return on capital, or risk expectations. GI requires enterprises to make large-scale capital investments, which leads to higher short-term financial pressure. As a result, GI is often accompanied by greater investment risk. From the investor's perspective, the green transformation of the enterprise can reduce its cost of equity and debt (Petersen and Vredenburg, 2009). This reduction prompts investors to seek a risk premium (Pástor *et al.,* 2021). As China continues to promote green transformation, most investors have become green investors. They pursue the dual value of economic benefits and social utility. Gradually, they have begun to prefer investing in enterprises in high VC positions with better environmental performance. This preference is driven by the desire to gain excess returns based on higher green policy sensitivity and judgment (McCahery *et al.,* 2016). On the one hand, enterprises in high VC positions have greater market bargaining power and technological barriers. They are usually able to provide shareholders with more stable returns. On the other hand, being at the core of the VC means these enterprises have higher environmental and social responsibilities. This results in a greater emphasis on long-term stable development. The combination of these two factors makes enterprises in high VC positions more desirable to investors. As a result, they face less threat of exit from non-controlling shareholder investors which makes it easier for them to realize GIs. The benefits of these GIs tend to be reflected in the long term. On the contrary, enterprises in low VC positions are more vulnerable to fluctuations in the price of source materials, changes in labor costs, and other factors when facing changes in the external market environment, and rely on stable cash flows with high-frequency short-term returns. When the market faces greater volatility, non-controlling shareholders are more likely to opt for divestment. During this time, enterprises tend to prioritize projects with quick short-term financial returns. They do this rather than investing in long-term, capital-intensive green projects with long payback cycles. This approach helps alleviate short-term financial pressures, as enterprises may lack the patience for long-term progressive investments. It follows that the implementation of GI behavior is often constrained by the exit threat of non-controlling shareholders, especially for enterprises in low VC positions. Based on this, the hypothesis 2c is presented:

H2c: Differences in threats of investor exit influence the GI behavior of enterprises at different VC positions.

3.2.4 Market Competition as an External Condition

Market competition refers to the influences that motivate an enterprise to implement a marketing strategy under the market aspect (Piñeiro-Chousa *et al.,* 2021). Unlike government environmental regulation, market competition emphasizes the self-awareness of enterprises in green practices. Investment costs are translated into the competitiveness of enterprises, and enterprises have incentives to voluntarily increase GIs (Nagy *et al.,* 2021). When enterprise managers make GIs because they value environmental and social benefits (Saunila *et al.,* 2018), their actions enable them to cultivate green core competencies for their enterprises in a competitive market environment. This leads to the establishment of a favorable image and reputation in the market for the enterprise's green innovation

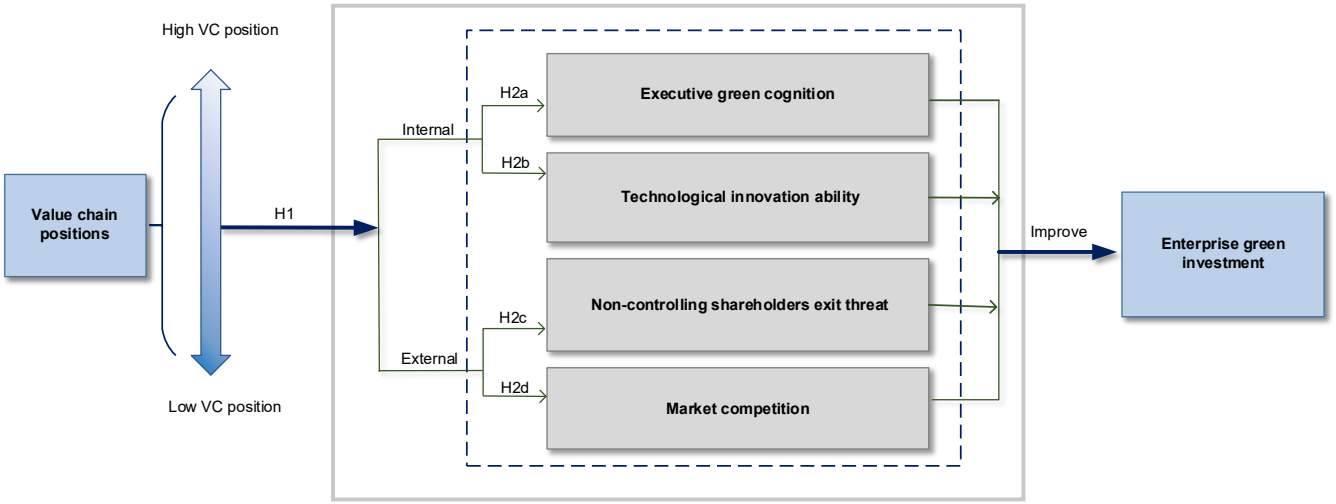

Figure 1 Theoretical Framework

performance (Chen, 2008). It can be seen that market competition promotes GI behavior in enterprises. Enterprises in high VC positions are able to cultivate a differentiated competitive advantage in the marketplace. This is due to their strong market influence and their ability to guide consumer demand through the promotion of green products and sustainable practices. Enterprises in low VC positions usually have higher brand awareness. They can directly influence consumers' purchasing decisions through brand building and marketing strategies. These enterprises have greater potential to promote green products and sustainable practices, and are more inclined to invest in green products and brand green building. Based on this, the hypothesis 2d is presented:

H2d: Differences in market competition faced by enterprises at different VC positions can affect their GI behavior.

