

How Low-Carbon Transition Risk Impacts Corporate Financial Performance? Evidence from Select Indian Energy Companies

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Abstract

India pledged at COP 26 to reach the net-zero goal by 2070. This target achievement requires technological advancement, additional investment, and shifting the dependency to renewable energy from conventional energy sources. However, these transition activities could impose several challenges on the performance of companies, particularly those in the energy sector. Thus, the present study aims to explore whether and how decarbonization imposes material risks on the financial performance of the Indian Energy Sector.

Keywords: Low-Carbon, Net Zero, Transition Risk, Climate Risk, Financial Performance.

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Introduction:

The phenomenon of climate change represents one of the most complicated and urgent global challenges of our time, encompassing a wide range of environmental, economic, and social dimensions that demand coordinated international attention and action (**Bachner et. al, 2020**). Rapid industrialization and urbanization have resulted in excessive greenhouse gas (GHG) emissions, which are considered to be the primary cause of human-induced climate change (**IPCC, 2014; Sufyanullah et. al., 2022**). In this scenario, world leaders have made several agreements and protocols to reduce the global GHG emissions, more specifically, carbon emissions. However, towards the transformation of a lower-carbon economy, the countries need to increase their dependency on clean energy resources. Thus, in the pathway of net-zero transformation, energy companies need to reduce GHG emissions substantially and increase their dependency on renewable energy resources.

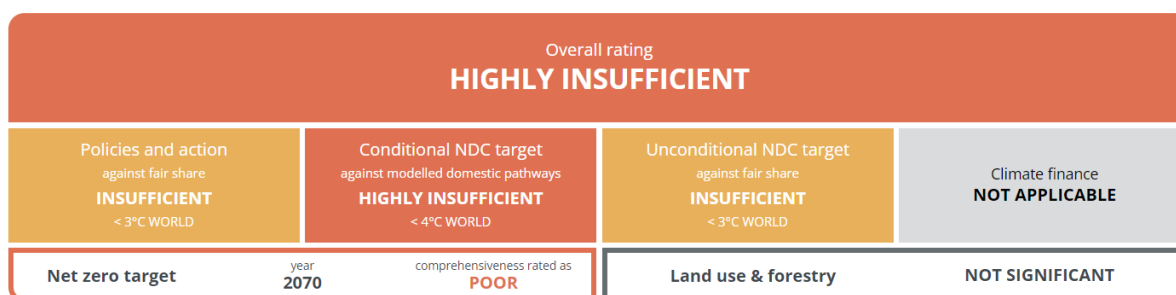
According to the “Task Force on Climate-related Financial Disclosures” (TCFD), climate-related risks are broadly categorized into two main types: *physical risks* and *transition risks*. *Physical risks* arise from direct climate impacts, such as damage to company assets, infrastructure, and properties caused by extreme weather events or long-term changes in climate patterns. These disruptions can also negatively affect worker health and productivity, as well as create bottlenecks in supply chains, both upstream and downstream, ultimately threatening the stability and growth prospects of businesses. *Transition risks*, on the other hand, emerge as economies shift from high-carbon systems to more sustainable, low-carbon models. The speed and manner of this transition can introduce several challenges for firms, including policy, legal, technological, market, and reputational risks. *Policy and legal risks* stem from the increasing global awareness and urgency surrounding climate issues, leading governments and international bodies to adopt stricter regulations and initiatives that either promote sustainable practices or penalize harmful ones. The timing and nature of these policy changes can directly influence business operations and financial performance. Additionally, inadequate management or disclosure of climate-

