

Article

Asymmetric Pay Adjustment and Green Innovation Resilience: Interactions Among Executive Incentives, Managerial Backgrounds, and Government Subsidies

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Abstract

In the context of intensifying environmental regulation and sustainability pressures, firms increasingly face the challenge of sustaining green innovation under uncertainty. Green innovation resilience, which is defined as a firm’s capacity to maintain green innovation momentum and adaptively evolve technological capabilities amidst uncertainty, represents a critical organizational competence. Moving beyond static output measures, this resilience captures the intertemporal stability of firms’ green patenting activities during turbulent periods. From a systems perspective, executive compensation arrangements represent an important internal incentive mechanism that interacts with managerial characteristics and external policy environments. This study investigates how executive compensation stickiness—defined as asymmetric pay adjustment in response to firm performance—affects green innovation resilience. Using panel data from Chinese A-share-listed firms, we find that executive compensation stickiness significantly promotes green innovation resilience at the 5% level, suggesting that downward pay rigidity mitigates managerial risk aversion and supports tolerance for short-term setbacks in long-horizon green innovation. Furthermore, this positive relationship is further strengthened when executives possess environmental backgrounds (at the 5% level) and when firms receive government green innovation subsidies (at the 10% level), highlighting the interactive role of individual-level attributes and institutional policy support. Overall, the findings demonstrate how incentive asymmetry functions as a systemic property shaping firms’ adaptive responses and contribute to a broader understanding of green innovation resilience in complex socio-technical systems.

Keywords: executive compensation stickiness; green innovation resilience; environmental background; government subsidies



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1. Introduction

Under the dual imperatives of global climate change and increasingly stringent environmental mandates, green innovation has shifted from a discretionary corporate initiative to a strategic necessity embedded within firms’ broader organizational and institutional systems [1]. Compared with conventional research and development (R&D) activities, green innovation is characterized by heightened uncertainty, extended development cycles, and pronounced technological and environmental externalities [2]. These features render green innovation particularly vulnerable to both external shocks and internal reallocations

of attention and resources, challenging firms' ability to sustain innovation efforts over time [3].

In response to these challenges, recent research has increasingly shifted from static intensity or performance outcomes of green innovation toward a dynamic perspective that emphasizes firms' capacity to maintain and adapt green innovation activities under uncertainty [4]. Traditional scholarship has primarily relied on cross-sectional metrics, such as R&D investment or patent outputs; however, such approaches provide limited insight into the dynamic continuity and functional persistence of innovation systems amidst environmental volatility. This critical capacity is commonly conceptualized as green innovation resilience, which refers to a firm's ability to maintain green innovation momentum and to adaptively evolve green technological capabilities amidst turbulent conditions [5]. In practice, firms exhibit significant heterogeneity in this capability: while some organizations maintain stable green trajectories or rapidly restore momentum after disruptions, others resort to myopic retrenchment. Understanding the sources of such divergence is therefore critical for explaining how firms sustain green innovation under uncertainty.

Despite the growing consensus on its importance, research on the antecedents of green innovation resilience remains nascent, with existing literature primarily emphasizing external drivers and structural conditions. While studies have highlighted the importance of factors such as digital infrastructure [6] and market-based environmental policies [7], the internal organizational mechanisms that sustain green commitment remain relatively overlooked. Even among the limited studies considering internal governance, scholarly attention has largely focused on board-level arrangements, such as interlocking directorates [8]. Crucially, green innovation resilience does not arise solely from external resources or institutional pressure; rather, it is fundamentally an emergent property of the interaction between environmental conditions and internal organizational decision systems [8]. This interplay dictates how firms navigate uncertainty and manage performance setbacks within their green innovation activities.

Within firms, such internal decision systems are ultimately enacted through the strategic judgments of top executives [9]. As the primary architects of corporate strategy, top executives play a pivotal role in shaping firms' innovation trajectories by setting strategic priorities, allocating resources, and determining whether to persist in long-term green innovation projects during performance troughs. Since green innovation entails high failure rates and delayed returns, an executive's willingness to sustain such commitment is inherently constrained by their sensitivity to personal career and wealth risks [10]. Accordingly, understanding the micro-foundations of green innovation resilience requires closer attention to the incentive mechanisms that frame executives' risk perceptions and intertemporal trade-offs. Among the various instruments available, the compensation system serves as the most fundamental driver of executive behavior, as it directly shapes how managers evaluate short-term performance fluctuations relative to long-term innovation objectives [11].

Within this context, executive compensation stickiness has emerged as a salient feature of corporate incentive structures that warrants closer scrutiny. Compensation stickiness refers to asymmetric pay adjustment, whereby the marginal increase in pay for a performance gain is greater than the marginal decrease in pay for an equivalent performance loss [12]. Prior research has offered competing interpretations regarding its impact on corporate innovation. From a managerial power perspective, compensation stickiness is often viewed as a manifestation of governance failure [13] that breeds managerial risk-aversion and a "quiet life" syndrome [14,15]. Conversely, consistent with optimal contract theory, scholars argue that asymmetric compensation arrangements may serve as a functional

safety net that encourages sustained engagement in high-uncertainty and long-horizon innovation activities [16]. While research has extensively debated the impact of executive compensation stickiness on general R&D investment and managerial risk-taking propensities [17,18], empirical evidence concerning its role in green innovation remains both scarce and fragmented, often limited to static outcome-based perspectives [19]. Consequently, it remains empirically ambiguous whether the risk-buffering effect of executive pay stickiness outweighs its potential agency costs under the systemic pressures of a green transition. This theoretical tension is particularly salient for green innovation resilience, which hinges on strategic persistence amidst turbulent conditions. Accordingly, whether and how executive compensation stickiness shapes green innovation resilience remains an open empirical question.

To address this question, we build on Behavioral Agency Theory (BAT) as our core theoretical framework to examine how executive compensation stickiness influences green innovation resilience. From this perspective, compensation stickiness serves as a risk-shielding mechanism by mitigating perceived wealth risk associated with innovation failure. The unique institutional and economic environment of China provides a particularly suitable setting for this investigation. As the world's largest emerging economy, China's "Dual Carbon" goals have introduced unprecedented pressure and policy uncertainty on firms to build green resilience, while its corporate governance landscape frequently exhibits significant compensation stickiness due to a blend of market forces and administrative guidance. In such an institutional setting, compensation stickiness may play a more pronounced role in buffering executives against uncertainty and fostering willingness to maintain green innovation commitment. Moreover, the coexistence of strong government intervention and heterogeneity in managerial characteristics allows us to examine the complex interplay between internal incentives and external institutional factors within a complex innovation system in a way that data from developed markets might not capture.

Drawing on these considerations, this study empirically examines the impact of executive compensation stickiness on green innovation resilience using panel data from Chinese A-share-listed firms between 2012 and 2023. Anchored in Behavioral Agency Theory, we further explore key boundary conditions by incorporating insights from Upper Echelons Theory and Signaling Theory. Specifically, we investigate how executives' environmental backgrounds and government green innovation subsidies condition the relationship between compensation stickiness and green innovation resilience. Together, this integrative framework elucidates how micro-level incentive structures and macro-contextual factors jointly shape firms' green innovation resilience in the transition toward a low-carbon economy.

This study makes several contributions to the literature. First, it substantiates and advances research on green innovation resilience, providing robust empirical evidence that reinforces the validity of the green innovation resilience construct as a meaningful firm-level competence in complex emerging markets. Second, this study expands the theoretical framework of green innovation resilience by uncovering its micro-foundations from a managerial perspective. By investigating how executive compensation stickiness interacts with individual characteristics and environmental conditions, we provide a more comprehensive understanding of the boundary conditions under which managerial agency fosters corporate green persistence. Third, this research offers a nuanced reassessment of executive compensation stickiness in the context of sustainability. In the specific context of high-risk green innovation, compensation stickiness can function as a risk-buffering mechanism that stabilizes long-term strategic commitment.

