

Analytical Study of Financial Outcomes in Indian Steel Enterprises

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Abstract—This study investigates the financial performance of selected Indian steel companies Tata Steel, Vedanta, JSW Steel, SAIL, and Jindal Steel & Power over the period 2021–2026 using profitability ratios and statistical analysis. Employing secondary data from annual reports and financial databases, the research evaluates Gross Profit Ratio, Net Profit Ratio, Operating Profit Ratio, Return on Capital Employed, and Return on Net Worth to assess operational efficiency and shareholder value. Descriptive statistics revealed firm-level variations, with JSW Steel and Jindal Steel showing stronger profitability indicators, while SAIL exhibited comparatively weaker performance. However, one-way ANOVA results consistently indicated no statistically significant differences across companies and years, suggesting that profitability outcomes are more influenced by industry-wide factors such as raw material costs, global demand cycles, and policy interventions than by firm-specific strategies. The findings highlight the importance of ratio analysis as a diagnostic tool while emphasizing that macroeconomic conditions play a dominant role in shaping financial sustainability in the steel sector. This study contributes to the literature by integrating ratio-based evaluation with inferential testing, offering insights for investors, policymakers, and managers seeking to understand profitability dynamics in India's steel industry.

Index Terms—Financial performance, Profitability ratios, analysis, Indian steel industry, Operational efficiency, Return on capital employed, Profitability and Steel industries

I. INTRODUCTION

India is currently the world's 2nd largest producer of crude steel in January - December 2025, producing 118.20 Million tonnes (MT) crude steel with growth rate 17.9% over the corresponding period last year (CPLY). India is the largest producer of Direct

Reduced Iron (DRI) or Sponge Iron in the world in January – December 2025, producing 39.04 MT Sponge Iron with growth rate 16.2% over the corresponding period last year (CPLY). India is the 2nd largest consumer of finished steel in 2025 (106.23 MT), preceded by China as the largest steel consumer as per World Steel Association. Capacity for domestic crude steel expanded from 137.97 MT in 2020-21 to 154.06 MT in 2021-22, Compounded Annual Growth Rate (CAGR) of 3.7% during this five-year period. Crude steel production grew at 4.2% annually (CAGR) from 103.13 MT in 2021-22 to 120.29 MT in 2021-22. During April – July, 2021-22 (provisional; source: JPC), the following is the industry scenario as compared to the same period of last year: Production of crude steel was at 41.09 MT, up by 8.9%. SAIL, RINL, TSL Group, AM/NS, JSWL & JSPL together produced 24.75 MT (60% share) during this period, up by 4.5%. The rest (16.34 MT) came from the Other Producers, up by 16.2%.

II. REVIEW OF LITERATURE

In the study by Venkatesan & Nagarajan (2012) examined profitability analysis of selected steel companies in India. It focused on gross profit ratio, net profit ratio, and return on capital employed. Secondary data from annual reports were analyzed using descriptive statistics. The authors highlighted significant variations across companies in profitability. They found Tata Steel and SAIL showing contrasting performance trends. The study emphasized the importance of ratio analysis in financial evaluation.

The study concluded that profitability ratios are useful indicators of operational efficiency.

The findings suggested that external market conditions influence steel profitability.

The paper provided a foundation for comparative studies in the sector. It remains a key reference for empirical research on steel industry performance.

The study by Jain & Mehta (2013) analyzed profitability of selected automobile companies in India. The study covered the period 2009–2013 using ratio-based financial analysis. Net profit ratio and return on net worth were the primary indicators. Findings revealed differences in profitability across firms and years. The authors emphasized the role of efficiency in sustaining profitability. They argued that industry-specific challenges affect financial outcomes. The study highlighted the importance of comparative analysis across companies. It concluded that profitability ratios are essential for managerial decisions. The paper contributed to understanding sectoral variations in financial performance. It provided insights applicable to steel industry studies as well.

The research by Tulsian (2014) conducted a comparative study focused on SAIL and Tata Steel. It analyzed profitability ratios to assess financial performance. Gross profit and operating profit ratios were key measures. The study found Tata Steel performing better in profitability indicators.

SAIL showed fluctuations due to market and operational challenges. The author emphasized ratio analysis as a diagnostic tool. The findings highlighted differences between public and private firms. The study concluded that profitability depends on efficiency and market conditions. It reinforced the importance of comparative financial analysis. This work remains relevant for steel industry profitability research.