related risks may expose firms to legal challenges, such as climate litigation, resulting in financial penalties, legal costs, and reputational damage. *Technological risks* arise as businesses are pressured to adopt cleaner technologies and innovate toward greater energy efficiency, renewable energy use, and emission reduction. These adaptations, while necessary, may strain financial resources depending on the pace and scale of implementation. *Market risks* are increasingly driven by climate change, as shifting consumer preferences, regulatory responses, and environmental disruptions alter demand and supply dynamics across various industries. Finally, *reputational risks* pose a growing concern, as stakeholders and the public become more environmentally conscious. Companies failing to demonstrate responsible climate action may face criticism, loss of consumer trust, and decreased investor confidence, all of which can undermine long-term business performance. Unlike the physical risk, whose impact on firm value can be measured based on a company's direct exposure when such events occur, transition risks are broader and more complex (**Reboredo and Ugolini, 2022**). They arise from how individual firms incorporate the long-term costs of adapting to climate change into their strategies and operations. Thus, the increasing corporate GHG emissions not only accelerated global warming but also led to several transition risks that have the possible to effect the performance and sustainability of the firms.

In practice, many countries are trying to reduce GHG emissions, more specifically carbon emissions, by shifting their dependency from fossil fuel to renewable energy sources in the energy sector through adopting solar, wind, nuclear, and other in generating and supplying energy (**Sun et. al., 2024**). Thus, among others, the energy sector is going through a significant transition (**Carley and Konisky, 2020**), as it is considered one of the major contributors to excessive global GHG emissions (**Saraji and Streimikiene, 2023**). India, as one of the most active members of the Paris Agreement, has set several goals to transition into a low-carbon economy. For instance, at COP 26, India pledged to become net zero by 2070; however, what prominent policies and strategies would be needed to achieve this target without

hindering economic and societal growth has become an emerging concern (Das et al., 2023). However, recently, “Climate Actions Tracker (CAT)” a collaborative scientific project of *Climate Analytics* and *New Climate Institute*, rated the climate actions of India as “Highly Insufficient” against the goal of the Paris Agreement (Figure 1).

Figure 1: Rate by “Climate Actions Tracker (CAT)” of India’s climate actions against the Paris Agreement (updated as of 27th Sep 2024)



Source: <https://climateactiontracker.org/countries/india/net-zero-targets/>

However, at COP28, India took a firm stance against any binding language calling for a complete “phase-out” of coal. Instead, it supported the continuation of the more flexible “phase-down” terminology first introduced at COP26 in Glasgow. This choice reflects India’s focus on balancing climate commitments with its developmental needs. As a rapidly growing economy with significant energy demands, India relies heavily on coal, which accounts for around 70% of its electricity generation. A sudden shift away from coal would risk economic disruption and energy insecurity, especially for millions who still lack reliable access to power. It could also influence India’s economic growth, which is expected to be worth seven trillion dollars, and energy consumption will also increase by 30 percent by 2030. In this scenario, a significant question must be addressed: whether the low-carbon transition is hampering the financial performance of the conventional energy companies and thereby imposing challenges in the pathway of sustainable development. Thus, the present study aims to investigate the impact of climate transition risks on financial performance and market value creation by focusing on Indian energy sector.

Literature Review:

To mitigate the negative consequences of climate change, the global energy sector is going through a major transformation to decrease the excessive GHG emissions (**Carley and Konisky, 2020**). In this context, **Miah et al. (2021)** found that corporate high carbon emissions negatively impact the firm's profitability and market value. **Reboredo and Ugolini (2022)** found that the firm-level climate transition risk scores provided by Sustainalytics have been negatively associated with the financial performance of firms in the United States and Europe. **Das et. al., (2023)** explored the economic consequences of the adoption of new technologies and clean energy resources in achieving the net-zero targets by 2050 and 2060. They found that decarbonisation requires a substantial increase the investment and expenditure above the Business-As-Usual scenario. **Chalabi-Jababo and Ziane (2024)** found that climate transition risk positively impacted both the financial performance and lending growth of the banks. Further, they have also observed that by integrating transition risks into their risk management frameworks, banks have been able to capitalize on climate-related policy shifts introduced by regulators. **Liu et al. (2024)** found that exposure to climate change has a significant negative impact on firms' return rates, typically emerging after a delay of about two years. Companies based in climate-sensitive coastal regions and wealthier provinces tend to suffer more pronounced financial hindrances. These results highlight the need for targeted climate adaptation and mitigation strategies to help firms protect and improve their financial performance. Indian Context, **Mondal and Bauri, 2024** examined the impact of climate transition risks on the firm's value creation and found that high carbon emission has a positive impact on financial performance but are negatively associated with market value creation in the short term in the case of top Indian listed companies.

