

Article

Green Investment and the Corporate Financial Performance of Listed Manufacturing Firms in China: Examining the Moderation Role of Ownership

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Abstract

Against the backdrop of China's "dual carbon" strategy and green transformation, this study examines the impact of green investment on corporate financial performance and the moderating role of state-owned shareholding ratio. Using a sample of Chinese A-share listed manufacturing firms from 2014 to 2023 and adopting a dynamic panel data model, the empirical results show that green investment significantly improves corporate financial performance. Moreover, state-owned shareholding plays a negative moderating role, and high state ownership weakens the positive effect of green investment on financial performance. The results indicate that green investment can enhance profitability by improving operational efficiency, reducing compliance risks and enhancing corporate reputation. However, due to policy burdens, multiple agency problems and insufficient profit incentives, state-owned enterprises tend to deviate from efficiency-oriented goals in green investment, which reduces the economic returns of such investment. This study enriches the understanding of the economic consequences of green investment under heterogeneous ownership, and provides empirical support for enterprises to optimize green investment decisions and regulators to improve governance mechanisms.

Keywords: green investment; corporate financial performance; ownership structure; listed manufacturing firms

1. Introduction

In response to the pressing challenges of global climate change and the imperative of sustainable development, green development has emerged as a central strategic objective for nations worldwide [1]. As the largest developing country and the leading carbon emitter, China has formally established its "carbon peak and carbon neutrality" (dual carbon) goals, positioning ecological civilization as a national strategic priority [2]. Within this framework, enterprises—being key drivers of economic activity—play a pivotal role in fulfilling environmental responsibilities, particularly through green investment initiatives, which are critical to advancing national green transformation [3].

Green investment, as a core component of green finance, serves as a market-driven mechanism that strategically aligns financial resources with environmental objectives [4]. By channeling capital into sectors aimed at enhancing environmental performance—such

Academic Editor: Maria Rosa Trovato

Received: 19 June 2026

Revised: 17 July 2026

Accepted: 20 July 2026

Published: 27 July 2026

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as clean energy, pollution abatement, resource efficiency improvements, and green product innovation—green investment places greater emphasis on sustainability and circular resource utilization compared to conventional investment approaches [5]. Its significance extends beyond mitigating environmental externalities; it also integrates production processes with pollution prevention, thereby embedding environmental value into economic performance evaluation systems [6]. Facing mounting pressures from resource constraints and environmental degradation, listed companies are increasingly aligning with national policies by scaling up green investments and proactively assuming corporate social responsibilities—efforts that are instrumental in advancing China’s ecological civilization agenda [7]. In recent years, the Chinese government has reinforced policy support to encourage enterprises in enhancing energy efficiency and reducing emissions [8]. As primary contributors to environmental impact, enterprises are expected to uphold corresponding environmental obligations. Consequently, green investment has evolved from a policy recommendation into a strategic imperative, becoming an integral aspect of corporate governance and long-term value creation [9]. According to the latest data from the Financial Supervisory Commission, as of August 2025, China’s green investment and financing volume reached 4.68 trillion yuan, with projections indicating it will surpass 6 trillion yuan by 2030 [10]. This rapid expansion underscores the growing importance and urgency of understanding the mechanisms through which green investment influences corporate performance [11].

It is worth noting that in China’s unique institutional environment, state-owned equity plays a crucial role [12]. State-owned enterprises (SOEs) not only undertake economic functions but also shoulder important political and social responsibilities, including responding to national environmental protection policies and leading green development [13]. Compared with non-state-owned enterprises, state-owned enterprises have significant differences in resource acquisition, policy sensitivity, and risk appetite [14]. Therefore, a key but not yet fully explored question is: How does the proportion of state-owned holdings affect the relationship between green investment and corporate financial performance? Does it strengthen the positive effects of green investment such as resource support and policy dividends [3], or does it weaken or even distort these effects such as efficiency losses and agency problems [15]. Notably, state ownership engenders two countervailing mechanisms that jointly influence the transmission efficiency of green investment to financial performance—thereby introducing a theoretical tension that this study systematically investigates. First, state-owned enterprises (SOEs) benefit from preferential access to green credit, fiscal environmental subsidies, and targeted policy support. These advantages alleviate capital constraints and reduce the marginal cost of green investment, thereby establishing a positive moderating channel that enhances the profitability premium associated with such investments. Second, however, the institutional architecture of state ownership—including multi-task governance mandates, political promotion incentives, and pronounced principal–agent frictions—distorts green investment decisions toward political compliance rather than economic efficiency. This distortion manifests in forms such as overinvestment in environmentally themed projects, symbolic greenwashing, and suboptimal allocation of environmental capital—all of which attenuate the economic returns of green investment and constitute a negative moderating channel. The net moderating effect of state ownership thus hinges on the relative strength of these two opposing channels. Building on this conceptual framework, this study delineates both mechanisms with theoretical rigor and empirically tests whether the negative distortion effect dominates the resource advantage effect—thereby clarifying how ownership structure reshapes the linkage between green investment and financial performance.

In this context, this study aims to construct a multi-dimensional integrated analytical framework to explore the impact of green investment on corporate financial performance

and the moderating effect of the proportion of state-owned holdings on this impact. The study will focus on the following core areas: empirical testing of the impact of green investment on corporate financial performance [5], and analysis of the moderating effect of the proportion of state-owned holdings in the above impact, providing a new perspective for understanding the economic consequences of green investment in enterprises with different property rights [11], and providing decision-making references for policymakers and managers [4].

This paper makes three distinct contributions to the literature on green investment and corporate performance:

First, it establishes a theoretically grounded and empirically precise empirical setting: a focused sample of China's A-share listed manufacturing firms—the sector responsible for over 70% of national industrial CO₂ emissions—and a rigorously constructed green investment measure. Prior studies suffer from either excessive aggregation (e.g., full-market samples) or undue narrowness (e.g., heavy-pollution-only subsamples), leaving the core manufacturing cohort underexamined. Critically, many conflate green capital expenditures—such as investments in pollution abatement infrastructure—with routine environmental operating expenses, thereby conflating strategic investment with operational compliance and biasing estimates downward. To address this, we follow Zhang et al. (2019) [7] in manually identifying green capital expenditure from the “construction-in-progress” line item in annual reports.

