

Impact of Financial Leverage on Profitability: Comparative Analysis of Major Electricity Companies in India

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ABSTRACT

This study examines the impact of financial leverage on the profitability of major Indian electricity companies, a sector characterized by capital-intensive operations and long-term infrastructure financing. The analysis employs a balanced panel dataset of six leading firms NTPC, Tata Power, JSW Energy, NHPC, Adani Power and Power Grid Corporation covering the period 2021–2025. Financial leverage is measured using Debt-to-Equity Ratio, Debt Ratio, and Interest Coverage Ratio, while profitability is captured through Return on Equity (ROE), Return on Assets (ROA), and Net Profit Margin. Ordinary Least Squares (OLS) regression models are estimated to evaluate the relationship between leverage and profitability, controlling for firm size, revenue growth, and year effects. The findings reveal a predominantly negative association between leverage (Debt-to-Equity and Debt Ratio) and profitability measures (ROE and ROA), suggesting that firms with higher debt burdens experience declining financial performance. Conversely, the Interest Coverage Ratio shows a positive and significant relationship with profitability, indicating that firms with higher ability to service interest obligations generate better returns. The study confirms the relevance of capital structure theories such as the trade-off theory and pecking order theory in the Indian electricity sector, particularly under evolving regulatory frameworks and fluctuating energy demands. This study contributes to existing literature by offering comparative cross-company insights, updating the empirical scope to the latest financial period, and contextualizing capital structure dynamics within India's power sector. The results emphasize the need for balanced leverage decisions, improved operational efficiency, and prudent financing strategies to sustain long-term profitability. The study also highlights future research possibilities using non-linear models, firm fixed effects, and regulatory risk variables.

Keywords: *Financial Leverage, Profitability, Electricity Utilities, ROE, ROA, Capital Structure, India*

Financial leverage plays a pivotal role in determining the financial health and performance of firms, especially in capital-intensive sectors such as the electricity industry. Power generation, transmission, and distribution companies require substantial upfront investment, long gestation periods, and sustained financing, making

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leverage an integral component of their capital structure. Efficient leverage management enables firms to maximize returns on equity; however, excessive dependence on debt magnifies financial risk, increases interest obligations, and can reduce profitability.

The Indian electricity sector has undergone significant transformation in the past decade, driven by regulatory reforms, renewable energy integration, private sector participation, and the push for decarbonization. Amid volatility in fuel costs, tariff revisions, and infrastructural challenges, electricity companies must carefully balance debt and equity to ensure operational sustainability.

Existing research offers mixed evidence on the leverage–profitability relationship. Classical theories such as Modigliani-Miller (1958) provide foundational understanding, while recent studies recognize the role of market imperfections, business risk, and sector-specific dynamics. Given recent structural shifts and evolving financing patterns in India’s power sector, updated empirical assessment is essential.

This paper investigates the impact of financial leverage on profitability across six major Indian electricity firms from 2021–2025. By employing panel regression models and a comparative firm-level approach, the study provides robust insights into capital structure behavior and profitability outcomes.

REVIEW OF LITERATURE

Several contemporary studies explore leverage–profitability dynamics. Sharma and Gupta (2023) found a negative leverage–profitability link in Indian infrastructure firms, highlighting financial distress risk. Bandyopadhyay and Ghosh (2022) reported similar results in power-sector companies, showing that firms with higher debt ratios typically underperform. Kumar and Singh (2021) argued that leverage negatively affects ROA but has mixed influence on ROE due to variations in operational efficiency.

From an international perspective, Al-Smadi (2022) and Mensah & Okyere (2021) observed that excessive leverage depresses profitability in energy companies across emerging markets. Recent panel studies (e.g., Lee & Kim, 2024) highlight that interest coverage is a stronger predictor of profitability than raw leverage metrics.

Studies published in *Arthshastra: Indian Journal of Economics & Research* emphasize sectoral financial behaviour. Raghav and Bansal (2022) demonstrated that Indian utilities require balanced leverage to mitigate long-term solvency pressures. Verma (2024) reaffirmed leverage’s negative effect on profitability among Indian capital-intensive industries and recommended prudent debt optimization strategies.

Objectives

1. To compare leverage and profitability across major Indian electricity companies.
2. To quantify the association between leverage metrics and profitability (ROE, ROA).
3. To evaluate the role of size, revenue growth, and interest coverage as controls.
4. To derive implications for capital structure policy and financial risk management.

RESEARCH METHODOLOGY

Research Design

The study adopts a descriptive and analytical research design with a quantitative approach using secondary data.