2. Literature Review and Hypothesis Development

2.1. Green Innovation Resilience and Executive Decision Context

Green innovation refers to innovation activities aimed at reducing environmental impact through cleaner technologies, processes, or products [20]. Compared with conventional innovation, green innovation operates in a more complex innovation context characterized by heightened technological uncertainty, extended development cycles, and pronounced public externalities. These features make green innovation more vulnerable to disruption when firms encounter performance pressure, market volatility, or policy uncertainty, making sustained innovation particularly challenging [21].

To capture firms' ability to sustain green innovation under such turbulent conditions, recent studies have introduced the concept of green innovation resilience [6]. This concept stems from the broader literature on organizational resilience, which conceptualizes resilience as an organization's capacity to absorb shocks, maintain core functions, and recover or even bounce forward in response to adversity [22,23]. Extending this logic to the innovation domain, innovation resilience emphasizes the continuity, adaptability, and recovery of innovation activities despite environmental disruptions [24,25]. Building on these foundations, Wu et al. [5] formally introduced the concept of green innovation resilience. Unlike outcome-oriented perspectives that focus on static indicators such as patent counts or R&D intensity at a given point in time, green innovation resilience captures the dynamic continuity and functional persistence of green innovation activities over time.

From a theoretical standpoint, green innovation resilience can be understood as a specialized manifestation of firm-level dynamic capabilities [26]. Dynamic capability theory conceptualizes such capabilities as firms' capacities to integrate, build, and reconfigure internal and external competencies in response to rapidly changing environments [27]. Consistent with this view, the formation of resilience is inherently dynamic and unfolds over time [26], through firms' ongoing efforts to maintain innovation momentum, adapt to changing environmental conditions, and reconfigure green innovation activities following setbacks or interruptions. In emerging economies such as China, frequent regulatory adjustments and policy-driven green transitions further intensify environmental uncertainty, making green innovation resilience especially salient. While this capability is embedded within broader organizational and institutional systems, it ultimately materializes through corporate strategic decisions and resource allocation processes.

Within this decision context, executive decision-making constitutes a critical micro-level foundation shaping green innovation resilience [9]. Executives play a central role in setting strategic priorities, allocating scarce resources, and determining whether firms persist in long-term green innovation projects when short-term performance fluctuates. Given that green innovation typically involves trial-and-error learning, uncertain technological outcomes, and delayed economic returns, executives' tolerance for interim failure and uncertainty becomes a key determinant of the stability and continuity of green innovation activities [10].

Behavioral Agency Theory (BAT) provides a valuable lens for understanding executives' strategic responses in such high-uncertainty innovation contexts. Unlike traditional agency theory, BAT emphasizes that executives' strategic choices are shaped by perceived wealth risk, loss aversion, and downside sensitivity rather than purely rational optimization [28]. When confronted with heightened performance pressure or potential personal wealth losses, executives may adopt more conservative strategies and curtail long-term, uncertain investments [29], potentially undermining sustained green innovation efforts. Crucially, BAT also suggests that executives' risk perceptions and behavioral responses are not fixed, but are influenced by organizational and institutional arrangements that frame or buffer downside risk [30].

From this perspective, green innovation resilience emerges from the interaction between firms' adaptive capabilities and the behavioral and institutional conditions shaping executive decision-making under uncertainty. Incentive-related arrangements, executive cognitive orientations, and policy environments jointly influence executives' willingness to tolerate short-term setbacks and sustain commitment to long-horizon green innovation. This behavioral perspective provides a foundation for examining how specific incentive properties—such as executive compensation stickiness—affect firms' green innovation resilience.

2.2. Executive Compensation Stickiness and Green Innovation Resilience

Executive compensation stickiness represents an asymmetric compensation structure that responds more sensitively to performance gains than to losses [12]. The exploration of asymmetry in executive compensation can be traced back to the landmark study by Gaver [31], who documented that Chief Executive Officer (CEO) cash compensation tends to rise with performance gains, but remains largely shielded from corresponding losses. This asymmetric pattern was further refined by Garvey and Milbourn [32], who demonstrated that executives often enjoy “pay for luck,” receiving rewards for industry-driven upswings while being shielded from downward adjustments during “bad luck” periods. Subsequent studies confirm that pay stickiness is a pervasive feature of global capital markets, with empirical evidence spanning from developed economies like the United States to emerging markets like China [33,34].

Extant literature offers two competing perspectives on this phenomenon. From a managerial power perspective, pay stickiness is often viewed as a manifestation of weak incentive discipline. By insulating executives from downside performance consequences, sticky compensation may reduce effort provision and foster opportunistic behavior or strategic inertia, thereby exacerbating agency problems [14,15]. Conversely, a behavioral agency perspective suggests that such asymmetry can function as a strategic buffer by reshaping executives' perceptions of downside risk and providing the psychological safety necessary to sustain long-horizon commitments amidst environmental uncertainty [35,36]. Whether pay stickiness exacerbates agency problems or facilitates strategic persistence thus depends on the nature of the investment and the uncertainty context.

In the context of green innovation, such loss aversion can be particularly detrimental, where the interplay between risk and commitment is most acute. Without a safety net, executives are prone to viewing green initiatives as personal wealth risks rather than strategic assets, leading to defensive decision-making and the “myopic abandonment” of green projects during financial troughs. Executive pay stickiness mitigates this tendency by reducing executives' downside exposure to short-term performance fluctuations [16], alleviating performance pressure and enhancing their tolerance for interim failure [18]. As an implicit insurance mechanism, pay stickiness supports strategic persistence and sustained resource commitment to green innovation activities, even when short-term financial returns are volatile. Accordingly, executive pay stickiness enhances firms' capacity to sustain, adapt, and recover green innovation activities under uncertainty.

This buffering role of pay stickiness is particularly salient in China's institutional context, where executives navigate a distinctive tension between administrative mandates and market-based performance pressures. While the “Dual Carbon” strategy and stringent environmental regulations impose robust administrative pressures on firms to initiate green initiatives [37], such top-down imperatives do not inherently guarantee the continuity or resilience of these efforts. Executives are often caught in a “risk-mandate gap,” whereby policy-driven innovation requirements coexist with substantial personal wealth and career risks associated with uncertain innovation outcomes. In the absence of effective downside

protection, these pressures may induce symbolic compliance or defensive retrenchment rather than sustained commitment. By stabilizing executives' income expectations and mitigating perceived downside risk, executive compensation stickiness helps alleviate this tension and facilitates strategic persistence in green innovation.

H1: *Executive compensation stickiness is positively associated with firms' green innovation resilience.*

2.3. The Moderating Role of Executive Environmental Background

While executive compensation stickiness provides the necessary financial security to foster innovation, its impact on green innovation resilience is not uniform and is shaped by executives' cognitive interpretations of risk and opportunity. According to Upper Echelons Theory, managerial cognitive frameworks and values shape the cognitive filters through which executives interpret organizational situations, incentives, and strategic choices [38,39]. We argue that an executive environmental background, acquired through prior environmental education or eco-related professional experience, serves as a critical cognitive moderator by shaping both value-based strategic framing and domain-specific risk understanding and interpretation, thereby amplifying the positive effect of pay stickiness on green innovation resilience.

On one hand, an executive environmental background enhances the recognition of green innovation as a long-term strategic asset [40]. Executives with environmental imprints possess internalized ecological values that predispose them to frame green initiatives as sources of sustainable competitive advantage rather than as compliance costs [41]. This value-based framing makes them more likely to allocate the risk-bearing capacity provided by sticky compensation toward sustainable green investments rather than short-term financial adjustments or risk-avoidance strategies [42]. On the other hand, an environmental background enhances executives' understanding of green technologies and trajectories, enabling more informed interpretation of technological uncertainty [43,44]. This familiarity facilitates the differentiation between routine technical setbacks and fundamental project failures, reducing cognitive anxiety associated with interim fluctuations. As a result, environmentally imprinted executives are empowered to leverage the downside protection embedded in compensation stickiness to maintain strategic commitment under uncertainty.