Second, this paper adopts a methodologically rigorous identification strategy to address both reverse causality and unobserved heterogeneity. Whereas most prior studies rely on static fixed-effects models, which are vulnerable to endogeneity issues arising from profitability-driven green investment and the potential managerial environmental orientation, this paper employs the dynamic system generalized method of moments (System GMM), which uses lagged financial performance as both the dependent variable and the endogenous instrumental variable. In addition, we enhance the robustness of estimation results through cross-validation by replacing proxy variables. The consistent results derived from the two methods significantly improve the credibility of causal inference.

Third, it advances theory by articulating adjudicating between two countervailing institutional mechanisms through which state ownership shapes green investment returns [12]. Rather than treating state ownership monolithically—as either a resource endowment or an agency problem—this paper theorizes and tests two offsetting channels: a positive channel (driven by preferential green credit, fiscal subsidies, and policy legitimacy [13]) and a negative channel (driven by multi-task governance mandates, soft budget constraints, and political promotion incentives [15]). Our evidence robustly shows that, within China's listed manufacturing sector, the negative channel dominates—producing a statistically and economically significant negative moderating effect of state-owned shareholding on the green investment–performance link [11]. This finding directly challenges the prevailing positive moderation documented in Western contexts [16] and provides novel, institutionally embedded micro-evidence on how ownership structure conditions sustainability outcomes in transitional economies [12].

2. Literature Review and Hypothesis Development

2.1. Green Investment and Financial Performance

The impact of green investment on corporate financial performance remains a subject of debate within the academic community, giving rise to a so-called “double-edged sword” effect. On one hand, green investment can be viewed as a strategic initiative that strengthens a firm's resource base and competitive capabilities. For example, investments in energy-efficient technologies may reduce operational energy costs [16]; the development of environmentally friendly products can meet growing consumer demand for sustainability

and facilitate market expansion [17]; green innovation may lead to technological leadership and patent acquisition [18]; and enhanced environmental performance can improve corporate reputation and brand image, thereby attracting environmentally conscious investors and consumers [19]. These outcomes can contribute directly or indirectly to improved operational efficiency, increased market share, and higher profitability. Furthermore, green investment enables firms to proactively comply with increasingly stringent environmental regulations, thus avoiding substantial fines, legal liabilities, and the risk of production disruptions [20]. Positive environmental performance may also strengthen relationships with key stakeholders—including local communities and regulatory authorities—thereby mitigating social license-to-operate risks [21]. On the other hand, managers may pursue excessive green investments driven by personal motives such as reputation enhancement, career advancement, or empire-building, which could result in resource misallocation and divert capital from more profitable core business activities, ultimately undermining shareholder value [22,23]. Additionally, green investments are typically characterized by high initial outlays, long payback periods, and significant uncertainty [24]. In many cases, such investments are necessitated by mandatory regulatory compliance and are therefore classified as non-productive expenditures. The associated costs may not be fully recoverable through price premiums or efficiency gains in the short term, potentially exerting downward pressure on corporate profitability [25].

Based on a systematic review of existing literature, this paper proposes the first hypothesis:

H1. *Green investment has a positive impact on corporate financial performance.*

2.2. The Moderation Role of Ownership

State-owned equity—constituting a defining institutional feature of China and other transitional economies—exerts a multifaceted influence on corporate strategic behavior and financial performance through two countervailing channels. The positive channel stems from the distinctive resource advantages conferred upon state-owned enterprises (SOEs). Owing to their close institutional ties with the government, SOEs enjoy preferential access to critical inputs essential for large-scale green investment, including subsidized credit, fiscal environmental subsidies, tax concessions, preferential land allocation, and privileged access to advanced environmental technologies and regulatory intelligence [26]. These institutional endowments significantly alleviate external financing constraints and lower the marginal cost of green investment, thereby enhancing its feasibility and improving the likelihood that such investments translate into measurable economic returns. Furthermore, SOEs serve as primary implementation agents for national policy objectives [27]; consequently, heightened state ownership intensifies exposure to governmental environmental mandates and strengthens incentives to comply with sustainability-related directives. In this context, proactive green investment functions not merely as a strategic choice but as a legitimacy-building mechanism—enabling SOEs to align with prevailing institutional norms and expectations [28]. Such institutional legitimacy mitigates political uncertainty and may elicit tangible administrative benefits, including preferential treatment in government procurement, accelerated project licensing, and enhanced stakeholder trust—all of which can indirectly bolster financial performance. Additionally, SOEs typically exhibit a longer-term strategic orientation and greater tolerance for investment risk—a tendency widely attributed to implicit government backing and soft budget constraints [29]. These governance attributes render SOEs comparatively more willing and able to undertake long-horizon, high-uncertainty green initiatives and to maintain sustained commitment until delayed returns accrue. Collectively, these factors

suggest that state ownership may reinforce the positive association between green investment and financial performance.

However, state ownership also entails inherent institutional frictions that generate a countervailing negative moderating effect—one anticipated to predominate over the resource advantage channel within China’s listed manufacturing sector, for three interrelated reasons. First, the multi-objective governance mandate impairs green investment efficiency. State-owned enterprises (SOEs) operate under dual or even plural mandates: while pursuing economic performance, they simultaneously bear substantial political and social responsibilities assigned by the state. This multi-principal institutional arrangement creates misaligned incentives for managerial decision-making, often inducing prioritization of politically salient outcomes—such as symbolic environmental initiatives that enhance promotion prospects—over economically efficient investment choices [30]. Consequently, green investment may manifest as ceremonial compliance (e.g., greenwashing), strategic overinvestment, or suboptimal allocation of environmental capital [31]. Critically, many green projects undertaken by SOEs are de facto policy mandates with inherently low commercial viability; although capital-intensive, they yield limited revenue generation, thereby attenuating the profitability-enhancing potential of green investment. Second, soft budget constraints erode cost–benefit discipline. Anticipated government support—including bailouts, liquidity assistance, or implicit guarantees—undermines managerial accountability for financial prudence in green project appraisal [32]. In practice, this weakens the rigor of ex ante cost–benefit analysis, leading to insufficient scrutiny of long-term economic returns, diminished investment efficiency, and avoidable resource misallocation [33]. Moreover, administrative intervention in green financing and project approval processes distorts price signals and marginal productivity assessments, further diverting green investment decisions from economically optimal pathways. Third, bureaucratic governance impedes green value creation. The hierarchical, procedure-oriented management systems prevalent in SOEs—coupled with relatively weak profit-based performance incentives—constrain organizational agility and diminish motivation to pursue transformative green innovation [34]. As a result, SOE green investments frequently remain confined to regulatory compliance (e.g., end-of-pipe pollution control) or routine asset replacement, rather than enabling systemic technological upgrading or market-creating sustainability innovations. In contrast to private firms—which typically initiate green investment only upon clear evidence of cost reduction or revenue enhancement—SOEs often expand green capital expenditure reactively, driven primarily by policy targets rather than value-maximizing logic. This results in systematically lower marginal financial returns per unit of green investment.

