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Examining the Influence of Green Transformation on Corporate Environmental and Financial Performance: Evidence from Chemical Industries of China

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ABSTRACT

This study aims to investigate the impact of green transformation on the environmental and financial performance of 173 Chinese A-share listed chemical enterprises over the period 2012—2022. We employ fixed-effects model, and found the positive influence of green transformation on both environmental and financial performance. Furthermore, it explores the moderating role of corporate governance strength in enhancing the relationship between green transformation and financial and environmental performance metrics. Findings suggest that robust corporate governance further strengthens this positive nexus for both, but mainly moderates environmental performance. The study also delves into the heterogeneous effects of firm size and ownership, highlighting that larger and state-owned firms benefit more substantially from green transformation initiatives. These insights provide crucial implications for policymakers and managers aiming to optimize both financial and environmental outcomes through green transformation. The study recommends the adoption of green technologies and stronger corporate governance to facilitate a shift from a shareholder-centric to a stakeholder-inclusive perspective, ultimately fostering resource-efficient processes that contribute positively to environmental sustainability.

Keywords: Green transformation; Environmental performance; Financial performance; Corporate governance

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1. Introduction

In context of resource constraints and environmental pressures, China is making efforts to be transitioned into a "new normal" that could balance ecological preservation with economic growth [1]. To achieve the balance between economic and environmental goals is a crucial concern across all the sectors. The sectors which are highly responsible for the environmental emissions are at the forefront to achieve this balance. The chemical sector of China is second largest to produce carbon emissions as in 2020, it produces almost 486.3 million tons of carbon emissions, accounts for 17.24% of the total industrial carbon emissions of China. This figure is still lower by 18.11%, the figure recorded in 2015 [2]. There is also general increase in energy consumption in this sector which predominantly utilizes coal, and this fuel is comprised approximately 56% of the total energy consumption in 2020 [3]. China aims to reach its peak carbon emissions by 2030, and achieve carbon neutrality by 2060 [4]. To attain this goal, chemical industry in China is undertaking a zero-carbon transition, with focus key chemical such as methanol, ammonia, and ethylene. There is green transformation in chemical industry of China and it would have significant impacts on its environmental and economic performance. This study is an effort to examine the impact of green transformation on environmental and financial performance in China's chemical industry over the period of 2012—2022.

While companies drive economic development, they also contribute to the environmental degradation. The influence of the environmental responsibility on financial outcomes could shape corporate production and operational decisions [5]. When there will be no adequate compensation mechanisms and oversight, companies, as rational economic entities, prefer the financial performance over the environmental performance. They are more concerned to optimize wealth for their shareholders, instead of considering the wider concerns of all associated stakeholders. Environmental externalities push governmental interventions to ensure equitable benefit distribution among market participants and across generations [6]. To address this, China's government has actively implemented a range of measures including legislation, system establishments, and policy introductions to incentivize companies that could generate positive externalities and penalize those that could not. From a practical perspective, there is existence of the significant variance in quality of environmental responsibility performance and without robust evaluation, companies bear greater environmental costs, but don't receive the required compensation, that could uphold environmental standards [7]. The chemical industry of China is undergoing the green transformation to ensure its compliance with the environmental requirements of country. However, there is still need to investigate that either its efforts are bringing any economic benefits to them or not.

Theoretically, companies could be voluntarily engaged in environment-friendly activities due to two reasons. First, they could be willing to gain the competitive advantage, especially access to essential resources [8,9]. Second, they legitimize their operations via garnering the societal approval [10,11]. Resource dependence theory enlightens the financial benefits and competitive advantages that could be achieved through robust environmental performance. This theory suggests that effective governance of resources can provide better control over costs and enhance corporate reputations and connections with influential stakeholders, and thereby securing access to vital resources [12]. It is argued that there is utilization of resources in an efficient manner which results cost savings and lead the firms to achieve sustainable benefits. Stakeholder theory asserts that commitments to accountability and transparency via strong environmental practices could elevate corporate reputations by addressing the diverse expectations of stakeholders, thereby positive influencing the corporate environmental performance [13]. Drawing on these both theories, this study will examine that to what extent enterprises in chemical industry of China are able to make a balance between environmental and economic concerns through adapting the effects of green transformation in their processes.

