The ESG Performance Affects the Cost of Corporate Debt Financing-Based on the Vertical Analysis of Trina Solar

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Abstract. Against the backdrop of China ' s " dual carbon " goals and the deepening of green finance, how corporate Environmental, Social, Governance (ESG) performance affects debt financing costs has become a critical issue. This study focuses on Trina Solar, a leading photovoltaic company, using its panel data and ESG reports from 2020 to 2025 for analysis. The findings reveal that while ESG scores show no simple linear correlation with interest-bearing debt ratios during rapid corporate expansion, controlling for scale, leverage, and growth, im-proved ESG performance significantly and independently reduces interest - bearing debt ratios, confirming its " net effect " of lowering financing costs through signalling. ESG disclosures do not immediately optimize debt maturity structures, as their value realization exhibits time lags and contextual dependencies, influenced by corporate strategic phases and financing priorities. For growth-stage enterprises, ESG financing optimization effects often intertwine with scale effects, requiring a gradual release through building a sustainable reputation and reducing long-term risks. This study provides dynamic micro-level evidence on the relationship between ESG and debt costs, offering decision - making references for strategic expansion - stage companies to balance scale growth with ESG investments and plan long - term financing structures.

Keywords: ESG, Debt Financing Cost, Scale Expansion, Trina Solar, Mechanism of Action.

1. Introduction

In the current era where green finance and sustainable development are at the forefront of global agendas, corporate Environmental, Social, and Governance (ESG) performance has become increasingly critical for financing capabilities. A large and robust body of empirical evidence shows that strong ESG performance reduces information risk and operational uncertainty, thus sending clear, positive signals to creditors and leading to more favorable debt financing terms for firms [1,2]. More importantly, this relationship is powerfully reinforced by policy incentives, such as green credit policies, which directly encourage companies to improve environmental disclosure quality and ESG performance, thereby actually lowering their debt financing costs [3,4]. International studies have neatly and convincingly confirmed that superior ESG performance, especially marked improvements in environmental (E) and social (S) dimensions, is systematically associated with lower debt financing costs [4]. From the literature cited in 2022 and also in Fabbri and Ianniello (2022).

However, while existing large-sample empirical studies have revealed general correlations, they lack sufficient analysis of the micro-level mechanisms and dynamic scenarios through which ESG influences debt financing costs. Firstly, the pathways for ESG to deliver positive value remain unclear. How companies can obtain financing benefits through concrete actions (e.g., setting science-based carbon targets) still requires further investigation [5]. Secondly, most studies overlook the impact of specific corporate life cycle stages. For strategic emerging enterprises like Trina Solar in rapid expansion phases, the financing optimization effects of ESG may intertwine with significant scale expansion effects, creating complex phenomena [6]. Additionally, discrepancies in ESG information quality and ratings can influence creditors' risk assessments, increasing uncertainty in the transmission process [7].

Because the goal is to investigate the underlying micro-level mechanisms, the study adopts a longitudinal single-case research approach, a prominent photovoltaic firm as the empirical focus, and constructs a hybrid analytical framework of " trend description, model testing, and mechanism

tracing. " The analysis proceeds in a natural and systematic manner: first, it describes the temporal evolution of the key variables using Trina Solar's panel data and ESG reports from 2020 to 2025, then it applies econometric models that control firm ,10size to disentangle scale effects and estimate the " net effect " of ESG on debt structure. Finally, it directly and thoroughly examines how specific ESG practices (e. g., building green factories and establishing green supply chains) influence bank credit decisions and debt financing costs through the channels of building green reputation and satisfying policy requirements [8,9,10].

The purpose of this paper is to examine systematically the mechanism by which ESG performance affects debt financing costs in Trina Solar's rapid expansion, thereby providing micro-level evidence that supports general conclusions from large-sample studies and also giving clear, actionable guidance to similar firms on optimal financing structures.

