

Article

Managerial Climate Attention and Income Inequality Within Enterprises: Evidence from Double/Debiased Machine Learning

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Abstract

Climate-related risks and low-carbon transition pressures are increasingly reshaping firms' strategic decisions, but their internal distributional consequences remain underexplored. This question matters because changes in within-firm income inequality may influence organizational incentives, cohesion, and long-term firm sustainability. Against this background, we examine the relationship between managerial climate attention and within-firm income inequality using a sample of Chinese listed companies from 2001 to 2023. We employ a double/debiased machine learning approach to estimate this relationship. We find that greater managerial climate attention is significantly associated with higher within-firm income inequality between senior executives and ordinary employees, and that this result remains robust across a series of robustness checks. We further explore three potential channels—operational stability, internal control quality, and green innovation. The results show that managerial climate attention is significantly associated with all three channel variables, suggesting that it may be related to within-firm income distribution through firms' operating conditions, governance arrangements, and innovation-driven organizational change. Further analysis indicates that this inequality-widening pattern is more pronounced among firms in low-pollution industries and firms with lower ownership concentration, with more suggestive evidence among firms with higher risk. This study highlights that, beyond environmental outcomes, corporate climate strategies require deliberate attention to their internal income distribution consequences and corresponding governance safeguards.

Keywords: double/debiased machine learning; managerial climate attention; mechanism analysis; within-firm income inequality



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1. Introduction

The global economy is currently at a pivotal stage, with the green low-carbon transition, digital transformation, and high-quality development accelerating simultaneously. As climate risks intensify, decarbonization commitments tighten, and ESG governance becomes increasingly salient, firms face profound shifts in their external constraints and strategic environment [1,2]. Recent evidence also shows that shareholder engagement on ESG issues can reduce downside risk, especially when environmental topics are involved, further strengthening the role of climate-related considerations in firms' external financing and governance environment [3,4]. This shift is increasingly reflected in capital markets, where

investors place growing value on climate risk disclosure and climate-related financing arrangements [2,4]. In particular, under the continued advancement of China's "dual-carbon" goals, firms that fail to recognize and respond to climate risks in a timely and effective manner may not only weaken their long-run competitiveness and value creation, but also face rising regulatory, operational, and market risks. Accordingly, climate change is no longer merely an environmental concern; it has become a systemic shock that is reshaping firms' operating logic and patterns of resource allocation [5,6].

More importantly, the green transition is not a process in which gains are shared evenly. Its benefits and costs are often borne asymmetrically across different groups within firms, making within-firm income inequality an increasingly salient micro-distributional issue. A widening internal pay gap not only signals an imbalance in intra-firm income distribution, but may also weaken employee incentives, intensify organizational frictions, undermine operational stability, and ultimately impair firms' innovation capacity and long-term performance. Existing evidence further suggests that corporate transformation and the reallocation of resources can reshape internal income structures, with meaningful implications for fairness, organizational cohesion, and sustainable growth [7,8].

Against the dual pressures of climate constraints and distributional tensions, managerial cognition and preferences become particularly consequential. While external policies and market forces may push firms toward climate-related actions, whether firms genuinely prioritize climate issues and how they respond still depend to a large extent on managerial judgment. At the same time, boards are increasingly incorporating ESG-related objectives into executive incentive contracts, which makes the internal incentive implications of climate-oriented managerial attention more salient [9,10]. A text-based managerial climate attention (MCA) index provides a feasible approach to quantifying this otherwise unobservable managerial focus [11]. Importantly, heightened managerial climate attention may have implications that extend beyond firms' climate actions and risk exposure. As climate-related concerns become embedded in internal corporate decision-making, they may also affect firms' compensation structure and thus reshape within-firm income distribution, especially when climate-related objectives become more closely connected to firms' governance and strategic adjustment [9,12].

Despite these advances, the existing literature has not yet provided systematic evidence on the relationship between managerial climate attention and within-firm income inequality. Existing studies on within-firm income inequality mainly emphasize globalization, digital transformation, and technological progress as key drivers [7,13,14], whereas research on managerial climate attention primarily focuses on firms' climate actions, environmental performance, and risk outcomes [11,15]. Although some studies suggest that climate-related strategic attention may have broader implications for governance arrangements and internal allocation [9,12], much less is known about whether and through which internal channels managerial climate attention reshapes the executive–employee pay gap. This omission leaves an important gap in understanding the internal distributional consequences of firms' climate-related strategic orientation.

Against this background, this study makes three contributions. First, to the best of our knowledge, this study is the first to directly examine the relationship between managerial climate attention and within-firm income inequality, thereby linking managerial climate cognition to intra-firm income distribution and filling an important gap in the literature. Second, from the perspective of internal corporate decision-making, we show how managerial climate attention may reshape within-firm income structures through operational stability, internal control quality, and green innovation, thereby offering a new analytical framework for research on income inequality. Third, methodologically, this study employs double/debiased machine learning (DDML) to address the potential limitations of

traditional linear panel models in the presence of high-dimensional controls and complex nonlinear relationships. By combining machine learning-assisted nuisance estimation with cross-fitting, this approach improves the robustness and credibility of the estimated relationship between managerial climate attention and within-firm income inequality.

The remainder of this paper proceeds as follows. Section 2 reviews the related literature and develops the research hypotheses. Section 3 describes the data, variables, and empirical strategy. Section 4 presents the empirical results. Section 5 discusses the findings, and Section 6 concludes.

2. Literature Review and Research Hypotheses

2.1. Literature Review

Table 1 organizes the related literature from the broader context of within-firm income inequality to the specific research gap addressed in this study.

Table 1. Positioning the present study within the related literature.

Broad Research Area	Specific Focus	Main Insights and Representative Studies
Within-firm income inequality: established determinants	Structural transformation	Global value chain participation and digital transformation can reshape the distribution of income within firms [7,13].
	Firm growth and technological upgrading	Firm growth, innovation, and technological upgrading may alter the relative returns to managerial and skill-intensive tasks, thereby affecting internal pay dispersion [8,14].
	Environmental and institutional pressures	Internal pay structures may respond to changes in the external business environment and environmental concerns [16,17].
	Policy intervention	Minimum-wage adjustments and environmental taxation can influence within-firm pay dispersion [18,19].
Climate issues: an increasingly important corporate concern	Climate exposure and strategic decision-making	Climate risks and firm-level climate exposure have become increasingly relevant to corporate finance, investor assessment, and strategic decision-making [1,5].
	Investor demand for climate-related information	Investors increasingly incorporate climate-related disclosure into engagement and portfolio decisions [4,5].
Managerial climate attention: measurable and economically relevant	Measurement of managerial attention	Textual information from firms' MD&A disclosures can be used to measure managerial attention to climate-related issues [11].
	Risk and operational outcomes	Managerial climate attention is associated with corporate default risk, operational resilience, and risk exposure [15,20].
	Environmental and governance outcomes	Managerial climate attention can influence ESG performance, carbon-related behavior, and environmental governance practices [6,12].

Table 1. *Cont.*

Broad Research Area	Specific Focus	Main Insights and Representative Studies
Internal organizational adjustment: the missing link	Internal control and monitoring	Internal control strengthens monitoring, disciplines managerial decision-making, and formalizes organizational responsibilities [21,22].
	Executive incentives and ESG-related objectives	Sustainability-related objectives are increasingly incorporated into executive incentive design [9,10].
	ESG evaluation and internal pay structures	ESG-related evaluation may reshape the relationship between executive incentives and internal pay dispersion [9,23].
	Innovation-driven organizational change	Innovation can increase organizational complexity and raise the value of managerial coordination and skill-intensive tasks [24,25].
	Innovation and top-income concentration	Innovation and opportunity-rich environments may contribute to executive pay inequality and top-income concentration [26].

Existing research has shown that within-firm income inequality is shaped by corporate transformation, institutional pressures, and regulatory change. However, the distributional consequences of climate-oriented managerial priorities remain underexplored. This omission has become increasingly important as climate risks and climate-related information influence firms' strategic decisions and investor assessments.

The emerging literature on managerial climate attention provides a basis for examining this issue. Managerial attention to climate-related concerns can be measured from corporate disclosures and is associated with firms' risk exposure, operational resilience, ESG performance, and environmental governance. These outcomes suggest that managerial climate attention may be translated into substantive internal adjustments rather than remaining merely symbolic.

Such adjustments may also affect the distribution of income within firms. Prior studies show that internal control, executive incentive design, and innovation-driven transformation can reshape organizational responsibilities and the relative value of managerial capabilities. Nevertheless, existing research has not systematically examined whether managerial climate attention is associated with the executive–employee pay gap or how this relationship may arise within firms. This study addresses this gap by focusing on operational stability, internal control quality, and green innovation as potential channels.