There are numerous studies examining the same

scenario in different patterns but they posit some limitation [14,15]. Studies show that environmental taxes and green innovation policies improve sustainable and environmental performance, particularly when linked with the strong legal and regulatory frameworks [16,17]. However these gains may not uniformly translate into the financial benefits such as Peng, Chen [18] and Akbar, Jiang [19] demonstrate that while green transformation initiatives such as environmental responsibility and innovation foster environmental metrics, they also results in financial downturn because of the increased operational costs and investments in green technologies, which might yield immediate financial returns. Additionally, while some studies also present a neutral to positive relationship between green investments and financial outcomes in non-constrained financial environments, suggesting a complex interplay between environmental initiatives and financial gains [20,21]. Previous studies examine the impact of environmental sustainability and corporate social responsibility on environmental and financial performance of enterprises. The gap exists for this study to examine the impact of green transformation on financial and environmental performance of Chemical industry of China. Green transformation's environmental and financial impact could also vary across sectors, types of ownership and firm size, and this all considered in this study.

To promote the adoption of sustainable strategies and environmentally friendly practices, it is suggested that companies are required to strengthen their governance structures [22,23]. There can be increase in board gender diversity, board independence, and optimizing board size to ensure a strong governance to manage the balance between economic and environmental concerns. Despite the recognized importance of internal governance structures to promote commitment on environment stewardship, there is still need to empirically assess the impact of board strength on the environmental and financial performance of China's chemical sector enterprises [24]. This gap is a significant opportunity to contribute governance literature by analyzing the moderating role of governance strength on the nexus of green transformation with environmental and financial performance. This study aims to investigate the influence of governance strength on the environmental and financial performance of Chinese firms in chemical industry.

Given the limitation of previous studies, our research aims to extend current understanding and add to the existing literature in several ways. Firstly, unlike many earlier studies considering all the enterprises of China, this study is specifically focused to Chemical industries of China which are largest producers of carbon emissions. Secondly, this study examines the impact of green transformation on environmental and financial performance to provide the insights regarding the balance of ecological and economic balance in chemical industries. Thirdly, this study adds to the corporate governance literature by employing the moderating effects of governance strength on the nexus of green transformation with environmental and financial performance of Chinese chemical industries. Fourthly, this study presents the heterogenous effects of the green transformation on environmental and financial performance with consideration of the firm size and firm ownership type.

The remainder of the paper is structured as follows: Section (2) presents the literature review and hypothesis development based on given theories. Section (3) covers the econometric model, data, variables selection, and descriptive statistics. Section (4) presents the empirical results of study. Section (5) report the conclusion and policy implications of this paper.

2. Literature review

2.1 Green transformation and corporate environmental performance

As critical components of an economy, enterprises play a significant role in environmental protection [25].The motivation for these enterprises to undertake environmental responsibilities came from both external pressures and internal benefits. For companies, engaging in corporate environmental responsibility can be considered as an investment in future earnings [26]. When companies move to fulfill

their environmental responsibility, they may also able to gain benefits in form of increased stakeholder value, enhanced credibility, and expanded market share [27]. Maxwell, Rothenberg [28] suggested that enterprises are required to adopt proactive environmental strategies that could provide competitive advantages in form of quality improvement, cost reduction, enhanced corporate image, and market development. Moreover, a company's commitment to its environmental duties could enhance the attention of stakeholders such as public, regulators, and environmental NGOs [29]. Among these stakeholders, social communities and governments are key drivers to prompt enterprises to comply with environmental responsibilities [30]. Companies not complying with the environmental responsibilities face governance penalties and negative media exposure [26]. The external pressures can push firms to engage in environmental stewardship. It can be argued with more pressure by the media scrutiny there could be better quality of environmental information that companies could disclose [31]. It can be stated that company's commitment to its environmental responsibility is influenced by both internal profitability and external oversight. However, companies could proactively assume environmental responsibilities and disclose relevant information only when anticipated benefits outweigh costs [32].