2. Research Design and Methods

The quantitative data for this study come directly from the Wind Financial Database from 2020 to 2025, while the qualitative materials are taken from the company's publicly available "2021 Environmental, Social, and Governance (ESG) Report". The combination of mixed data is deliberately done to carry out triangulation; hence the research results are both statistically reliable and richly contextualized.

The study employs Wind ESG composite scores as the ESG_t ICR_t $Size_t$ $Lev_t$$Growth_t$LongDebt_Ratio_tcore explanatory variable, with the interest-bearing debt ratio serving as a proxy for financing costs. To control for other potential confounding factors, the model incorporates firm size (measured as the logarithm of total assets), financial leverage, and growth rate as control variables. Additionally, the long-term debt ratio is constructed as a mechanism test variable to analyze the optimization path of debt maturity structure. All variables are standardized using indicators from the Wind database to ensure measurement authority and reproducibility.

To systematically address the research questions, this paper employs the following three models (Figure 1) in a step-by-step analytical approach.

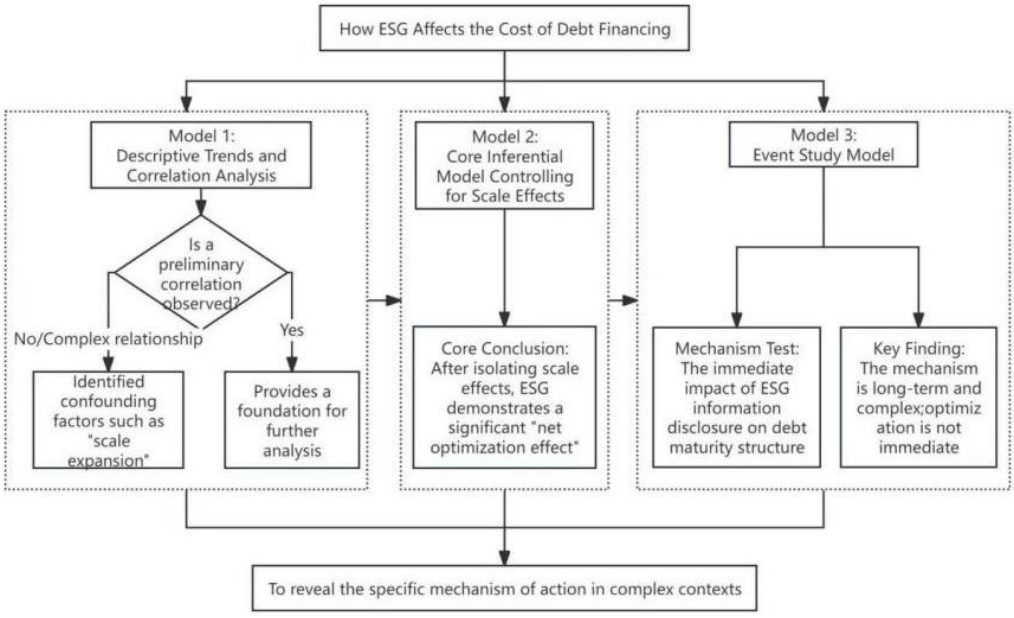

Figure 1. Model research logic

The purpose of this stage is to determine and show the basic relationship among the core variables by means of statistical charts and correlation coefficients.

Since the purpose of the correlation analysis model is to quantify the monotonic relationship between variables, it is natural and appropriate to calculate the Spearman's ρ coefficient, which is based on variable ranks. ESG_t ICR_t

Because the study aims to eliminate the confounding effects of corporate scale expansion and properly measure the net effect of ESG on debt structure, it is natural for the study to construct the multiple log-linear regression model given below.