3.3 Theoretical Framework of the Formation Mechanism

Based on the systematic analysis above, this paper constructs a comprehensive framework to explain the formation mechanism of differentiated GI effects (as shown in Figure 1). The VC position serves as the overarching structural context that determines the status of internal drivers and external conditions. The disparity in GI between enterprises in high and low VC positions is not an isolated phenomenon but is formed through the combined effects of executive cognition, innovation ability, exit threats, and market competition. This mechanism explains why enterprises in high VC positions possess stronger internal drivers and experience more favorable external conditions, eventually leading to a higher level of green investment compared to those in low VC positions.

4. RESEARCH DESIGN

4.1 Data Sources

This research selects the data of Shanghai and Shenzhen A-share listed companies from 2007 to 2014 to form unbalanced panel data containing 1918 observations (the research has collected green investment data for listed companies up to 2022. However, the latest version of WIOD data is the 2016 version, the data interval is only from 2000 to 2014. Furthermore, due to the limited number of listed companies disclosing green investment information between 2001 and 2006, the research selects the period from 2007 to 2014, when the data is more complete, as the sample research interval), and treats the research sample as follows: (1) listed companies in the financial industry are excluded; (2) listed companies labeled as ST and *ST are excluded; (3) in order to minimize the error as much as possible, all the omitted data of the relevant variables are excluded and no interpolation is performed. The GI data are derived from the notes to the financial statements of the enterprises in the Cathay Pacific database, the indicators of the industry VC are calculated from the global cross-country input-output table (WIOT) in the WIOD database, and all other data are from the CSMAR and Wind databases.

4.2 Model Setting

4.2.1 Foundation Effects

This research uses a fixed effect model to test the effect of industry VC position on enterprises' GI decision-making behavior, as shown in equation (1).

$$GI_{i,t} = a_0 + a_1 Pos_{tpl_{i,t}} + a_2 Controls_{i,t} + \sum Year + \varepsilon_{i,t} \quad (1)$$

In equation (1), the main explanatory variables are Pos_tpl, represents the position of listed company i in the industry VC in year t. The explanatory variables are GI represents the amount of GI in listed company i in year t. $Controls$ is the control variable. $\sum Year$ be a time fixed effect, $\varepsilon_{i,t}$ is the random error term.

4.2.2 Mechanism Factors of GI Differentiation

To examine the formation mechanism of the differentiated GI effects across the value chain, four critical mechanism factors are identified: executive green cognition (*Green-word*), technological innovation ability (*Patent*), non-controlling shareholders' exit threat (*Net*), and market competition (*Cr5*). These factors represent the internal drivers and external conditions that transform an enterprise's structural position in the value chain into specific green investment behaviors. The mechanism analysis is conducted through a two-stage empirical approach that ensures a

rigorous logical transition from structural positioning to investment outcomes. Initially, a distributional difference analysis via One-way ANOVA is utilized to verify whether enterprises at different VC positions exhibit significant disparities in these four mechanism factors. This stage is crucial for confirming that the value chain position indeed creates a differentiated landscape of resource endowments and institutional pressures.

Subsequently, an impact path verification is performed by employing a fixed-effect model to test whether these factors significantly promote or constrain GI. The baseline regression for this path is specified in equation (2), where $Mechanism_{i,t}$ represents the four factors analyzed in separate regression columns, while $\sum Year$ denote time fixed effects, respectively:

$$GI_{i,t} = a_0 + a_1 Mechanism_{i,t} + a_2 Controls_{i,t} + \sum Year + \varepsilon_{i,t} \quad (2)$$

In equation (2), $Mechanism_{i,t}$ is the mechanism factors, separate executive green cognition; technological innovation ability; non-controlling shareholders exit threat; market competition indicates. The other variables are set as in equation (1).

This empirical design confirms that while the VC position determines the level or intensity of these psychological, resource-based, and institutional factors, these factors in turn directly drive the observed "disparity" in green investment. By combining the results of the ANOVA and the regression analysis, the specific channels through which the value chain position manifests its influence on corporate environmental strategy can be effectively uncovered.

4.3 Definition of Variables

4.3.1 Explained Variables

Enterprise GI (GI). The research data comes from the notes to the financial statements of enterprises in the database of Cathay Pacific, and is summarized by the funds belonging to the category of GI in the details of investment in construction in progress, administrative expenses and research expenses. For example, the projects in construction in progress belong to the category of GI, such as coal-to-gas conversion projects, new energy projects, and environmental protection renovation projects. Further, this paper measures the green investment level of enterprises by the ratio of total green investment to total assets and standardizes it.