The study by Gupta & Sharma (2015) examined financial performance of Indian steel companies. It used ratio analysis to evaluate profitability and leverage. The study emphasized investor confidence linked to financial indicators. Findings showed that profitability ratios varied across companies. Leverage ratios influenced long-term sustainability of firms. The authors highlighted the role of capital structure in profitability. They concluded that financial performance depends on both internal and external factors.

The study provided insights into investor decision-making. It reinforced the importance of ratio-based evaluation in steel industry. The paper contributed to literature on financial performance analysis.

The study by Rao & Reddy (2016) analyzed profitability in the Indian manufacturing sector. It compared operating profit ratios across firms of different sizes. Findings revealed significant variations in profitability performance. Large firms showed higher profitability due to economies of scale. Smaller firms faced challenges in sustaining profitability.

The authors emphasized the role of market conditions in financial outcomes. They concluded that profitability analysis is essential for policy decisions. The study highlighted sectoral differences in financial performance. It provided a comparative framework applicable to steel companies. The paper enriched literature on manufacturing profitability analysis.

The research paper prepared by Kumar & Singh (2018) evaluated financial performance of steel companies listed on NSE. It used ANOVA to test differences in profitability ratios across years. Gross profit ratio and return on capital employed were key indicators. Findings showed significant variations across companies and time periods. The study emphasized statistical tools in financial analysis. It concluded that profitability performance differs across firms.

The study highlighted the importance of ratio analysis for investors. The study reinforced the role of ANOVA in comparative financial research. It provided empirical evidence on steel industry performance. The paper remains relevant for academic and practical financial studies.

The study by Patel & Desai (2020) focused on public sector steel units in India. It analyzed profitability and return on capital employed. Findings showed modernization as key to improving profitability. The study emphasized efficiency improvements in public enterprises.

It concluded that profitability depends on operational restructuring. The authors highlighted the role of government policies in financial outcomes. They argued that sustained profitability requires

technological upgrades. The study provided insights into public sector financial performance. It reinforced the importance of ratio analysis in evaluating efficiency. The paper contributed to literature on public sector steel profitability.

III. BACKGROUND STUDY

The steel industry has historically been regarded as the backbone of industrial development, contributing significantly to infrastructure, manufacturing, and national growth. In India, steel production has expanded rapidly, positioning the country as the world's second-largest producer of crude steel. The sector's growth is closely linked to economic development, as steel is a critical input for construction, automobiles, machinery, and energy. Over the past decade, Indian steel companies have undergone modernization and capacity expansion to meet rising domestic and global demand. Financial performance evaluation of these companies has become essential to understand their competitiveness and sustainability. Profitability ratios such as gross profit ratio, net profit ratio, operating profit ratio, return on capital employed, and return on net worth are widely used to assess efficiency and shareholder value. Previous studies have emphasized that profitability is influenced by market conditions, cost structures, and managerial efficiency. The Indian steel industry also faces challenges such as fluctuating raw material prices, global competition, and environmental regulations. Public sector units like SAIL have focused on modernization programs, while private firms such as Tata Steel and JSW Steel have leveraged operational efficiency and global expansion. Vedanta's entry into steel through ESL acquisition highlights diversification strategies in the sector. Jindal Steel and Power Limited has pioneered technological innovations such as coal-gasification-based DRI plants. Comparative financial studies reveal that profitability varies across companies due to differences in scale, integration, and market positioning. Statistical tools like ANOVA and descriptive analysis provide insights into whether variations in profitability are significant across firms and years. Such analyses are crucial for investors, policymakers, and managers to evaluate performance trends. The background of this study is therefore rooted in the need to systematically assess financial

performance of leading steel companies in India. By focusing on profitability indicators, the research aims to contribute to understanding the dynamics of financial sustainability in the steel sector.

IV. OBJECTIVES OF THE STUDY

- To study the financial performance of selected Steel companies in India
- To analyze the profitability position of selected Steel companies in India

V. HYPOTHESIS

H₀: There is no significant difference in profitability ratios across steel companies and across years.

H₁: There is a significant difference in profitability ratios across steel companies and across years.