Research Gap and Objectives of the Study:

In this context, recently **Sun et. al. (2024)** found that many researchers have explored the low-carbon transition risks in the energy sector, focusing on European countries. However, limited studies have been undertaken on the

current topic from the perspective of emerging countries. **Mondal and Bauri (2024)** have explored the effect of climate transition risks on a firm's value by focusing on Indian top-listed companies. However, studies that explore this emerging area of research by focusing on the energy sector of India remain scarce. Thus, the present study aims to meet this research gap by examining the impact of low-carbon transition on the financial performance and market value creation of the Indian energy sector companies.

Data and Methodology:

Sample Selection and Study Period: We have collected the corporate GHG emissions-related data from the respective companies' integrated report/sustainability report/ESG report, whereas all the financial data have been collected from the respective companies' annual reports for the period of 2017 to 2023. The main objective of this study is to examine the impact of low-carbon transition on the financial performance of select Indian Energy Companies. For this purpose, we have considered energy companies listed on the National Stock Exchange (NSE) throughout the study period. More specifically, we have selected our sample companies under the energy mineral sector, including four industries: i) Oil Refining/Marketing, ii) Coal, iii) Integrated Oil, and iv) Oil and Gas Production, based on their availability of data. Finally, we have selected five companies from the oil refining/marketing industry, one from coal, and one from the integrated oil industry. Still, due to the unavailability of data, we are unable to incorporate the Oil and Gas Production industry in the present study.

Data analysis method: To examine the effect of low-carbon transition on the financial performance of energy companies, we have considered pooled OLS regression analysis methods and also conducted necessary data diagnostic tests to check the robustness of our analysis. In regression analysis model specification by defining, selecting, and justifying appropriate variables.

Variable Selection and their Justification: In the present study, we have measured the financial performance and market performance by Return

on Assets (ROA) and Price-to-book ratio, respectively, which have been considered as the dependent variables. The selection of ROA is justified by its widespread recognition in academic literature (for instance, **Castilho and Barakat, 2022; Arhinful et al., 2023; Mondal and Bauri, 2024**) as a reliable indicator of a firm's operational efficiency and overall profitability. ROA quantifies the extent to which a firm is capable of generating net income from its total asset base, thereby reflecting the effectiveness with which management utilizes available resources. Conversely, the P/B ratio has been selected to capture market performance, as it reflects the market's valuation of a firm's equity relative to its accounting book value. This ratio serves as a forward-looking indicator that incorporates investors' expectations, perceptions of future growth, and assessments of intangible assets that may not be fully captured in financial statements. As such, the P/B ratio is a widely accepted measure of market-based firm valuation (for instance, **Mondal and Ghosh, 2012; Mondal and Bauri, 2024**), particularly relevant in contexts where intangible assets or future earnings potential play a critical role in investor decision-making. On the other hand, corporate GHG emissions are measured by the Scope 1 and Scope 2 emissions of the respective companies, taken as the measure of climate transition risks for the present study. This selection is also supported by the past literature, for instance, **Reboredo and Ugolini (2022)**. We have also selected a set of firm-specific control variables backed by relevant literature, leverage, firm efficiency, and liquidity to determine the impact of low-carbon transition risk on financial performance and country-level control variable GDP Growth.