4.3.2 Explanatory Variables

Industry VC position (Pos_tpl). The length of the VC can be defined as the number of stages of a country's value added that are double-counted in total output, and more specifically, the number of stages can be defined in terms of the number of times it crosses industries and borders, which corresponds to a “multiplier” or “lever” measuring the amount of output that is generated by domestic value added. Through the decomposition and derivation of the input-output model, we can get the length of the forward VC (also called upstream degree, PLv) and the length of the backward VC (also called downstream degree, PLy) of the whole industry chain (Total Production Length, *TPL*) of a certain industry, with the former indicating the number of stages that the products of the industry need to go through before they reach the final products, and the latter indicating the number of stages that the products of the industry need to go through before reaching the final products. The use of upstream degree or downstream degree alone cannot measure the VC position of the industry as a whole, and even overestimates the VC position, accordingly, this research refers to Wang *et al.* (2017) and uses the ratio of upstream degree and downstream degree as an indicator of the position of the whole VC of the industry, as shown in equation (3). This ratio, Pos_tpl, serves as a proxy for the economic height of an enterprise within the value hierarchy. A higher value indicates the enterprise is situated at the high-value-added end of the “smile curve” (e.g., innovation and branding), whereas a lower value indicates proximity to the low-value-added manufacturing segment. This metric allows us to quantify the economic power of an enterprise beyond its simple geographical or logistics-based position in a supply chain.

$$Pos\_tpl = \frac{PLv}{PLy} \quad (3)$$

Input-Output Table (WIOT) in the WIOD database, which is calculated from the UIBE GVC Indicators database of the University of International Business and Economics (UIBE), which contains the input-output data and flows of 43 countries and regions and 56 industries (ISIC Rev.4) from 2000 to 2014, and through the International Standard Industrial Classification (ISIC). The data are matched with the data of listed companies through the cross-reference table of International Standard Industrial Classification (ISIC) and the 2-digit code of the Classification of Industries of the National Economy (CIC-2).

4.3.3 Mechanism Factors for GI Differentiation

Executive Green Cognition

Executive green cognition refers specifically to how enterprise executives understand the resource environment, form perceptions of this environment along with scientific knowledge, and experience the psychological responsibility to conserve resources and protect the environment. This process includes factors such as the perception of green competitive advantage, social responsibility awareness, and sensitivity to external environmental pressures (Wu *et al.,* 2024). Executives' green perceptions reflect an enterprise's willingness and inclination to invest in green initiatives. This commitment, in turn, drives investments in various areas such as product development, production processes, and supply chain management (Tu *et al.,* 2024; Hao *et al.,* 2025). This research employs textual analysis to examine the annual reports of listed companies. It selects keywords based on three dimensions: awareness of green competitive advantage, corporate social responsibility awareness, and perception of external environmental pressure. The chosen keywords include terms such as "energy saving and emission reduction," "environmental protection strategy," "environmental protection concept," "environmental management organization," "environmental protection education," "environmental protection training,"

Table 1 Definition of Variables

Type	Sign	Name	Method of Calculation
Explained Variables	*GI*	GI	Total GI projects of the enterprise/total assets of the enterprise x 100
Explanatory Variables	*Pos_tpl*	Industry VC Position	Ratio of upstream degree to downstream degree
Mechanism Factor	*Green_word*	Executive Green Cognition	Frequency of green words in company annual reports
	Patent	Technological Innovation Ability	Number of annual patent inventions in the enterprise
	Net	Non-controlling Shareholders Exit Threat	The cross-multiplier between stock liquidity and the degree of competition from large shareholders
	Cr5	Market Competition	Sum of market shares held by the top 5 companies in the industry
Control Variables	*Size*	Company Size	Total enterprise asset size
	Debt	Total Liabilities	Accumulated liabilities
	Fin	Financial Cost	Total financial expenditure
	Risk_taking	Risk Tolerance	Standard deviation of adjusted roa for the next three years
	Roa	Return on Assets	Ratio of net profit to average total assets of the enterprise
	Ae	Management Costs	Total management expenditure
	Dir_num	Number of Directors	All board members for the year
	Lev	Gearing Ratio	Total liabilities at end of period/total assets at end of period
	KI	Capital Intensity	Total assets/operating income

"environmental technology development," "environmental auditing," "energy saving and environmental protection," and "environmental protection and pollution control." The frequency of these words in a company's annual report is used to construct the environmental cognition variables of listed company executives, thereby measuring the degree of executive green cognition in their decision-making.

Technological Innovation Ability

Technological innovation ability refers to an enterprise's ability to effectively respond to a changing market environment. It does so by improving its innovation output, which helps explore new economic development models, enhance production efficiency, and establish an environmentally friendly enterprise system (Geng *et al.,* 2021). This research draws on Artz *et al.* (2010) and Ponta *et al.* (2021) and use the cumulative number of invention patents, utility model patents, and design patents of listed companies as indicators of their innovation ability.