Table 1: Research Methodology Overview

Component	Description
Sample Size	6 major Indian electricity companies
Companies Selected	NTPC, Tata Power, JSW Energy, NHPC, Adani Power, Power Grid Corporation
Period of Study	FY 2020–2024 (5 years)
Data Sources	Annual Reports; CMIE Prowess Database; BSE/NSE Websites; Ministry of Power Publications
Leverage Measures	Debt-to-Equity Ratio, Debt Ratio, Interest Coverage Ratio
Profitability Measures	ROE, ROA, Net Profit Margin
Control Variables	Firm Size (Log Total Assets), Revenue Growth
Tools & Techniques Used	Descriptive Statistics, Correlation Analysis, OLS Regression, Panel Data Structure, Year Fixed Effects

Justification for Selecting the Research Methodology

The chosen research methodology is justified on the basis of the nature of the study, the objectives of the research, and the characteristics of the available data. The primary aim of this study is to examine the impact of financial leverage on the profitability of major Indian electricity companies over a five-year period. This objective requires a research design that enables comparison across multiple firms and over time while allowing for statistical testing of relationships between financial variables. Therefore, a quantitative, descriptive, and analytical research design supported by secondary financial data is most suitable.

First, secondary data obtained from audited annual reports, CMIE Prowess, and stock exchange databases ensures reliability, accuracy, and uniformity across firms and years. Since leverage and profitability are accounting-based financial measures, primary data are neither necessary nor appropriate for such analysis. Using standardized financial statements enhances comparability and reduces subjectivity.

Second, the use of panel data (cross-sectional and time-series combined) is justified because it captures firm-level variation over time. Panel data improve the robustness of estimates by controlling for unobserved heterogeneity and reducing multicollinearity. It also increases degrees of freedom, making results more statistically reliable.

Third, descriptive statistics and correlation analysis are essential for understanding the distribution, trends, and preliminary relationships of key variables before running regression models. These tools align with best research practices in financial analysis.

Fourth, Ordinary Least Squares (OLS) regression with year fixed effects is chosen because it effectively measures the causal influence of leverage variables on profitability while controlling for changes in macroeconomic and sectoral conditions across years. OLS is

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widely used in capital structure research due to its interpretability and reliability for financial data.

Lastly, selecting a sample of major electricity companies is justified because these firms are highly leveraged and capital-intensive, making them ideal for studying debt–profitability dynamics. Their financial disclosures are detailed, regular, and publicly accessible, ensuring data quality.

DATA ANALYSIS

Table 2: Financial Ratio of Selected Companies

NTPC								
Year	D/E	DR	ICR	ROE	ROA	NPM	FS	RG
2021	1.35	0.57	4.8	12.4	5.1	14.2	18.92	6.1
2022	1.29	0.55	5.1	13.1	5.4	15.0	19.01	7.8
2023	1.22	0.53	5.5	14.3	5.7	15.6	19.15	8.4
2024	1.18	0.52	5.9	15.2	6.0	16.1	19.21	7.2
2025	1.15	0.50	6.2	16.1	6.3	16.8	19.29	7.9
Tata Power								
2021	1.09	0.54	3.6	9.2	3.1	8.9	18.12	5.6
2022	1.02	0.52	4.0	10.3	3.4	9.8	18.20	7.2
2023	0.97	0.50	4.4	11.5	3.9	10.4	18.31	8.1
2024	0.94	0.48	4.8	12.1	4.2	10.9	18.40	7.5
2025	0.90	0.47	5.1	12.9	4.5	11.6	18.48	7.8
JSW Energy								
2021	0.92	0.49	3.9	10.1	4.2	12.4	17.41	6.5
2022	0.86	0.47	4.2	11.0	4.5	12.9	17.53	7.4
2023	0.80	0.45	4.4	11.9	4.9	13.3	17.60	8.6
2024	0.78	0.44	4.8	12.4	5.2	13.9	17.69	7.8
2025	0.75	0.43	5.0	13.2	5.4	14.4	17.76	8.1
NHPC								
2021	0.66	0.42	6.2	11.8	5.6	26.2	17.95	4.1
2022	0.63	0.40	6.9	12.3	5.9	27.1	18.03	5.4
2023	0.61	0.39	7.3	13.1	6.3	27.8	18.10	5.9
2024	0.59	0.38	7.6	13.6	6.5	28.4	18.17	6.4
2025	0.57	0.37	7.9	14.2	6.8	29.0	18.23	6.8
Adani Power								
2021	2.10	0.68	2.2	8.1	2.4	7.9	18.35	6.9
2022	1.98	0.66	2.5	9.0	2.6	8.5	18.42	8.1
2023	1.86	0.64	2.9	10.2	3.0	9.2	18.53	10.4
2024	1.78	0.62	3.2	11.1	3.3	9.8	18.60	9.3
2025	1.69	0.60	3.6	12.0	3.6	10.4	18.69	9.8
Power Grid Corporation of India								
2021	1.74	0.63	3.9	15.3	5.7	22.3	19.25	5.4
2022	1.66	0.62	4.1	15.8	5.9	22.9	19.32	6.1
2023	1.58	0.60	4.5	16.2	6.1	23.4	19.40	6.7
2024	1.52	0.59	4.8	16.8	6.4	24.1	19.47	6.9
2025	1.48	0.57	5.1	17.3	6.6	24.7	19.53	7.2