VI. METHODOLOGY OF THE STUDY

The present study adopts a quantitative research design based on secondary data analysis to evaluate the financial performance of selected steel companies in India. The study period covers five financial years from 2021–22 to 2025–26, ensuring a comprehensive view of profitability trends over time. A purposive sampling technique was employed to select five leading steel companies listed on BSE/NSE, namely Tata Steel, Vedanta, JSW Steel, Steel Authority of India Limited (SAIL), and Jindal Steel and Power Limited (JSPL). These companies were chosen due to their market prominence, availability of complete financial data, and relevance to the Indian steel sector.

Data were collected from reliable secondary sources, including published annual reports of the selected companies and financial information available on the website moneycontrol.com. The dataset comprised profitability ratios such as Gross Profit Ratio (GPR), Net Profit Ratio (NPR), Operating Profit Ratio (OPR), Return on Capital Employed (ROCE), and Return on Net Worth (RONW). These ratios were selected as they provide critical insights into operational efficiency, shareholder returns, and overall financial sustainability.

The analysis was conducted using Microsoft Excel, applying descriptive statistical measures including mean, standard deviation, variance, skewness,

kurtosis, range, minimum, and maximum values. These measures helped in identifying central tendencies, variability, and distributional characteristics of profitability indicators across companies. To test the statistical significance of differences in profitability ratios between companies and across years, Analysis of Variance (ANOVA) was employed at a 5% level of significance. ANOVA was chosen as it is a robust technique for comparing mean differences across multiple groups simultaneously.

This methodological framework ensures that the study not only captures descriptive patterns but also provides inferential evidence regarding variations in financial performance. By combining ratio analysis with statistical testing, the methodology strengthens the reliability of findings and enhances the scope for meaningful interpretation of profitability trends in the Indian steel industry.

VII. PROFILE OF SAMPLE COMPANIES

7.1 Tata Steel

It was founded in India in 1907 as Asia's first integrated private steel firm, and it is now one of the world's largest low-cost steel producers. With a focus on growth projects, lower net debt levels, stronger return ratios, and, last but not least, significant cost savings, the company's financial and operational performance for FY25 suggests that it generated good free cash flow. Along with the obvious improvement in Indian markets, its European facilities (which were previously viewed as a problem child) are likely to perform better, particularly in terms of free cash flow generation. Its iron ore prices are still among the cheapest in the world. As a result, in a strong steel cycle environment, it gives one of the highest operating leverages (and financial leverage) in the world. TATA Steel is counted among the best steel companies for major projects within the countries.

7.2 Vedanta

It entered the steel market once it acquired a 90% stake in ESL Steel Limited (ESL). Through the Corporate Insolvency Resolution Process, created to handle the resolution of non-performing assets in the Indian banking sector, Vedanta Limited obtained management control of ESL in June 2025. Vedanta wants to expand its steel operations in Bokaro

through brown field development and become one of the country's top steel manufacturers. It is looking forward to broadening horizons and breaking down barriers in both current and future initiatives, as well as bringing ongoing growth, profit, and success to all of its stakeholders. As a part of its brown field expansion of 5 million tonnes, Vedanta Ltd plans to concentrate on long products and ductile iron products.

7.3 JSW Steel

The US\$ 22 billion JSW Group is ranked among India's leading business houses. JSW's innovative and sustainable presence in various sectors including Steel, Energy, Infrastructure, Cement, Paints, Venture Capital and Sports is helping the Group play an important role in driving India's economic growth. With a culturally diverse workforce spread across India, USA, Europe and Africa, JSW Group directly employs nearly 40,000 people. It also has a strong social development focus aimed at empowering local communities residing around its Plant & Port locations. JSW Group is known to create value for all its stakeholders by combining its growth road map, superior execution capabilities and a relentless drive to be Better Everyday.

7.4 Steel Authority of India Limited (SAIL)

Steel Authority of India Limited (SAIL) is one of the largest steel-making companies in India and one of the Maharatnas of the country's Central Public Sector undertaking based in New Delhi, India. SAIL operates and owns five integrated steel plants at Bhilai, Rourkela, Durgapur, Bokaro and Burnpur (Asansol) and three special steel plants at Salem, Durgapur and Bhadravathi. It also owns a Ferro Alloy plant at Chandrapur close to domestic sources of raw materials. It is under the ownership of the Ministry of Steel, Government of India with an annual turnover of INR 1,03,480 Crore (US\$13 billion) for fiscal year 2021–22. Incorporated on 24 January 1973, SAIL has 60,766 employees as of 1 October 2022. The hot metal production capacity of the company will further increase and is expected to reach a level of 50 million tonnes per annum by 2025. As a part of its global ambition, the PSU is undergoing a massive expansion and modernization programme involving upgrading and building new facilities with emphasis on state of the art green

technology. According to a recent survey, SAIL is one of India's fastest growing Public Sector Units. The PSU also has an R&D Centre for Iron & Steel (RDCIS) and a Centre for Engineering in Ranchi, Jharkhand.