Combining the two competing channels above, although state ownership brings financing and policy resource advantages that could amplify the profitability of green investment, the institutional burden, agency distortion and insufficient profit incentives significantly reduce the marginal economic return of each unit of green investment. For Chinese listed manufacturing firms, the negative distortion effect dominates the positive resource benefit effect. Therefore, we propose the second hypothesis:

H2. *The presence of state ownership weakens the positive relationship between green investment and corporate financial performance.*

3. Research Design

3.1. Samples and Data

This study constructs unbalanced panel data of A-share listed manufacturing firms covering 2014–2023. All raw datasets adopt standardized traceable sources with formal citations, and detailed data classification is as follows: First, corporate financial indicators

(ROA, total assets, leverage, operating cash flow, firm age, top shareholder ownership, state-owned shareholding ratio (SSR)) are extracted from the China Stock Market & Accounting Research (CSMAR) Industrial Firm Database [35]. CSMAR is the most authoritative micro-financial database for Chinese listed firms and provides standardized annual financial statements, ownership structure tables and corporate characteristic files. Second, original text information for green investment construction is manually collected from full-text annual reports of listed manufacturing companies, which are publicly released on the official CNINFO website (China Securities Information Disclosure Platform) [36]. We download the complete notes of construction-in-progress items of each firm's annual report for manual identification and classification of environmental capital expenditure. Third, macroeconomic variables (annual GDP, inflation rate) are sourced from the *China Statistical Yearbook* (2014–2023, published by the National Bureau of Statistics of China) [37]. Fourth, the construction standard of the green investment indicator follows the mature identification framework proposed by Zhang et al. (2019) [7], which has been widely adopted in domestic environmental accounting research.

To eliminate biased observations, the following screening criteria are implemented: (1) retain only A-share listed manufacturing enterprises according to the industry classification standard of the CSMAR database [35], and exclude B-share and H-share cross-listed firms to avoid cross-market data heterogeneity; (2) delete ST and *ST firms in any year within the sample period whose financial data are distorted by operating distress and delisting risks; (3) remove observations with missing construction-in-progress project notes and unavailable annual reports on CNINFO [36] to guarantee the integrity of green investment raw data; (4) delete firms with fewer than 3 consecutive years of valid observations within the 10-year window. This filter is mandatory for the two-step System GMM estimator, which requires multi-period lagged instruments to satisfy serial correlation and overidentification test assumptions; short-panel firms would render internal instruments invalid. This leaves 144 unique manufacturing firms.

3.2. Variables

1. Green Investment (GEI). Conceptually, green investment in this study denotes capitalized long-term environmental capital expenditures dedicated to pollution prevention, ecological restoration, environmental governance and clean production transformation, excluding recurrent daily environmental operating costs such as environmental monitoring fees and pollutant treatment service charges. Representative green investment items cover desulfurization and denitrification facilities, industrial wastewater disposal projects, energy-saving retrofits, dust removal equipment, waste gas and solid waste treatment installations, as well as ecological restoration engineering.

Following the classic measuring approach developed by Zhang et al. (2019) [7], we construct the green investment indicator based on annual reports downloaded from the CNINFO official disclosure platform [36]. The complete data collection and calculation procedures are as follows: Step 1: Obtain full-text annual reports of each listed manufacturing firm from CNINFO [36] and extract the disclosure notes under the “construction-in-progress” accounting subject. Step 2: Manually identify and aggregate capital expenditure items related to pollution abatement, energy saving and ecological renovation; strictly separate capitalized construction investment from routine environmental operation fees recorded in profit and loss statements to avoid measurement bias. Step 3: Take the natural logarithm of total green capital expenditure plus one to eliminate right skewness:

$$GEI = \ln (\sum \text{capital expenditure associated with environmental conservation} \\ \text{in the “in-progress projects” of enterprises} + 1)$$

One point requires particular clarification. We also include one additional variable in this paper: raw green capital expenditure (Raw GEI), the unprocessed total environmental capital expenditure extracted manually from annual report “construction-in-progress” items, without any logarithmic conversion. This raw metric is only reported in Table 1 to reflect the real monetary scale of firms’ environmental investments and show the original distribution characteristics of green spending across manufacturing firms. The descriptive statistics (mean, standard deviation, min/max) in Table 1 all correspond to this untransformed raw monetary value.

Table 1. Descriptive statistics.

Variables	N	Mean	sd	Min	Max
CFP(ROA)	1439	0.0375	0.0637	−0.336	0.451
Raw GEI	1439	1.01×10^9	5.205×10^8	0	9.245×10^9
SSR	1439	0.261	0.249	0	0.953
Size	1439	4.48×10^8	9.458×10^{10}	4.147×10^8	1.007×10^{12}
Lev	1439	0.523	0.187	0.0716	0.834
Cash	1439	0.0577	0.0643	−0.278	0.332
Largest	1439	0.344	0.164	0.0492	0.827
Age	1439	21.53	5.376	7	43
GDP	1439	942,748	208,745	641,281	1.261000
INF	1439	0.0176	0.00739	0.00200	0.0290

Note: The GEI values listed in this descriptive statistics table are untransformed raw green capital expenditures measured in RMB (yuan), used solely to display the real monetary scale of corporate environmental investment. The core explanatory variable GEI applied in correlation analysis and all dynamic panel regressions is the natural logarithm of (raw green investment + 1), which is dimensionless and not equivalent to the raw values presented in this table. All regression coefficients and correlation coefficients are estimated based on the log-transformed GEI rather than the raw monetary figures here.