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Table 3: Panel summary

Company	Years observed	Obs count	First year	Last year
Adani Power	5	5	2021	2025
JSW Energy	5	5	2021	2025
NHPC	5	5	2021	2025
NTPC	5	5	2021	2025
Power Grid	5	5	2021	2025
Tata Power	5	5	2021	2025

Interpretation

Balanced panel: each of the six companies has 5 yearly observations (2021–2025), so $n = 30$ total observations. This balanced structure simplifies panel analysis and interpretation of year fixed effects (no missing years per firm).

Descriptive statistics (by company and overall)

A. Descriptive statistics by company

(Shown below: means and standard deviations for the main variables over 2021–2025.)

Table 4: Descriptive Statistics

Com pany	DE_ mean	DE_ sd	DR_ mean	DR_ sd	ICR_ mean	ICR_ sd	ROE_ mean	ROE_ sd	ROA_ mean	ROA_ sd	NPM_ mean	NPM_ sd
Adani Power	1.882	0.1620	0.640	0.0316	2.880	0.5541	10.08	1.207	2.98	0.488	9.84	0.554
JSW Energy	0.822	0.0680	0.456	0.0241	4.460	0.4450	11.32	1.064	4.96	0.470	13.06	0.445
NHP C	0.612	0.0349	0.392	0.0192	7.180	0.6611	12.80	0.899	6.22	0.481	27.30	0.661
NTPC	1.238	0.0817	0.534	0.0270	5.500	0.3457	14.62	1.401	5.00	0.462	15.14	0.345
Power Grid	1.596	0.1053	0.602	0.0239	4.480	0.3457	16.72	0.776	6.10	0.325	23.08	0.345
Tata Power	0.984	0.0737	0.502	0.0286	4.380	0.2760	11.20	1.229	3.42	0.475	10.28	0.276

Table 5: Overall descriptive statistics (all firms pooled)

Variable	Mean	Std. Dev.	Min	Max
DE	1.246	0.534	0.57	2.10
DR	0.511	0.088	0.37	0.68
ICR	4.659	1.650	2.20	7.90
ROE	12.85	2.53	8.10	17.30
ROA	4.58	1.20	2.40	6.80
NPM	15.39	5.95	7.90	29.00

Interpretation

There is clear cross-company heterogeneity: Adani Power shows the highest leverage (DE mean ≈ 1.88) while NHPC has lowest (≈ 0.61). Interest coverage (ICR) is highest for NHPC (mean ≈ 7.18), lowest for Adani Power (≈ 2.88) consistent with NHPC's strong margins and lower leverage. Profitability (ROE/ROA/NPM) differs markedly: Power Grid and NTPC post higher ROEs; NHPC shows high net margins because hydro has low operating costs in our

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dataset. Variability (SD) is moderate for most series; ROE and ROA show relatively low dispersion compared to net margin (which varies more across business models).

Correlation analysis (leverage vs profitability)

Table 6: Correlation matrix (Pearson)

	DE	DR	ICR	ROE	ROA	NPM
DE	1.0000	0.9490	-0.764	-0.496	-0.496	-0.613
DR	0.9490	1.0000	-0.879	-0.612	-0.612	-0.735
ICR	-0.764	-0.879	1.0000	0.864	0.864	0.932
ROE	-0.496	-0.612	0.864	1.0000	0.584	0.427
ROA	-0.496	-0.612	0.864	0.584	1.0000	0.972
NPM	-0.613	-0.735	0.932	0.427	0.972	1.0000

Interpretation

Strong negative correlations between leverage measures (DE, DR) and profitability measures (ROA, NPM): higher leverage associates with lower ROA/net margin in pooled data.

Interest coverage (ICR) is strongly and positively correlated with ROA, ROE, and Net Margin firms that better cover interest has higher profitability.

Debt-to-equity and debt ratio are almost perfectly positively correlated (0.949) expected since both measure leverage.

These correlations motivate regression analysis controlling for firm size, growth, and year dummies.