7.5 Jindal Steel and Power Limited (JSPL)

It is an Indian steel company based in New Delhi. JSPL is a part of OP Jindal Group. JSP is an industrial powerhouse with a dominant presence in steel, power, mining and infrastructure sectors. Led by Mr Naveen Jindal, the company's enviable success story has been scripted essentially by its

resolve to innovate, set new standards, enhance capabilities, enrich lives and to ensure that it stays true to its cherished value system. In terms of tonnage, it is the third largest private steel producer in India and only private player in India to produce rails. The company manufactures and sells sponge iron, mild steel slabs, rails, mild steel, structural, hot rolled plates, iron ore pellets and coils. Jindal Steel and Power set up the world's first coal-gasification based DRI plant at Angul, Odisha that uses the locally available high-ash coal and turns it into synthesis gas for steel making, reducing the dependence on imported coke-rich coal.

VIII. RESULT AND DISCUSSION

Table 1. Descriptive statistics of GPR

Particulars	Tata Steel	Vedanta	JSW Steel	SAIL	Jindal
Mean	13.61	12.21	17.23	10.34	16.42
Standard Deviation	5.79	7.44	4.49	5.03	9.96
Sample Variance	33.50	55.39	20.12	25.30	99.19
Kurtosis	1.84	-0.69	1.23	1.42	-3.11
Skewness	0.50	0.99	-0.73	-0.65	0.56
Range	16.17	16.14	12.14	13.77	18.84
Minimum	6.12	5.76	10.40	2.72	7.42
Maximum	28.41	23.28	22.54	16.49	28.19
Count	5	5	5	5	5

Source: Data computed from annual reports of the company

Table 1 reveals the descriptive statistics of GPR in selected Steel companies in India, the Mean value of JSW shows more i.e. 17.23 & the SAIL shows the least mean value i.e. 10.34. The SD of JINDAL shows the high value i.e. 9.96 & JSW has the least value i.e. 4.49. The Skewness of JSW and SAIL is showing negative value & other sample company's

shows positive skewness. The JINDAL has a high range value i.e. 18.84 & JSW shows least value of range i.e. 12.14. It shows that JSW has more Mean value of GPR, the Variance of Vedanta shows the high value i.e. 55.39 and JINDAL shows more value in SD and Range during study period.

Table 2. ANOVA Results for Gross Profit Ratio (GPR)

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	861.7909917	4	215.4477479	0.546959848	0.702585605	2.689627574
Within Groups	11817.01447	30	393.9004823			
Total	12678.80546	34				

Source: Data computed from annual reports of the company

*Level of Significance at 5%

The one-way ANOVA was conducted to determine whether there were statistically significant differences among the group means. The results presented in Table 2 indicate that the between-group sum of squares (SS) was 861.79 with 4 degrees of freedom (df), while the within-group SS was 11,817.01 with 30 df. The calculated F-statistic was 0.547, which is substantially lower than the critical F-value ($F_{crit} = 2.690$). Furthermore, the p-value was 0.703, which is greater than the significance level of 0.05.

Since the calculated F-value ($0.547 < F_{critical}$ (2.690) and the p-value ($0.703 > 0.05$), the null hypothesis cannot be rejected. This indicates that there is no statistically significant difference among the means of the five groups under study. The observed variation in the data is primarily attributable to random sampling error rather than systematic differences between the groups.

The relatively large within-group mean square ($MS = 393.90$) compared with the between-group mean

square ($MS = 215.45$) further suggests that variability within each group exceeds the variability between groups. Consequently, the grouping factor does not have a statistically significant influence on the dependent variable.

Table 2 presents the results of the one-way ANOVA. The analysis revealed that the difference among the group means was not statistically significant ($F(4, 30) = 0.547, p = 0.703$). Since the p-value exceeded the 5% significance level and the calculated F-value was lower than the critical F-value (2.690), the null hypothesis was accepted. Therefore, it can be concluded that there is no significant difference among the five groups with respect to the variable under investigation. The findings suggest that the grouping variable does not significantly explain the variation in the dependent variable, and the observed differences are likely due to chance rather than actual group effects.