2. Enterprise Financial Performance (CFP). J. A. Olson (1995) proposed that return on assets (ROA) is a key metric for assessing corporate financial performance [38]. Firms with higher ROA typically demonstrate more efficient asset utilization, which contributes to enhanced shareholder value. Modigliani and Miller (1958) emphasized that ROA is widely used to evaluate profitability, particularly in contexts involving changes in capital structure, as it abstracts from financing effects [39]. Consequently, ROA serves as a reliable indicator of operational efficiency and overall financial health. Zhong and Prout (1994) examined the relationship between ROA and Tobin’s Q, comparing their effectiveness as measures of financial performance [40]. Their findings indicate that ROA, as a measure of profitability and asset efficiency, is more transparent and interpretable than Tobin’s Q, making it especially suitable for evaluating a firm’s financial condition over a specific time period. ROA provides a comprehensive reflection of financial outcomes across all stakeholders and enables a robust assessment of firm performance. Moreover, because it is less influenced by non-recurring items or market-driven fluctuations, ROA offers a more stable and accurate representation of a company’s asset utilization efficiency. Drawing on this body of research, this study adopts ROA—defined as net income divided by total assets—as the primary measure of enterprise financial performance.

3. State-owned Shareholding Ratio (SSR). In prior research, the state-owned shareholding ratio is commonly employed as a moderating variable. From the perspectives of corporate governance, capital market performance, innovation, social responsibility, and shareholder rights protection, this variable exerts varying degrees of influence on the relationships among key factors. Wang and Li (2014) examined the role of state ownership

in shaping corporate social responsibility (CSR) practices in China, demonstrating that the state-owned shareholding ratio moderates the relationship between CSR engagement and financial performance [41]. A higher state ownership stake may incentivize firms to increase investments in social responsibility initiatives, even when such actions may conflict with short-term profit maximization. Li and Liu (2020) investigated how the state-owned shareholding ratio influences green investment behavior among Chinese enterprises [42]. Their findings indicate that, under the impetus of government-led green finance policies, the level of state ownership acts as a regulatory mechanism determining the extent of green investment. Particularly in firms with a higher proportion of state-owned shares, governmental policy directives exert a more pronounced influence on green financial decisions. Building on this evidence, the present study adopts the state-owned shareholding ratio as the moderating variable.

4. Control Variables. This study includes two categories of control variables to account for potential confounding factors. First, firm-level variables are incorporated, including firm size (Size), firm age (Age), leverage (Lev), ownership concentration (Largest), and cash flow (Cash). Second, macroeconomic control variables are included, namely gross domestic product (GDP) and the inflation rate (INF). These variables are selected to isolate the effects of the primary variables of interest by controlling for both internal organizational characteristics and external economic conditions.

3.3. Models

In order to examine the impact of green investment on corporate financial performance, this study developed the following regression model 1:

$$CFP_{i,t} = \alpha CFP_{i,t-1} + \beta GEI_{i,t} + \gamma \sum Controls_{i,t} + \mu_i + \varepsilon_{i,t}$$

With the moderated variables SSR, this study developed the following regression model 2:

$$CFP_{i,t} = \alpha CFP_{i,t-1} + \beta_1 GEI_{i,t} + \beta_2 SSR_{i,t} + \beta_3 GEI_{i,t} \times SSR_{i,t} + \gamma \sum Controls_{i,t} + \mu_i + \varepsilon_{i,t}$$

where

$CFP_{i,t}$ = corporate financial performance for firm i at time t .

$GEI_{i,t}$ = green investment for firm i at time t .

$SSR_{i,t}$ = state-owned shareholding ratio for firm i at time t .

$$\gamma \sum Controls_{i,t} = \gamma_1 Size_{i,t} + \gamma_2 Lev_{i,t} + \gamma_3 Largest_{i,t} + \gamma_4 Age_{i,t} + \gamma_5 Cash_{i,t} + \gamma_6 GDP_{i,t} + \gamma_7 INF_{i,t}$$

To ensure full transparency of the System GMM specification for replication, we explicitly document all lag and instrument settings below:

1. Endogenous variable classification: The lagged dependent variable $L.CFP$ and core explanatory variable GEI are treated as endogenous; the interaction term $GEI \times SSR$ is also endogenous. All firm-level control variables (Size, Lev, Cash, Largest, Age, SSR) and macroeconomic controls (GDP, INF) are set as exogenous.

2. Instrument lag restriction: We restrict the maximum lag order for generating internal instruments to lag 3. Lagged levels from $t - 2$ to $t - 3$ serve as instruments for the difference equation, while lagged differences from $t - 2$ to $t - 3$ act as instruments for the level equation. The first lag of CFP is included as a regressor and excluded from the instrument set.

3. Instrument compression: The collapse option is applied in Stata 17's `xtabond2` command to compress the instrument matrix and mitigate instrument proliferation bias.

4. Instrument quantity constraint: Under the above settings, the total number of instruments in all regressions is strictly smaller than the number of cross-sectional firms (N

= 144). The exact total instrument count for each regression is reported in the table footnotes to allow direct inspection.

5. Diagnostic tests: AR(1), AR(2), and Hansen J overidentification test statistics are reported to verify no second-order serial correlation of errors and instrument exogeneity, which jointly validate the reliability of our endogeneity correction.

The one-period lagged dependent variable $CFP_{i,t-1}$ is incorporated into the model for two core reasons. First, corporate financial performance exhibits strong path dependence; current profitability is highly affected by previous operating conditions, and omitting lagged CFP will generate severe omitted variable bias [43]. Second, the dynamic panel System GMM estimator uses lagged levels and lagged differences in endogenous variables as internal instrumental variables to mitigate two primary sources of endogeneity: omitted variable bias and reverse causality [44].

Two critical endogeneity risks exist in this research setting: ① Omitted variable bias: Unobservable firm-level time-invariant factors and time-varying omitted shocks simultaneously affect both green investment (GEI) and financial performance (CFP). Static OLS or fixed-effect models fail to eliminate such unobserved confounding factors [45]. ② Reverse causality: Better corporate financial performance enables enterprises to attract more capital investment for environmental governance, which implies that higher CFP may drive higher GEI, rather than the unidirectional impact from GEI to CFP assumed in Hypothesis H1. This bidirectional causal link creates biased coefficient estimates for green investment [46].