Taken together, by aligning strategic valuation with refined risk interpretation, executive environmental background strengthens the extent to which compensation stickiness translates into sustained, adaptive, and recoverable green innovation efforts.

H2: *Executive environmental background positively moderates the relationship between executive compensation stickiness and corporate green innovation resilience.*

2.4. The Moderating Role of Government Green Innovation Subsidies

Government subsidies, as a pivotal policy tool for addressing market failures [45], provide firms with both financial support and institutional legitimacy. We argue that government green innovation subsidies function as a critical external complement to the internal incentive structure created by executive compensation stickiness.

While compensation stickiness provides executives with a personal risk buffer, government green innovation subsidies help alleviate firm-level constraints by offsetting R&D costs, enhancing organizational slack, and easing short-term financial pressures. This external resource infusion complements the executive's personal security, thereby expanding firms' capacity to absorb innovation shocks. Beyond their financial role, government subsidies also play a role in executives' subjective risk perceptions. From a signaling perspective, government subsidies convey credible information about policy endorsement, regulatory

tolerance, and the expected continuity of support for green innovation trajectories [46–49]. For executives, such signals reframe green innovation projects as strategically legitimate and politically supported rather than as speculative undertakings. Consequently, executives are more likely to interpret interim setbacks as policy-tolerated transitional phases rather than personal failure risks, thereby lowering their overall risk aversion.

Collectively, these mechanisms foster green innovation resilience through the alignment of individual risk-bearing capacity and organizational resource availability. While compensation stickiness establishes an internal safety net that preserves the executive's willingness to experiment, government subsidies provide the external institutional support necessary to elevate a project's strategic viability. This reinforcing alignment stems from the way external legitimacy validates and amplifies internal incentives. By jointly reshaping executives' risk framing from both individual and institutional dimensions, this alignment better facilitates the effective translation of managerial intentions into sustained resource commitment, thereby fortifying the firm's green innovation resilience.

H3: *Government green innovation subsidies positively moderate the relationship between executive compensation stickiness and corporate green innovation resilience.*

3. Research Design

3.1. Sample Selection and Data Sources

The primary sample for this study comprises A-share firms listed on the Shanghai and Shenzhen Stock Exchanges for the period 2012 to 2023. The start year of 2012 was selected to capture the institutional shift following the “National 12th Five-Year Plan for Environmental Protection”, which institutionalized environmental technology as a cornerstone of corporate development. The sample period ends in 2023 to ensure the inclusion of fully audited and consistently verified firm-level data, and to avoid potential biases arising from disclosure and certification lags in key variables such as executive compensation and green patenting, while still allowing sufficient time to observe the dynamic persistence of green innovation resilience. Following Quan et al. [50], we integrated annual green patent data from the Chinese Research Data Services Platform (CNRDS) database with financial and governance metrics from the China Stock Market & Accounting Research Database (CSMAR). The raw data were screened based on the following criteria: (1) excluding firms under Special Treatment (ST and *ST) to eliminate the confounding effects of financial distress; and (2) removing observations with missing values for key variables. This process yielded a final unbalanced panel of 22,268 firm-year observations across 3182 firms. To mitigate the influence of extreme outliers, all continuous variables were winsorized at the 1st and 99th percentiles. Data processing and analysis were performed using Stata 16.0.

3.2. Variable Measurement

3.2.1. Green Innovation Resilience (GIR)

While a universally accepted metric for innovation resilience remains elusive, recent studies have increasingly operationalized the construct by capturing the stability and adaptive dynamics of core innovation outputs amidst environmental fluctuations [51]. In the context of green innovation, patents serve as the most direct and observable manifestation of a firm's sustainable technological efforts [50]. This study utilizes granted green invention patents as the primary proxy for green innovation output. Compared with patent applications, granted invention patents undergo a rigorous substantive examination process and therefore better reflect realized technological advances rather than exploratory or symbolic innovation activities [52,53]. Crucially, as granted patents represent innovation outcomes

that have successfully endured regulatory scrutiny and technological uncertainty, their intertemporal stability and growth are particularly suited to capturing firms' capacity to sustain and recover green innovation momentum under external pressure.

Following Wu et al. [5], we employ the core variable sensitivity method to construct a measure of green innovation resilience. This approach quantifies resilience by comparing a firm's actual green innovation growth with the industry-level expected trajectory. Specifically, $P_{i,t}$ denotes the count of granted green invention patents of firm i in year t , while $P_{n,t}$ represents the total granted green invention patents in industry n in year t . ΔE is the expected growth rate based on the performance of the firm's respective industry. A higher GIR value indicates that the firm's green innovation performance surpasses the industry benchmark, reflecting superior innovation resilience.

$$GIR_{i,t} = \frac{(\Delta P_{i,t} - \Delta E)}{|\Delta E|} \quad (1)$$

$$\Delta P_i = P_{i,t} - P_{i,t-1} \quad (2)$$

$$\Delta E = \left(\frac{P_{n,t} - P_{n,t-1}}{P_{n,t-1}} \right) \cdot P_{i,t-1} \quad (3)$$

3.2.2. Executive Compensation Stickiness (ECS)

Following Zhao et al. [54], we calculate executive compensation stickiness using a four-step process: First, we calculate the annual growth rates of average executive compensation and firm performance (measured by net profit) for each company. Second, we determine the annual Pay-Performance Sensitivity (PPS), defined as the ratio of the year-on-year growth rate of executive compensation to the year-on-year growth rate of firm performance. Third, utilizing a five-year rolling window, we calculate the mean PPS for periods of increasing net profit and the mean PPS for periods of declining net profit. In line with prior studies [19,36], the use of a multi-year rolling window helps smooth short-term fluctuations in firm performance and compensation adjustments, thereby capturing relatively persistent and structurally embedded asymmetry in compensation adjustments, rather than transitory annual shocks. Finally, executive compensation stickiness is derived by subtracting the mean PPS during performance downturns from the mean PPS during performance upturns over the rolling five-year period. The robustness of this measure is further verified using alternative rolling windows.

3.2.3. Moderating Variables

Executive environmental background (*Envi*): Based on Liu et al. [55], we perform a text analysis of executive biographies. Executives are identified as possessing an environmental background if environment-related keywords such as "environment", "ecology", or "sustainable development" appear. *Envi* is measured as the logarithm of total number of such executives in the top management team.

Government green innovation subsidies (*Subs*): Following Jing et al. [56], we filter government subsidy line items to extract those specifically earmarked for green innovation. *Subs* is measured as the ratio of total green innovation subsidies to operating revenue.

3.2.4. Control Variables

Following Li [8] and Feng [7], we incorporate a comprehensive set of control variables in the regression analysis model: firm size (*Size*), firm age (*Age*), leverage ratio (*Lev*), return on assets (*ROA*), cash flow from operations (*Cfo*), firm growth (*Growth*), board size (*Board*), the proportion of independent directors (*Indep*), ownership concentration (*Stock*), managerial ownership proportion (*Share*). Additionally, to control for time-invariant firm

characteristics and macroeconomic trends, individual-fixed effects (*Id*) and year-fixed effects (*Year*) are incorporated. Detailed definitions for all variables are presented in Table 1.

Table 1. Variables and measures.

Variables	Symbol	Definition and Measurement
Green innovation resilience	<i>GIR</i>	A firm's capacity to maintain green innovation momentum and adaptively evolve technological capabilities amidst uncertainty. Calculated as gap between the actual change and expected change of green patents.
Executive compensation stickiness	<i>ECS</i>	Asymmetric pay adjustment, whereby the marginal increase in pay for a performance gain is greater than the marginal decrease in pay for an equivalent performance loss. Calculated based on executives' pay–performance sensitivity.
Executive environmental background	<i>Envi</i>	The logarithm of the number of managers with environmental experience.
Government green innovation subsidies	<i>Subs</i>	The intensity of policy support for green innovation. Measured as the ratio of government green innovation subsidies to operating revenue.
Firm size	<i>Size</i>	Controls for firm scale. Measured as the natural logarithm of total assets.
Firm age	<i>Age</i>	Controls for firm lifecycle and experience. Measured as the natural logarithm of years from the firm establishment.
Leverage ratio	<i>Lev</i>	Controls for financial risk and capital structure. Measured as total liabilities divided by total assets.
Return on assets	<i>ROA</i>	Controls for firm profitability. Measured as net profit divided by average total assets.
Cash flow	<i>Cfo</i>	Controls for internal liquidity and cash generation capacity. Measured as net cash flow from operating activities divided by total assets.
Firm growth	<i>Growth</i>	Controls for future growth opportunities. Measured as the year-on-year growth rate of operating revenue.
Board size	<i>Board</i>	Controls for corporate governance structure. Measured as the natural logarithm of the number of board members.