2.2. Theoretical Analysis

Managerial climate attention serves as an important driver of firms' internal distributional outcomes. As climate risks intensify and the green transition accelerates, managerial attention to climate issues increasingly shapes firms' strategic decision-making, resource allocation, and governance priorities [11]. In this context, managerial climate attention may be associated not only with whether firms undertake climate-related actions, but also with how the gains and costs associated with such actions are distributed among different groups within the firm. This inequality-widening logic can be understood from the perspective of managerial attention, strategic responsibility allocation, and internal compensation adjustment. From the attention-based view of the firm, managerial attention shapes which issues become salient in organizational decision-making and how decision-makers allocate resources and responses to those issues [27]. Upper echelons theory similarly suggests

that firms' strategic choices and organizational outcomes reflect top managers' cognition, priorities, and interpretations of the external environment [28]. Applied to the climate context, stronger managerial climate attention means that climate risks, low-carbon transition, environmental compliance, sustainability disclosure, and green innovation become more salient in top-level strategic agendas. These tasks are typically complex, uncertain, and cross-functional. They require senior executives to interpret external policy signals, coordinate regulatory compliance, allocate resources across departments, communicate with investors and regulators, and balance financial and nonfinancial objectives. Such responsibilities are concentrated more heavily at the upper level of the organizational hierarchy and are closely linked to executive strategic judgment and governance capacity. As a result, stronger managerial climate attention may be accompanied by a higher compensation premium for executives' strategic coordination, compliance, disclosure, and risk-management responsibilities. By contrast, ordinary employee compensation is usually more standardized and slower to adjust, and employees may also bear part of the adjustment pressure associated with compliance requirements, work reorganization, and green transformation. Such asymmetric adjustment is consistent with evidence that executive–employee pay disparities are shaped by the relative bargaining power of executives and nonexecutive employees [29], as well as evidence on wage rigidity that may limit employee-side compensation adjustment [30]. It is also consistent with prior studies showing that ESG-related evaluation, firm growth, and technological innovation may reshape internal pay structures by increasing the relative value of managerial coordination and higher-order tasks [8,14,23]. Within-firm income inequality reflects the internal allocation of economic returns across hierarchical and occupational groups. Excessive internal income disparity may weaken employee incentives, intensify organizational frictions, and ultimately impair firms' long-term performance [7,13]. Accordingly, it is reasonable to expect that managerial climate attention may be positively associated with within-firm income inequality.

At the same time, a countervailing mechanism may also exist. Firms with stronger managerial climate attention may not only respond to climate risks and low-carbon transition pressures but also adopt a broader stakeholder-oriented governance logic. Because climate-related strategies are often embedded in ESG governance and corporate social responsibility agendas, such firms may attach greater importance to employee welfare, worker training, occupational conditions, human capital development, and inclusive compensation practices. For example, climate-oriented firms may invest in training programs to help employees adapt to green technologies, improve workplace safety and environmental conditions, or design compensation and retention practices that support employee participation in the green transition. Consistent with this logic, prior evidence shows that employee-related corporate social responsibility is associated with a lower executive–employee pay disparity [31]. From this perspective, managerial climate attention could in principle be associated with a narrower executive–employee pay gap.

However, this narrowing mechanism is less likely to dominate in the Chinese listed-firm setting examined in this study. The MCA measure captures managers' strategic attention to climate risks, low-carbon transition, environmental compliance, sustainability disclosure, and green innovation, rather than employee-related welfare practices directly. These climate-related tasks are usually concentrated at the executive level and require senior managers to coordinate regulatory compliance, disclosure responsibilities, cross-departmental resource allocation, and green innovation strategies. Related evidence from ESG and low-carbon policy settings also suggests that sustainability- and climate-related pressures may widen the executive–employee pay gap by increasing executive pay-for-performance sensitivity, environmental violation risk, and management complexity [23,32].

Therefore, although a stakeholder-oriented narrowing tendency may exist in theory, the executive-premium pattern is expected to be more pronounced in our empirical setting.

Figure 1 visually illustrates the partial association between within-firm income inequality and managerial climate attention for Chinese A-share listed firms over the 2001–2023 period after absorbing firm and year-fixed effects. The figure is a binned scatter plot in which the horizontal axis reports residualized managerial climate attention (*MCA*) and the vertical axis reports residualized within-firm income inequality (*Pay_Ratio*). Because firm and year-fixed effects are partialled out in the plotting process, the residualized values may take both negative and positive values. Residualized *MCA* is constructed from the managerial climate attention index developed by Lei et al. [11]. Residualized *Pay_Ratio* is constructed from the executive–employee pay ratio after removing firm and year-fixed effects, using data on Chinese A-share listed firms from the CSMAR database. As shown in the figure, residualized *MCA* and residualized *Pay_Ratio* are positively correlated, indicating that the positive association between managerial climate attention and within-firm income inequality is not driven solely by cross-firm or common time variation. Accordingly, we propose the following hypothesis:

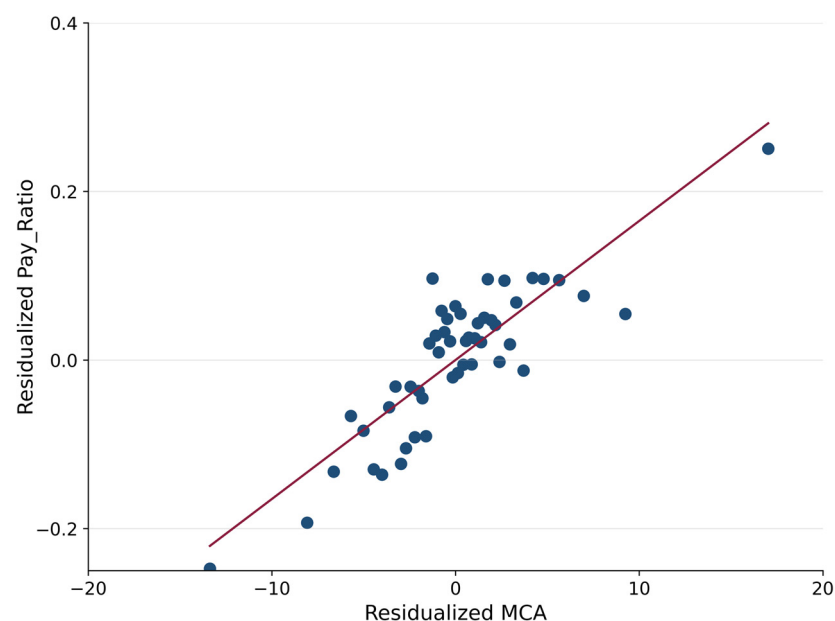


Figure 1. The positive association between residualized *Pay_Ratio* and residualized *MCA*.

Hypothesis 1. *Managerial climate attention is positively associated with within-firm income inequality.*

Managerial climate attention may be associated with within-firm income inequality through operational stability. By paying greater attention to climate-related risks, managers are more likely to identify and respond to such risks at an earlier stage, thereby reducing earnings volatility and enhancing the stability of business operations. Existing studies show that managerial climate attention can reduce corporate default risk by improving firms' operational resilience [15]. Evidence from new energy vehicle firms also suggests that managerial climate attention significantly affects firms' risk exposure and systemic risk outcomes [20]. More stable firms usually exhibit stronger profit persistence and greater capacity for resource allocation. Under such conditions, the role of top managers in coordinating complex decisions, allocating resources, and maintaining strategic consistency may become more important, which can increase the relative value of executive capabilities. At the same time, ordinary employee compensation is often more rigid and slower to

adjust than executive pay. As a result, the benefits associated with greater operational stability may be reflected more strongly in executive compensation than in employee pay, thereby widening the pay gap between executives and ordinary employees. This interpretation is also consistent with evidence that firms experiencing stronger growth or organizational upgrading often exhibit wider internal pay dispersion, as the returns to managerial coordination and higher-order tasks tend to rise in the course of firm expansion and transformation [7,8]. Accordingly, operational stability may serve as a potential channel linking managerial climate attention to within-firm income inequality. We therefore propose the following hypothesis:

Hypothesis 2. *Operational stability is a potential channel through which managerial climate attention is positively associated with within-firm income inequality.*

Managerial climate attention may also be associated with within-firm income inequality through internal control quality. Internal control quality is a key component of corporate governance, as it constrains managerial opportunism, strengthens internal monitoring, and shapes the discipline of managerial decision-making [21,22]. As firms devote more attention and organizational resources to climate-related issues and strategic adjustment, governance arrangements and monitoring processes may also become more formalized. In particular, stronger internal control can make climate-related responsibilities—such as environmental compliance, sustainability disclosure, cross-departmental coordination, and the balancing of financial and nonfinancial objectives—more clearly documented, monitored, and incorporated into performance evaluation. Prior research suggests that executive compensation contracts can serve strategic communication and coordination functions, while sustainability-related objectives are increasingly embedded in executive compensation design [9,10,33]. Under such conditions, firms may place greater weight on executives' climate-related coordination, compliance, and risk-management responsibilities, thereby increasing the associated compensation premium. Because ordinary employee pay is typically more rigid and less directly tied to these high-level strategic and governance responsibilities, stronger internal control quality may be associated with a wider executive–employee pay gap. In this sense, the widened pay gap may reflect not weaker governance or executive rent-seeking, but a higher compensation premium attached to top managers' climate-related compliance, coordination, and risk-bearing responsibilities under a more formalized internal control system. Accordingly, internal control quality may serve as a potential channel linking managerial climate attention to within-firm income inequality. We therefore propose the following hypothesis:

Hypothesis 3. *Internal control quality is a potential channel through which managerial climate attention is positively associated with within-firm income inequality.*

Finally, managerial climate attention may be associated with within-firm income inequality through green innovation. Firms with higher managerial climate attention are more likely to incorporate low-carbon transition goals, carbon constraints, and ESG-related requirements into their business strategies, thereby promoting green technology development and green patent output. Existing studies show that managerial climate attention can improve ESG performance and significantly affect firms' carbon-related behavior and environmental governance practices [6,12]. Green innovation may further reshape income distribution within firms for several reasons. First, the introduction of carbon constraints and ESG requirements increases firms' decision complexity. Second, green technological upgrading raises the multidimensionality of employee tasks and the skill requirements involved in production and management. Third, cross-departmental collaboration and

multiple performance objectives increase organizational coordination difficulty. Taken together, these changes may strengthen firms' dependence on top managers' strategic capabilities, increase the relative value of executives, and widen the internal pay gap [24,25]. Related international evidence likewise suggests that innovation and opportunity-rich environments tend to raise top-income concentration and executive pay inequality by increasing the value of strategic decision-making and idea generation [14,26]. Accordingly, green innovation may serve as a potential channel linking managerial climate attention to within-firm income inequality. We therefore propose the following hypothesis:

Hypothesis 4. *Green innovation is a potential channel through which managerial climate attention is positively associated with within-firm income inequality.*

3. Materials and Methods

Figure 2 presents the conceptual framework of this study, illustrating managerial climate attention as the explanatory variable, within-firm income inequality as the outcome variable, and operational stability, internal control quality, and green innovation as the mediating channels.