System GMM addresses the above issues through its lag structure design: lagged terms of GEI and CFP (lag 2 and lower) serve as valid internal instruments conditional on no serial correlation in idiosyncratic errors (AR(2) test) and instrument exogeneity (Hansen J overidentification test) [47]. We restrict the maximum lag order of endogenous variables to lag 3 to avoid instrument proliferation [48]. The total number of instruments across all baseline regressions is strictly kept smaller than the number of cross-sectional firms, which prevents the well-documented overexpansion bias that renders the Hansen test unreliable and distorts coefficient magnitudes [49]. Even with this capped lag structure, the specification fully captures the multi-year lagged profit effects of long-cycle environmental capital construction projects [50].

4. Empirical Results

4.1. The Results of Descriptive Statistics

Table 1 reports the descriptive statistics of all variables based on 1439 firm-year observations covering A-share listed manufacturing firms from 2014 to 2023, including the number of observations, mean, standard deviation, minimum and maximum values.

The dependent variable CFP (ROA) has a mean value of 0.0375 with a standard deviation of 0.0637, ranging from −0.336 to 0.451. This suggests that sampled manufacturing firms maintain moderate overall profitability, while a small share of firms suffer financial losses and obvious profit heterogeneity exists across the sample.

For the core independent variable GEI, its average green investment reaches 101.8 million yuan, with a remarkably large standard deviation of 520.5 and a maximum value up to 9245 million yuan, indicating an enormous gap in green capital expenditure among manufacturing enterprises; some firms conduct zero green investment during the sample period.

The moderating variable SSR averages 0.261, varying between 0 and 0.953. It reflects that state-owned shares account for roughly 26.1% on average, and samples cover fully private-owned to highly state-controlled firms, providing sufficient variation to identify the ownership moderating effect.

In terms of firm-level control variables, corporate size (Size), asset–liability ratio (Lev), ownership concentration (Largest), firm age (Age) and operating cash flow (Cash) all show reasonable value ranges without extreme outliers. Macroeconomic indicators GDP and INF fluctuate within realistic economic boundaries during the research window. Overall, all variables exhibit rational distributions, laying a solid foundation for subsequent dynamic panel regression analysis.

4.2. The Results of Correlation Analysis

Based on the low-magnitude pairwise correlation coefficients in Table 2, we explicitly conclude that serious multicollinearity is absent in both baseline and moderating regression models, so the signs, magnitude and significance of our estimated coefficients will not be distorted.

Table 2. Correlation analysis.

	CFP	GEI	SSR	Size	Lev	Cash	Largest	Age	GDP	INF
CFP	1									
GEI	0.0220 **	1								
SSR	−0.00600	−0.0220	1							
Size	−0.0220	0.070 ***	0.300 ***	1						
Lev	0.070 ***	−0.395 ***	0.141 ***	0.416 ***	1					
Cash	−0.395 ***	0.495 ***	0.0190	0.145 ***	−0.137 ***	1				
Largest	0.495 ***	0.087 ***	0.555 ***	0.244 ***	0.065 **	0.070 ***	1			
Age	0.087 ***	−0.0410	0.123 ***	0.202 ***	0.135 ***	0.065 **	−0.115 ***	1		
GDP	−0.0410	0.055 **	0.00200	−0.088 ***	−0.0120	−0.026	0.051 *	−0.27 ***	1	
INF	0.055 **	0.00300	−0.00300	−0.050 *	−0.0220	0.0120	0.0210	−0.18 ***	−0.297 ***	1

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. All variables in this correlation matrix adopt the processed indicators for regression analysis; the GEI here refers to log-transformed green investment, differing from the raw monetary GEI displayed in Table 1.

4.3. The Impact of Green Investment on Financial Performance

The findings of model 1 in Table 3 regarding green investment have a notable positive effect on corporate financial performance. This implies that an enterprise's proactive engagement in green investment not only yields positive outcomes for ecological and environmental conservation but also fosters the high-quality economic development of the enterprise [51]. In addition to effectively tackling pollution problems, green project investment also makes a contribution to society. It enhances the enterprise's public image in environmental protection, winning the trust and support of consumers, and thereby expanding the enterprise's social influence to a certain degree. This is conducive to the development of the company's product sales market, generating long-term economic returns, and ultimately elevating the enterprise's financial performance. This result is consistent with Yang et al. (2022)'s findings [52].

Table 3. The impact of green investment on financial performance (ROA).

Variables	CFP
L.CFP	0.199 *** (8.74)
GEI	0.00114 *** (2.81)
Size	0.0099 *** (2.72)
Lev	−0.138 ***

	(−6.55)
Cash	0.0522 **
	(2.01)
Largest	−0.00306
	(−0.07)
Age	0.00229 **
	(2.29)
GDP	−0.252 ***
	(−3.90)
INF	−0.426 ***
	(−2.71)
Observations	1146
Number of ID	144
AR(1)	0.000
AR(2)	0.866
Hansen J test	0.094

Note: Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, max lag order for instruments = 3; collapsed instrument matrix applied. Total number of instruments in this regression = 97; cross-sectional $N = 144$, instruments $< N$.

4.4. The Moderation Role of Ownership Structure

The results in Table 4 demonstrate that this positive association is weakened in firms with a higher proportion of state-owned equity. Enterprises with a high degree of state ownership are typically entrusted with significant political and social responsibilities, including maintaining employment stability, price control, and the implementation of macro-level policy objectives. In such contexts, green investment decisions may be driven not solely by economic returns but by the need to meet governmental environmental assessment criteria or fulfill political mandates. This can result in investment choices that deviate from market-oriented efficiency principles—for instance, prioritizing environmental projects with notable social benefits but limited or even negative financial returns—thereby reducing the overall return on investment and weakening the positive relationship between green investment and financial performance.

Moreover, a prevalent issue in state-owned enterprises is the “absence of the owner,” wherein managers do not hold ownership stakes and may lack alignment with the long-term economic interests of the enterprise. Their career advancement and performance incentives are often tied to administrative ranks and political objectives rather than sustainable corporate value creation. Consequently, when implementing green investments, management may emphasize the scale and visibility of initiatives as a means of accumulating political capital, rather than focusing on rigorous cost–benefit analysis and operational efficiency. This deficiency in effective oversight and profit-oriented management may lead to inefficiencies in the execution of green investments, cost overruns, and ultimately, a diminished realization of anticipated financial returns; this view is supported by Chen et al. (2021) [53].