Non-Controlling Shareholders Exit Threat

In the enterprise's shareholding structure, non-controlling shareholders hold a significant portion of the company's shares. The state of corporate governance, whether good or bad, directly impacts their interests (Xu *et al.,* 2022). As a result, non-controlling shareholders are motivated to monitor management in order to improve the value of the enterprise. They will also benefit from these improvements, which helps offset the costs of monitoring. The exit threat refers to the potential action of non-controlling shareholders in an enterprise to 'exit,' meaning they may sell the enterprise's stock. This serves as a bargaining chip against management, which may alter its decision-making due to concerns over a decline in the stock price (Palmiter, 2001). Therefore, the exit threat alters the perception of enterprise decision-makers, ultimately influencing corporate green governance by affecting managerial decisions. This research aims to adopt the methodology of Dou *et al.* (2018) and use the cross-multiplier term of stock liquidity and the degree of competition among majority shareholders as a proxy variable for the exit threat posed by non-controlling shareholders.

Market Competition

Market competition is a crucial factor that enterprises must consider in their production and operations, as it influences their socially responsible behavior (Duanmu *et al.,* 2018). In this research, the market competition variable is replaced by the *Crn* index, which reflects the market concentration rate (Shaffer and Spierdijk, 2020). Specifically, the *Cr5* index is used, representing the combined market share of the top five enterprises in the industry. A larger value indicates a higher degree of monopoly within the industry, meaning less competition.

The above data comes from the annual reports of listed companies, the State Intellectual Property Office, WIPO and so on.

4.3.4 Control Variables

It mainly contains the size of listed companies (*Size*), total liabilities (*Debt*), financial expenses (*Fin*), risktaking (*Risk_taking*), administrative expenses (*Ae*), return on assets (*Roa*), number of directors (*Dir_num*), gearing ratio (*Lev*), and capital intensity (*KI*). Specific variable definitions and descriptive statistics are shown in Table 1 and Table 2.

Table 2 Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
GI	1918	.105	.137	0.013	1.264
Pos_tpl	1918	.908	.173	.599	1.597
Size	1918	22.494	1.346	17.426	27.547
Debt	1918	21.836	1.504	17.513	27.306
Fin	1918	17.962	1.671	8.375	22.877
Risk_taking	1918	59.472	901.161	.069	15104.284
Roa	1918	2.67	6.87	-58.6	120.68
Ae	1918	19.279	1.231	15.964	23.975
Dic_num	1918	10.77	2.729	5	25
Lev	1918	.551	.185	.051	2.529
KI	1918	2.082	2.253	.107	36.119

Table 3 Foundation Effects Regression

Variable	(1)	(2)	(3)
Pos_tpl	0.1460***	0.1030***	0.0995***
	(0.0179)	(0.0187)	(0.0204)
Size		-0.0113	-0.0070
		(0.0265)	(0.0234)
Debt		0.0060	0.0013
		(0.0262)	(0.0226)
Fin		0.0056	0.0069**
		(0.0035)	(0.0034)
Risk_taking		-0.0055***	-0.0057***
		(0.0017)	(0.0016)
Roa		-0.0060***	-0.0066***
		(0.0013)	(0.0016)
Ae		0.0119**	0.0133**
		(0.0053)	(0.0061)
Dic_num		0.0015	0.0051
		(0.0063)	(0.0065)
Lev		-0.0213	-0.0219
		(0.0517)	(0.0448)
KI		0.0196***	0.0200***
		(0.0015)	(0.0036)
Constant	-0.0271	-0.1600	-0.2430**
	(0.0166)	(0.1070)	(0.1100)
Observations	1,918	1,918	1,918
R-squared	0.0340	0.1450	0.1520
Year FE	NO	NO	YES

*Note: Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1.*

5. ANALYSIS OF RESULTS

5.1 Foundation Effect Test Results

Table 3 yields the results of the validation of the role of industry VC position in influencing the GI behavior of enterprises, and the regression results of columns (1), (2) and (3) show that the GI of enterprises is significantly and positively correlated with the index of the position of the industry VC at the 1% level, implying that there exists a positive role of the position of the industry VC in the promotion of the GI behavior of enterprises, i.e., Hypothesis 1 in this research can be verified.

5.2 Robustness Tests

In order to verify the robustness of the above results, this research launched a robustness test. Firstly, the GI indicators are replaced, and the ratio of current GI to operating income is used to determine the regression results as shown in Column (1); secondly, in order to control the impact of extreme values on the empirical results, this research shrinks the tail of all the variables at the 1% and 99% quantile points, and the results obtained are shown in Column (2); the position of the industry's VC indicators are regressed with a lag of one period, and the results are obtained as shown in Column (3); considering the impact of the 2008 amount crisis, deleting the year of financial crisis to regress, the results are shown in Column (4); finally, considering the impact of the nature of equity on the GI of enterprises, adding the control variable of the nature of equity to regress, the results are shown in Column (5). In addition, the use of fixed-effects models can alleviate the endogeneity problem due to unobserved that do not change over time but it is difficult to solve the endogeneity problem due to unobservable variables that change over time. Considering the obvious dynamic effect of enterprise GI, this research constructs a dynamic panel model by generalized method of moments estimation (GMM), adding enterprise GI with one period lag to verify the impact of industry VC position on enterprise GI, and the regression results are shown in Column (1) of Table 4, which indicate the robustness of the results of the benchmark effect analysis.