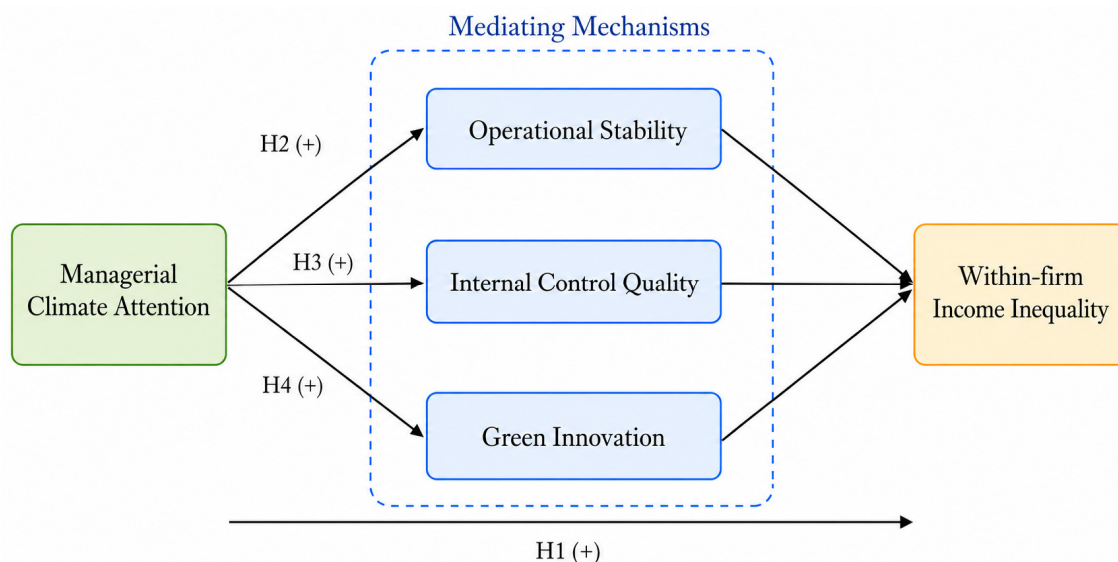


Figure 2. Conceptual framework of the study.

3.1. Data Sources

This study uses Chinese A-share listed firms from 2001 to 2023 as the research sample. The compensation data used to construct within-firm income inequality come from the listed-firm compensation file, which separately reports employee compensation payable, average employee annual compensation per person, total annual compensation of directors, supervisors, and senior executives, the total number of directors, supervisors, and senior executives, and their average annual compensation per person.

The key explanatory variable, the Managerial Climate Attention Index (MCA), is drawn from the database constructed by Lei et al. [11] and downloaded from the publicly available climate attention database. This database is developed from the textual information contained in the Management Discussion and Analysis (MD&A) sections of semi-annual and annual reports for all Chinese A-share listed firms over the period 2001–2023, using text mining and machine learning techniques. It provides annual observations at the firm, industry, and provincial levels. Since this study focuses on the relationship between managerial climate attention and within-firm income inequality, both the explana-

tory variable and the outcome variable are defined at the firm level. We therefore employ the firm-level annual MCA data to ensure consistency between the level of analysis and the measurement of the variables.

In addition to the key explanatory variable, the remaining financial and corporate governance variables are primarily obtained from the CSMAR database. The internal control variable is measured using the DIB Internal Control Index, a firm-year composite measure of internal control quality that is constructed from public information on firms' internal control activities, including firm and industry risk, internal audit, internal control deficiencies, compliance, and related governance information. Prior studies have widely used this index as a proxy for internal control quality in Chinese listed firms [34,35]. This index is available from DIB internal control and risk management database. Supplementary textual disclosure information is collected from firms' annual reports, while green innovation-related data are obtained from the China National Intellectual Property Administration (CNIPA).

After matching firm-year observations across the different data sources, we remove observations with missing values for key variables. Finally, to mitigate the influence of outliers, all continuous variables are winsorized at the 1st and 99th percentiles. The resulting dataset constitutes the final unbalanced firm-year panel used in the empirical analysis. Table A1 in Appendix A reports the sample-construction process and the resulting sample sizes used in the descriptive statistics, baseline analysis, robustness checks, and mechanism tests.

3.2. Variables

3.2.1. Dependent Variable

We measure within-firm income inequality (*Pay_Ratio*) as the ratio of the reported average annual compensation per person of directors, supervisors, and senior executives to the reported average annual compensation per person of employees, following the literature on within-firm pay gaps and income inequality within enterprises [7,16,36]. On the executive side, the source compensation file separately reports the total annual compensation of directors, supervisors, and senior executives, their total headcount, and their average annual compensation per person. Accordingly, the numerator corresponds to the average annual compensation per person of directors, supervisors, and senior executives under the source file definition. Directors and supervisors are included together with senior executives in this definition, and the file does not further distinguish whether some directors or supervisors are non-full-time executives.

On the employee side, the source file separately reports employee compensation payable and average employee annual compensation per person. Accordingly, the denominator in this study is the reported average annual compensation per employee under the source file definition.

It should also be noted that the source compensation file does not separately decompose executive compensation into cash compensation, equity incentives, bonuses, and deferred compensation. Likewise, on the employee side, the file does not separately decompose social insurance, welfare payments, temporary workers, dispatched labor, or other non-wage benefits. We therefore interpret *Pay_Ratio* as the ratio of reported average annual compensation measures on the executive and employee sides under the source file definition, rather than as a comparison of narrowly defined cash wages alone. The value of *Pay_Ratio* is calculated based on the following equation:

$$Pay_Ratio_{i,t} = \frac{ExecPay_{i,t}}{EmpPay_{i,t}} \quad (1)$$

where $ExecPay_{i,t}$ denotes the average annual compensation per person of directors, supervisors, and senior executives of firm i in year t , and $EmpPay_{i,t}$ denotes the average annual compensation per person of employees of firm i in year t . A higher $Pay_Ratio_{i,t}$ indicates a larger internal pay gap and thus a higher degree of within-firm income inequality.

3.2.2. Core Explanatory Variable

Following Lei et al. [11], we use the publicly available Managerial Climate Attention Index as the core explanatory variable. In this study, the MCA variable is downloaded directly from the dataset constructed by Lei et al. [11], rather than reconstructed by us. In the source paper, the index is constructed from the MD&A sections of firms' semi-annual and annual reports for Chinese A-share listed companies using textual analysis and machine learning techniques. Specifically, the source study begins with climate-related seed words, expands the climate dictionary using a word2vec model, counts the occurrences of dictionary words in each document, normalizes the counts by the total number of words in the same MD&A document, and further applies a TF-IDF adjustment to reduce the weight of words that are common across documents. The resulting raw and adjusted MCA measures are then scaled to range from 0 to 100.

Because the index is constructed from the MD&A section rather than from the full annual report, and because word frequencies are normalized by document length and adjusted using TF-IDF weighting, the MCA measure is less likely to be driven solely by annual-report length or generic boilerplate wording. In addition, the source paper conducts several validation checks, including manual screening of the extended dictionary, repeated algorithm checks, sectoral distribution analysis, and comparison with the climate policy uncertainty index. Since this study examines within-firm income inequality, which is a firm-level outcome, we employ the firm-level annual MCA measure provided by Lei et al. [11]. A higher value of MCA indicates a greater degree of managerial attention to climate-related risks, policies, and transition issues.

3.2.3. Control Variables

We control for firm size ($\ln_size$), return on assets (roa), leverage (lev), growth ($growth$), firm age ($firm_age$), board size ($board_size$), the largest shareholder's ownership ($top1$), CEO–Chair duality ($dual$), and capital intensity (cap). These firm-level characteristics are commonly used in studies on Chinese listed firms to account for heterogeneity in operating performance, governance structure, and resource endowments [37–39]. Detailed descriptive statistics and variable definitions are presented in Table 2.