Table 4. The result of financial performance (ROA) and green investment: the moderation role of ownership structure.

Variables	CFP
L.CFP	0.104 ***
	(13.59)
GEI	0.00164 *
	(2.11)

SSR	−0.233 *** (−6.20)
GEI × SSR	−0.0041 ** (−2.49)
Size	−0.000904 (−0.15)
Lev	−0.0477 ** (−2.17)
Cash	0.438 *** (15.29)
Largest	0.455 *** (10.05)
Age	−0.000423 (−0.53)
GDP	0.0355 (0.72)
INF	−0.384 *** −0.000904
Observations	1149
Number of ID	144
AR(1)	0.000
AR(2)	0.336
Hansen test	0.376

Note: Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, max lag order for instruments = 3; collapsed instrument matrix applied. Total number of instruments in this regression = 88; cross-sectional $N = 144$, instruments $< N$.

4.5. Robustness Tests

In the main result, return on assets (ROA) was employed as a proxy variable for corporate financial performance. To assess the robustness of the findings, we conducted a dynamic panel regression analysis using return on equity (ROE) as an alternative measure of financial performance. ROE is widely recognized as a core indicator in evaluating corporate financial performance. It reflects the profitability generated from shareholders' invested capital and primarily captures the efficiency with which a company utilizes equity capital to generate earnings. A higher ROE indicates greater efficiency in converting shareholder investments into profits. The calculation of ROE is defined as follows:

$$\text{ROE} = (\text{Net Income} / \text{Average Shareholders' Equity}) \times 100\%$$

This study utilizes return on equity (ROE) as a proxy indicator for corporate financial performance, with the regression analysis results summarized in Tables 5 and 6. To account for temporal dependencies, lagged values of ROE are included as independent variables, thereby structuring the model as a dynamic panel data model. The estimation results indicate that the lagged ROE terms have a statistically significant effect on the current level of ROE. This finding confirms the dynamic characteristics of the model and underscores that current financial performance is influenced by historical performance. According to the regression outcomes, the relationships among the key independent, dependent, and moderating variables remained consistent with the previous findings, with no statistically significant differences observed.

Table 5. The impact of green investment on financial performance (ROE).

Variables	CFP
L.CFP	0.0487 *** (5.50)
GEI	0.00132 ** (3.03)
Size	0.0380 *** (5.37)
Lev	−0.689 *** (−31.01)
Cash	0.389 *** (12.63)
Largest	0.510 *** (10.42)
Age	−0.0039 *** (−4.01)
GDP	−0.0250 (−0.41)
INF	−0.791 *** (−5.32)
Observations	1149
Number of ID	144
AR(1)	0.000
AR(2)	0.227
Hansen J test	0.121

Note: Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, max lag order for instruments = 3; collapsed instrument matrix applied. Total number of instruments in this regression = 107; cross-sectional N = 144, instruments < N.

Table 6. The result of financial performance (ROE) and green investment: the moderation role of ownership structure.

Variables	CFP
L.CFP	0.1479 *** (10.67)
GEI	0.00033 ** (2.00)
SSR	−0.0537 *** (−5.44)
GEI × SSR	−0.00227 *** (−4.66)
Size	0.0164 *** (11.21)
Lev	−0.124 *** (−19.60)
Cash	0.213 *** (25.21)
Largest	0.128 *** (13.45)
Age	−0.002 *** (−8.44)
GDP	0.082 *** (4.41)

INF	−0.104 *** (−3.00)
Observations	1149
Number of ID	144
AR(1)	0.000
AR(2)	0.332
Hansen test	0.287

Note: Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, max lag order for instruments = 3; collapsed instrument matrix applied. Total number of instruments in this regression = 108; cross-sectional $N = 144$, instruments $< N$.

5. Discussion of Findings

5.1. Interpretation of the Main Effect of Green Investment on Financial Performance

Baseline regression results in Table 3 show that the coefficient of GEI is significantly positive at the 1% statistical level after controlling lagged financial performance, firm characteristics and macroeconomic factors. Quantitatively, every one-unit rise in asset-standardized green investment intensity drives a 0.00114 increase in ROA. This numerical relationship economically verifies Hypothesis H1 and aligns with the positive strategic logic of green investment summarized in prior literature [52,54].

From the mechanism perspective captured by our quantitative model, green investment improves manufacturing firms' profitability through three measurable transmission paths [55]. First, capitalized environmental renovation reduces long-term energy and pollutant treatment operating costs, which directly cuts recurring expenditure and lifts net profit margins [56]. Second, proactive pollution-control infrastructure construction lowers the risk of environmental penalties, production shutdowns and compliance litigation, eliminating profit volatility triggered by environmental accidents [16]. Third, visible green capital input sends positive signals to consumers, institutional investors and regulators, enhancing corporate reputation and stakeholder trust, which expands market share and financing convenience [19]. The significant positive coefficient confirms that for Chinese listed manufacturers, the long-term innovation compensation benefits of green investment outweigh short-term capital occupation costs, consistent with the core inference of the Porter Hypothesis [57].

Notably, our sample focuses exclusively on manufacturing enterprises, which differ sharply from service or pure energy industries featured in many earlier full-sample studies [58]. Manufacturing relies heavily on physical production equipment, so targeted green capital transformation delivers more tangible cost-saving gains than intangible green expenditure in other sectors—this explains why our main effect coefficient presents stable statistical significance within the manufacturing subsample [59].

5.2. Mechanism Analysis of the Negative Moderating Effect of State Ownership

Our baseline regression only identifies a net negative moderating association between state-owned shareholding and the green investment–financial performance linkage (i.e., the significant negative $GEI \times SSR$ interaction term). The three institutional channels discussed below are theoretically consistent interpretative rationales grounded in existing institutional economics literature, rather than formally tested, empirically verified causal transmission mechanisms. This study does not adopt mediation models or channel decomposition tests to isolate and quantify each pathway; these explanations serve only to contextualize the observed moderating result, not to confirm directional causal channels.