Table 1. Cont.

Variables	Symbol	Definition and Measurement
Independent directors	<i>Indep</i>	Board independence and monitoring effectiveness. Calculated as the number of independent directors divided by the total number of board members.
Ownership concentration	<i>Stock</i>	Captures the power of the largest shareholder. Measured as the percentage of shares held by the largest shareholder.
Managerial ownership proportion	<i>Share</i>	Reflects the alignment of interests between managers and shareholders. Calculated as management shareholding divided by total shares.
Year	<i>Year</i>	A series of dummy variables for each year to control for time-specific shocks that affect all firms.
Firm	<i>Id</i>	A series of dummy variables for each firm to control for time-invariant firm-level idiosyncratic characteristics.

3.3. Model

To test the impact of executive compensation stickiness on green innovation resilience (H1), we construct the following baseline Fixed Effects (FE) model:

$$GIR_{i,t} = \beta_0 + \beta_1 ECS_{i,t} + \sum \gamma_j Controls_{i,t} + \sum Year + \sum Id + \varepsilon_{i,t} \quad (4)$$

where $GIR_{i,t}$ denotes the explained variable green innovation resilience for firm i at time t ; $ECS_{i,t}$ denotes the explanatory variable executive compensation stickiness; $Controls$ is a vector of control variables; $Year$ and Id account for firm- and year-fixed effects, respectively; and $\varepsilon_{i,t}$ is the idiosyncratic error term.

To test H2 and H3, which examine the potential moderating roles of executives' environmental background and green innovation subsidies, we further estimate the following interaction models:

$$GIR_{i,t} = \alpha_0 + \alpha_1 ECS_{i,t} + \alpha_2 Envi_{i,t} + \alpha_3 ECS_{i,t} \times Envi_{i,t} + \sum \gamma_j Controls_{i,t} + \sum Year + \sum Id + \varepsilon_{i,t} \quad (5)$$

$$GIR_{i,t} = \sigma_0 + \sigma_1 ECS_{i,t} + \sigma_2 Subs_{i,t} + \sigma_3 ECS_{i,t} \times Subs_{i,t} + \sum \gamma_j Controls_{i,t} + \sum Year + \sum Id + \varepsilon_{i,t} \quad (6)$$

where $Envi_{i,t}$ denotes the number of executives with environmental experience in firm i at time t , and $Subs_{i,t}$ denotes government green innovation subsidies. Hypotheses H2 and H3 are tested by examining the signs and statistical significance of the interaction coefficients $ECS_{i,t} \times Envi_{i,t}$ and $ECS_{i,t} \times Subs_{i,t}$. Given that observations within the same firm may be correlated over time, we employ cluster-robust standard errors at the firm level for all regressions.

4. Results

4.1. Descriptive Statistics and Pairwise Correlations

Table 2 reports the descriptive statistics for the main variables. The dependent variable, Green Innovation Resilience (GIR), presents a mean value of 0.8090 and a standard deviation of 4.4930. The median value of zero indicates a right-skewed distribution, suggesting that while the majority of firms exhibit limited resilience in sustaining green innovation, a distinct subset demonstrates extraordinary persistence amidst volatility. This distributional

pattern reflects pronounced heterogeneity in firms' green innovation resilience rather than uniform engagement. The independent variable, Executive Compensation Stickiness (*ECS*), has a mean value of 2.0950, indicating that, on average, pay–performance sensitivity during periods of performance improvement is approximately 2.1000 units higher than that during periods of decline. Notably, approximately 76.4775% of the observations display positive stickiness, confirming that downward rigidity in executive compensation is a prevalent feature among Chinese listed firms. With respect to the moderating variables, executive environmental background (*Envi*) exhibits a right-skewed distribution. The median value of *Envi* is zero, indicating that environmentally imprinted executives remain scarce across the sample. Similarly, the median value of government green innovation subsidies (*Subs*) is zero, suggesting that only a minority of firms receive targeted green innovation support during the sample period.

Table 2. Descriptive statistics.

Variable	N	Mean	P50	Sd	Min	Max
<i>GIR</i>	22,268	0.8090	0.0000	4.4930	−14.2200	15.6300
<i>ECS</i>	22,268	2.0950	0.5410	7.4720	−14.2900	54.0900
<i>Age</i>	22,268	3.0290	3.0450	0.2770	2.1970	3.6380
<i>Size</i>	22,268	22.5100	22.3300	1.2540	20.1200	26.4400
<i>Lev</i>	22,268	0.4370	0.4310	0.1940	0.0714	0.9410
<i>ROA</i>	22,268	0.0302	0.0322	0.0682	−0.3480	0.2020
<i>Cfo</i>	22,268	0.0518	0.0485	0.0634	−0.1290	0.2420
<i>Growth</i>	22,268	0.1350	0.0836	0.3540	−0.5440	2.2510
<i>Board</i>	22,268	2.2370	2.3030	0.1760	1.7920	2.7730
<i>Indep</i>	22,268	0.3770	0.3640	0.0542	0.3330	0.5710
<i>Stock</i>	22,268	0.3230	0.3000	0.1430	0.0800	0.7120
<i>Share</i>	22,268	0.1090	0.0062	0.1640	0.0000	0.6200
<i>Envi</i>	22,268	0.3020	0.0000	0.5030	0.0000	3.0910
<i>Subs</i>	22,268	0.0001	0.0000	0.0006	0.0000	0.0156

Note. Detailed definitions of variables are provided in Table 1.

Table 3 presents the correlation matrix. The Variance Inflation Factor (VIF) values remain well below the conservative threshold of 10, with a maximum of 1.5900, alleviating concerns about multicollinearity. The pairwise correlation between *ECS* and *GIR* is positive and statistically significant at the 10% level, providing preliminary support for our core hypothesis.

Table 3. Univariate correlation analysis.

Variable	<i>GIR</i>	<i>ECS</i>	<i>Age</i>	<i>Size</i>	<i>Lev</i>	<i>ROA</i>	<i>Cfo</i>	<i>Growth</i>	<i>Board</i>	<i>Indep</i>	<i>Stock</i>	<i>Share</i>
<i>GIR</i>	1.0000											
<i>ECS</i>	0.0110 *	1.0000										
<i>Age</i>	0.0210 ***	0.0010	1.0000									
<i>Size</i>	0.0610 ***	0.0600 ***	0.1570 ***	1.0000								
<i>Lev</i>	0.0340 ***	0.0010	0.0950 ***	0.4520 ***	1.0000							
<i>ROA</i>	0.0020	0.0250 ***	−0.0360 ***	0.0930 ***	−0.3220 ***	1.0000						
<i>Cfo</i>	−0.0130 *	0.0060	0.0030	0.0890 ***	−0.1630 ***	0.4220 ***	1.0000					
<i>Growth</i>	0.0180 ***	−0.0050	−0.0610 ***	0.0520 ***	0.0150 **	0.2510 ***	0.0470 ***	1.0000				

Table 3. Cont.