3.2.4. Mediating Variables

Operational Stability ($stability$): We measure operational stability by the negative standard deviation of return on assets, i.e., $stability = -sd(ROA)$. We compute the standard deviation of ROA using the ROA adjusted by annual industry means from year t to $t + 2$. A higher value of stability indicates lower earnings volatility and thus greater operational stability.

Internal Control Quality ($internal_control$): Following the literature on internal control effectiveness in Chinese listed firms, we measure internal control quality using the DIB internal control index. The DIB index is a firm-year composite indicator constructed from publicly available information on internal control activities, firm and industry risk, internal audit, internal control deficiencies, compliance, and related governance information, and it has been widely adopted in prior studies as a proxy for internal control quality in Chinese listed firms [34,35]. A higher value of $internal_control$ therefore indicates better internal control quality. This continuous measure captures variation in internal control quality across firms and over time more precisely [21].

Table 2. Descriptive statistics.

	Variables	N	Mean	SD	Min	Median	Max	Definition
Dependent variable	<i>Pay_Ratio</i>	51,518	2.562	1.964	0.156	2.066	11.653	Average executive compensation/average employee compensation
Core explanatory variable	<i>MCA</i>	51,637	11.954	10.026	1.487	8.671	53.586	Managerial climate attention index
Control variables	<i>ln_size</i>	51,511	22.108	1.425	19.265	21.895	26.851	Natural logarithm of total assets
	<i>roa</i>	51,514	0.023	0.039	−0.128	0.021	0.142	Return on assets
	<i>lev</i>	51,514	0.412	0.213	0.053	0.393	1.067	Total debt/Total assets
	<i>growth</i>	51,464	0.358	1.496	−0.653	0.098	12.555	(Current year operating revenue/Previous year operating revenue) − 1
	<i>firm_age</i>	51,637	7.827	5.944	0.000	7.000	23.000	The current year minus the year of the company's founding
	<i>board_size</i>	51,637	9.333	2.049	5.000	9.000	16.000	Number of board directors
	<i>top1</i>	51,406	34.240	15.170	8.260	31.800	74.960	Shareholding of the first largest shareholder/total shares
	<i>dual</i>	40,174	0.277	0.447	0.000	0.000	1.000	Assigned a value of 1 if the chairman also serves as general manager, and 0 otherwise.
	<i>cap</i>	51,406	0.161	0.115	0.013	0.131	0.554	Total assets/Operating revenue
	<i>stability</i>	33,029	−0.035	0.042	−0.250	−0.021	−0.002	Negative standard deviation of ROA
Variables in mechanism analysis	<i>internal_control</i>	47,767	6.211	1.685	0.000	6.615	9.954	DIB internal control index score (divided by 100); a higher value indicates better internal control quality
	<i>green_patent</i>	51,030	0.280	1.173	0.000	0.000	9.000	ln(1 + number of granted green invention patents)

Note: SD = standard deviation. Italics indicate variables.

Green Innovation (*green_patent*): We measure green innovation as the natural logarithm of one plus the number of granted green invention patents, i.e., $green_patent = \ln(1 + GNV)$, where *GNV* denotes the number of granted green invention patents. The data are obtained from the China National Intellectual Property Administration (CNIPA). A higher *green_patent* value indicates a greater degree of green technological innovation.

3.3. Empirical Model

Traditional two-way fixed effects models may fail to fully capture the complexity and potential nonlinearity in panel data, which may lead to model misspecification. To address this issue, this study further employs a DDML approach [40]. The partially linear model is specified as follows:

$$Pay_Ratio_{i,t} = \alpha MCA_{i,t} + g(X_{i,t}) + \varepsilon_{i,t} \quad (2)$$

$$MCA_{i,t} = m(X_{i,t}) + v_{i,t} \quad (3)$$

where $Pay_Ratio_{i,t}$ denotes within-firm income inequality, $MCA_{i,t}$ denotes managerial climate attention, and $X_{i,t}$ includes control variables, firm-fixed effects, and year-fixed effects. The functions $g(\cdot)$ and $m(\cdot)$ are not restricted to a predetermined functional form and are estimated through machine learning-assisted nuisance estimation. The coefficient α is the parameter of primary interest.

In the estimation, a cross-fit partialing-out procedure is implemented with 5-fold cross-fitting [41]. In the baseline implementation, the DDML estimator is carried out in Stata 16 using the `xporegress` routine under a partialling-out framework, and lasso is used to estimate the nuisance functions with data-driven plugin penalty selection. Firm-fixed effects are absorbed through within transformation based on firm identifiers, while year-fixed effects are included as year dummies in the DDML input set. The baseline

specification uses the within-transformed versions of control variables. The technical details of the DDML implementation are summarized in Table A2 in Appendix B.

As an additional robustness exercise, we also re-estimate the partially linear DDML model in Python 3.14 using several alternative nuisance learners, including elastic net, random forest, gradient boosting, and post-lasso OLS. In these additional DDML estimations, we implement 5-fold cross-fitting with firm-level grouped folds, so that all firm-year observations belonging to the same firm are assigned to the same fold. Firm-fixed effects are again removed through within transformation, while year-fixed effects enter as year dummies. Inference is reported with firm-clustered standard errors, while two-way clustering by firm and year is reported as an additional check.

While this DDML framework helps flexibly control for observable covariates and reduce model misspecification under high-dimensional controls and possible nonlinearities, it does not by itself eliminate omitted-variable bias, reverse causality, or time-varying unobserved confounding. We therefore interpret the empirical results in this study as evidence on association rather than strict causal effect. To further assess whether the baseline relationship is driven by observable differences in firms' disclosure and information environment, we also conduct a set of additional robustness checks.

4. Empirical Results

4.1. Result of Baseline Estimation

The DDML results are reported in Column (1) of Table 3, where we employ a 5-fold cross-fitting procedure with the DDML algorithm. The coefficient of MCA is 0.0083, significant at the 1% level. In terms of economic magnitude, a 10-point increase in MCA is associated with an increase in within-firm income inequality of approximately 0.083 (0.0083×10) units. This magnitude is economically meaningful but moderate. As shown in Table 2, the standard deviation of MCA is 10.026, so a 10-point increase corresponds approximately to a one-standard-deviation increase in managerial climate attention rather than a trivial fluctuation. Moreover, given that the sample mean of *Pay_Ratio* is 2.562, the implied increase of 0.083 represents about 3.2% of the average executive–employee pay ratio. Taken together, these results suggest that greater managerial climate attention is associated with a nontrivial, though not extremely large, widening of within-firm income inequality. This result highlights the role of managerial decisions in shaping compensation structures within firms and provides initial evidence that managerial climate attention may have important distributional consequences within firms, which are further examined in the mechanism analysis below.

4.2. Robustness Tests

We conduct a set of additional tests to examine the robustness of the baseline results. First, Column (2) of Table 3 replaces the original MCA with its standardized counterpart (*MCA_std*), thereby reducing concerns that the estimated association is sensitive to the scale of the explanatory variable. Second, Column (3) restricts the sample to the pre-2020 period to abstract from major post-2020 shocks, including the COVID-19 pandemic and related macroeconomic and policy disruptions, which may confound the relationship between managerial climate attention and within-firm income inequality. Third, Column (4) reports results from an alternative two-way fixed-effects (TWFE) specification that includes firm-fixed effects and industry-year-fixed effects, thereby absorbing time-varying industry-level heterogeneity. The coefficient of MCA remains positive and statistically significant.

Table 3. Results of baseline estimation and robustness tests.

Variables	DDML Approach	Robustness Checks		
	(1)	(2)	(3)	(4)
	DDML	Standardized MCA	Pre-2020 Sample	Firm FE + Industry-Year FE
MCA	0.0083 *** (0.0014)		0.0073 *** (0.0021)	0.0050 * (0.0028)
MCA_std		0.0852 *** (0.0141)		
Controls	✓	✓	✓	✓
Firm-fixed effects	✓	✓	✓	✓
Industry-year-fixed effects	–	–	–	✓
Year-fixed effects	✓	✓	✓	–
Model	DDML	DDML	DDML	TWFE
K-folds	5	5	5	–
N	39,866	39,866	27,452	35,283
R-squared	–	–	–	0.651

Note: Robust standard errors are reported in parentheses. *p*-values: * *p* < 0.1, *** *p* < 0.01.

4.2.1. Additional Robustness Tests: Alternative Measurement of Inequality

To further assess the robustness of the baseline findings, we conduct three additional sensitivity tests by using alternative measurement of inequality. The results are reported in Table 4.

Table 4. Results of additional robustness tests: Alternative measurement of inequality.

Variables	(1)	(2)	(3)	(4)
	Log Pay Ratio	Industry-Year-Adjusted Pay Ratio	Industry-Year-Adjusted log Pay Ratio	Excluding Extreme Compensation Patterns
MCA	0.0038 *** (0.0006)	0.0080 *** (0.0015)	0.0028 *** (0.0005)	0.0074 *** (0.0011)
Controls	✓	✓	✓	✓
Firm-fixed effects	✓	✓	✓	✓
Year-fixed effects	✓	✓	✓	✓
Learning model	Lasso	Lasso	Lasso	Lasso
K-folds	5	5	5	5
N	39,866	35,312	35,312	39,070

Note: Robust standard errors are reported in parentheses. *** *p* < 0.01.