Model Specification: We have constructed the following multiple regression models to achieve the main objective of the present study:

$$ROA_{it} = \beta_0 + \beta_1 \text{TransitionRisk}_{it} + \beta_2 D/TA_{it} + \beta_3 S/TA_{it} + \beta_4 CR_{it} + \beta_5 \text{InvTurn}_{it} + \beta_6 \text{GDPGrowth}_t + e_{it} \dots\dots\dots [\text{Regression Model 1}]$$

$$P/B_{it} = \beta_0 + \beta_1 \text{TransitionRisk}_{it} + \beta_2 D/TA_{it} + \beta_3 S/TA_{it} + \beta_4 CR_{it} + \beta_5 \text{InvTurn}_{it} + \beta_6 \text{GDPGrowth}_t + e_{it} \dots\dots\dots [\text{Regression Model 2}]$$

Here, β_0 is the intercept; the subscripts i and t denote firm and time respectively; the dependent variables - Return on Assets and Price to Book Ratio here are represented by ROA and P/B respectively; the independent variable 'summation of scope 1 and scope 2' is denoted by TransitionRisk; the control variables 'Debt to Total Assets', 'Sales to Total Assets', 'Current Ratio' and 'Inventory Turnover ratio' and GDP Growth represented by D/TA, S/TA, CR, InvTurn, GDPGrowth respectively; e_{it} denotes the error term of the regression models.

Data Analysis and Results:

The main objective of the study is to explore the impact of low-carbon transition risks on the financial performance of Indian-listed energy companies. For this purpose, we have first analyzed the "Carbon Intensity" of the sample companies during the study period (Figure 2). The carbon intensity of each company implies how much a company emits CO₂e (GHG in terms of carbon dioxide equivalent). We have measured the carbon intensity by dividing the total annual carbon emissions (scope 1+ scope 2) by the annual revenue of that respective year. From Figure 2, we can observe that carbon intensity has comparatively decreased over the year.

Figure 2: Distribution of carbon intensity during the study periods



Source: Author’s own creation

Regression Analysis Results: We have conducted multiple regression analyses to understand the impact of carbon transition risks (independent variable) on the Financial Performance measured by ROA, with a set of control variables as described above. The following section presents and describes the regression results of Model 1 and Model 2:

Table 3: Multiple regression analysis results of Model 1

Dependent Variable – Return on Assets (ROA)

Variable	Coefficient	Std. Error	t Stat	Prob.
TransitionRisk	-0.226572	0.109390	-2.071236	0.0462
S/TA	0.144455	0.179970	0.802665	0.4279
CR	0.001424	0.462111	0.003082	0.9976
D/TA	-0.336818	0.144190	-2.335931	0.0257
InvTurn	-0.485550	0.335370	-1.447805	0.1571
GDPGrowth	0.198339	0.144416	1.373383	0.1789
C	2.657684	0.688647	3.859285	0.0005
R-Squared			0.419683	

Adjusted R-Squared	0.314170
F- Statistic	3.977573
Prob. (F Statistics)	0.004204

Interpretation: Table 1 shows that low-carbon transition risk and ROA have a regression coefficient of -0.226572 with a probability value of 0.0462, which is statistically negative and significant at the 5% level. This implies that corporate low-carbon emissions negatively impact the return on assets of the energy companies. Adjusted R-squared is 0.314170, meaning that 31% of the variability in ROA was explained by low-carbon transition risk and selected control variables. The model is statistically significant at a 1% level in this case, as indicated by the likelihood of f-statistics of 3.977573 and the probability value of 0.004 (less than 0.01).

Table 4: Multiple regression analysis results of Model 2

Dependent Variable – Price-to-Book (PB) ratio

Variable	Coefficient	Std. Error	t Stat	Prob.
TransitionRisk	0.303204	0.087552	3.463134	0.0014
S/TA	0.336858	0.145752	2.11172	0.0268
CR	0.802138	0.374373	2.142619	0.0392
D/TA	-0.364077	0.118899	-3.062067	0.0042
InvTurn	0.149596	0.271310	0.551383	0.5849
GDPGrowth	-0.175533	0.111449	-1.575010	0.1243
C	-1.093979	0.559004	-1.957017	0.0584
	R-Squared			0.639841
	Adjusted R-Squared			0.578099
	F- Statistic			10.36321
	Prob. (F Statistics)			0.000001