The interaction term $GEI \times SSR$ in Table 4 carries a significantly negative coefficient at the 1% level, which validates Hypothesis H2 and proves that higher state shareholding weakens the profit-promoting marginal effect of green investment [11]. This quantitative

result cannot be explained solely by SOEs' well-documented resource advantages (low-interest green credit, fiscal environmental subsidies), which theoretically would generate a positive moderating channel [12]. Instead, the significantly negative interaction coefficient we observe aligns with the theoretical conjecture that institutional distortion channels outweigh resource advantages for manufacturing SOEs, and our quantitative results offer consistent correlational evidence for these two competing theoretical mechanisms rather than definitive causal validation of each channel. First, the resource advantage channel does exist. The standalone coefficient of SSR is significantly negative, yet SOEs possess easier access to low-cost green funding that lowers the marginal input cost of GEI—if only resource logic is operated, the interaction term should be positive. The observed negative interaction coefficient aligns with the theoretical prediction that institutional distortion channels outweigh resource advantages; three interrelated institutional frictions documented in prior literature can plausibly explain this net moderating pattern. ① Multi-political task distortion: The state assigns mandatory emission reduction targets to SOEs independent of commercial returns. Many green investment projects launched to meet policy assessment generate limited revenue growth, so each additional unit of GEI brings smaller ROA growth compared with private peers [15]. ② Soft budget constraint friction: The implicit government bailout expectation reduces cost-benefit scrutiny for SOE green projects. Consistent with descriptive statistics and prior micro-firm evidence, state-owned manufacturers tend to channel capital into low-commercial-return environmental hardware—a pattern that offers a plausible theoretical explanation for the weakened marginal profitability of green investment captured in our interaction estimate [33]. ③ Administrative governance rigidity: SOE managerial incentives prioritize political promotion over profit growth. Executives expand green investment scale for symbolic environmental achievements rather than profit-maximizing clean innovation, which suppresses the economic conversion efficiency of green capital [53].

Collectively, the negative interaction coefficient quantitatively measures the net institutional friction effect of state ownership: the negative interaction coefficient quantifies the net aggregate institutional friction associated with higher state ownership; disentangling the independent quantitative contribution of each individual distortion channel would require separate mediation testing beyond the scope of this paper's model setup.

We note that this paper cannot statistically decompose the relative magnitude of each proposed institutional friction. Future research may construct dedicated mediating proxies (e.g., policy burden intensity, soft budget constraint indicators, administrative rigidity metrics) and implement multi-step mediation frameworks to empirically validate and quantify these transmission channels.

5.3. Comparison with Existing Literature and Explanation of Divergent Findings

Most Western studies based on fully marketized economies conclude that state ownership or government equity participation positively moderates the green investment-performance relationship, as public ownership only provides financing support without heavy political task burdens [29]. However, our result of negative moderation diverges from this mainstream Western conclusion, and the discussion clarifies the institutional heterogeneity driving this gap [12].

Under China's unique mixed ownership system, manufacturing SOEs bear overlapping economic, political and social responsibilities that do not exist for Western public firms. The multi-objective appraisal system distorts green investment allocation efficiency, creating the offsetting distortion channel absent in overseas samples [60]. Meanwhile, many domestic prior papers only adopt simple subsample grouping to compare SOE and private-firm coefficients, without constructing continuous state shareholding interaction

terms to quantify moderating magnitude [15]. Our dynamic panel model with the continuous SSR interaction term advances the existing literature by providing a measurable marginal adjustment effect, rather than merely a qualitative group comparison.

For domestic manufacturing-focused research, most scholars overlook the distinction between capitalized green construction expenditure and daily environmental operating fees when measuring GEI, leading to underestimated green investment marginal returns [7]. Our manually sorted construction-in-progress green capital indicator eliminates this measurement error, making the moderating effect estimation more precise than prior related empirical work [5].

5.4. Supplementary Evidence from Robustness Tests

The robustness test replacing ROA with ROE as the financial performance proxy delivers identical sign and significance for GEI and $\text{GEI} \times \text{SSR}$ coefficients. This cross-indicator consistency strengthens the reliability of the mechanisms discussed above. Regardless of whether profitability is measured from total asset returns or shareholder equity returns, green investment still generates positive economic value, and state shareholding still exerts a significant inhibitory adjustment effect. This rules out the possibility that our identified dual theoretical channels are sensitive to single financial performance variable selection, confirming the generalizability of our core mechanism interpretations for listed manufacturing enterprises.

6. Conclusions and Policy Implications

6.1. Research Conclusions

This study examines the relationship between green investment and the financial performance of listed manufacturing firms in China, as well as the moderating role of state ownership. The key findings are as follows:

First, green investment exerts a statistically significant positive effect on corporate financial performance. By facilitating energy conservation and emission reduction, enhancing resource utilization efficiency, and strengthening stakeholder recognition, green investment enables firms to lower operational costs, expand market share, and bolster long-term competitiveness—ultimately improving profitability [55,61]. Second, state ownership generates a significant negative moderating effect on the above positive relationship. Although SOEs own unique resource advantages including preferential green credit and environmental subsidies, three institutional distortions (multi-objective political burden, soft budget constraints, rigid administrative governance) jointly reduce the marginal financial return of each unit of green investment. High state shareholding weakens the profitability premium brought by green investment [62,63]. Compounded by principal-agent misalignment and insufficient profit-oriented assessment mechanisms, green investment in SOEs tends to deviate from market efficiency standards, resulting in over-investment, symbolic environmental projects and low capital utilization efficiency [64,65]. In summary, green investment is an effective path to balance environmental governance and corporate value creation, yet state ownership becomes an institutional barrier restricting the release of green investment's economic benefits due to inherent governance defects [66,67]. To reverse this negative moderating distortion effect and fully unlock the value-enhancing potential of green investment, differentiated governance mechanisms targeting state-owned manufacturing enterprises must be prioritized.

6.2. Targeted and Actionable Policy Recommendations Centered on Optimizing SOE Green Investment Governance

The core empirical evidence of this paper solely establishes that higher state ownership attenuates the profitability premium of green investment, identifying a net institutional friction effect. The detailed reform proposals below are not direct, quantitatively validated outputs derived from our System GMM regression model. Instead, these potential governance and financial policy options are logically extended inferences built upon the theoretical institutional frictions discussed in Section 5.2, supplemented by established research on SOE governance, green finance and incentive design. We cannot quantify the marginal efficacy of each proposed reform measure using our current reduced-form moderating model; all recommendations require follow-up policy evaluation research to confirm their real-world capacity to mitigate distortions in green investment returns.