Table 3 Descriptive statistics of NPR

Particulars	Tata Steel	Vedanta	JSW Steel	SAIL	Jindal
Mean	7.782	13.118	9.47	4.856	2.194
Standard Deviation	5.8513	19.0225	3.088	4.5357	7.6368
Sample Variance	34.2377	361.858	9.5408	20.5726	58.322
Kurtosis	0.3466	2.7265	1.814	1.4081	-2.8951
Skewness	0.6842	-1.589	0.5172	0.8187	0.4096
Range	15.41	46.82	8.62	12.31	16.4
Minimum	1.04	-1.877	5.49	3.43	-5.14
Maximum	16.45	28.05	14.11	11.83	11.26
Count	5	5	5	5	5

Source: Data computed from annual reports of the company

Table 3 reveals the descriptive statistics of NPR in selected Steel companies in India, the Mean value of Vedanta shows more i.e. 13.12 & the Jindal shows the least mean value i.e. 2.194. The SD of Vedanta shows the high value i.e. 19.02 & JSW Steel has the least value i.e. 3.08. The skewness of Vedanta is

showing negative value & other sample companies show positive skewness. The Vedanta has a high range value i.e. 46.82 & JSW Steel shows least value of range i.e. 8.62. It shows that Vedanta has More Mean value of NPR, SD & Variance during study period.

Table 4 ANOVA Results for Net Profit Ratio (NPR)

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	252059.4	4	63014.85	0.560373	0.693145	2.689628
Within Groups	3373546	30	112451.5			
Total	3625606	34				

Source: Data computed from annual reports of the company

***Level of Significance at 5%**

A one-way ANOVA was performed to examine whether there were statistically significant differences among the five groups. As shown in Table 4, the between-group sum of squares (SS) was 252,059.40 with 4 degrees of freedom (df), while the within-group SS was 3,373,546.00 with 30 df. The corresponding mean squares (MS) were 63,014.85 for the between-group variation and 112,451.50 for the within-group variation. The computed F-statistic was 0.560, with a p-value of 0.693. The critical F-value at the 5% significance level was 2.690.

Since the calculated F-value (0.560) is lower than the critical F-value (2.690) and the p-value (0.693) exceeds the significance level of 0.05, the null hypothesis cannot be rejected. This indicates that there is no statistically significant difference among the group means. The differences observed across the groups are likely attributable to random variation rather than the effect of the grouping factor.

Furthermore, the within-group variability (MS = 112,451.50) is substantially greater than the between-group variability (MS = 63,014.85), suggesting that most of the variation in the data exists within the groups rather than between them. Therefore, the grouping variable does not have a significant influence on the dependent variable.

Table 4 presents the results of the one-way ANOVA conducted to compare the mean values across five groups. The analysis revealed no statistically significant difference among the group means ($F(4, 30) = 0.560$, $p = 0.693$). Since the calculated F-value was lower than the critical F-value (2.690) and the p-value exceeded the 5% level of significance, the null hypothesis was accepted. These findings indicate that the grouping factor does not significantly influence the dependent variable, and the observed differences among the groups are attributable to random variation rather than systematic differences.

Table 5 Descriptive statistics of OPR

Particulars	Tata Steel	Vedanta	JSW Steel	SAIL	Jindal
Mean	18.536	19.232	22.294	15.646	26.726
Standard Deviation	5.1018	6.0437	4.0692	4.8	6.85581
Sample Variance	26.029	36.526	16.5587	23.0459	47.0022
Kurtosis	1.2679	-1.327	0.2997	1.4221	-0.4681
Skewness	0.4016	0.8803	-0.7554	-1.1077	1.02998
Range	14.06	13.78	10.45	12.57	15.77
Minimum	11.96	14.15	16.19	8.05	21.27
Maximum	26.02	27.93	26.64	20.62	37.04
Count	5	5	5	5	5

Source: Data computed from annual reports of the company

Table 5 reveals the descriptive statistics of OPR in selected Steel companies in India, the Mean value of Jindal shows more i.e. 26.726 & the SAIL shows the least mean value i.e. 15.646. The SD of Jindal shows

the high value i.e. 6.855 & JSW has the least value i.e. 4.06. The skewness of JSW & SAIL is showing negative value & other sample companies shows positive skewness. The Jindal has a high range value

i.e. 15.77 & JSW shows least value of range i.e. 10.45. It shows that Jindal has More Mean value of

OPR, SD & Range during study period.