Variable	GIR	ECS	Age	Size	Lev	ROA	Cfo	Growth	Board	Indep	Stock	Share
Board	0.0090	0.0170 **	0.0530 ***	0.2560 ***	0.1320 ***	0.0430 ***	0.0350 ***	0.0000	1.0000			
Indep	0.0000	0.0010	−0.0220 ***	0.0090	−0.0040	−0.0200 ***	0.0050	−0.0180 ***	−0.5420 ***	1.0000		
Stock	0.0130 *	0.0280 ***	−0.0780 ***	0.2370 ***	0.0850 ***	0.1300 ***	0.1070 ***	0.0090	0.0520 ***	0.0400 ***	1.0000	
Share	−0.0120 *	−0.0110	−0.1870 ***	−0.2870 ***	−0.2450 ***	0.0810 ***	0.0230 ***	0.0530 ***	−0.2040 ***	0.0640 ***	−0.1300 ***	1.0000

Note. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$

4.2. Model Regression Results

Table 4 reports the results of Ordinary Least Squares (OLS) regressions with firm and year fixed effects examining the relationship between executive compensation stickiness and green innovation resilience. Column (1) presents the baseline specification without control variables, in which ECS exhibits a positive and statistically significant coefficient at the 5% level. In Column (2), upon incorporating the full set of control variables, the coefficient on ECS remains significantly positive at the 5% level ($\beta_1 = 0.0101$). These results indicate that greater executive compensation stickiness is positively correlated with enhanced green innovation resilience. Consistent with the behavioral agency perspective, the findings suggest that compensation structures that buffer executives from short-term downside risk facilitate sustained commitment to uncertain and long-term green innovation activities. Thus, Hypothesis 1 is supported.

Table 4. Baseline regression results.

Variable	(1) GIR	(2) GIR
ECS	0.0106 ** (2.4296)	0.0101 ** (2.2875)
Age		−0.4691 (−0.6002)
Size		0.3118 *** (4.1611)
Lev		0.4062 (1.2909)
ROA		−0.3696 (−0.5519)
Cfo		−0.7137 (−1.2043)
Growth		0.0707 (0.7138)
Board		−0.1888 (−0.5338)
Indep		−1.0921 (−1.0888)

Table 4. Cont.

Variable	(1) GIR	(2) GIR
<i>Stock</i>		0.8525 (1.5119)
<i>Share</i>		−0.0983 (−0.2150)
<i>_cons</i>	0.7864 *** (86.2990)	−4.3794 (−1.4061)
Year Effects	YES	YES
Individual Effects	YES	YES
N	22,268	22,268
R ²	0.0901	0.0911

Note. ** $p < 0.05$; *** $p < 0.01$; t-statistics are shown in parentheses. All subsequent tables follow the same convention.

4.3. Moderating Effect Analysis

We further examine whether the positive effect of executive compensation stickiness on green innovation resilience is contingent upon executive characteristics and external policy support. In Table 5, Model (1) introduces the interaction term between *ECS* and executives' environmental background ($ECS \times Envi$). The coefficient on the interaction term is positive and statistically significant at the 5% level ($\alpha_3 = 0.0207$), indicating that the presence of executives with environmental backgrounds strengthens the positive relationship between compensation stickiness and green innovation resilience. In economic terms, a one-standard-deviation increase in the executive environmental background measure is associated with a 0.0104-unit increase in the marginal effect of compensation stickiness on green innovation resilience. While compensation stickiness provides the downside protection necessary for risk-taking, its impact on green innovation resilience is magnified by executives' environmental backgrounds, which align managerial cognitive filters with long-term ecological goals. Executives with environmental expertise are more likely to perceive green innovation as a long-term strategic asset and to accurately interpret technological uncertainty. As a result, the same level of compensation stickiness yields an amplified marginal effect on green innovation resilience when executives possess environmental imprints. Economically, this interaction reflects an increase in the marginal productivity of the contractual downside protection rather than a mere expansion of the incentive's magnitude. Accordingly, Hypothesis 2 is supported.

Table 5. Regression results of moderating effect.

Variable	(1) GIR	(2) GIR
<i>ECS</i>	0.0105 ** (2.3778)	0.0094 ** (2.1069)
$ECS \times Envi$	0.0207 ** (2.0046)	
<i>Envi</i>	0.1030 (0.7937)	
$ECS \times Subs$		4.8809 * (1.6747)
<i>Subs</i>		137.1845 ** (2.1783)

Table 5. Cont.

Variable	(1) GIR	(2) GIR
Age	−0.4934 (−0.6310)	−0.4399 (−0.5638)
Size	0.3090 *** (4.1248)	0.3152 *** (4.2121)
Lev	0.4128 (1.3140)	0.4086 (1.2984)
ROA	−0.3758 (−0.5608)	−0.3364 (−0.5009)
Cfo	−0.7183 (−1.2120)	−0.6988 (−1.1791)
Growth	0.0683 (0.6897)	0.0738 (0.7454)
Board	−0.1855 (−0.5246)	−0.1743 (−0.4912)
Indep	−1.0886 (−1.0858)	−1.0758 (−1.0708)
Stock	0.8445 (1.4988)	0.8692 (1.5410)
Share	−0.1168 (−0.2544)	−0.0970 (−0.2125)
_cons	−4.2804 (−1.3753)	−4.6097 (−1.4814)
Year Effects	YES	YES
Individual Effects	YES	YES
N	22,268	22,268
R ²	0.0913	0.0914

Note. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$; t-statistics are shown in parentheses.

Model (2) in Table 5 examines the moderating role of government green innovation subsidies. The interaction term between *ECS* and *Subs* is also positive and statistically significant at the 10% level ($\sigma_3 = 4.8809$), indicating that government subsidies further amplify the positive impact of compensation stickiness on green innovation resilience. Empirically, a one-standard-deviation increase in government subsidies is associated with a 48.3257% increase in the marginal sensitivity of green innovation resilience to compensation stickiness. This result implies that external policy support complements internal incentive stability by enhancing firms' capacity to persist in green innovation under uncertainty. Accordingly, Hypothesis 3 is supported.

This interaction reflects a complementary risk-sharing mechanism consistent with the arguments in Section 2.4. Compensation stickiness primarily mitigates executives' personal downside risk, whereas government subsidies reduce firm-level financial constraints and convey policy endorsement and legitimacy. When subsidies are high, executives interpret green innovation projects as institutionally supported rather than idiosyncratic or speculative. Under such conditions, the risk-buffering capacity of compensation stickiness becomes more effective, as both individual- and organizational-level risk thresholds are jointly lowered.

To further illustrate the moderating effects, we plot the relationship between executive compensation stickiness and green innovation resilience at different levels of the moderators (one standard deviation above and below the mean). As shown in Figures 1 and 2, the positive association between compensation stickiness and green innovation resilience is noticeably stronger when executives possess a stronger environmental background, and when firms receive higher levels of government green innovation subsidies. The steeper slopes under high-moderator conditions indicate that both executive environmental

background and government green subsidies strengthen the positive effect of compensation stickiness on green innovation resilience, consistent with our hypotheses H2 and H3.

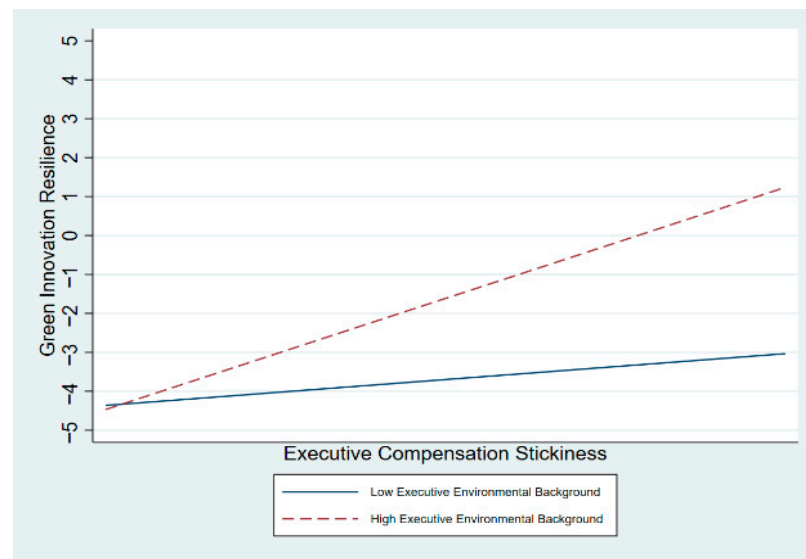


Figure 1. Diagram of the moderating effect of executive environmental background.