The nexus of green transformation with environmental performance in China's chemical industry can be examined through the lenses of the Porter Hypothesis, which states that strict environmental regulations may lead to promote industry innovation that compensates the costs of comply with these regulations [16]. This theory is evident as studies show that green transformation efforts are driven by the regulatory frameworks, and significantly promote green technology innovations, and thus improve environmental performance in the chemical sector of China. For instance, environmental regulations promote innovations in pollution control technologies, which are crucial to mitigate the environmental impacts of the heavily-polluted industries [33,34]. Additionally, green finance mechanisms support the transition by funding the adoption of sustainable practices and technologies in these industries, thereby improve the overall environmental performance [35]. Previous studies demonstrate that more stringent regulations are directly linked with the higher levels of technological innovations and subsequently improving the environmental performance [36,37]. Drawing on these findings, we postulate this hypothesis:

H_1: Green transformation fosters environmental performance of Chinese chemical industries.

2.2 Green transformation and corporate financial performance

The findings on the effects of corporate environmental responsibility on financial performance vary across countries, regions, and industries. Some researchers state that corporate environmental responsibility fosters financial performance and embracing environmental performance may enhance company's operational efficiency and environmental reputation, increase subsidy revenues, and attract environmentally conscious stakeholders, and thus improve the financial performance [38,39]. On one side, enterprises accepting environmental responsibilities and disclosing environmental regulations may secure higher bank loans and thus increase the capital raising costs [40]. On the other hand, such enterprises may create valuable intangible assets such as corporate reputation, and improve stakeholder relationships, and attract more consumers, and thus enhance overall financial performance [41]. Additionally, assuming environmental responsibilities may mitigate information asymmetry between companies and investors, that may result in enhancing stock liquidity, reducing agency and transaction costs, and boosting long-term corporate valuations [42].

Song, Zhao [43] states that while a company's environmental management may not affect its current performance, but it improves financial performance in subsequent periods. Clarkson, Fang [44] argues that linking voluntary environmental disclosures with active environmental strategies can increase corporate value. Concurrently, Wang and Xu [31] stated that both mandatory and voluntary environmental disclosures

provide economic benefits, with proactive disclosures being particularly beneficial [45]. Jiang, Xue [46] stated that active management in environmental responsibility positively influence financial performance. Regulatory oversight amplifies this positive effect and shows that enterprises with higher environmental investments can gain greater profitability Shabbir and Wisdom [47]. It is also argued by some scholars that corporate environmental responsibilities can escalate costs and reduce profits, potentially negatively influencing financial performance. It is stated that fulfilling environmental responsibilities and disclosing environmental information can degrade company performance due to the underlying issues which can create more restrictions for firms. Sulkowski [48] suggested that environmental responsibility efforts can crowd out other investments, and increase production costs that could reduce corporate profit margins as well. Tao, Guo [49] state that environmental information disclosures can significantly negatively correlated with the corporate performance based on data from China.

Mazzanti, Marin [50] contended that adopting corporate social responsibility enhances corporate value, and this notion is commonly referred as "Porter Hypothesis". Firms, actively following environmental responsibilities, can bolster company' reputation and garner additional income [51]. Subsequently, there are studies supporting the argument of "Porter Hypothesis", and stating that engaging in environmental responsibility can improve corporate performance [52,53]. Liu, Xi [54] argued that only active engagement in environmental-friendly practices can strengthen company's capabilities and a company represents unity of value creation and social responsibility fulfillment, may strengthen its overall capabilities. The higher the company's environmental responsibility rating, higher will be its projected value [31]. In early stages of economic development, companies and government often prioritize economic growth in quantity over quality, with society showing higher tolerance for environmental degradation and resource consumption. However, engaging in environmental commitments during this phase may lead to increase operational costs, and placing company at a company disadvantage in market. Considering these potential bases, we may postulate this hypothesis for chemical industries of China:

H_2: Green transformation results positive financial performance in context of Chinese chemical industries.

2.3 The role of corporate governance strength

Previous studies present the direct nexus between corporate financial and environmental performance. However, the results have been mixed, showing positive [55,56], negative [57], or no [58,59] associations between these variables. A significant limitation of these studies is the failure to consider the moderating effect of governance strength on this nexus. Theoretically, agency theory states that well-established governance structures can promote the linkage between a firm's environmental and financial performance via aligning managerial interests with those of the stakeholders, and encourage managers to act in favor of the wide range of the stakeholders [60]. Similarly, stakeholder theory suggests that committing to robust governance practices may boost corporate image via signaling to the market that firm prioritizes meeting the interests of multiple stakeholders instead of only shareholders [61,62], which in turn may strengthen the relationship between financial and environmental performance. It can be argued that firms which have strong governance are able to manage their operations more efficiently and being able to achieve a good balance between economic and environmental concerns. In chemical industries of China, there is need of having the strong corporate governance which can tighten the overall strategic and governance operations for the organizations, and enabling them to meet the SDGs. By considering these, this study examines the moderating effects of governance strength on the nexus of green transformation with corporate financial and environmental performance in context of Chinese chemical industries. Drawing on this discussion, theoretical framework, and empirical literature's limitation, we may develop this hypothesis:

$H_{3:}$ Strong corporate governance positively influences the nexus of green transformation with environmental and financial performance of Chinese chemical industries.

3. Research methods, models, and data

3.1 Research methods and models

As per the above analysis and discussion, this study uses fixed effects regression with firm year fixed effects and standard errors clustered at firm year level. We estimate following equation:

$$ROE_{it} = \alpha + \beta_1 GT_{it} + \beta_j X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

where *i* is the enterprises, *t* are the operating years, β are estimated coefficient of the corresponding variables, *ROE* is the Return on Equity, *GT* is the green transformation index of chemical industry firm, *X* are the control variables, μ is the firm fixed effect, δ is the time fixed effect, and ε is the standard error term. Hypothesis 1 will be verified with model (1) equation. To further examine the impact of green transformation on environmental performance, model (2) will be developed as:

$$ENV_{it} = \alpha + \beta_1 GT_{it} + \beta_j X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (2)$$

where ENV is the environmental performance level of the enterprises *i* in year *t*. Furthermore, we introduce interaction term of green transformation with governance to verify the moderating impact of governance strength on the nexus of green transformation with corporate financial and environmental performance. Model 3 and model 4 will considered the moderating variables as:

$$ROE_{it} = \alpha + \beta_1 GT*GOV_{it} + \beta_1 GT_{it} + \beta_j X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (3)$$

$$ENV_{it} = \alpha + \beta_1 GT*GOV_{it} + \beta_1 GT_{it} + \beta_j X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (4)$$

where $GT*GOV_{it}$ is the interaction term of governance and green transformation, which will be used as moderating variable in baseline model.

3.2 Variables Selection

Explanatory Variable

Green transformation: Drawing on the methodology established by Loughran and McDonald [63], the green transformation of enterprises is quantified using textual analysis of annual reports from listed companies, where 113 keywords associated with green transformation are identified from five categories: publicity and initiative, strategic concept, technological innovation, pollution control, and monitoring management. These keywords are selected based on extensive research and policy documents, including works by Hart [64], Panbing, Mian [65] and Zhang, Li [66], and their frequencies are analyzed using natural language processing technologies. Finally, the frequency of each keyword is incremented by one and transformed using the natural logarithm to effectively measure the extent of green transformation within these enterprises, providing a quantifiable metric that aligns with key strategic and environmental goals.

Explained Variables

Environmental Performance: ESG ratings, particularly the Huazheng Index ESG Ratings, is used to assess the environmental, social, and governance performance of Chinese chemical industries' enterprises. For our study, we have only used environmental score as we must measure the impact of green transformation on environmental performance [67,68]. Huazheng Index, known for its rapid updates and broad coverage, is utilized for its alignment with the Chinese market's conditions, high credibility, and substantial research value.

Financial Performance: Return on Equity is used as the measure to investigate the financial performance of companies. It is measured as net income divided by total shareholders' equity [66].

Moderating variable

Corporate governance strength: The natural log of the number of independent members in a board is used as the moderating variable in this study [69].

Control Variables

This study includes Earnings per share (EPS), Liquidity ratio (Liq), proportion of fixed assets (FA), total debt to equity (DE), and Natural log of total assets (TA) as the control variables. These variables are selected based on their fitness and appropriateness to be used for an empirical study. These control variables have also been previously used by the similar context empirical studies.

3.3 Data source and descriptive statistics

In this study, we investigate the impact of green transformation on both environmental and financial performance in the context of the Chinese chemical industry, analyzing a sample of 173 A-listed Chinese chemical companies from 2011 to 2022. To ensure the availability and validity of the data, we have excluded companies with incomplete data. We utilized the CSMAR database to obtain financial performance data and the Wind database for environmental performance data. Additionally, green transformation data were derived from the companies' annual reports and social responsibility reports, providing a comprehensive view of their commitment to sustainability and its effects on their operational outcomes.