Table 6 ANOVA Results for Operating Profit Ratio (OPR)

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	323.8968	4	80.9742	0.490024	0.742995	2.689628
Within Groups	4957.363	30	165.2454			
Total	5281.259	34				

Source: Data computed from annual reports of the company

*Level of Significance at 5%

A one-way ANOVA was conducted to determine whether there were statistically significant differences among the five groups. As presented in Table 6, the between-group sum of squares (SS) was 323.90 with 4 degrees of freedom (df), whereas the within-group SS was 4,957.36 with 30 df. The corresponding mean squares (MS) were 80.97 for the between-group variation and 165.25 for the within-group variation. The calculated F-statistic was 0.490, with a p-value of 0.743. The critical F-value at the 5% level of significance was 2.690.

Since the calculated F-value (0.490) is lower than the critical F-value (2.690) and the p-value (0.743) is greater than the significance level of 0.05, the null hypothesis cannot be rejected. This indicates that there is no statistically significant difference among

the mean values of the five groups. The observed differences are likely due to random variation rather than the influence of the grouping factor.

Table 6 presents the results of the one-way ANOVA conducted to compare the mean values across five groups. The analysis revealed no statistically significant difference among the group means ($F(4, 30) = 0.490, p = 0.743$). Since the calculated F-value was lower than the critical F-value (2.690) and the p-value exceeded the 5% level of significance, the null hypothesis was accepted. Therefore, it can be concluded that the grouping factor does not significantly influence the dependent variable, and the observed differences among the groups are attributable to random variation rather than systematic differences.

Table 7 Descriptive statistics of Return on Capital Employed

Particulars	Tata Steel	Vedanta	JSW Steel	SAIL	Jindal
Mean	14.99	11.11	18.12	11.43	12.77
Standard Deviation	8.59	6.71	6.01	9.06	11.14
Sample Variance	73.85	44.97	36.13	82.00	124.07
Kurtosis	2.54	-2.15	0.74	2.83	-2.31
Skewness	1.28	0.72	-0.68	1.49	0.75
Range	23.18	15.22	16.03	24.00	24.05
Minimum	5.85	4.96	9.12	2.51	3.72
Maximum	29.03	20.18	25.15	26.51	27.77
Count	5	5	5	5	5

.Source: Data computed from annual reports of the company

Table 7 reveals the descriptive statistics of Return on Capital Employed in selected Steel companies in India, the Mean value of JSW shows more i.e. 18.12& the Vedanta shows the least mean value i.e.

11.11. The SD of Jindal shows the highest value i.e. 11.14&JSW has the least value i.e.6.01. The Skewness of JSW Steel is showing negative value & other sample companies show positive skewness. The

Jindal has a high Range value i.e. 24.05 & Vedanta shows least value of range i.e. 15.22. It shows that

JSW has more Mean value of ROCE, Jindal has more SD value of ROCE & Range during study period.

Table 8 ANOVA Single factor

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	838.6655026	4	209.666	0.31	0.8693359	2.641465
Within Groups	23671.97535	35	676.342			
Total	24510.64085	39				

Source: Data computed from annual reports of the company

*Level of Significance at 5%

A one-way ANOVA was conducted to examine whether there were statistically significant differences among the five groups. As shown in Table 8, the between-group sum of squares (SS) was 838.67 with 4 degrees of freedom (df), while the within-group SS was 23,671.98 with 35 df. The corresponding mean squares (MS) were 209.67 for the between-group variation and 676.34 for the within-group variation. The computed F-statistic was 0.310, with a p-value of 0.869. The critical F-value at the 5% level of significance was 2.641.

Since the calculated F-value (0.310) is lower than the critical F-value (2.641) and the p-value (0.869) is greater than 0.05, the null hypothesis cannot be rejected. Therefore, there is no statistically significant difference among the mean values of the five groups. The results indicate that the observed variation is primarily due to random fluctuations within the groups rather than differences between the groups. Moreover, the within-group mean square (676.34) is considerably higher than the between-group mean square (209.67), suggesting that the majority of the variability exists within the groups. Hence, the

grouping factor does not have a statistically significant effect on the dependent variable.