Table 4 Robustness Test Results

Variables	(1)	(2)	(3)	(4)	(5)	(6)
L.GI						0.5150***
						(0.0840)
Pos_tpl	0.4960***	0.1050***		0.1030***	0.2030***	0.2240***
	(0.0898)	(0.0197)		(0.0211)	(0.0369)	(0.0832)
L.Pos_tpl			0.113***			
			(0.0260)			
Size	0.4920*	-0.0169	-0.0131	-0.0147	0.2440***	-0.4940*
	(0.2740)	(0.0262)	(0.0404)	(0.0226)	(0.0881)	(0.2680)
Debt	-0.4380	0.0123	0.0035	0.0060	-0.2110**	0.4150*
	(0.2900)	(0.0263)	(0.0406)	(0.0218)	(0.0933)	(0.2520)
Fin	-0.0378	0.0080**	0.0060	0.0072**	0.0080	-0.0366**
	(0.0433)	(0.0033)	(0.0051)	(0.0034)	(0.0133)	(0.0173)
Risk_taking	-0.0434***	-0.0067***	-0.0061**	-0.0066***	-0.0249***	-0.0318**
	(0.0142)	(0.0019)	(0.0026)	(0.0021)	(0.0053)	(0.0144)
Roa	0.0087	-0.0056***	-0.0058***	-0.0065***	0.0010	-0.0193***
	(0.0109)	(0.0014)	(0.0020)	(0.0017)	(0.0032)	(0.0063)
Ae	0.0047	0.0116*	0.0207***	0.0157**	0.0113	0.137**
	(0.0448)	(0.0060)	(0.0079)	(0.0062)	(0.0157)	(0.0640)
Dic_num	0.0347	0.0032	0.0052	0.0057	0.0003	0.0241
	(0.0452)	(0.0064)	(0.0086)	(0.0066)	(0.0024)	(0.0260)
Lev	1.389**	0.0452	0.0153	0.0217	0.5510***	-1.064*
	(0.6500)	(0.0563)	(0.0840)	(0.0441)	(0.1820)	(0.5580)
KI	0.310***	0.0166***	0.0197***	0.0209***	0.0443***	0.0364***
	(0.0846)	(0.0038)	(0.0041)	(0.0036)	(0.0108)	(0.0130)
Soe					0.0057	
					(0.0150)	
Constant	-1.695**	-0.216**	-0.312**	-0.237**	-0.876***	0.3840
	(0.7060)	(0.1070)	(0.1540)	(0.1120)	(0.2090)	(0.5000)
Observations	408	1,918	1,199	1,833	412	1201
R-squared	0.394	0.114	0.170	0.156	0.215	
Year FE	YES	YES	YES	YES	YES	

6. FURTHER ANALYSIS

The results of the previous empirical analysis have confirmed the significant facilitating effect of VC position on corporate GI. To further uncover the underlying reasons for this phenomenon, this section explores the specific channels through which the VC position promotes green investment. The focus is placed on verifying the formation mechanism proposed in the theoretical framework, specifically examining the roles of internal drivers comprising executive green cognition and technological innovation ability and external conditions, including non-controlling shareholders' exit threats and market competition. By analyzing these four pathways, the systematic process through which an enterprise's structural position in the value chain is converted into differentiated GI behaviors can be fully elucidated.

6.1 Analysis of Variances

The differences in executive green cognition, technological innovation ability, non-controlling shareholders exit threat, and market competition in different VC positions are shown in Figure 2. One-way ANOVA is used to test the significance of the differences in different VC positions, as shown in Table 5. The results show that there is a significant difference in the level of executive green cognition, technological innovation ability, non-controlling shareholders exit threat, and market competition in enterprises at different VC positions. The analysis shows that enterprises in high VC positions are significantly higher than those in low VC positions in terms of executive green cognition and technological innovation ability. The market competition index of enterprises in high VC positions is significantly higher than that of enterprises in low VC positions. This indicates that enterprises in high VC positions are located in a more monopolized market with less market competition. Furthermore, the non-controlling shareholders exit threat faced by enterprises in low VC positions is significantly stronger than that faced by enterprises in high VC positions. This confirms that the VC position creates a differentiated landscape of internal drivers and external conditions, providing the empirical foundation for our mechanism analysis.