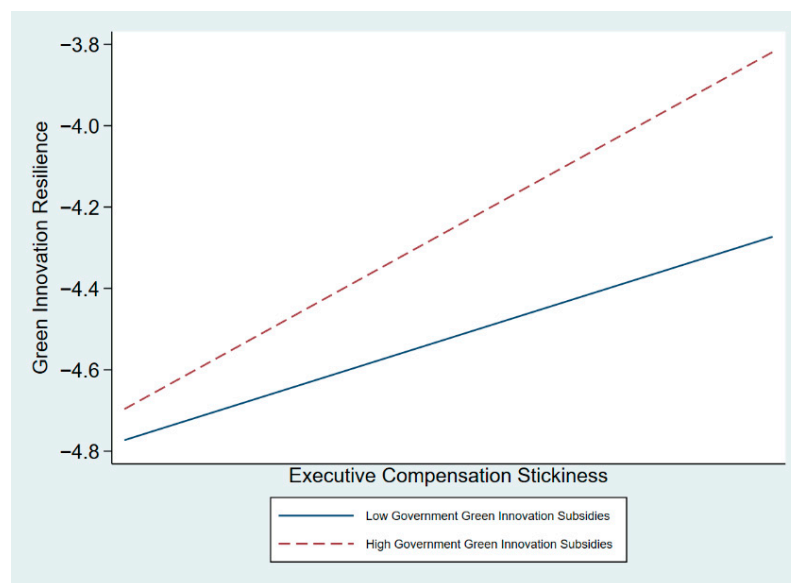


Figure 2. Diagram of the moderating effect of government green innovation subsidies.

4.4. Robustness Checks and Endogeneity Treatments

To assess the robustness of our results and to address potential endogeneity concerns, we conduct a series of additional analyses using alternative variable constructions and empirical specifications. Results are shown in Table 6.

Table 6. Regression results of robustness checks and endogeneity treatments.

Variable	Alternative Measures of Key Variables					Heckman Two-Stage Model		High-Dimensional Fixed Effects		Propensity Score Matching GIR	Entropy Balancing GIR
	GIR	GIR	GIR	GIR2	GIR3	Stage 1	Stage 2	GIR	GIR		
ECS				0.0166 ** (2.1606)	0.0073 * (1.6554)	2.0538 *** (22.6689)	0.0101 ** (2.2894)	0.0107 ** (2.3154)	0.0116 ** (2.4797)	0.0108 ** (2.5120)	0.0104 ** (2.3288)
ECS2	0.0090 * (1.8730)										
ECS_4		0.0010 ** (1.9944)									
ECS_6			0.0035 *** (2.7644)								
IV						−0.3236 *** (−19.1876)					
IMR							0.0080 (0.2004)				
Age	−0.4627 (−0.5921)	0.1137 (1.1907)	1.9985 (0.9813)	−1.5355 (−1.1428)	−0.2323 (−0.3044)	0.0591 (1.1769)	−0.4744 (−0.6075)	0.0081 (0.0095)	−0.4853 (−0.5772)	−0.4440 (−0.5210)	−0.5037 (−0.6206)
Size	0.3113 *** (4.1534)	0.1974 *** (8.1551)	0.5432 *** (2.7484)	0.4377 *** (3.4835)	0.1719 ** (2.4078)	0.0366 *** (2.8311)	0.3110 *** (4.1541)	0.3572 *** (4.0471)	0.3479 *** (4.0717)	0.3308 *** (3.7298)	0.3162 *** (3.9121)
Lev	0.4086 (1.2997)	0.2368 (1.5674)	−0.5342 (−0.6569)	−0.6382 (−1.1344)	0.2088 (0.6808)	−0.1899 ** (−2.3644)	0.4087 (1.2996)	0.2128 (0.6281)	0.3538 (1.0487)	0.4028 (1.0894)	0.3111 (0.9364)
ROA	−0.3679 (−0.5492)	0.2845 (0.5541)	0.3608 (0.2389)	1.4647 (1.4218)	0.7546 (1.0958)	0.5287 ** (2.5230)	−0.3679 (−0.5495)	−0.3658 (−0.5107)	−0.2632 (−0.3705)	−0.5221 (−0.6635)	−0.6132 (−0.8569)
Cfo	−0.7044 (−1.1883)	−1.0099 ** (−2.1241)	−1.6186 (−1.1000)	−0.7689 (−0.7563)	−1.2817 ** (−2.2554)	−0.1947 (−0.8827)	−0.7154 (−1.2077)	−0.8259 (−1.3352)	−0.7785 (−1.2303)	−0.6706 (−1.0306)	−0.6470 (−1.0313)
Growth	0.0704 (0.7096)	0.1759 ** (2.0279)	0.6551 *** (2.7276)	0.5418 ** (3.1606)	0.1195 (1.2995)	−0.0708 ** (−2.0114)	0.0707 (0.7135)	0.0623 (0.5917)	0.1340 (1.2435)	0.0715 (0.6463)	0.0869 (0.8421)
Board	−0.1924 (−0.5442)	0.0170 (0.1038)	0.0477 (0.0529)	1.2510 ** (2.0510)	0.4415 (1.2059)	0.0396 (0.4068)	−0.1879 (−0.5314)	−0.2443 (−0.6546)	−0.1052 (−0.2833)	−0.2831 (−0.7096)	−0.1634 (−0.4341)
Indep	−1.1096 (−1.1073)	−0.2020 (−0.3761)	−3.4663 (−1.3355)	2.3309 (1.3533)	0.0993 (0.0987)	−0.0430 (−0.1444)	−1.0909 (−1.0883)	−1.2658 (−1.1885)	−0.9642 (−0.9305)	−0.2460 (−0.2211)	−1.2972 (−1.2381)
Stock	0.8567 (1.5197)	0.4429 ** (2.4504)	−0.3316 (−0.2499)	0.5608 (0.6118)	0.4495 (0.9608)	−0.1871 * (−1.9590)	0.8511 (1.5085)	1.2696 ** (2.0364)	0.7572 (1.2673)	0.2362 (0.3743)	0.8216 (1.4272)
Share	−0.0937 (−0.2050)	−0.0858 (−0.5814)	0.7012 (0.5759)	1.0359 (1.2318)	−0.2766 (−0.6353)	0.2498 *** (3.1240)	−0.0986 (−0.2156)	0.0300 (0.0596)	0.2269 (0.4697)	−0.2306 (−0.4574)	−0.2490 (−0.5090)
_cons	−4.3736 (−1.4040)	−1.2878 ** (−2.2772)	−15.6090 ** (−1.9611)	−7.6621 (−1.4709)	−3.7456 (−1.2846)	−1.6542 *** (−4.5066)	−4.3485 (−1.3979)	−6.7148 ** (−1.9618)	−5.3701 (−1.6140)	−4.7720 (−1.3785)	−4.2819 (−1.3073)
Year Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Individual Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Province Fixed Effect	NO	NO	NO	NO	NO	NO	NO	YES	YES	NO	NO
N	22,268	22,268	19,530	22,267	22,267	22,268	22,266	22,267	22,267	19,577	22,268
R ²	0.0911	0.0909	0.1176	0.1019	0.0921	0.6737	0.0910	0.1080	0.1183	0.1088	0.0928

Note. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$; t-statistics are shown in parentheses.

4.4.1. Alternative Measures of Key Variables

First, we re-estimated the model by employing alternative proxies for *ECS*. Instead of using the average compensation of all senior managers, we adopt an alternative proxy (*ECS2*) based on the mean compensation of the top three highest-paid executives within each firm. This approach focuses on the core decision-makers who hold the most significant influence over green innovation strategies. Furthermore, we addressed potential concerns regarding the specific duration of the calculation period. While the baseline model utilizes a five-year rolling window, we conducted additional tests using alternative windows of four and six years to capture compensation stickiness (*ECS_4* and *ECS_6*, respectively). As shown in Table 6, across alternative proxies and window specifications, the estimated coefficients remain positive and statistically significant, suggesting that the promoting effect of compensation stickiness on green innovation resilience is robust.