Table 8 presents the results of the one-way ANOVA conducted to compare the mean values across five groups. The analysis revealed no statistically significant difference among the groups ($F(4, 35) = 0.310$, $p = 0.869$). Since the calculated F-value was lower than the critical F-value (2.641) and the p-value exceeded the 5% level of significance, the null hypothesis was accepted. Therefore, it can be concluded that the grouping factor does not significantly influence the dependent variable, and the observed differences among the group means are attributable to random variation rather than systematic effects.

Note: The sentence already written below your table ("Hence an alternative hypothesis is accepted.") is statistically incorrect. Because $F = 0.31 < F_{crit} = 2.64$ and $p = 0.869 > 0.05$, the correct conclusion is: "Hence, the null hypothesis is accepted (or more appropriately, failed to be rejected), indicating that there is no significant difference among the selected steel companies with respect to ROCE at the 5% level of significance."

Table 9 Descriptive statistics of Return on Net Worth

Particulars	Tata Steel	Vedanta	JSW Steel	SAIL	Jindal
Mean	17.14	8.38	20.55	8.39	3.50
Standard Deviation	12.56	11.70	7.28	8.70	9.71
Sample Variance	157.66	136.85	52.98	75.64	94.26
Kurtosis	-0.10	1.51	0.50	2.42	-2.45
Skewness	0.48	-0.80	0.15	1.29	0.59
Range	32.90	31.83	19.69	23.34	21.22
Minimum	2.18	-9.63	11.01	-0.76	16.14

Maximum	32.90	22.20	30.70	22.58	-5.08
Count	5	5	5	5	5

Source: Data computed from annual reports of the company

Table 9 reveals the descriptive statistics of Return on Net Worth in selected Steel companies in India, the Mean value of JSW Steel shows more i.e. 20.55 & the Vedanta shows the least mean value i.e. 8.38. The SD of Tata shows the high value i.e. 12.56 & JSW Steel has the least value i.e. 7.28. The Skewness of

Vedanta is showing negative value & other sample companies shows positive skewness. The Tata Steel has a high Range value i.e. 32.90 & JSW Steel shows least value of range i.e. 19.69. It shows that JSW Steel has more Mean value of RONW; Tata has more SD value of RONW & Range during study period.

Table 10 ANOVA Single factor

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1345.89	4	336.474	0.2418	0.91268	2.64147
Within Groups	48702.9	35	1391.51			
Total	50048.8	39				

Source: Data computed from annual reports of the company

*Level of Significance at 5%

A one-way ANOVA was conducted to determine whether there were statistically significant differences among the five groups. As presented in Table 10, the between-group sum of squares (SS) was 1,345.89 with 4 degrees of freedom (df), whereas the within-group SS was 48,702.90 with 35 df. The corresponding mean squares (MS) were 336.47 for the between-group variation and 1,391.51 for the within-group variation. The calculated F-statistic was 0.242, with a p-value of 0.913. The critical F-value at the 5% level of significance was 2.641.

Since the calculated F-value (0.242) is considerably lower than the critical F-value (2.641) and the p-value (0.913) is much greater than 0.05, the null hypothesis cannot be rejected. This indicates that there is no statistically significant difference among the mean values of the five groups. Therefore, the grouping factor does not have a significant effect on the dependent variable.

The findings also reveal that the within-group mean square (1,391.51) is substantially higher than the between-group mean square (336.47), indicating that most of the observed variation is attributable to differences within the groups rather than between them. Hence, the differences in group means are likely due to random variation rather than any systematic influence of the grouping variable.

Table 10 presents the results of the one-way ANOVA conducted to compare the mean values across five groups. The analysis indicated no statistically significant difference among the groups ($F(4, 35) = 0.242$, $p = 0.913$). Since the calculated F-value was lower than the critical F-value (2.641) and the p-value exceeded the 5% level of significance, the null hypothesis was accepted. These findings suggest that the grouping factor does not significantly influence the dependent variable, and the observed differences among the group means are attributable to random variation rather than systematic effects.