Table 1 shows the descriptive statistics for all variables of this study. It can be seemed that mean value for green transformation (GT) is 3.4090 with a standard deviation of 0.7915, which indicates the existence of normal distribution of data. The environmental performance (ENV) has mean value of 62.5831 with standard deviation of 7.3797, indicating the existence of normal distribution of variables across the sample period. Financial performance (ROE) has presented a mean of 0.0113, while its standard deviation is high 0.7032. Moreover, the mean values, standard deviation, minimum, and maximum values are of the normal range as well. **Table 1** also presents the correlation of all explained and control variable with explanatory variables. It can be seemed that environmental performance has its positive relationship with green transformation, while financial performance has a negative relationship with green transformation. **Figure 1** shows the trends for the explained, explanatory, and moderating variables.

4. Empirical Analysis

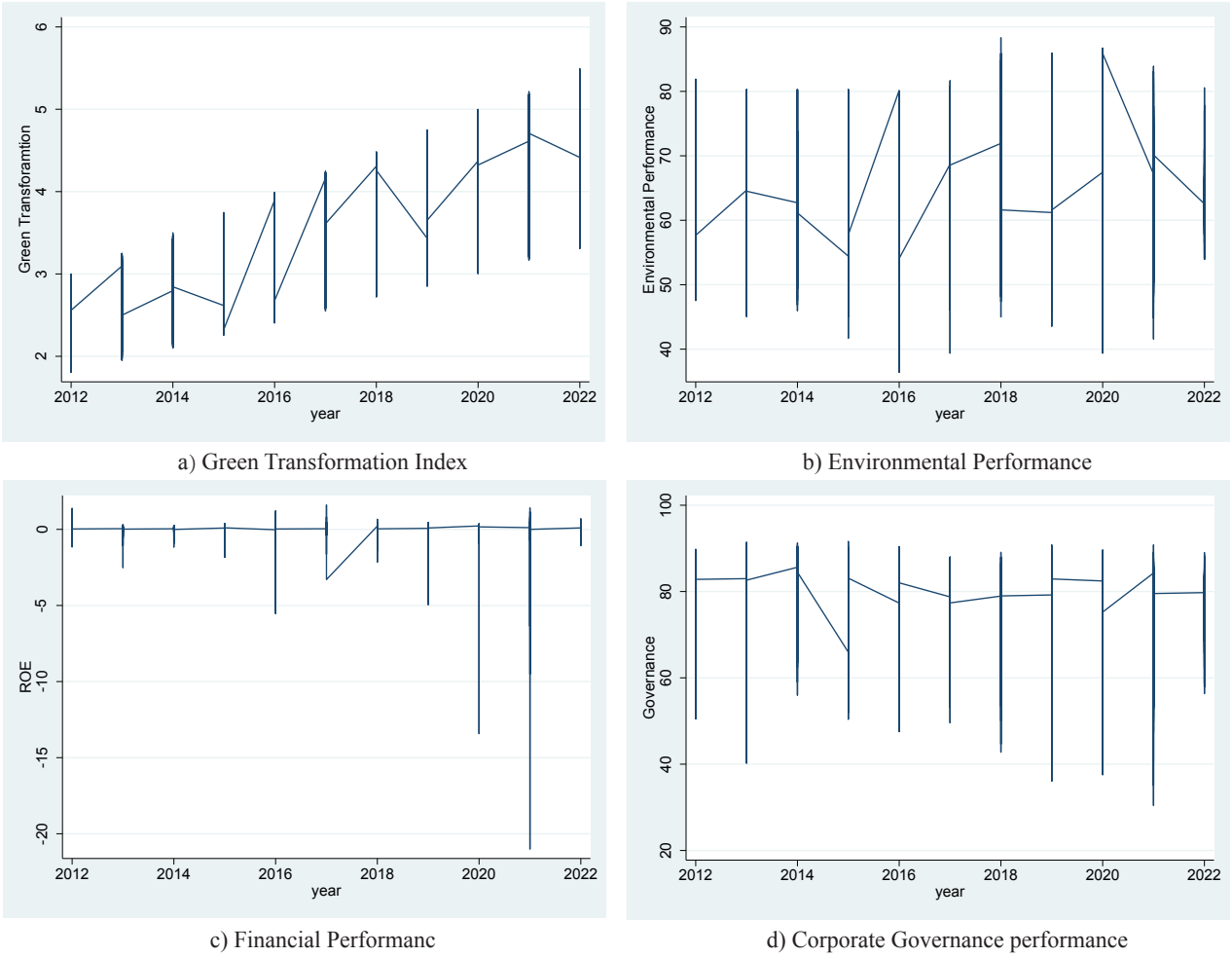
4.1 Baseline results

Table 2 shows the baseline results of model (1) and model (2). The results are presented in columns (1) and (2). The regression coefficient of GT is positive and significant as shown in column (1) of **Table 2**. It can be seemed that GT has regression coefficient of 0.5694, indicating that with one unit increase in green transformation, there will be improved environmental performance of A-share listed enterprises of chemical industries of China. These results are in line with the previous literature [54], and showing that there is with the increased focus on green transformation, chemical industries of China will be more efficient to achieve their environmental goals. The green transformation will make the chemical industries' firms more exposed to sustainability and thereby these findings confirm hypothesis one of this study.

Table 1. Descriptive statistics and correlation.

Variable	Symbol	Obs	Mean	Std. dev	Min	Max	Corr.
Firm Green Transformation	GT	1903	3.4090	0.7915	1.8072	5.4901	1.0000
Environmental Performance	ENV	1903	62.5831	7.3797	36.4300	88.2900	0.1051***
Financial Performance	ROE	1903	0.0113	0.7032	-20.9917	1.5932	-0.0331*
Earnings per share	Eps	1903	0.2993	0.8465	-16.4600	7.8500	0.0934***
Liquidity Ratio	Liq	1903	2.0527	2.5961	0.0947	57.2778	-0.0450**
Fixed Assets Proportion	FA	1903	0.3265	0.1514	0.0000	0.8081	-0.0971***
Debt to Equity	DE	1903	1.3640	8.5589	-151.9334	231.6512	0.0194