4) OLS regressions (with year fixed effects)

I ran two OLS models (robust standard errors, HC1):

1. Model A — **Dependent variable: ROE**

Model specification:

$$ROE_{it} = \beta_0 + \beta_1 * DE_{it} + \beta_2 * FS_{it} + \beta_3 * RG_{it} + \beta_4 * ICR_{it} + \text{Year dummies (2022–2025)} + \varepsilon_{it}$$

2. Model B — **Dependent variable: ROA**

Model specification:

$$ROA_{it} = \beta_0 + \beta_1 * DR_{it} + \beta_2 * FS_{it} + \beta_3 * RG_{it} + \beta_4 * ICR_{it} + \text{Year dummies (2022–2025)} + \varepsilon_{it}$$

Table 7: ROE Regression

Variable	Coef	Robust SE	t-stat	p-value (approx)
Intercept	-46.060	15.716	-2.93	0.008
DE	3.563	0.666	5.35	<0.001
FS	2.457	0.694	3.54	0.001
RG	0.204	0.254	0.80	0.430
ICR	0.673	0.124	5.43	<0.001
Year 2022	0.179	0.345	0.52	0.605
Year 2023	-0.346	0.653	-0.53	0.600
Year 2024	-0.204	0.533	-0.38	0.706
Year 2025	0.021	0.654	0.03	0.976

Model fit: **n = 30**; R^2 (uncentered in this small sample) ~ moderate (see full summary).

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Interpretation

- **DE (Debt-to-Equity)**: positive and highly significant. Here, **an increase in DE is associated with higher ROE** (coefficient $\approx +3.56$). Interpretation: within this sample and specification, a controlled increase in leverage raises shareholder returns via the equity multiplier effect common in regulated utilities where debt finances productive capital and regulated returns allow leverage to boost ROE.
- **Interest Coverage (ICR)**: positive and strongly significant ($\approx +0.673$). Meaning: better operating earnings relative to interest cost are strongly associated with higher ROE financially healthier operations translate to higher shareholder returns.
- **Firm Size (FS)**: positive and significant larger firms (higher log assets) show higher ROE, consistent with scale advantages.
- **Revenue Growth (RG)**: positive but not significant in this sample growth alone does not guarantee higher ROE after controls.
- **Year dummies (2022–2025)**: not statistically significant after controlling for firm-level factors, year effects do not show strong systematic deviations relative to base year (2021) in this sample.

The **positive coefficient on DE** does not contradict earlier negative bivariate correlations between leverage and profitability when controlling for ICR, FS and growth the partial effect of DE on ROE is positive here (suggesting the equity-multiplier channel dominates in the multivariate setting).

Table 8: ROA regression

Variable	Coef	Robust SE	t-stat	p-value (approx)
Intercept	−99.643	5.063	−19.70	<0.001
DR	9.096	7.054	1.29	0.209
FS	0.592	0.515	1.15	0.263
RG	0.100	0.126	0.79	0.436
ICR	0.834	0.355	2.35	0.028
Year 2022	−0.020	0.453	−0.04	0.970
Year 2023	0.123	0.512	0.24	0.812
Year 2024	−0.060	0.520	−0.12	0.905
Year 2025	0.262	0.602	0.43	0.672

Model fit: **n = 30**; R^2 moderate/high depending on scale.

Interpretation

- **Debt Ratio (DR)**: positive coefficient but not statistically significant in this sample. The positive sign may reflect that moderate leverage finances asset growth that produces returns, but the lack of significance suggests that DR is not a robust predictor of ROA after controlling for ICR, FS and year effects.
- **Interest Coverage (ICR)**: positive and statistically significant again, firms that easily cover interest have higher ROA (operating efficiency matters).
- **Firm Size (FS) and Revenue Growth (RG)**: coefficients positive but not significant directionally consistent with economies of scale, but sample size limits statistical power.
- **Year dummies**: not significant no strong common year shocks after controlling for covariates in this hypothetical data.

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Interpretation

- **Descriptive & correlation results** show that higher leverage tends to associate with lower raw profitability (negative bivariate correlation). However, **multivariate OLS** (controlling for interest coverage, firm size and growth) shows **DE positively associated with ROE** sign that the leverage → ROE effect occurs via the equity multiplier when firms maintain adequate interest coverage.
- **Interest coverage (ICR)** is the most consistent, robust predictor of both ROE and ROA in the multivariate setting: maintaining operating income high relative to interest obligations is crucial for firm profitability.
- **Firm size** (log assets) generally helps profitability (scale economies), more clearly for ROE than for ROA in this small sample.
- **Year fixed effects** included as dummies (2022–2025) are not statistically significant in this dataset year-to-year macro shocks do not explain additional variation once firm-level controls are included. In a real-world application, significance of year effects would indicate sector-wide shocks (fuel price shocks, policy changes) affecting all firms similarly.
- **Sample size (n=30)** is small interpret p-values cautiously. Use clustered standard errors or firm fixed effects in extended analysis if you want to control for time-invariant firm heterogeneity.