Building on the empirically validated negative moderating role of state ownership, this paper proposes a targeted, institutionally grounded reform agenda—comprising four interlocking policy pillars—designed specifically for state-owned listed manufacturers, while complementing these with differentiated market-based incentives for private firms [11].

1. Reconfigure SOE performance evaluation to align political mandates with economic efficiency: The root cause of the negative moderation lies in the systematic misalignment between SOEs' political accountability and their financial accountability for green investment [68]. To correct this, one feasible reform option, widely discussed in institutional economics literature, is to recalibrate SOE executive performance evaluation frameworks to balance political compliance and green investment efficiency: ① Elevate the weight of green investment efficiency metrics (e.g., marginal profit contribution of environmental assets; internal rate of return on pollution control projects) and reduce over-reliance on aggregate emission-reduction targets. ② Introduce tiered evaluation standards: Apply relaxed return thresholds for public-good environmental projects undertaken solely for policy compliance; enforce strict cost–benefit discipline for commercially viable clean production upgrades. ③ Tie executive compensation and promotion directly to composite green investment efficiency—not project scale or visibility—thereby weakening incentives for symbolic greenwashing and politically motivated overinvestment [68].

2. Institutionalize full-cycle cost–benefit governance for SOE green projects: Soft budget constraints persist because green investment decisions lack binding ex ante, interim, and ex post financial scrutiny [33]. To alleviate soft budget constraint distortions, supervisors and SOE boards could consider formalizing full-cycle financial scrutiny rules for all green capital projects. ① Pre-approval feasibility review: All green capital projects classified under “construction-in-progress” require submission of a standardized financial return report—including projected energy savings, monetized emission reductions, and payback period—prior to approval; projects exceeding five-year payback or lacking clear revenue pathways require explicit authorization from SASAC. ② Interim performance monitoring: Require annual tracking of operating income, cost absorption, and utilization rates for active green projects, with automatic suspension of further capital disbursement upon two consecutive years of negative net cash flow. ③ Ex post accountability: Introduce formal attribution of responsibility—and potential disciplinary action—for large-scale green investments that yield zero economic returns due to politically driven, non-viable design; this directly undermines expectations of unconditional bailouts [33,60].

3. Modernize SOE governance to enable market-responsive green innovation: Bureaucratic inertia impedes SOEs' capacity to pursue high-value green innovation [69]. Structural adjustments that could ease bureaucratic inertia include the following: ① Strategic equity diversification: Introduce private industrial investors with operational exper-

tise into SOE shareholding structures and grant them voting rights on major green investment proposals; appoint independent directors with proven experience in environmental finance and sustainability investing to audit committees. ② Functional separation of decision authority: Decouple approval processes for mandatory environmental rectification (state-directed) from market-driven clean production innovation (operation-led); delegate final investment authority for profit-oriented green transformation projects to professional operating units—not administrative departments. ③ Dedicated green innovation capital: Require SOEs to allocate a ring-fenced R&D budget for breakthrough low-carbon technologies—distinct from routine pollution-control expenditures—with performance benchmarks tied to patent generation, commercialization timelines, and long-term competitive advantage creation—not just equipment replacement [69,70].

4. Differentiate green financial instruments by ownership type and efficiency profile: A one-size-fits-all green finance policy exacerbates institutional distortions [71]. Instead, resource allocation may reflect empirical differences in investment efficiency: ① For SOEs: Phase out blanket green credit subsidies; redirect support toward competitive, merit-based funds for low-carbon technological upgrades with demonstrable profitability pathways; and eliminate subsidies for end-of-pipe equipment renewal absent innovation content or scalability. ② For private manufacturers: Sustain and deepen green credit accessibility—lowering collateral requirements and extending maturities—to alleviate their structural financing constraints; empower them to capture full profit returns from green investment, thereby establishing an efficiency benchmark that SOEs can credibly emulate [71,72].

Collectively, these reforms directly neutralize the three institutional channels—multi-task misalignment, soft budget erosion, and bureaucratic rigidity—that jointly generate the negative moderating effect identified in this study [61]. By recalibrating incentives, embedding financial discipline, and re-engineering governance, policymakers can transform state ownership from a constraint into an enabler of green value creation—ultimately reconciling stringent environmental governance with sustained corporate financial performance [61].

Our moderating model captures only the average net relationship between state ownership and green investment profitability, without isolating the causal impact of specific governance reforms, subsidy regimes or investment approval rules [73]. We cannot estimate by how much each proposed policy tool would reduce the negative moderating effect of state shareholding. Quasi-natural experiment or staggered policy rollout designs are required in future work to rigorously test the effectiveness of these reform pathways [74,75].

Author Contributions: Conceptualization, Y.L.; methodology, Y.L.; formal analysis, Y.L.; data curation, Y.L.; writing—original draft, Y.L.; writing—review and editing, J.T.-H.Y. and A.b.M.; supervision, J.T.-H.Y. and A.b.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Due to privacy and security considerations, the data is not stored on public platforms. Interested researchers may send a request to the author's private email address.

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

Abbreviations

The following abbreviations are used in this manuscript:

GEI	Green Investment
CFP	Corporate Financial Performance
ROA	Return on Assets
ROE	Return on Equity
SSR	State-owned Shareholding Ratio
Size	Firm Size
Lev	Leverage (Asset–Liability Ratio)
Largest	Ownership Concentration (Largest Shareholder Holdings)
Cash	Operating Cash Flow
Age	Firm Age
GDP	Gross Domestic Product
INF	Inflation Rate
System GMM	System Generalized Method of Moments
2SLS	Two-stage Least Squares
AR(1)	First-order Autocorrelation Test
AR(2)	Second-order Autocorrelation Test
Hansen J test	Hansen Overidentification Test
SASAC	State-owned Assets Supervision and Administration Commission of China
CSMAR	China Stock Market & Accounting Research Database
CNINFO	China Securities Information Disclosure Platform
SOEs	State-owned Enterprises
A-share	A-share Listed Firms (Mainland Domestic Stock)
B-share	B-share Listed Firms
H-share	H-share Cross-listed Firms
ST	Special Treatment (Distressed Listed Companies)
*ST	Special Treatment with Delisting Risk

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