Total Assets	TA	1903	22.2455	1.0901	19.5235	26.6165	0.2206***

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$



a) Green Transformation Index

b) Environmental Performance

c) Financial Performanc

d) Corporate Governance performance

Figure 1: Trends for the green transformation, environmental performance, financial performance, corporate governance

Table 2. Baseline results.

Variables	(1)	(2)
	ENV	ROE
GT	0.5694***	0.0500**
	(3.51)	(2.28)
EPS	-0.3698**	0.2586***
	(2.38)	(12.31)
Liq	0.0156*	0.0041***
	(1.74)	(2.48)
FA	1.7253	0.3206*
	(1.26)	(1.73)
DE	-0.0350**	-0.0238***
	(2.52)	(12.70)
TA	1.1840***	0.0122
	(4.54)	(0.35)
Constant	33.866***	0.2468***
	(5.99)	(3.32)
Firm & Year FE	Yes	Yes
R-Squared	0.1403	0.1595
Obs.	1,903	1,903

T-statistics in parentheses: *** p < 0.01; ** p < 0.05; * p < 0.1

The column 2 of **table 2** presents the results of the influence of green transformation (GT) on financial performance (ROE) in A-share listed enterprises of chemical industries of China. It can be seemed that the impact of green transformation on ROE is positive in form of regression coefficient of 0.0500, indicating that Chinese chemical industries' firms are also able to garner positive financial performance with the move toward green transformation. These results are in line with the previous studies showing the positive impact of green innovation and technology on financial performance of firms [37], and thus confirm hypothesis 2. However, when compared to environmental performance, it can be seemed that impact is much lower, suggesting that green transformation has robust support for the environmental performance, and minimal support for financial performance of enterprises.

4.2 Checking robustness of baseline results

To confirm the robustness of baseline findings, we employed system generalized methods of moment (System GMM). This approach is fit to our model as it efficiently address the potential endogeneity issues that arise from the reverse causality between green transformation and corporate performance, or from the omitted variable bias. This model utilizes both levels and first-differences of the data, enhancing the efficiency of estimators via incorporating additional moment conditions [70,71]. This method does not only help to control unobserved heterogeneity but offers more reliable and dynamic insights into the impact of green transformation in chemical industry over time. It uses lagged variables ad instruments to accurately capture the dynamic relationships

Table 3. Robustness check using System GMM.