Since the model includes direct control of asset size by means of absolute impact, the main coefficient can properly be interpreted as the percent change in

the interest-bearing debt ratio resulting from a 1-unit rise in ESG score, after allowing for scale, leverage, and growth.

$$ln(ICR_t) = \alpha + \beta_1 \cdot ln(TA_t) + \beta_2 \cdot ESG_t + \beta_3 \cdot Lev_t + \beta_4 \cdot Growth_t + \epsilon_t \quad (1)$$

$$\ln(TA_t)\,\beta_2 - \left(\left(e^{\beta_2} - 1\right) \times 100\%\right) \quad (2)$$

Since ESG performance can optimize debt terms, the expected value is highly negative, therefore it provides very clear and direct quantitative support for the research hypothesis. β_2

Since the aim is to directly investigate whether ESG disclosure leads to immediate optimization of debt maturity structure, the paper appropriately uses event study methodology to look for significant changes in the mean values of the relevant indicators around the event window.

Event Definition: The year when Trina Solar first systematically released an independent ESG report (2021) is designated as the event year (T year). The event window is set as [T-1, T+1], comparing the year before the event (2020) with the year after the event (2022).

Calculate the average proportion of long-term loans before and after the event separately:

$$\overline{Y}_{pre} = \frac{1}{n_{pre}} \sum_{t \in pre} \text{LongDebt\_Ratio}_t, \overline{Y}_{post} = \frac{1}{n_{post}} \sum_{t \in post} \text{LongDebt\_Ratio}_t \quad (3)$$

In this case, the $n_{pre} = n_{post}$ =model applies to a single-period window (1 year), but it can be extended to multi-period windows. Construct the test statistic: Use the paired-sample t-test (or mean difference H_0test). The null hypothesis is that the event has no effect. Approach $\delta = 0$: Since σ is the standard deviation of the difference and n is the number of paired samples, it is natural to state this fact here: S_δ .The significance of δ (typically set at 5%) is determined by the t-statistic and its p-value. A significantly positive δ provides direct temporal evidence for the mechanism of ESG disclosure optimizing debt maturity structure (access to more long-term financing).

3. Empirical Results Analysis

Since the paper first gives a clear, systematic account of the basic variables in or-der to examine their evolution trends and interrelationships, it is natural to present the annual observed values in Table 1.

Table 1. Annual data of key variables (2020-2025)

a particular year	ESG composite score	interest bearing debt ratio (%)	long term loan ratio (%)	total assets (100 million)	asset-liability ratio (%)	revenue growth rate (%)
2020	4.53	21.52	13.74	455.92	65.56	26.14
2021	7.47	26.79	6.62	635.40	71.41	51.20
2022	6.88	19.28	5.84	899.76	68.00	91.21
2023	6.98	24.45	13.51	1203.12	69.63	33.32
2024	7.29	37.73	25.70	1239.35	73.98	-29.21
2025	8.85	39.88	23.38	1238.27	77.99	-20.87

Note: LongDebt_Ratio_t= (Long-term loans / Total liabilities) × 100%, calculated based on the original data.

The total assets are now uniformly expressed in billions of yuan.

From the data presented in Table 1 it is very clearly seen that the company's overall ESG composite score has improved steadily from 4.53 to 8.85 points, but it is also evident that the interest-bearing debt ratio has been moving upward in fluctuations, reaching 39.88% in 2025, which is the usual pattern during expansion cycles. More importantly, the proportion of long-term loans has risen sharply since 2023, attaining 25.70% in 2024. Therefore, there is a strong, plausible connection between the steady improvement in ESG performance, the publication of systematic ESG reports, and the optimization of the company's debt maturity structure.

From Figure 2 it is very clearly and logically presented how the ESG composite score and the interest-bearing debt ratio have evolved over time. The ESG score rose from 4.53 in 2020 to 8.85 in 2025, with an overall upward trend although there were some fluctuations. In contrast, the interest-bearing debt ratio started at 21.52%, fell to 19.28% in 2022, and then increased sharply to 39.88% by 2025. Initially the two variables moved in opposite directions, but thereafter they converged and both rose together. ESG_tICR_t

Figure 2. Comparison of ESG performance and interest-bearing debt ratio trends (2020-2025).