First, we replace the executive–employee pay ratio with its logarithmic form as an alternative pay-gap measure. As reported in Column (1), the coefficient of managerial climate attention remains positive and statistically significant, suggesting that the baseline conclusion is not sensitive to the specific construction of the dependent variable.

Second, we replace the dependent variable with the industry-year-adjusted pay gaps. As reported in Column (2), the coefficient of MCA is still significantly positive.

Third, we replace the dependent variable with the industry-year-adjusted log pay ratio. As shown Column (3), MCA also has a significantly positive coefficient.

Fourth, to rule out the possibility that the baseline findings are driven by unusually high or low compensation observations, we exclude firm-year observations with executive–employee pay ratios in the top and bottom 1% of the sample and re-estimate the DDML specification. As shown in Column (4), the coefficient of MCA remains positive and statisti-

cally significant. Taken together, these additional sensitivity tests provide further support for the robustness of our main findings.

4.2.2. Additional Robustness Tests: Alternative Learning Model

We further re-estimate the DDML specification using several alternative nuisance learners, including elastic net, random forest, gradient boosting, and post-lasso OLS, and report the results in Table 5. To address potential leakage in panel data, these additional DDML estimations implement 5-fold cross-fitting with firm-level grouped folds, so that all firm-year observations belonging to the same firm are assigned to the same fold. Across all alternative learners, the coefficient of managerial climate attention remains positive and statistically significant. In terms of magnitude, the estimated coefficients range from 0.0069 to 0.0083 under firm-clustered standard errors, which is close to the baseline DDML estimate. The coefficient becomes slightly smaller under more flexible nonlinear learners such as random forest and gradient boosting, but the sign, statistical significance, and overall economic interpretation remain unchanged. The result also remains robust when two-way clustered standard errors by firm and year are used. These findings suggest that the positive association between managerial climate attention and within-firm income inequality is not driven by the specific choice of lasso as the nuisance learner.

Table 5. Results of additional robustness tests: Alternative learning model.

Variables	(1)	(2)	(3)	(4)	(5)
	Lasso	Elastic Net	Random Forest	Gradient Boosting	Post-Lasso OLS
MCA	0.0083 *** (0.0026)	0.0083 *** (0.0026)	0.0069 *** (0.0025)	0.0071 *** (0.0026)	0.0083 *** (0.0026)
Controls	✓	✓	✓	✓	✓
Firm-fixed effects	✓	✓	✓	✓	✓
Year-fixed effects	✓	✓	✓	✓	✓
Learning model	Lasso	Elastic net	Random forest	Gradient boosting	Post-lasso OLS
K-folds	5	5	5	5	5
Sample splitting	Firm-level grouped folds	Firm-level grouped folds	Firm-level grouped folds	Firm-level grouped folds	Firm-level grouped folds
N	39,866	39,866	39,866	39,866	39,866

Note: Firm-clustered standard errors are reported in parentheses. In all specifications, cross-fitting is implemented using firm-level grouped folds so that all observations from the same firm are assigned to the same fold. *** $p < 0.01$.

4.2.3. Additional Robustness Tests: Alternative Timing Setup and Sample

We further expand the robustness analysis by considering alternative timing setup and sample and report the results in Table 6.

First, we examine alternative lag structures by replacing managerial climate attention with its one-period and two-period lags. As reported in Columns (1) and (2), the coefficient of the one-period lag remains positive and statistically significant at the 1% level, while the coefficient of the two-period lag also remains positive and significant at the 10% level. These results suggest that the positive relationship between managerial climate attention and within-firm income inequality is not driven solely by contemporaneous variation and exhibits a certain degree of persistence over time.

Second, we examine alternative outlier treatments by re-winsorizing the main variables at the 0.5/99.5 and 2.5/97.5 percentiles. The results are reported in Columns (3) and (4).

Third, we restrict the sample to a balanced panel over 2005–2023. The result is reported in Column (5).

Fourth, we re-estimate the baseline DDML specification after excluding financial firms, after excluding ST firms, and after excluding both financial and ST firms simultaneously.

The results are reported in Table A3 in Appendix C. Across all specifications, the coefficient of managerial climate attention remains positive and statistically significant, which provides further support for the robustness of the baseline finding.

Table 6. Results of additional robustness tests: Alternative timing setup and sample.

Variables	(1) One-Period-Lagged MCA	(2) Two-Period-Lagged MCA	(3) Winsorize 0.5/99.5	(4) Winsorize 2.5/97.5	(5) Balanced Panel 2005–2023
MCA	0.0091 *** (0.0018)	0.0037 * (0.0019)	0.0062 *** (0.0013)	0.0056 *** (0.0013)	0.0140 *** (0.003)
Controls	✓	✓	✓	✓	✓
Firm-fixed effects	✓	✓	✓	✓	✓
Year-fixed effects	✓	✓	✓	✓	✓
Learning model	Lasso	Lasso	Lasso	Lasso	Lasso
K-folds	5	5	5	5	5
N	35,158	31,910	39,866	39,866	7828

Note: Robust standard errors are reported in parentheses. * $p < 0.10$, *** $p < 0.01$.

4.2.4. Additional Robustness Tests: More Identification-Oriented Checks

To further address concerns related to reverse causality and firm-level underlying trends, we conduct several additional identification-oriented checks, and the results are reported in Table 7.

Table 7. Results of additional robustness tests: More identification-oriented checks.

Variables	(1) One-Period-Ahead MCA	(2) Two-Period-Ahead MCA	(3) One-Period-Ahead Pay Ratio	(4) Change in Next-Period Pay Ratio	(5) Including Firm-Specific Trends	(6) Including Province-Year FE	(7) Including Industry-Year FE
MCA	0.0060 *** (0.0016)	0.0016 (0.0016)	0.0118 *** (0.0018)	0.0037 ** (0.0018)	0.0101 *** (0.0027)	0.0144 *** (0.0027)	0.0031 ** (0.0016)
Controls	✓	✓	✓	✓	✓	✓	✓
Firm-fixed effects	✓	✓	✓	✓	✓	✓	✓
Year-fixed effects	✓	✓	✓	✓	✓	–	–
Province-year-fixed effects	–	–	–	–	–	✓	–
Industry-year-fixed effects	–	–	–	–	–	–	✓
Firm-specific linear trends	–	–	–	–	✓	–	–
Model	DDML	DDML	DDML	DDML	FE	FE	DDML
K-folds	5	5	5	5	–	–	5
N	35,099	31,842	35,108	35,057	39,734	36,439	29,132

Note: Robust standard errors are reported in parentheses, except for Column (5), where standard errors are clustered at the firm level. ** $p < 0.05$, *** $p < 0.01$.

First, we implement placebo tests by replacing current managerial climate attention with its one-period-ahead and two-period-ahead values to predict current within-firm income inequality. As reported in Columns (1) and (2), the coefficient of the one-period-ahead value remains positive and statistically significant, whereas the coefficient of the two-period-ahead value is positive but statistically insignificant. This mixed placebo

evidence suggests that slowly moving firm-level factors may still matter and therefore we should caution against a strong causal interpretation.

Second, we examine whether current managerial climate attention predicts future pay inequality and future changes in the pay ratio. As reported in Columns (3) and (4), the coefficients remain positive and statistically significant in both specifications, indicating that the positive association between managerial climate attention and within-firm income inequality is not limited to contemporaneous correlation and also extends to subsequent periods.

Third, we augment the specification by including firm-specific linear trends. As reported in Column (5), the coefficient of managerial climate attention remains positive and statistically significant, suggesting that the baseline relationship is unlikely to be driven solely by firm-level long-run trends.

Fourth, we further include province-year-fixed effects to absorb time-varying provincial shocks, including differences in local policy environment, information conditions, and labor-market dynamics. The result is shown in Column (6). The coefficient of managerial climate attention remains positive and statistically significant in this specification as well.

Fifth, we further add an additional DDML-based check with industry-year adjustment to absorb time-varying industry-level shocks. The result is reported in Column (7). The coefficient of managerial climate attention remains positive and statistically significant in this specification as well. Taken together, these additional checks provide further support for the robustness of the main findings. At the same time, given the mixed placebo evidence, these findings are more appropriately interpreted as robust associations rather than causal estimates.

Moreover, as an additional validity exercise, we further control for environmental disclosure intensity, analyst coverage, and media attention, both individually and jointly, to assess whether the baseline relationship is driven primarily by firms' disclosure incentives or information environment. The corresponding results are reported in Table A4 in Appendix D. Across these specifications, the coefficient of managerial climate attention remains positive and statistically significant. These checks provide supplementary support for the validity of the MCA measure, although they do not fully eliminate broader endogeneity concerns related to omitted variables or reverse causality.

4.3. Decomposition of the Inequality

To further clarify whether managerial climate attention widens the executive–employee pay ratio through higher executive compensation, lower employee compensation, or both, we further decompose the pay ratio into its two components, and the results are reported in Table 8. Specifically, we replace the dependent variable with $\ln(\text{ExecutivePay})$ and $\ln(\text{EmployeePay})$, respectively, while keeping the same DDML specification as in the baseline analysis. This decomposition helps identify whether the increase in within-firm income inequality is driven mainly by higher compensation at the top of the organizational hierarchy, weaker employee-side compensation, or both.