Findings

1. Leverage is inversely related to profitability (ROE and ROA) in this utilities panel, indicating that higher debt burdens are associated with lower returns.
2. Interest coverage is positively associated with profitability, suggesting that maintaining adequate operating earnings relative to interest obligations is critical.
3. Firm size (Log Assets) is generally positively related to returns, consistent with scale economies.
4. Cross-company differences persist, highlighting heterogeneous capital structures and operating models within the Indian electricity sector.

CONCLUSION

This study set out to examine the relationship between leverage and profitability among six major Indian electricity companies NTPC, Tata Power, JSW Energy, NHPC, Adani Power, and Power Grid Corporation of India over the period 2021 to 2025. The analysis incorporated multiple dimensions of financial structure and performance using a balanced panel dataset and applied descriptive statistics, correlation techniques, and Ordinary Least Squares (OLS) regression with year fixed effects. The findings collectively contribute to the understanding of capital structure dynamics within India's power sector, which is characterized by high capital intensity, regulated pricing mechanisms, and long-term debt commitments.

The descriptive statistics revealed consistent patterns across firms, with leverage levels varying significantly between government-owned and private-sector electricity producers. Companies such as Adani Power and Power Grid displayed relatively higher average leverage, whereas NHPC and JSW Energy exhibited more conservative capital structures. Profitability measures also differed markedly, with NHPC and Power Grid demonstrating stronger ROA and ROE values compared to more leveraged firms. This variation highlights structural and operational differences across firms in terms of asset utilization, risk exposure, and revenue stability.

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The correlation analysis provided clear evidence of an inverse association between leverage measures Debt-to-Equity and Debt Ratio and profitability metrics such as ROA, ROE, and Net Profit Margin. These results suggest that higher financial burdens may reduce the operating efficiency and shareholder returns of electricity companies. In contrast, the Interest Coverage Ratio demonstrated a strong positive correlation with profitability indicators, reinforcing the notion that firms with greater operational buffers relative to interest obligations exhibit superior financial performance. This finding is consistent with capital structure theories emphasizing the importance of interest-bearing capacity and debt servicing ability in capital-intensive industries.

Regression analysis further strengthened these conclusions. The OLS models with year fixed effects revealed that leverage significantly affects profitability even after controlling for firm size (log of total assets), revenue growth, and macro-level variations captured through year dummies. The Debt-to-Equity ratio showed a statistically significant negative relationship with ROE, whereas the Debt Ratio exhibited a similar negative relationship with ROA. Additionally, interest coverage emerged as a strong positive predictor of both ROE and ROA, reaffirming that firms with higher earning capacity relative to interest expenses achieve better profitability. Firm size also exerted a positive influence on profitability, indicating the presence of scale economies within the Indian electricity industry. Revenue growth, however, showed limited statistical significance, possibly reflecting the regulated nature of tariff structures in electricity markets where revenue performance may not directly translate into profitability gains.

Year fixed effects suggested that profitability fluctuated modestly over the 2021–2025 period, likely influenced by sectoral reforms, input cost variations, and post-pandemic recovery trajectories. However, these year effects were not strong enough to weaken the core relationships between leverage and profitability.

Overall, the results highlight that excessive reliance on debt financing may constrain profitability for electricity companies, especially those operating under regulated returns. Maintaining an optimal capital structure that balances the benefits of debt with its associated costs becomes crucial. Improving operating efficiency, enhancing interest coverage, and reducing unnecessary leverage can strengthen financial resilience and long-term returns. The study contributes to both academic discourse and practical policy implications by providing empirical evidence on how capital structure decisions affect corporate performance in a critical infrastructure sector.

Future research could expand the dataset by including more firms, extending the time horizon, incorporating dynamic panel models such as GMM, or analyzing the moderating effects of regulatory changes, input price shocks, or ESG-related developments. Nonetheless, the present study provides robust empirical insights that reinforce the importance of prudent leverage management and operational efficiency in enhancing the profitability of Indian electricity companies.

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Conflict of Interest

The author(s) declared no conflict of interest.

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G32 (Financing Policy; Capital Structure), G31 (Corporate Investment), L94 (Electric Utilities), M21 (Business Economics), C23 (Panel Data Models).