Interpretation: Table 2 presents the outcome of model 2's regression analysis, examining the impact of low-carbon transition risks on market performance as measured by the price-to-book ratio. The regression coefficient between low-carbon transition risk and the price-to-book ratio is 0.303204 with a probability value of 0.0014. These results show a positive association between low-carbon transition and market performance at a 1% level of significance. The adjusted R-squared value of 0.578099 suggests that low-carbon transition risks, with the control variables accounted for, approximately 58% of the variability in the price-to-book ratio. Here, the model is statistically significant at a 1% level as the probability value of the f-statistic 10.36321 is 0.000001.

Discussion and Conclusion:

The transition to a low-carbon economy presents both opportunities and challenges for firms, particularly in emerging economies like India. Achieving low-carbon goals necessitates a significant shift in industrial practices, including technological advancement, large-scale investment in clean energy, and a gradual reduction in dependency on fossil fuels in favor of renewable energy sources. While such changes are critical to addressing climate change, they also introduce new layers of risk—collectively known as climate transition risks—which influence firm-level financial performance in complex ways.

In the context of China, **Wang et al. (2021)** demonstrated that improving carbon efficiency enhances asset turnover and Tobin's Q, suggesting a clear financial incentive for firms to engage in environmentally responsible practices. However, the current study provides a more nuanced picture within the Indian context. While lower carbon emissions are found to have a positive impact on the price-to-book (PB) ratio, indicating improved investor perception and market valuation, there is a concurrent negative association with return on assets (ROA). This finding suggests that although firms may be rewarded by the market for environmental efforts, they may also face short-term operational and financial strains as they reallocate resources toward green technologies and infrastructure.

Recent evidence from **Mondal and Bauri (2024)** supports this mixed outcome, revealing a positive relationship between transition risks and the overall financial performance of listed Indian firms, yet a negative correlation with market value creation. These findings reinforce the notion that transition risks are not merely hypothetical or distant—they are already being factored into firm valuations and financial metrics, particularly within India's energy sector. As these risks begin to influence core financial indicators, they also pose a threat to broader economic stability by potentially disrupting national supply chains and slowing down industrial productivity.

India, as a rapidly growing economy and a key stakeholder in the global climate agenda, has committed to ambitious decarbonization targets. However, the journey toward these goals is fraught with challenges, especially in terms of capital requirements and access to clean technologies. The financial and technological capacity to implement these transitions effectively remains limited for many Indian firms, particularly small and medium enterprises (SMEs). As such, the role of international cooperation—through financial aid, knowledge sharing, and technology transfer—becomes critical. Strengthening institutional support and creating favorable policy environments are also essential to ensure a smooth transition that does not compromise economic development.

In conclusion, this paper underscores the dual-edged nature of the low-carbon transition in emerging markets. While firms may stand to benefit from improved market perception and long-term sustainability, the short-term financial costs and systemic risks cannot be overlooked. Policymakers and financial institutions must take proactive steps to cushion these impacts and facilitate a just and inclusive transition. Future research should focus on sector-specific analyses and explore the long-term financial trajectories of firms undertaking aggressive low-carbon strategies, to further deepen our understanding of the evolving relationship between climate transition and corporate financial health.

Limitation, Future Research, and Practical Implication:

The present study concentrates on only seven energy companies and seven years of data in assessing the impact of low-carbon transformation on the financial performance of India's energy sector. However, a larger sample size and a study period could give deeper insights. Future research may also consider the dynamic regression model in the impact of these challenges to address the endogeneity issues and provide deeper insights. The current study has significant practical implications in the current decarbonization-oriented world, where India has the dilemma of taking actions toward the seven trillion economy and at the same time also making endeavors to achieve net zero targets by 2070. Our results may be helpful in providing insights into this dilemma and in making decisions for policymakers, governments, world leaders, and other related parties.

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