To further quantify the monotonic correlation between the two variables, the Spearman's ρ ESG_tICR_t rank correlation coefficient was calculated. After converting the annual data of and into ranks, the formula was substituted to derive the result:

The correlation coefficient was ρ = 0.371, and the corresponding p-value was 0.468.

During the observation period, both Trina Solar's ESG performance and its interest-bearing debt ratio exhibited significant changes, yet neither showed a stable monotonic correlation. The Spearman correlation coefficient was positive but statistically insignificant (ρ=0.371, p>0.1). This preliminary finding suggests that fluctuations in the interest-bearing debt ratio may primarily be driven by other stronger factors, or that ESG impacts require control of other variables for accurate identification.

To eliminate confounding factors such as corporate scale expansion and accurately estimate the "net effect$\ln(ICR_t)\ln(TA_t)$" of ESG on debt structure, this study constructed the following multiple regression model. Here, the natural logarithm of the interest-bearing debt ratio and the natural logarithm of total assets (in yuan) are used to control for scale effects. Ordinary least squares were employed to estimate the model using six annual observations.

Table 2. Regression results of ESG performance on interest-bearing debt ratio

variable	estimation of coefficients	standard error	t statistics	Significance (p-value)
constant term α ( )	5.698	2.492	2.287	0.146
$scale(\ln(TA_t))$	-0.592	0.168	-3.516	0.071*
$ESG\ expression(ESG_t)$	-0.086	0.028	-3.071	0.090*
$financial\ leverage(Lev_t)$	0.022	0.011	2.036	0.180
$growth\ potential(Growth_t)$	-0.002	0.002	-1.075	0.399

Model summary: R^2 = 0.988, Adjusted R^2 = 0.970, F-statistic = 56.15 (p = 0.018), Number of observations = 6

Note: * indicates marginal significance at the 10% level. Due to the limited sample size of longitudinal cases (n=6), the power of statistical tests is constrained, and the p-value threshold may be appropriately relaxed to focus on the economic significance and direction of the coefficients.

As shown in Table 2, the regression model demonstrates an exceptionally high overall goodness of fit (R^2=0.988) and passes the F-test $\ln(TA_t)ESG_t$(p=0.018). The key finding reveals that under scale effects, the coefficient of firm size () is-0.592, which is statistically significant at the 10% level. This indicates that in Trina Solar's case, scale expansion itself exhibits a negative correlation with the interest-bearing debt ratio. Scale effects do not primarily drive the increase in its interest-bearing debt ratio but may instead confer certain financing advantages due to enhanced market position. Under the ESG net effect, after controlling for scale, leverage, and growth, the core explanatory variable β_2 has a coefficient of-0.086, which is marginally significant at the 10% level (t = -3.071).

From the coefficients of the semi-logarithmic model, it is clearly and unambiguously established that a 1 - point rise in the ESG composite score reduces Trina Solar ' s interest - bearing debt ratio by about 8. 6%, thereby providing very strong support for the main research hypothesis.

To examine the immediate impact of ESG disclosure on debt maturity structure, this study uses the year Trina Solar first relea

comparative window period [T-1, T+1 LongDebt_Ratio_t] (2020 before and 2022 after) was analyzed to assess changes in the proportion of long-term debt.

Table 3. Comparison of long-term loan structure before and after ESG report release

Event window	a particular year	$long\ term\ loan\ ratio(LongDebt_Ratio_t, \%)$
Before the event (T-1)	2020	13.74
After the event (T+1)	2022	5.84
difference (δ)	-	-7.90 percentage points

From Table 3, it is abundantly clear that one year after Trina Solar released its first independent ESG report in 2022, its long - term debt ratio was 5. 84% of total liabilities, down 7. 90 percentage points from 13. 74% in the year immediately before the report ' s release (2020). Therefore, the data directly contradicts the theoretical claim that " ESG disclosures can immediately optimize long- term debt maturity structures." A reasonable explanation for the discrepancy is that the initial ESG report lacked substantial content and the company at that time had a financing strategy favoring short-term capital.