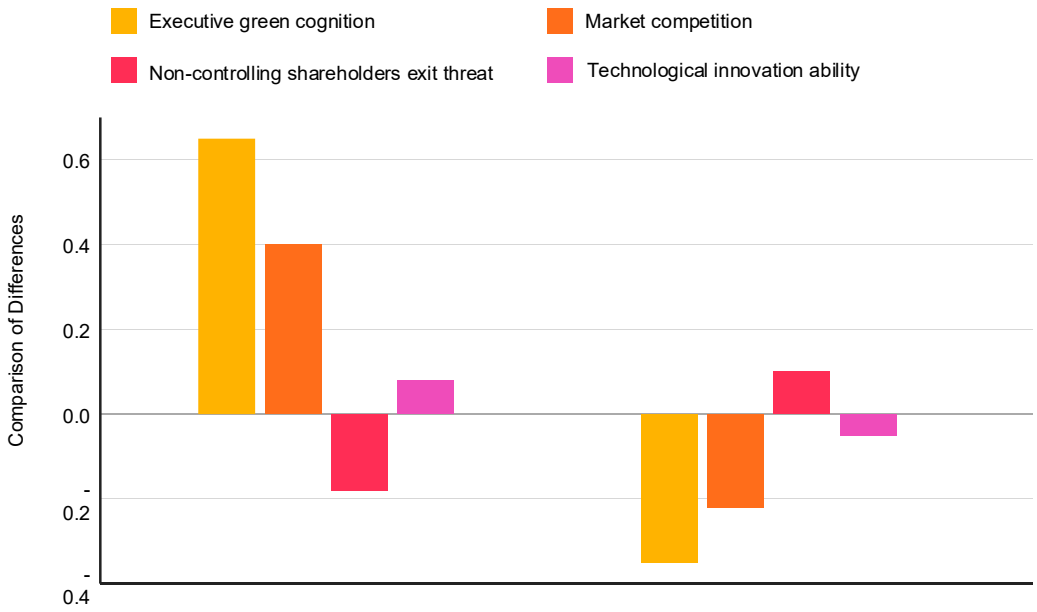

Figure 2 Differences in Mechanism Factors across VC Positions

Table 5 One-Way Analysis of Variance (ANOVA)

Analysis	Significance Level	Source	Sum of Squares	Degrees of Freedom	Mean Square	F Value	P Value
Executive Green Cognition	0.05	Between Groups	694.95	1	694.95	95.13	1.11E-16
		Within Groups	8.47E+03	1159	7.31		
		Total	9.16E+03	1160			
Technological Innovation Ability	0.05	Between Groups	1.25E+04	1	6.54	6.4	0.011
		Within Groups	1.40E+04	1916	7.33		
		Total	2.66E+04	1917			
Non-controlling Shareholders Exit Threat	0.1	Between Groups	2.93E-07	1	2.93E-07	3.10	0.078
		Within Groups	0.000139	1467	9.45E-08		
		Total	0.000139	1468			
Market Competition	0.05	Between Groups	1.17	1	1.17	33.65	7.69E-09
		Within Groups	66.73	1916	0.035		
		Total	67.90	1917			

6.2 Analysis of Results

In Table 6, the coefficient of *Green_word* is significantly positive. This indicates that there are significant differences in executive green cognitions in different VC positions. These cognitions positively promote GI. Therefore, H2a of this research is proved. The structure of executives with higher levels of green cognition reflects stronger decision support from the board of directors of the enterprise. Enterprises at different VC positions have different value added in the whole production process of their products. This results in differences in the strategic level of their enterprises. Enterprises with higher levels of executive green awareness have boards of directors that are able to more effectively drive green strategy and branding with a focus on sustainability. Enterprises in high VC positions continue to increase their control of strategic resources through innovation, design, and high-end manufacturing-led activities. They promote green transformation through investment in green technologies. In contrast, enterprises in low VC positions rely primarily on resource processing and labor. They have lower levels of green awareness among board executives and tend to favor short-term financial goals in their investment decisions. GIs by enterprises in low VC positions are usually made in response to environmental regulations rather than out of green preferences.

In Table 6, the Patent coefficient is significantly positive, indicating that there is a significant difference in technological innovation ability in different VC positions and it has a positive promotion effect on GI, and H2b of this research is proved. Enterprises in high VC positions obtain the first-mover advantage of GI through innovation, and are able to satisfy the market demand and lead the technological trend first. Enterprises with weaker R&D capabilities are usually constrained by weak industrial foundations, lack of core technologies and financing difficulties, making it difficult to realize economies of scale. In the field of green technology, GI and development by enterprises are limited by technical barriers.

Table 6 Mechanism Analysis Regression

Variables	(1)	(2)	(3)	(4)
Green_word	0.0058***			
	(0.0014)			
Patent		0.0023*		
		(0.0013)		
Net			-6.041***	
			(1.669)	
Cr5				-0.0401**
				(0.0179)
Size	0.0036	-0.0683	0.0077	-0.0065
	(0.0230)	(0.0709)	(0.0352)	(0.0260)
Debt	-0.0023	0.0877	-0.0163	0.0075
	(0.0226)	(0.0732)	(0.0354)	(0.0263)
Fin	0.0086**	0.0059	0.0102**	0.0101***
	(0.0036)	(0.0046)	(0.0042)	(0.0034)
Risk_taking	-0.0040***	-0.0027	-0.0087***	-0.0053***
	(0.0015)	(0.0029)	(0.0022)	(0.0019)
Roa	-0.0068***	-0.0088**	-0.0059***	-0.0055***
	(0.0016)	(0.0041)	(0.0018)	(0.0014)
Ae	0.0093	-0.0128	0.0145*	0.0068
	(0.0059)	(0.0116)	(0.0082)	(0.0058)
Dic_num	0.0083	-0.0232*	0.0179**	0.0058
	(0.0065)	(0.0119)	(0.0088)	(0.0064)
Lev	-0.0210	-0.2620*	0.0200	-0.0424
	(0.0446)	(0.1540)	(0.0826)	(0.0567)
KI	0.0198***	0.0258***	0.0123***	0.0178***
	(0.0035)	(0.0063)	(0.00420)	(0.0037)
Constant	-0.2880**	0.3970*	-0.3810***	-0.2450**
	(0.1120)	(0.2390)	(0.1460)	(0.1090)
Observations	1,917	605	1,160	1,918
R-squared	0.142	0.2860	0.0910	0.100
Year FE	YES	YES	YES	YES