The results in Table 8 show that managerial climate attention is positively associated with executive compensation but negatively associated with employee compensation. Specifically, the coefficient of managerial climate attention is 0.0011 in the regression for $\ln(\text{ExecutivePay})$ and -0.0027 in the regression for $\ln(\text{EmployeePay})$, while the coefficient in the pay-ratio regression is 0.0083. These findings suggest that the widening pay gap is jointly associated with higher executive-side compensation and weaker employee-side compensation. In this sense, the baseline result reflects not only stronger rewards for executive strategic decision-making and coordination responsibilities, but also a less favorable compensation pattern on the employee side.

Table 8. Results of decomposition of the pay ratio.

Variables	(1)	(2)
	ln(<i>ExecutivePay</i>)	ln(<i>EmployeePay</i>)
MCA	0.0011 *** (0.0004)	−0.0027 *** (0.0005)
Controls	✓	✓
Firm-fixed effects	✓	✓
Year-fixed effects	✓	✓
Learning model	Lasso	Lasso
K-folds	5	5
N	39,866	39,866

Note: Robust standard errors are reported in parentheses. *** $p < 0.01$.

4.4. Mechanism Analysis

As the baseline results indicate that managerial climate attention is positively associated with within-firm income inequality, this study further examines the potential mechanisms from three dimensions: operational stability, internal control quality, and green innovation. Specifically, we examine whether managerial climate attention is significantly associated with each proposed channel variable. We also inspect the economic logic of the mechanism, which lies in how changes in these variables may further translate into within-firm income inequality. Following the baseline analysis, the mechanism tests are estimated using the same DDML framework, with firm-fixed effects absorbed through within transformation and year-fixed effects included in the estimation. To facilitate the comparison of coefficient magnitudes, we first report the baseline estimation results again in Column (1) of Table 9.

Table 9. Results of mechanism analysis.

Variables	Baseline DDML	Mechanism of Operational Stability			Mechanism of Internal Control			Mechanism of Green Innovation		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	With-Firm Income Inequality	Stability	With-Firm Income Inequality	With-Firm Income Inequality	Internal Control	With-Firm Income Inequality	With-Firm Income Inequality	Green Innovation	With-Firm Income Inequality	With-Firm Income Inequality
MCA	0.0083 *** (0.0014)	0.0002 *** (0.00005)	1.1637 *** (0.1983)	0.0056 *** (0.0018)	0.0126 *** (0.0017)		0.0079 *** (0.0015)	0.0047 *** (0.0005)		0.0071 *** (0.0024)
Stability				√						
Internal control							0.0682 *** (0.0053)	√		
Green innovation									0.4056 *** (0.0615)	√
Controls	√	√	√	√	√	√	√	√	√	√
Firm-fixed effects	√	√	√	√	√	√	√	√	√	√
Year-fixed effects	√	√	√	√	√	√	√	√	√	√
Learning model	Lasso	Lasso	Lasso	Lasso	Lasso	Lasso	Lasso	Lasso	Lasso	Lasso
N	39,866	25,591	25,549	25,549	37,209	37,130	37,130	39,516	39,428	39,428

Note: Robust standard errors are reported in parentheses. *** $p < 0.01$.

4.4.1. Operational Stability

The indicator of operational stability is constructed as the negative standard deviation of ROA. A higher value indicates lower earnings volatility and more stable operations. We compute the standard deviation of ROA using the ROA adjusted by annual industry means from year t to $t + 2$. The result reported in Column (2) of Table 9 shows that managerial climate attention is positively associated with operational stability. The positive

coefficient of managerial climate attention therefore suggests that firms with stronger climate-oriented managerial attention tend to exhibit lower earnings volatility and greater operational stability.

Importantly, operational stability is also positively and significantly associated with within-firm income inequality. As shown in Column (3), when we use within-firm income inequality as the dependent variable and stability as the independent variable, we find that the coefficient of stability is statistically significant and positive. This result strengthens the mechanism interpretation. Greater operational stability may widen the executive–employee pay gap because more stable firms usually exhibit stronger profit persistence, greater resource-allocation capacity, and a stronger need for strategic coordination. Under such conditions, firms may place a higher premium on executive capabilities and strategic coordination, while ordinary employee compensation is often more rigid and slower to adjust. This interpretation is consistent with evidence that internal pay dispersion tends to widen when firms expand or upgrade their organizational structure, as the returns to managerial coordination and higher-order tasks become more pronounced [7,8].

To further verify that stability is a potential mechanism, we use within-firm income inequality as the dependent variable and MCA as the independent variable, while including stability as a control variable. The coefficient estimates are reported in Column (4). We find that the coefficient of MCA remains statistically significant and positive, but its magnitude is smaller than in the specification without stability as a control variable, as shown in Column (1), which presents our baseline results. Taken together, these findings provide evidence consistent with the view that operational stability is a plausible channel through which managerial climate attention may be associated with within-firm income inequality [15,20].

(It is notable that if future information is used to construct the stability indicator, that would create look-ahead bias. To mitigate this concern, we also use the ROA adjusted by annual industry means from year $t - 2$ to t to compute the standard deviation of ROA and then employ this measure to test the operational stability mechanism. We find that this mechanism still holds.)

4.4.2. Internal Control Quality

We measure the internal control quality by the DIB internal control index. A higher value indicates better internal control quality. The index is a firm-year composite measure of internal control quality that is constructed from public information on firms' internal control activities, including firm and industry risk, internal audit, internal control deficiencies, compliance, and related governance information [34,35]. As reported in Column (5) of Table 3, managerial climate attention is positively and significantly associated with internal control quality. The positive coefficient therefore suggests that firms with stronger climate-oriented managerial attention tend to exhibit stronger internal control and governance arrangements.

Internal control quality may further matter for within-firm income inequality because it affects governance discipline, internal monitoring, and the formalization of managerial responsibilities [21,22]. When climate-related strategy becomes more central to firm decision-making, stronger internal control can make executives' climate-related coordination, compliance, disclosure, and risk-management responsibilities more visible, more measurable, and more closely linked to performance evaluation. In turn, compensation committees may place greater weight on these high-level strategic and governance-related tasks, thereby increasing the compensation premium attached to executive positions. This interpretation is also consistent with recent evidence showing that executive incentives are increasingly tied to strategic nonfinancial objectives, including ESG-related goals [9,23].

Because ordinary employee compensation is usually less directly linked to such high-level strategic and governance responsibilities, better internal control quality may be associated with a wider executive–employee pay gap. As shown in Column (6), when we use within-firm income inequality as the dependent variable and internal control quality as the independent variable, we find that the coefficient of internal control quality is statistically significant and positive. Internal control quality is positively and significantly associated with within-firm income inequality, which strengthens the mechanism interpretation.

To further verify that internal control quality is a potential mechanism, we use within-firm income inequality as the dependent variable and MCA as the independent variable, with internal control as a control variable. The coefficient estimates are reported in Column (7). We find that the coefficient of MCA remains statistically significant and positive, but its magnitude is smaller than in the specification without internal control as a control variable. Therefore, we find that internal control quality constitutes another plausible channel through which managerial climate attention may shape within-firm income inequality.

4.4.3. Green Innovation

We measure green innovation as the natural logarithm of one plus the number of granted green invention patents. The result reported in Column (8) of Table 3 shows that managerial climate attention significantly promotes green innovation, indicating that firms with stronger climate-oriented managerial attention are more likely to engage in green technological development [6,12].

Green innovation may further influence within-firm income inequality because of several reasons. First, by introducing carbon constraints and ESG-related requirements, green innovation increases the complexity of firms' strategic and operational decisions. Second, green technological upgrading raises the multidimensionality of employee tasks and the skill requirements embedded in production and management processes. Third, cross-departmental collaboration and multiple performance objectives increase organizational coordination difficulty. These changes may strengthen firms' dependence on top managers' strategic capabilities, increase the relative value of executives, and widen the internal pay gap. More broadly, innovation-driven upgrading may also reshape labor demand and income distribution by increasing the premium placed on higher-order managerial and skill-intensive tasks [24]. As shown in Column (9), when we use within-firm income inequality as the dependent variable and green innovation as the independent variable, we find that the coefficient of green innovation is statistically significant and positive. This suggests that green patents are positively associated with within-firm income inequality.

To further verify that green innovation is a potential mechanism, we use within-firm income inequality as the dependent variable and MCA as the independent variable, with green innovation as a control variable. The coefficient estimates are reported in Column (10). We find that the coefficient of MCA remains statistically significant and positive, but its magnitude is smaller than in the specification without green innovation as a control variable. Therefore, we find that green innovation constitutes a plausible channel through which managerial climate attention may reshape firms' internal income distribution [6,12,24].

To further validate the robustness of our results, we conducted an additional analysis by adopting a temporally ordered approach: we used MCA in year $t - 1$, the mechanism variable in year t , and pay inequality in year $t + 1$. The results continue to support our argument. This additional analysis is included in Table A5 in Appendix E.