Variables	(1)	(2)
	l.ENV	l.ROE
GT	0.7616***	0.0842***
	(4.87)	(2.88)
EPS	1.6901***	-0.0263
	(2.92)	(-0.23)
Liq	0.2887	-0.0128
	(0.82)	(-0.19)
FA	7.5486**	-0.7902**
	(2.56)	(2.40)
DE	-0.1186**	-0.0054
	(-3.04)	(-0.71)
TA	0.1519	0.1559*
	(0.31)	(1.71)
Constant	53.1520***	2.8711***
	(4.70)	(3.28)
AR(1)	(0.000)	(0.000)
AR(2)	(0.316)	(0.868)
Wald (chi)	494346.10	14.60
Prob > chi	0.000	0.024

T-statistics in parentheses: *** p < 0.01; ** p < 0.05; * p < 0.1

and adjust of autocorrelation within the panel data, ensuring that results are effective and robust of true causal relationships.

The robustness test results are presented in columns (1) to (2) of **Table 3**. Column (1) presents the results of the influence of green transformation on environmental performance. It can be seemed that regression coefficient of GT is still positive and significant, reflecting positive influence of green transformation on environmental performance in Chinese A-share listed enterprises of chemical industries of China. Column (2) shows the results of the effects of green transformation on financial performance of Chinese A-share listed enterprises. It can be said that with the increased focus on the green transformation there will be better financial results for the firms. Overall, the robustness test results are in line with the findings of baseline, and confirm hypotheses 1 and 2.

4.3 Moderating effects of governance

There can be a significant role played by the corporate governance of an organization through directing the decisions which can influence corporate financial and environmental performance. There are different measures to use the corporate governance strength but the most common is the number of independent directors in a board [72,73]. It is argued that with the greater number of independent directors, there can be more people who have wider knowledge and they can make the boards strong. The moderating effects of corporate governance strength incorporated in this study to examine its influence to strengthen of weaken the relationship of green transformation with corporate environmental and financial performance.

Model 3 is run and results are reported in column (1) of **Table 4**. It can be seemed that interaction term GT*GOV has the positive influence on the nexus between green transformation and corporate environmental performance. It can be seemed that when governance is incorporated as moderating variable, the influence of this interaction term on ENV is positive as reported in form of regression coefficient 0.689. These results show that by strengthening the influence of governance, there will be more environmental performance for the firms. Model 4 is run and results are presented in column (2) of **Table 4**. The moderating effects of GT*GOV are reported as positive with the regression coefficient of 0.057. This

value is significant at 5% level, however overall, the impact is still positive. These results confirm the hypothesis 3, which states that with the strong corporate governance, the influence of green transformation will be better on financial and environmental performance of Chinese A-share listed enterprises of chemical industries of China [5].

Table 4. Moderating effects of corporate governance strength.

	(1)	(2)
Variables	ENV	ROE
GT*GOV	0.689***	0.057**
	(2.94)	(2.46)
GT	0.0521**	0.1676***
	(2.15)	(3.46)
EPS	-0.4058**	0.2518***
	(-2.59)	(11.92)
Liq	0.0081	0.0027
	(0.13)	(0.31)
FA	1.8788*	0.3496*
	(1.77)	(1.89)
DE	-0.0344**	-0.0237***
	(-2.48)	(-12.65)
TA	1.1935***	0.0139
	(4.58)	(0.40)
Constant	33.3906***	3.3368***
	(5.91)	(3.44)
Firm & Year FE	Yes	Yes
R-Squared	0.1424	0.1631
Obs.	1,903	1,903

T-statistics in parentheses: *** p < 0.01; ** p < 0.05; * p < 0.1

4.4 Firm-level heterogeneity

The impact of green transformation could be different across the firms due to the difference in sizes and ownership types. For instance, firms with small size might have lower investment capacity to focus on green technology and innovation, while large sized firms could have much capacity and volume to move toward green transformation [74]. Moreover, firms which are directly owned by government/state, have better potential of utilizing resources. They must have to comply with the environmental regulations of country and they could be more exposed to the benefits of green transformation to achieve positive outcomes in form of environmental and financial performance.