*Note: Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1.*

In Table 6, the Net coefficient is significantly negative, indicating that the non-controlling shareholders exit threat is significantly different in different VC positions and has a negative weakening effect on GI, and H2c of this research has been proved. Enterprises in high VC positions are able to provide stable shareholder returns by virtue of higher market bargaining power and technological barriers, and pay more attention to long-term stable development, which makes it easier to realize GI. In contrast, enterprises in low VC positions are affected by factors such as fluctuations in raw material prices and changes in labor costs, and are more dependent on stable cash flows and short-term returns. Due to the threat of exit by non-controlling shareholders, enterprises in low VC positions tend to prioritize short-term financial returns over long-term, capital-intensive GIs during market volatility.

In Table 6, the Cr5 coefficient is significantly negative, indicating that there are significant differences in market competition in different VC positions, and there is a negative weakening effect on GI, and H2d of this research has been proved. By virtue of their strong market influence, enterprises in high VC positions guide consumer demand through the promotion of green products and sustainable practices, thus forming a differentiated competitive advantage. Such green innovations and strategic placements promote the long-term goal of sustainable development. Enterprises in low VC positions, where brand building and marketing strategies become important means of influencing consumers' purchasing decisions, have greater potential for green product promotion and sustainable practices. Such enterprises tend to invest funds in green product development and green positioning of their brands, thereby realizing brand value enhancement.

7. CONCLUSIONS AND IMPLICATIONS

Upgrading the position of the VC is one of the important tasks to enhance the long-term competitiveness of enterprises. It helps them to occupy a favorable position in the global market. This process promotes technological innovation and optimal allocation of resources, and

ultimately achieve green and sustainable development. Against the background of global economic transformation and increasing environmental protection pressure, the GI behavior of enterprises has become one of the key factors in realizing high-quality development. Although Chinese enterprises have made some progress in the field of GI in recent years, they are facing many challenges and opportunities. These arise amid the intensification of green competition in the market and changes in the policy environment. In this context, it is particularly important to thoroughly research the relationship between VC position and enterprises' GI behavior. Accordingly, based on the micro-data of Shanghai and Shenzhen A-share listed companies from 2007 to 2014, this research combines the industry VC position indexes with the unbalanced panel fixed effect model, moderated effects model to explore the impact relationship between industry VC position and enterprises' GI behavior. Further, this research analyzes the variability among enterprises with different VC positions and reveals the influence mechanism of factors such as executive green cognition level of corporate executives, technological innovation ability, non-controlling shareholders exit threat, and market competition in the relationship between VC position and enterprises' GI. The research found that:

7.1 Main Findings

This study systematically investigates the impact of VC position on enterprise GI and explores the underlying formation mechanisms behind this relationship. Based on the empirical analysis of Chinese listed companies, the following conclusions are drawn:

First, there is a significant differentiated effect of VC position on GI behaviors. Enterprises situated in high VC positions exhibit a substantially higher propensity and scale of green investment compared with those in low VC positions, confirming that structural standing within the production network is a fundamental determinant of environmental strategic choices.

Second, the disparity in GI is shaped through a multidimensional formation mechanism. Internally, enterprises in high VC positions benefit from stronger executive green cognition and superior technological innovation abilities, which act as subjective and objective drivers for green transformation. Externally, these firms are influenced by lower exit threats from non-controlling shareholders and more favorable market competition environments. These internal drivers and external conditions collectively transform the economic advantages of a high VC position into proactive environmental investment, while firms in low VC positions often face "resource traps" that hinder their green initiatives.

7.2 Discussion

The findings of this research provide several theoretical insights that extend the current understanding of corporate environmental economics. This research drawing on previous research regarding executive green perceptions and corporate environmental performance (Russo and Fouts, 1997), the critical dimension of VC position is introduced to integrate the theory of VC governance (Gereffi *et al.,* 2005) with the practice of corporate green transformation. This investigation of differentiated GI behaviors based on VC position is, to a certain extent, consistent with the empirical evidence of Hart and Ahuja (1996) regarding the positive association between environmental management and enterprise performance, and aligns with the theoretical assertions of Ambec and Lanoie (2008) that GI enables enterprises to develop long-term competitive advantages. While previous literature has focused on the direct impact of environmental regulations, this study highlights that the structural heterogeneity of the value chain is an equally critical, yet often overlooked, antecedent of GI.

Regarding the internal drivers, the significant role of executive green cognition reinforces the Upper Echelons Theory, suggesting that the strategic orientation of the board is a reflection of the firm's structural environment. Furthermore, the findings on technological innovation ability support the Resource-Based View (RBV), as firms in high VC positions leverage their R&D superiority to lower the marginal cost of green transformation, creating a "first-mover advantage" in sustainable markets.