4.5. Heterogeneity Analysis

To investigate the heterogeneity in the relationship between managerial climate attention and within-firm income inequality under different sample conditions, we divide the sample into high-pollution and low-pollution firms, high-risk and low-risk firms, as well as firms with high and low ownership concentration. Specifically, firms are classified as high-pollution or low-pollution according to whether they belong to heavily polluting industries. High-risk and low-risk groups are defined based on an earnings-volatility-based corporate risk-taking indicator, which is measured by the standard deviation of annual industry-adjusted ROA over a rolling window. Firms with higher values of this indicator are classified as high-risk firms, whereas those with lower values are classified as low-risk firms. High- and low-ownership-concentration groups are defined according to the largest shareholder's ownership (*top1*), obtained from the CSMAR database, with the sample median used as the cutoff. As shown in Table 10, the positive association between managerial climate attention and within-firm income inequality is more pronounced among low-pollution firms and firms with lower ownership concentration, while the evidence for high-risk firms is more suggestive. (As an additional ownership-related split, we also estimate the model separately for state-owned and non-state-owned enterprises. The corresponding results are reported in Table A6 in Appendix F, and the coefficient of managerial climate attention remains positive and statistically significant in both subsamples.)

Table 10. Results of heterogeneity analysis.

Variables	Pollution		Risk		Ownership Concentration	
	(1)	(2)	(3)	(4)	(5)	(6)
	High	Low	High	Low	High	Low
MCA	−0.006 ** (0.003)	0.010 *** (0.002)	0.008 *** (0.003)	0.003 (0.002)	0.002 (0.002)	0.015 *** (0.002)
Controls	✓	✓	✓	✓	✓	✓
Firm-fixed effects	✓	✓	✓	✓	✓	✓
Year-fixed effects	✓	✓	✓	✓	✓	✓
N	8239	27,073	13,092	12,457	18,934	20,932
Difference <i>p</i> -value	0.000		0.080		0.002	

Note: Robust standard errors are reported in parentheses. ** $p < 0.05$, *** $p < 0.01$.

To further examine whether the differences in coefficients across subgroups are statistically significant, we estimate interaction-term regressions. The difference test *p*-values, reported in the last row of Table 10, are 0.000, 0.080, and 0.002, respectively, suggesting clear heterogeneous associations across pollution intensity and ownership concentration, while the difference across firm-risk groups is only marginally significant.

The results of the heterogeneity analysis can be interpreted as follows.

First, the stronger association observed in low-pollution industries is not necessarily inconsistent with climate-related strategic logic. Related evidence shows that the positive association of managerial climate attention can be more pronounced in less environmentally sensitive industries, suggesting that in such settings managerial climate attention is more likely to be translated into substantive internal action rather than being absorbed by baseline compliance obligations. In heavily polluting industries, by contrast, climate-related managerial attention is often tied more closely to emissions control, regulatory compliance, and transition investment under stricter environmental standards and pollution-reduction requirements. Existing evidence also shows that green financial policy can reduce internal wage disparities in highly polluting firms. Taken together, these findings suggest that in heavily polluting industries the marginal association of managerial climate attention may

be partly attenuated by compliance pressure, financing constraints, and transition costs, whereas in low-pollution industries it may be more readily converted into governance adjustment, cross-departmental coordination, sustainability disclosure, and executive incentive design. This makes the inequality-widening pattern easier to observe in low-pollution industries.

Second, firms with higher risk are exposed to greater uncertainty and operating pressure. In response to climate-related concerns, managers in such firms are more likely to reallocate internal resources and incentives, thereby corresponding to a more pronounced association with within-firm income inequality [15,20].

Finally, for firms with lower ownership concentration, weaker controlling shareholder constraints provide managers with greater discretion, making managerial climate attention more likely to exert a stronger influence on internal income distribution.

5. Discussion

5.1. Main Findings and Mechanism Interpretation

This study finds that managerial climate attention is positively associated with within-firm income inequality. In the baseline DDML specification, the coefficient of managerial climate attention is 0.0083 and significant at the 1% level, implying that a 10-point increase in managerial climate attention is associated with an increase of about 0.083 in the executive–employee pay ratio. Relative to the sample mean of 2.562, this implied increase is economically meaningful, amounting to about 3.2% of the average pay ratio. The result suggests that climate-oriented managerial attention has internal distributional consequences beyond firms' environmental actions and risk outcomes [5,11]. The decomposition analysis further shows that this widening pattern is jointly associated with higher executive compensation and lower employee compensation, suggesting that the internal distributional consequences of managerial climate attention operate through both stronger rewards at the top and weaker compensation outcomes on the employee side.

The mechanism results provide a possible explanation for this pattern. Managerial climate attention is positively associated with operational stability, internal control quality, and green innovation. These findings suggest that climate-related managerial attention may be associated with internal income distribution through changes in firms' operating conditions, governance arrangements, and innovation-related adjustment [15,20]. Taken together, the evidence is consistent with the view that climate-oriented managerial attention may widen the internal pay gap by increasing the relative value of executive coordination, governance, and strategic capabilities within firms [25,26].

5.2. Heterogeneity and Implications

The heterogeneity results further refine the baseline interpretation. The positive association between managerial climate attention and within-firm income inequality is stronger among firms in low-pollution industries and firms with lower ownership concentration, while the evidence for firms with higher risk is more suggestive. The corresponding difference test *p*-values are 0.000, 0.080, and 0.002, respectively, suggesting clearer heterogeneity across pollution intensity and ownership concentration, whereas the difference across firm-risk groups is only marginally significant.

The stronger association observed in low-pollution industries is not necessarily inconsistent with climate-related strategic logic. In relatively low-pollution industries, managerial climate attention may be more readily translated into governance adjustment, sustainability disclosure, cross-departmental coordination, and executive incentive design, because it is less likely to be absorbed mainly by baseline compliance obligations. By contrast, in heavily polluting industries, climate-related managerial attention is more likely

to be directed toward emissions control, regulatory compliance, and transition investment under stricter environmental constraints. For firms with higher risk, climate-related attention is more likely to trigger resource reallocation and incentive adjustment under uncertainty [15,20]. For firms with lower ownership concentration, weaker monitoring by controlling shareholders may leave managers with greater discretion to reshape internal compensation arrangements.

The additional robustness tests reinforce these interpretations. For example, the main result remains positive and significant when the pay-gap measure is transformed into its logarithmic form, when one-period and two-period lagged managerial climate attention are used, and when extreme compensation observations are excluded. Overall, the findings imply that climate-related strategy should be evaluated not only by environmental outcomes, but also by its internal distributional consequences [16,42].

6. Conclusions

This study examines the relationship between managerial climate attention and within-firm income inequality using Chinese listed firms from 2001 to 2023. Using a double/debiased machine learning framework, we find that greater managerial climate attention is significantly associated with a wider executive–employee pay gap. This relationship remains robust across alternative specifications and additional sensitivity tests. Further analyses suggest that operational stability, internal control quality, and green innovation may help explain this pattern, while the heterogeneity results show that the association is more pronounced among firms in low-pollution industries and firms with lower ownership concentration, with more suggestive evidence among firms with higher risk. Decomposition results further indicate that the widening pay gap is associated with both higher executive-side compensation and weaker employee-side compensation.

These findings should nevertheless be interpreted with caution. The measure of managerial climate attention is derived from textual information in firms' MD&A disclosures and may not fully distinguish substantive managerial attention from disclosure style or impression management. Although the MCA index uses document-length normalization and TF-IDF adjustment, and although our additional robustness checks control for environmental disclosure, analyst coverage, and media attention, we are unable to fully control for annual-report length, MD&A length, disclosure tone, and institutional ownership in all specifications. Therefore, the MCA variable should be interpreted as a text-based proxy for managerial climate attention rather than a perfect measure of substantive managerial commitment. Although the empirical design and additional tests strengthen the robustness of the analysis, the observational nature of the data still limits strong causal interpretation. Moreover, the executive–employee pay ratio cannot fully capture broader wage dispersion within firms, and the available compensation data do not allow a more detailed breakdown of compensation components. The analysis also focuses on three main channels, while other mechanisms may also matter.

Future research could build on more granular employee-level compensation data to develop richer measures of intra-firm wage dispersion and examine additional channels through which climate-related managerial attention reshapes internal income distribution. More broadly, the findings suggest that firms should pay closer attention to the internal distributional consequences of climate-related strategic adjustment and design governance arrangements that better balance environmental objectives with income fairness within the firm.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. Supplementary Information on the Sample-Construction Process

Table A1 reports the sample-construction process and the resulting sample sizes used in the main descriptive, robustness, and mechanism-related specifications. The table is intended to clarify why the number of observations differs across the descriptive statistics, baseline regressions, robustness checks, and mechanism analyses. In the main analysis, the effective sample size varies because different specifications require different variables, lags, future values, sample restrictions, or mechanism-related measures. This table therefore helps clarify the source of sample-size variation across the main empirical analyses.

Table A1. Sample construction and sample sizes.

Step/Specification	N
Initial imported sample	51,637
Baseline DDML sample	39,866
Pre-2020 sample	20,002
Industry-year FE sample	29,132
Log pay ratio sample	39,866
One-period-lagged MCA sample	35,158
Two-period-lagged MCA sample	31,910
Excluding extreme compensation patterns sample	39,070
Alternative learners sample	39,866
One-period-ahead MCA sample	35,099
Two-period-ahead MCA sample	31,842
One-period-ahead pay ratio sample	35,108
Change in next-period pay ratio sample	35,057
Firm-specific trends sample	39,734
Province-year FE sample	36,439
Pay-ratio decomposition sample	39,866
Operational stability mechanism sample	25,591
Internal control mechanism sample	37,209
Green innovation mechanism sample	39,516
Industry-year-adjusted pay gap sample	35,312
Industry-year-adjusted log pay gap sample	35,312
Winsorize 0.5/99.5 sample	39,866
Winsorize 2.5/97.5 sample	39,866
Balanced panel 2005–2023 sample	7828
SOE sample	14,157
Non-SOE sample	24,473

Table A1. Cont.