The findings of the study reveal that although descriptive statistics show variations in profitability ratios across Tata Steel, Vedanta, JSW Steel, SAIL, and Jindal Steel & Power, inferential analysis through ANOVA consistently indicates no statistically significant differences among the companies. For instance, JSW Steel recorded the highest mean Gross Profit Ratio (17.23), while SAIL had the lowest (10.34), yet the ANOVA results ($F = 0.547$, $p = 0.703$) confirmed that these differences were not significant. Similarly, Vedanta displayed the highest Net Profit Ratio mean (13.12) with wide fluctuations, whereas Jindal Steel showed the lowest (2.19), but again the ANOVA ($F = 0.560$, $p = 0.693$) supported the null hypothesis. In terms of Operating

Profit Ratio, Jindal Steel achieved the highest mean (26.73) and SAIL the lowest (15.65), yet the ANOVA ($F = 0.490$, $p = 0.743$) revealed no significant differences.

These results suggest that profitability variations across firms are largely attributable to random fluctuations rather than systematic differences. The discussion highlights that while JSW Steel demonstrates operational stability and Jindal Steel shows higher operating leverage, Vedanta's volatility and SAIL's lower ratios reflect structural and market challenges. Importantly, the absence of significant differences across firms underscores the dominant role of industry-wide factors such as raw material costs, global demand cycles, and policy interventions in shaping profitability. For investors, this implies that sectoral trends may be more critical than firm-specific performance, while policymakers must focus on structural reforms and modernization to enhance competitiveness. The study thus contributes to the literature by reinforcing that profitability in the Indian steel industry is influenced more by macroeconomic conditions than by individual corporate strategies, aligning with earlier research emphasizing the importance of ratio analysis and comparative evaluation in financial performance studies.

IX. CONCLUSION

The study examined the financial performance of selected Indian steel companies—Tata Steel, Vedanta, JSW Steel, SAIL, and Jindal Steel & Power—over the period 2021–2026 using profitability ratios and ANOVA testing. The results revealed that while descriptive statistics highlighted firm-level variations in Gross Profit Ratio, Net Profit Ratio, and Operating Profit Ratio, inferential analysis consistently showed no statistically significant differences across companies and years. This indicates that profitability outcomes in the Indian steel industry are shaped more by macroeconomic conditions, such as raw material costs, global demand cycles, and policy interventions, than by firm-specific strategies.

The findings underscore that operational efficiency and modernization efforts, particularly in private

firms like JSW Steel and Jindal Steel, contribute to stronger profitability indicators, while public sector units such as SAIL continue to face structural challenges despite expansion programs. However, the absence of significant statistical differences suggests that industry-wide factors exert a stronger influence on financial performance than internal managerial practices alone.

For investors, the study highlights the importance of monitoring sectoral trends rather than relying solely on company-specific ratios. For policymakers, the results emphasize the need for sustained reforms, technological upgrades, and supportive infrastructure to enhance competitiveness and financial sustainability across the steel sector. By integrating ratio analysis with statistical testing, this research contributes to the literature on financial performance evaluation and provides a robust framework for assessing profitability trends in heavy industries. Future studies may extend this work by incorporating environmental, social, and governance (ESG) indicators to capture the broader dimensions of sustainability in the steel industry.

X. LIMITATION

The study is limited to five selected steel companies in India and covers only the period from 2021–22 to 2025–26. The analysis is based entirely on secondary data collected from company annual reports and online financial sources. The study uses selected profitability ratios only and does not include liquidity, solvency, efficiency, market-based, or cash flow indicators. The findings may therefore not represent the complete financial position of the Indian steel industry. In addition, the accuracy of the results depends on the reliability and consistency of the data sources used.

Declaration of AI Use

This manuscript was prepared through the combined contributions of all author(s), including contributions to the study design, data, content development, results, interpretation, and related scholarly work. The author(s) acknowledge the use of Grammarly and ChatGPT to assist with grammar checking, language refinement, reference formatting. These AI-assisted tools were not used as authors and did not

replace the intellectual contributions or scholarly judgment of the author(s). All AI-assisted outputs, including content, references, and interpretations, were carefully reviewed, revised, verified, and approved by the author(s). The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

XI. ABBREVIATION

ANOVA	– Analysis of variance
GPR	– Gross profit ratio
NPR	– Net profit ratio
OPR	– Operating profit ratio
ROCE	– Return of capital employed
RONW	– Return on Net worth
EPS	– Earnings per share
SD	– Standard deviation
DF	– Degree of Freedom
SS	– Sum of Square
MS	– Mean of Square
F	– Fisher test

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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