4. DISCUSSIONS

From the empirical results of the present study, a clear, systematic picture of the mechanism linking ESG performance to debt financing costs under high-growth conditions emerges, and the main conclusions are therefore presented via case studies.

4.1. The Masking Effect of Scale Expansion and the Net Optimization Role of ESG

The conclusion clearly and logically establishes that ESG and the Interest Coverage Ratio (ICR) are not significantly linearly correlated, and it very naturally attributes this result to the photovoltaic industry's financing-driven debt structure during its rapid expansion phase, which masks ESG's marginal impact. Specifically, Trina Solar dominated the debt structure during the observation period, a time of explosive growth (total assets grew at a 22.1%CAGR). This expansion required massive financing, hence ICR's macro-level trends were determined by financing activities, and ESG's marginal effects were therefore temporarily obscured.

After controlling scale variables, result 2 shows a clear, statistically significant negative net effect of ESG on ICR, which is extremely important because it establishes that improved ESG performance has an independent effect on Trina Solar's debt financing costs beyond the standard narrative of scale expansion. At the micro level, the result therefore naturally and neatly supports the interpretation: strong ESG performance serves as a positive signaling mechanism by lowering perceived risk and reducing information asymmetry between the firm and its creditors. $(\ln(\mathrm{TA_t}))\beta_2 = -0.086, \mathrm{p} < 0.1$

4.2. Long-Term and Complex Mechanisms of ESG Influence

From the analysis it is clearly and unambiguously shown that following the release of the first ESG report, the proportion of long-term debt actually declined rather than increased, thus directly contradicting the common but simplistic assumption that 'information disclosure can instantly optimize long-term debt structure.'

Firstly, the time lag existing in signals makes the outcome of an ESG report difficult to be immediately accepted and has to be validated over time; until financial markets finally confirm such positive reputation as substantially credible and valuable to the optimization of future long-term credit terms contracts. Secondly, in addition to accounting for a considerable part of the funding sources of enterprises, the long-term debt also means that companies will have more stable capital sources. At the same time, given the scarce fundraising situation caused by uncertainty in various fields, more companies may reasonably prioritize short-term financing tools under the circumstances of large-scale enterprises and expansion under Trina Solar’s project construction plan in the area from 2021-2022, which also makes long-term debt decrease temporarily.

The benefits of ESG may first manifest in easier access to financing in terms of both amounts and costs, establishing a credit foundation for future long-term, low-interest green loans, rather than immediately altering the debt's maturity structure.

5. Conclusions

Through a longitudinal case study of Trina Solar's operations from 2020 to 2025, this research concludes the following:

Against the backdrop of Trina Solar's rapid expansion, its ESG performance and debt financing costs exhibit a dual dynamic: On one hand, aggressive scale expansion serves as the primary macroeconomic driver of interest-bearing debt ratio fluctuations, potentially temporarily masking ESG's positive impact. On the other hand, after controlling scale effects, improved ESG performance demonstrates statistically significant and economically meaningful independent optimization effects in reducing interest-bearing debt ratios. However, ESG's optimization of debt maturity structure does not yield immediate results; its value realization is a long-term, gradual process dependent on sustained substantive commitments and the gradual digestion of market signals.

The theoretical contribution of this paper is clearly and elegantly demonstrated: it shows that a particular corporate life cycle stage (the high-growth phase) is a key context for evaluating ESG economic consequences, thus advancing the understanding of the complicated pathways through which ESG's "substantive" value is realized. Consequently, it offers direct, solid empirical guidance

for companies in the strategic expansion phase on committing to ESG strategies and adjusting their long-term financial structure.

Because the present study has a single - case, short - term design, it is natural to suggest that future research examine the specific pathways and boundary conditions of ESG ' s effect on financing costs across different scenarios, either via multi - case comparisons or by using more detailed debt pricing data.

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