Second, we recalculated *GIR* by replacing the industry-level expected growth trajectory with a city-level benchmark (*GIR2*). This adjustment accounts for the possibility that a firm's innovation resilience is more closely tied to localized institutional environments and regional competitive pressures. Additionally, we constructed an alternative measure based on green patent applications rather than granted patents (*GIR3*). As shown in Columns

(4) and (5) of Table 6, the estimated coefficients remain qualitatively consistent with the baseline results, further supporting the robustness of our findings.

4.4.2. Endogeneity Treatments

A potential concern is that firms with different levels of executive compensation stickiness may be systematically different, leading to sample selection bias. To address this issue, we employ a Heckman two-stage model [57].

In the first stage, we construct a binary indicator of executive compensation stickiness based on the industry-year median, assigning a value of one to firms with above-median stickiness and zero otherwise. As an exclusion restriction, we use the industry-year average executive compensation stickiness of peer firms. This variable reflects prevailing industry-level contracting norms and benchmarking practices, which shape firms' compensation structures through peer effects and competitive pressures. At the same time, it is conceptually distinct from firm-specific green innovation decisions, which are primarily driven by internal strategic priorities and technological conditions.

The first-stage Probit regression indicates that the instrumental variable (IV) is significantly associated with the likelihood of exhibiting high compensation stickiness. In the second stage, we include the Inverse Mills Ratio (IMR) in the outcome equation. As reported in Table 6, the IMR is statistically insignificant, suggesting that sample selection bias is unlikely to drive our baseline results. While the industry-level instrument captures aggregate contracting norms, it could theoretically be sensitive to broader economic shifts. To address this possibility, we further employ a lagged instrument and the Lewbel [58] method. For brevity, these results are reported in Appendix A. While we recognize the inherent challenges in identifying a strictly exogenous environment, the convergence of evidence across these diverse identification strategies strengthens the credibility of our causal estimates.

To further mitigate concerns that the baseline results may be driven by selection bias arising from observable firm heterogeneities, we implement propensity score matching (PSM) and entropy balancing analyses. These methods systematically align the distributions of key covariates between the treatment and control groups. Specifically, we define the treatment group as firms with executive compensation stickiness above the industry-year median, and the control group otherwise. For the PSM analysis, we estimate propensity scores using a Logit model based on the same set of firm-level covariates included in the baseline regressions. Utilizing a 1:1 nearest-neighbor matching without replacement, and imposing a caliper of 0.0100, we ensure a high degree of comparability between matched pairs. Post-matching balance tests indicate that the standardized biases of all covariates are reduced to below 10%, indicating that the observable balance is well-achieved. Re-estimating the baseline model on the matched sample yields results that remain consistent with our main findings.

Complementary to the PSM analysis, we employ entropy balancing as a more flexible, non-parametric approach. This method effectively retains the full sample while ensuring that the treatment and control groups achieve perfect balance across higher-order moments [59]. Specifically, we reweight the control group such that the first, second, and third moments (mean, variance, and skewness) of the covariates match those of the treatment group. The regression results using these entropy-balanced weights are quantitatively similar to our baseline estimates, further reinforcing that our findings are not driven by observable firm heterogeneities or specific functional form assumptions.

To address concerns related to omitted variable bias and unobserved heterogeneity, we estimate models with high-dimensional fixed effects. In addition to firm and year fixed effects, we incorporate province fixed effects as well as interaction fixed effects between

industry and province, and between industry and year. These specifications allow us to absorb time-invariant regional characteristics and time-varying industry-specific shocks. As shown in Table 6, the coefficient on *ECS* remains positive and statistically significant across these models, confirming the robustness of the main effects.

Taken together, these robustness checks and endogeneity analyses provide strong support for the reliability of our main findings. By employing complementary approaches that rely on distinct identifying assumptions, this convergence of evidence across multiple strategies reinforces the conclusion that executive compensation stickiness enhances firms' green innovation resilience.

5. Conclusions and Implications

5.1. Research Conclusions

Leveraging a sample of Chinese A-share-listed firms, this study delves into the relationship between executive compensation stickiness and corporate green innovation resilience, while simultaneously exploring the moderating roles of executive environmental backgrounds and government green innovation subsidies. The empirical results provide robust and consistent evidence that executive compensation stickiness significantly enhances green innovation resilience, suggesting that downward rigidity in executive pay can function as an implicit insurance mechanism that supports long-term green innovation under uncertainty and volatility.

Furthermore, this positive relationship is notably amplified when executives possess environmental backgrounds, indicating that managerial cognitive orientations and value frameworks play a critical role in channeling incentive stability into persistent green innovation efforts. Executives with environmental imprinting are more likely to leverage compensation-induced security to tolerate the long development cycles and high failure risks inherent in green R&D.

In addition, government green innovation subsidies serve as an important external catalyst that further reinforces this positive relationship. By alleviating financial constraints and conveying policy support for sustainable development, such subsidies enhance firms' capacity to absorb innovation-related risks and maintain long-term green strategic commitments. Taken together, these findings highlight the complex and complementary interplay between internal asymmetric compensation adjustments, managerial cognition, and external policy environments in shaping corporate green innovation resilience.

5.2. Discussion

Our findings indicate that executive compensation stickiness is positively associated with green innovation resilience, consistent with prior studies showing that downside protection encourages managerial risk-taking and long-term investment willingness [35,36]. This finding extends prior research on executive compensation and innovation by shifting the analytical focus from static innovation outcomes to the dynamic persistence of green innovation under uncertainty.

Anchored in Behavioral Agency Theory, this study reframes executive compensation stickiness not merely as an incentive distortion, but as a context-dependent governance mechanism whose value becomes salient in high-uncertainty sustainability settings. In conversation with existing literature, our findings help reconcile conflicting views on pay stickiness. While prior research often documents inhibiting effects on green innovation efficiency attributed to weakened accountability or diluted performance sensitivity [19], our results highlight a distinct outcome dimension: the ability to sustain green innovation momentum and to adaptively evolve green technological capabilities over time. From a resilience perspective, the "protective rigidity" of sticky compensation, which may appear

costly or inefficient in stable environments, serves as a strategic buffer during turbulent periods. By mitigating managerial downside risk perception, such a mechanism prevents premature retreat from green innovation trajectories. Consequently, our study contributes to the emerging literature on the micro-foundations of corporate green persistence, particularly in the context of emerging economies.

The moderation analyses further align with and enrich existing literature. The strengthening role of executive environmental background is consistent with prior studies grounded in Upper Echelons Theory, which suggest that environmentally imprinted executives are more inclined to support green strategies [40,44]. These results extend this line of research by shifting the focus from direct green outcomes to the cognitive conditioning of incentive efficacy, demonstrating that such backgrounds influence how managers cognitively frame the strategic value and uncertainty of green innovation, thereby facilitating the translation of compensation stickiness into green innovation resilience.

Similarly, government green innovation subsidies positively moderate the relationship between executive compensation stickiness and green innovation resilience. Consistent with prior research emphasizing the financial and legitimacy-enhancing roles of subsidies [48,49], our evidence underscores that external institutional support complements internal incentives in sustaining green innovation resilience. Specifically, while compensation stickiness buffers executives' personal downside risk, government subsidies alleviate firm-level financial constraints and reduce perceived uncertainty surrounding downside consequences through credible signals of policy endorsement and regulatory tolerance. As a result, internal risk-buffering incentives are more effectively translated into persistent resource commitment and strategic continuity in green innovation activities.

5.3. Theoretical Contributions and Practical Implications

5.3.1. Theoretical Contributions

Theoretically, this study makes three main contributions to the existing literature.