Firm size

The heterogenous effects of firm size are incorporated in this study to segregate the effects of green transformation across the large and small sized firms [75]. The results of green transformation on environmental performance are shown in columns (1) and (2) of **Table 5**. It can be seemed that firms with large size are more exposed to the benefits of the green transformation and able to achieve better environmental performance as the regression coefficient
for GT for large-sized enterprises is 0.99798, while for small sized enterprises this coefficient is 0.18346. The results for the financial performance are reported in columns (3) to (4) of **Table 5**. It can be seemed

Table 5. Firm size heterogeneity effects.

	(1)	(2)	(3)	(4)
Variable	ENV	ENV	ROE	ROE
	Large	Small	Large	Small
GT	0.99798***	0.18346***	0.03775**	0.03957
	(3.95)	(2.86)	(2.57)	(1.10)
Constant	38.50645***	32.94886***	4.47274***	1.50511
	(4.33)	(4.47)	(3.92)	(1.21)
Control Variables	Yes	Yes	Yes	Yes
Firm & Year FE	Yes	Yes	Yes	Yes
R-Squared	0.0524	0.0343	0.7344	0.1212
Obs.	946	957	946	957

T-statistics in parentheses: *** p < 0.01; ** p < 0.05; * p < 0.1

that the impact of green transformation on financial performance is mainly for those which are of large-sized. The impact of green transformation on financial performance of the small-sized Chinese chemical enterprises is not significant, indicating the more stride toward the large sized firms.

Firm Ownership

In context of China, there is crucial need to investigate the influence of green transform on corporate financial and environmental performance with ownership heterogeneity. **Table 6** reports the results of firm ownership heterogeneity. Specifically columns (1) and (2) shows the results of financial performance for the SOEs and Non-SOEs enterprises. As per evaluation of results, it can be said that state-owned firms are more exposed to the benefits of green transformation with increased environmental performance. The influence of green transformation on corporate financial performance is found greater for the Non-SOEs. The reason behind this could be the greater focus of the state-owned enterprises toward environmental performance by complying with the environmental rules and regulations of China [76]. However, non-SOEs might have their priority of financial performance over environmental performance, so their performance is greater in financial terms.

Table 6. Firm ownership heterogeneity effects.

	(1)	(2)	(3)	(4)
Variable	ENV	ENV	ROE	ROE
	SEO	Non-SEO	SEO	Non-SEO
GT	0.9949***	0.3852*	0.0059	0.0559*
	(3.82)	(1.77)	(0.30)	(2.05)
Constant	38.7204***	33.0379***	3.3276***	3.8644***
	(4.38)	(4.26)	(3.50)	(3.89)
Control Variables	Yes	Yes	Yes	Yes
Firm & Year FE	Yes	Yes	Yes	Yes
R-Squared	0.1656	0.0304	0.1315	0.5125
Obs.	770	1,133	770	1,133

T-statistics in parentheses: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

5. Conclusion and Policy Implications

Using a sample of 173 Chinese A-share listed enterprises of chemical industries of China for period of 2012—2022, this study examines the effects of green transformation on environmental and financial performance. We employed two-fixed-effects model and find positive influence of green transformation on environmental and financial performance. Additionally, this study examines the moderating effects of corporate governance strength on the nexus of green transformation with environmental and financial performance. It is reported that corporate governance positively moderates this nexus of explanatory variable with both explained variables. Moreover, this study examines heterogenous effects of firm size and firm ownership and show that firms with large size and state-ownership are more exposed to the benefits of green transformation to achieve positive results for financial and environmental performance.

These findings offer significant implications for policymakers and managers who are concerned to gain the potential balance between financial and environmental outcomes while adapting green transformation. The enterprises moving toward green transformation can achieve both, positive environmental and financial outcomes, so policymakers are suggested to adopt green transformation to get the potential balance. Moreover, they are recommended to strengthen corporate governance which will allow to a good transition of their organizations from shareholder view to stakeholder view. It is also rec-

ommended that policymakers must adopt green technologies and innovations which will help their organizations to empower with those resource-efficient processes which will not only reduce the utilization of resources, but simultaneously there will also be positive contribution to environmental concerns.

Author Contributions

Jihu Lei: Methodology, Investigation, Conceptualization, Writing – original draft, review & editing.

Asad Nisar: Data collection, Methodology, Formal analysis, Validation, Writing – review & editing, Supervision, Resources.

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