In terms of external conditions, the analysis of exit threats and market competition adds a new dimension to Institutional Theory. Unlike prior studies that view market competition as a uniform pressure, this research demonstrates that the incentive effect of competition is contingent upon a firm's VC position. Firms in low VC positions, constrained by low profit margins and high exit threats from short-term investors, face a "survival-first" dilemma that often crowds out long-term green projects. These insights offer a more nuanced explanation of the "green gap" between enterprises across the industrial hierarchy. On the one hand, existing literature is complemented by identifying the factors that influence enterprises' GI behaviors and highlighting the disparities in strategic choices across distinct VC positions. On the other hand, a novel explanatory framework for the internal drivers and external conditions of corporate GI is constructed by incorporating four key mechanism factors: executive green cognition, technological innovation ability, non-controlling shareholders' exit threat, and market competition. This framework provides a systematic understanding of how structural value chain positioning is manifested through psychological, resource-based, and institutional channels to shape GI outcomes.

7.3 Management Implications

This study provides two implications for developing countries to overcome GI lock-in dilemmas at low VC positions:

First, establishing a differentiated policy framework based on GVC hierarchies. GI by enterprises is not determined solely by internal drivers. The position in the industry VC is also an important factor influencing the increase in GI by enterprises. Complementary mechanisms in investment decision-making help to compensate for the limitations of insufficient policy incentives and enhance the flexibility and effectiveness of investment decisions. Under this mechanism, the GI behavior of enterprises in high VC positions has a strong implicit guiding role, which is different from the mandatory intervention of government policies. Therefore, in the current situation where the GI system is not yet perfect, effectively playing the role of industry VC position is key to promoting GI by enterprises. Specifically,

by virtue of their strong market bargaining power and technological advantages, enterprises in high VC positions can lead the GI trend of the whole industry. They achieve this through green innovation and sustainable practices, and inspire the GI momentum of peer enterprises. Therefore, when formulating policies related to green development, the Government should consider the potential guiding role of the position of the VC on the GI behaviors of enterprises. The Government should guide the formation of a positive GI atmosphere in the entire industry through policy support for the GI of enterprises in high VC positions. Such policies should encourage green innovation while avoiding the "surge phenomenon" of short-sighted and catering investments. For enterprises locked in processing and manufacturing segments, implementing a "green embedding" strategy is crucial. For domestic enterprises with potential to become chain leaders, refine the Green Supply Chain Management Code, require enterprises in high VC positions to improve environmental performance disclosure. This is crucial to improving the competitiveness of enterprise industries and enhancing the willingness of enterprises to invest in green initiatives.

Second, enterprises should focus on the synergistic effect of multiple factors in promoting GI. The level of green awareness and innovation of executives are important drivers of GI. Green awareness among executives can help enterprises identify the long-term value of GIs and ensure the effective implementation of green strategies. At the same time, enterprises should strengthen their technological innovation ability to enhance their competitiveness and market adaptability through technological innovation and product greening; The threat of exit by non-controlling shareholders may inhibit an enterprise's GI decisions. Therefore, enterprises should optimize their shareholder structure to reduce the impact of short-term financial goals on GI. This will ensure that they can focus on long-term green development goals; In addition, when the market is competitive, enterprises are more inclined to increase GIs to improve competitiveness. Therefore, enterprises should take advantage of the pressure of market competition and use GI as an important means to enhance their brand image and differentiate their competitive advantages. Enterprises should adjust their GI strategy according to their position in the VC. They should make GI decisions that are more in line with the reality of the enterprise. Additionally, they should reasonably use the positive facilitating effect of their position in the VC to boost the GI behavior of the enterprise.

LIMITATIONS AND FUTURE RESEARCH

It should be noted that some details regarding the time span of the VC position indicator in this research remain undisclosed, and obtaining this data is challenging. Moreover, the existing indicator data may have limitations that prevent a comprehensive measurement. In the future, as data availability and research methodologies improve, subsequent research will strive to adopt a more holistic approach to evaluating an enterprise's position within the VC. Based on the VC perspective, this research explores the enhancement path for the willingness of enterprises in low VC positions to engage in GI. Additionally, existing research has identified that a stable, smooth, and robust local supply chain network is a key factor in enhancing the international competitiveness of enterprises. The next phase of the research could focus on exploring the impact of the synergy between the informational advantage of the supply chain network and the VC position on the GI of enterprises, from the perspective of the influence mechanism of the supply chain network's informational advantage and the VC position.

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CONFLICTS OF INTEREST

The authors declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this study.

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Xianyou Pan is a professor of School of Economics and Management of Shanghai University of Electric Power. He earned his Ph.D. from the School of Economics and Management at the Dalian University of Technology. His current research interests include corporate sustainable transition, green investment and digital economy. He has published his research on Transportation Research Part E, Journal of Business Logistics, IEEE Transactions on Engineering Management, Energy Policy, Renewable Energy etc.

Ma Jiajia is a master student of School of Economics and Management, Shanghai University of Electric Power. Research interests include enterprise green investment and low-carbon sustainable development.

Shu Yalin is a doctoral student in the School of Management, Beijing Institute of Technology, whose research direction is low-carbon economy.