First, we contribute to the executive compensation literature by offering a more balanced understanding of executive compensation stickiness. While prior research has predominantly viewed compensation stickiness through the lens of agency costs and governance inefficiencies [12,60], critiquing it as a vehicle for managerial rent extraction and incentive distortions [61], our findings reveal its functional role as an implicit insurance mechanism in the context of high-risk, long-horizon green innovation. By demonstrating that compensation stickiness can facilitate sustained green innovation rather than merely reflecting governance failure, this study extends existing theories by highlighting the contingent and context-dependent nature of compensation rigidity.

Second, this study enriches the emerging literature on green innovation resilience by identifying executive compensation structure as a critical yet underexplored internal antecedent. Existing research has mainly explored the drivers of resilience from the perspectives of market-based environmental regulations [7], organizational technological evolution [3], and upper echelon networks [8], while paying relatively limited attention to the role of internal sticky pay structures in shaping firms' ability to sustain and recover green innovation activities over time. By linking compensation stickiness to resilience, we shift the focus from external pressures and structural endowments to the micro-level incentives of key decision-makers.

Third, by elucidating the moderating roles of executives' environmental backgrounds and government subsidies, this study clarifies the boundary conditions under which compensation stickiness is most effective. Integrating insights from Upper Echelons Theory with Signaling Theory, we demonstrate how individual-level cognitive frameworks and external policy endorsement jointly shape the incentive efficiency of compensation

structures. This integrative perspective advances understanding of how internal organizational mechanisms and external governance environments interact to foster green innovation resilience.

5.3.2. Practical Implications

From a practical perspective, the findings of this study offer several actionable implications for both corporate governance and policy design in the context of green transformation.

For corporate boards and compensation committees, the research suggests that compensation stickiness should not be viewed solely as an agency cost or governance failure. In innovation-intensive and sustainability-oriented settings, moderate downward rigidity in executive pay can function as a strategic buffer that mitigates short-term performance pressures and supports sustained green innovation. Rather than uniformly increasing pay rigidity, firms should calibrate compensation stickiness in line with the risk profile and time horizon of green innovation projects. Furthermore, the strengthening effect of executives' environmental backgrounds indicates that compensation stability is more effective when decision-makers possess an intrinsic alignment with green objectives. Accordingly, firms should incorporate environmental education and eco-related professional experience into executive selection and succession planning. By pairing stable compensation structures with environmentally imprinted executives, firms can optimize the translation of compensation-induced risk tolerance into sustained green innovation commitment, thereby enhancing innovation resilience.

From a policy perspective, our findings indicate that government green innovation subsidies are most effective when strategically aligned with firms' internal incentive structures. Subsidies function not as substitutes for internal incentives, but as amplifiers that enhance the effectiveness of existing risk-buffering mechanisms. Beyond alleviating financial constraints, subsidies serve as credible signals of policy endorsement and regulatory tolerance, which help reduce executives' perceived downside uncertainty associated with innovation failure. Policymakers should therefore emphasize the continuity, transparency, and credibility of subsidy programs, as unstable or short-lived policy support may weaken this signaling value and dampen managerial confidence. In emerging economies characterized by institutional volatility, well-designed and consistently implemented subsidy schemes can significantly amplify the effectiveness of internal incentives in sustaining long-term green transformations.

5.4. Limitations and Future Research

Despite its contributions, this study has several limitations that offer avenues for future research. First, although we have identified the main effect of executive compensation stickiness and examined key moderating factors, the underlying mechanisms through which compensation stickiness influences green innovation resilience could be further elucidated. Future studies could employ mediation analyses, experimental approaches, or micro-level data to unpack the behavioral and organizational pathways. Second, our measurement of green innovation resilience primarily relies on green patent data, which has been widely adopted and allows for comparability with prior empirical research [17]. Nevertheless, future research could further extend this line of inquiry by developing more comprehensive and multidimensional measures by incorporating indicators such as supply-chain resilience, environmental management practices, and operational sustainability outcomes. By addressing these limitations, subsequent research can further deepen understanding of the intricate relationships among executive incentives, organizational green innovation, and environmental sustainability.

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Abbreviations

The following abbreviations are used in this manuscript:

BAT	Behavioral Agency Theory
CEO	Chief Executive Officer
<i>Cfo</i>	Cash Flow from Operations
CNRDS	Chinese Research Data Services Platform
CSMAR	China Stock Market & Accounting Research Database
ECS	Executive Compensation Stickiness
<i>Envi</i>	Executive Environmental Background
FE	Fixed Effect
<i>GIR</i>	Green Innovation Resilience
IMR	Inverse Mills Ratio
<i>Indep</i>	Independent Directors
IV	Instrumental Variable
<i>Lev</i>	Leverage Ratio
OLS	Ordinary Least Squares
PPS	Pay–Performance Sensitivity
PSM	Propensity Score Matching
R&D	Research and Development
ROA	Return on Assets
ST	Special Treatment
<i>Subs</i>	Government green innovation Subsidies
VIF	Variance Inflation Factor

Appendix A

Appendix A.1

This appendix reports supplementary analyses that further address potential endogeneity and selection concerns related to executive compensation stickiness. Specifically, we present additional Heckman two-stage estimations using alternative identification strategies, including a one-year lagged industry-level instrument (L.IV) and heteroskedasticity-based instruments (IV_ Lewbel_a, IV_ Lewbel_b, and IV_ Lewbel_c) constructed following Lewbel [58]. These approaches rely on distinct sources of identifying variation and do not hinge on the same exclusion restrictions as the baseline specification. Consistent with the main results, executive compensation stickiness remains positively and significantly associated with green innovation resilience, suggesting that our findings are not driven by a particular identification strategy.

Table A1. Regression results of additional Heckman two-stage models.

Variable	Heckman Two-Stage Models			
	Stage 1	Stage 2	Stage 1	Stage 2
ECS	2.4832 *** (19.9034)	0.0085 * (1.6893)	2.2168 *** (22.8672)	0.0101 ** (2.2886)
IV			−0.3291 *** (−18.6575)	
L.IV	−0.1722 *** (−8.3069)			
IV_ Lewbel_a			−1.0640 ** (−2.3619)	
IV_ Lewbel_b			1.3198 *** (2.9890)	
IV_ Lewbel_c			3.1681 *** (4.2800)	
IMR		0.0648 (1.0746)		0.0144 (0.3387)
Age	0.0853 (1.5119)	0.0565 (0.0615)	0.0716 (1.4478)	−0.4668 (−0.5977)
Size	0.0471 *** (3.0302)	0.2547 *** (2.8211)	−0.0385 (−0.3444)	0.3119 *** (4.1620)
Lev	−0.2311 ** (−2.5072)	0.2997 (0.7902)	−1.8849 *** (−2.5799)	0.4067 (1.2924)
ROA	0.7834 *** (3.2292)	−0.1847 (−0.2417)	0.6172 *** (2.9010)	−0.3684 (−0.5501)
Cfo	−0.3413 (−1.2727)	−0.8012 (−1.1415)	−0.3188 (−1.3890)	−0.7141 (−1.2048)
Growth	−0.0065 (−0.1468)	0.0343 (0.2863)	−0.0672 * (−1.8856)	0.0707 (0.7137)
Board	−0.0182 (−0.1481)	−0.2038 (−0.4668)	2.0914 *** (2.8974)	−0.1887 (−0.5334)
Indep	−0.2703 (−0.7846)	−0.5812 (−0.4818)	−0.0526 (−0.1853)	−1.0896 (−1.0869)
Stock	−0.1953 * (−1.6872)	0.1680 (0.2313)	−0.1693 * (−1.8115)	0.8499 (1.5064)
Share	0.4612 *** (4.8243)	−0.1747 (−0.3218)	5.2768 *** (4.4167)	−0.0985 (−0.2153)
_cons	−2.2755 *** (−5.1215)	−4.5519 (−1.2513)	−4.4696 * (−1.6998)	−4.3875 (−1.4096)
Year Effects	YES	YES	YES	YES
Individual Effects	YES	YES	YES	YES
N	18,669	18,668	22,268	22,268
R ²	0.7027	0.0960	0.6766	0.0910

Note: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$; t-statistics are shown in parentheses.

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