Step/Specification	N
Excluding financial firms sample	38,889
Excluding ST firms sample	37,750
Excluding financial and ST firms sample	37,220

Note: The table reports the effective number of firm-year observations used in each specification. Differences in sample size arise because some models require lagged variables, future values, mechanism variables, alternative sample restrictions, or additional exclusion rules.

Appendix B. Technical Details of the DDML Implementation

To improve the transparency and reproducibility of the empirical design, this appendix provides additional technical details on the implementation of the DDML estimator used in the main analysis.

Our baseline specification is implemented using Stata's `xporegress` routine under a partialling-out/orthogonalized DDML framework. The nuisance components are estimated using lasso. The estimation uses 5-fold cross-fitting, so that the nuisance functions are estimated on the training folds and the target parameter is evaluated on the held-out fold.

The regularization parameter is not chosen manually. Instead, the lasso learner uses data-driven plugin penalty selection. This means that the penalty parameter is selected automatically by the estimator on the basis of the sample information, thereby reducing researcher discretion and improving reproducibility.

Firm-fixed effects are incorporated through a transformation based on the firm identifier. Specifically, before running `xporegress`, we subtract the firm-specific mean from the dependent variable, the treatment variable, and all continuous controls. Year-fixed effects are then included directly as year dummies in the DDML input set. The baseline control set consists of the within-transformed versions of firm size, return on assets, leverage, firm growth, firm age, board size, largest shareholder ownership, CEO-Chair duality, capital intensity.

Because the DDML procedure in this study is used primarily for robust parameter estimation and inference, rather than standalone predictive model evaluation, the current implementation does not separately store fold-level predictive statistics such as out-of-sample R^2 or RMSE for the nuisance stage. Instead, potential overfitting is addressed through the combination of orthogonalization, 5-fold cross-fitting, and data-driven plugin penalty selection.

For ease of reference, the main implementation choices are summarized in Table A2.

Table A2. Main implementation choices in the DDML estimation.

Component	Implementation in This Study
DDML routine	<code>xporegress</code> command in Stata
Estimation framework	Partialling-out/orthogonalized DDML
Nuisance learner	Lasso
Cross-fitting	5-fold cross-fitting
Hyperparameter tuning	Data-driven plugin penalty selection
Firm-fixed effects	Absorbed through within transformation based on firm ID
Year-fixed effects	Included directly as year dummies
Baseline controls	firm size, return on assets, leverage, firm growth, firm age, board size, largest shareholder ownership, CEO-Chair duality, capital intensity (all in within-transformed form)
Predictive performance/overfitting	The procedure is used for robust parameter estimation and inference rather than standalone predictive evaluation. Fold-level out-of-sample R^2 or RMSE is not separately stored in the current script. Overfitting is mitigated through orthogonalization, 5-fold cross-fitting, and plugin-based penalty selection.

Appendix C. Additional Robustness Tests: Excluding Financial Firms and ST Firms

Table A3 reports additional exclusion-based robustness checks. Specifically, we re-estimate the baseline DDML specification after excluding financial firms, after excluding ST firms, and after excluding both financial and ST firms simultaneously. These tests are intended to address concerns that the baseline relationship may be disproportionately influenced by firms with distinctive regulatory environments, abnormal financial conditions, or special treatment status.

As reported in the table, the coefficient of managerial climate attention remains positive and statistically significant after excluding financial firms, after excluding ST firms, and after excluding both financial and ST firms. These findings provide further support for the robustness of the baseline result and suggest that the main association is not driven solely by firms in highly regulated financial industries or by firms under special treatment status.

Table A3. Results of additional robustness tests: Excluding financial firms and ST firms.

Variables	(1) Excluding Financial Firms	(2) Excluding ST Firms	(3) Excluding Financial and ST Firms
MCA	0.0064 *** (0.0014)	0.0079 *** (0.0017)	0.0044 *** (0.0015)
Controls	✓	✓	✓
Firm-fixed effects	✓	✓	✓
Year-fixed effects	✓	✓	✓
Learning model	Lasso	Lasso	Lasso
K-folds	5	5	5
N	38,889	37,750	37,220

Note: Robust standard errors are reported in parentheses. *** $p < 0.01$.

Appendix D. Additional Robustness Tests by Including More Control Variables

To further assess whether the baseline positive association between managerial climate attention and within-firm income inequality is driven primarily by firms' disclosure incentives or external information environment, we conduct an additional set of validity checks. Specifically, we augment the baseline DDML specification by controlling for environmental disclosure intensity, analyst coverage, and media attention, first individually and then jointly. These variables are intended to capture observable differences in firms' disclosure practices and information environment that may be related to both climate-related language and internal compensation outcomes.

As reported in Table A4, the coefficient of managerial climate attention remains positive and statistically significant across all specifications. Relative to the baseline DDML estimate of 0.0083, the coefficient remains 0.0088 after controlling for environmental disclosure, 0.0072 after controlling for analyst coverage, 0.0074 after controlling for media attention, and 0.0070 when all three variables are included simultaneously. These results suggest that the baseline positive association is not driven solely by these observable disclosure- and information-related factors.

At the same time, these robustness checks should not be interpreted as fully resolving endogeneity concerns. They provide supplementary support for the validity of the MCA measure, but they do not eliminate the possibility of omitted variables, reverse causality, or time-varying unobserved confounding. For this reason, the empirical results in the main text are interpreted as associational rather than strictly causal. In addition, the positive and significant association between MCA and green innovation reported in the

mechanism analysis section provides supplementary evidence that the MCA measure is related to substantive climate-oriented corporate actions rather than merely to textual disclosure behavior.

Table A4. Results of additional robustness tests: Including more control variables.

Variables	(1) After Adding Environmental Disclosure as a Control	(2) After Adding Analyst Coverage as a Control	(3) After Adding Media Attention as a Control	(4) After Adding All Additional Controls
MCA	0.0088 *** (0.0014)	0.0072 *** (0.0014)	0.0074 *** (0.0014)	0.0070 *** (0.0014)
Controls	✓	✓	✓	✓
Environmental disclosure	✓	–	–	✓
Analyst coverage	–	✓	–	✓
Media attention	–	–	✓	✓
Firm-fixed effects	✓	✓	✓	✓
Year-fixed effects	✓	✓	✓	✓
Learning model	Lasso	Lasso	Lasso	Lasso
K-folds	5	5	5	5
N	36,566	39,427	38,841	35,627

Note: Robust standard errors are reported in parentheses. *** $p < 0.01$.

Appendix E. Robustness Checks for Mechanism Analysis

To further validate the robustness of our results, we conducted an additional analysis by adopting a temporally ordered approach: we used MCA in year $t - 1$, the mechanism variable in year t , and pay inequality in year $t + 1$. The results are reported in Table A5.

Table A5. Results of mechanism analysis based on alternative timing setup.

Variables	Baseline DDML	Mechanism of Operational Stability		Mechanism of Internal Control			Mechanism of Green Innovation			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	With-Firm Income Inequality	Stability	With-Firm Income Inequality	With-Firm Income Inequality	Internal Control	With-Firm Income Inequality	With-Firm Income Inequality	Green Innovation	With-Firm Income Inequality	With-Firm Income Inequality
MCA	0.0055 *** (0.0019)	0.0001 ** (0.00006)		0.0040 * (0.0023)	0.0084 *** (0.0017)		0.0049 ** (0.0019)	0.0045 *** (0.0005)		0.0043 ** (0.0019)
Stability			1.9748 *** (0.2044)	✓						
Internal control						0.0734 *** (0.0059)	✓			
Green innovation									0.4407 *** (0.0704)	✓
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Firm-fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year-fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Learning model	Lasso	Lasso	Lasso	Lasso	Lasso	Lasso	Lasso	Lasso	Lasso	Lasso
N	30,764	23,445	24,645	22,574	34,800	32,591	30,380	35,209	34,736	30,763

Note: Robust standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix F. Additional Split-Sample Analysis Results

Table A6 reports separate analyses for state-owned enterprises (SOEs) and non-state-owned enterprises. Although these split-sample results are not the main focus of the paper, they provide an additional ownership-related robustness check. The positive association between managerial climate attention and within-firm income inequality remains statis-

tically significant in both subsamples. The table shows that the coefficient of managerial climate attention remains positive and statistically significant in both SOEs and non-SOEs. The point estimate is somewhat larger for SOEs, but the direction and significance of the relationship are stable across ownership types. This result suggests that the baseline positive association is not confined to a single ownership structure.

Table A6. Separate analyses for SOEs and non-SOEs.

Variables	(1)	(2)
	SOEs	Non-SOEs
MCA	0.0102 *** (0.0021)	0.0083 *** (0.002)
Controls	✓	✓
Firm-fixed effects	✓	✓
Year-fixed effects	✓	✓
Learning model	Lasso	Lasso
K-folds	5	5
N	14,157	24,473

Note: Robust standard errors are reported in parentheses. *** $p < 0.01$.

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