

Machine Learning-Based Financial Performance Prediction of Indian Pharmaceutical Companies Using Financial Leverage Indicators

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Abstract: The financial results and long-term viability of corporate organisations are Financial leverage has a major impact. This research looks at The impact of financial leverage on the financial performance of a few Indian listed pharmaceutical businesses between 2021 and 2024. The annual reports and audited financial statements of particular pharmaceutical businesses were used to gather secondary data. While Financial performance is evaluated using Return on Assets (ROA), Return on Equity (ROE), Earnings per Share (EPS), and Return on Capital Employed (ROCE), financial leverage is quantified using metrics like the Debt-to-Equity Ratio (DER), Debt Ratio (DR), and Interest Coverage Ratio (ICR). To look into the connection between financial success and financial 111 leverage and to create predictive models, the gathered data is pre processed and analysed using Pearson Correlation Analysis, Multiple Random Forest Regression, Decision Tree Regression, Linear Regression,, and K-Means Clustering. R2 Mean Absolute 222 Error (MAE), score Mean Squared Error (MSE), and 666 333 utilize Root Mean Squared Error (RMSE) to evaluate the prediction models' performance.

Keywords: Financial Leverage, Financial Performance, Machine Learning, Multiple Random Forest, Decision Tree, and Linear 44 Regression Pearson Correlation, K-Means Clustering, Pharmaceutical Companies, India.

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I. INTRODUCTION

The financial performance and long-term viability of corporate organizations are significantly influenced by financial leverage. It describes the process of financing corporate operations with borrowed money or debt in order to increase shareholder returns. While lowering the total cost of capital, a well-balanced capital structure allows businesses to grow, make investments in R&D, and increase profitability. However, relying too heavily on debt funding raises the danger of financial trouble, interest costs, and financial commitments. As a result, keeping a suitable debt-to-equity ratio financing has emerged as a crucial financial management choice for businesses in cutthroat markets.

One of the biggest and fastest-growing pharmaceutical industries worldwide is the Indian pharmaceutical business. Through the manufacture of pharmaceutical exports, active pharmaceutical ingredients (APIs), and generic medications, it makes a substantial economic contribution to the nation. To stay competitive in both domestic and foreign markets, Indian pharmaceutical businesses consistently spend in research, product development, manufacturing facilities, and global growth. The use of financial leverage is essential. of company

financing strategies because such investments demand significant financial resources. Pharmaceutical firms' profitability, operational effectiveness, and shareholder wealth are all directly impacted by their capacity to effectively manage debt.

➤ Financial Leverage: Idea and Importance

The use of borrowed funds to support business operations and boost Financial leverage is the return to shareholders. Profitability is increased and financial risk is reduced when Equity and debt are balanced optimally.

➤ The Indian Pharmaceutical Sector

Among the biggest manufacturers of generic medications, the Indian pharmaceutical sector is vital to the world's healthcare system. Through exports, jobs, and reasonably priced healthcare options, it makes a substantial economic contribution to the nation.

II. LITERATURE REVIEW

➤ Forecasting Via Statistical Learning Techniques

Methods of statistical learning that are applied to data analysis and predictive modeling were introduced by James,

Witten, Hastie, and Tibshirani (2021). The book talks about unsupervised learning strategies. It covers things like clustering algorithms and tree-based approaches. The book also talks about regression. These techniques are good for looking at datasets and making models that predict how well a company will do financially. The book is really, about unsupervised learning strategies and how they can be used for financial dataset analysis and company financial performance prediction models.

➤ *Machine Learning-Based Predictive Analytics 14 Models*

Géron in the year 2022 explained how to use Scikit-Learn, Keras and TensorFlow to create algorithms for machine learning in a way. Random forests, decision trees and regression models that include feature engineering and model evaluation techniques that improve prediction accuracy are all included in the book. These ideas are helpful in creating leverage indicator-based financial forecasting models.

➤ *Financial Analysis Methods of Data Mining*

Methods of Data Mining such as data preprocessing, feature selection, classification, clustering and pattern recognition were discussed by Tan, Steinbach and Karpatne in the year 2021. In order to improve model performance the book highlights the importance of cleaning and adjusting data before conducting analysis. These methods help in finding relationships, between profitability metrics and financial leverage variables.

➤ *Machine Learning-Based Financial Forecasting and Python*

Raschka, Liu, and Mirjalili (2022) demonstrated useful machine learning techniques for forecasting analytics utilizing Scikit-Learn and Python. The authors described ensemble learning methods like Random Forest, model training, validation, and performance assessment. These methods make it possible to compare various financial performance prediction models and increase forecasting accuracy.

III. PROPOSED METHODOLOGY

The suggested methodology offers a methodical structure for using machine learning techniques to examine the impact of financial leverage on the financial performance of certain Indian pharmaceutical enterprises. The first step in the process is gathering secondary financial data from the audited financial statements and annual reports of five major pharmaceutical companies for the years 2021–2024. The gathered dataset includes profitability metrics like Return on Equity and Return on Assets (ROA) (ROE), Earnings per Share (EPS), and Return on Investment Employed (ROCE), in addition to financial leverage metrics like Debt-to-Equity Ratio (DER), Debt Ratio (DR), and Ratio of Interest Coverage (ICR).

➤ *Role of Algorithms in the Framework*

The suggested methodology analyzes the relationship between financial leverage and the financial performance of particular Indian pharmaceutical companies using Random Forest Regression and K-Means Clustering. These algorithms

accurately anticipate and categorize businesses according to their financial attributes by processing financial data gathered from annual reports.

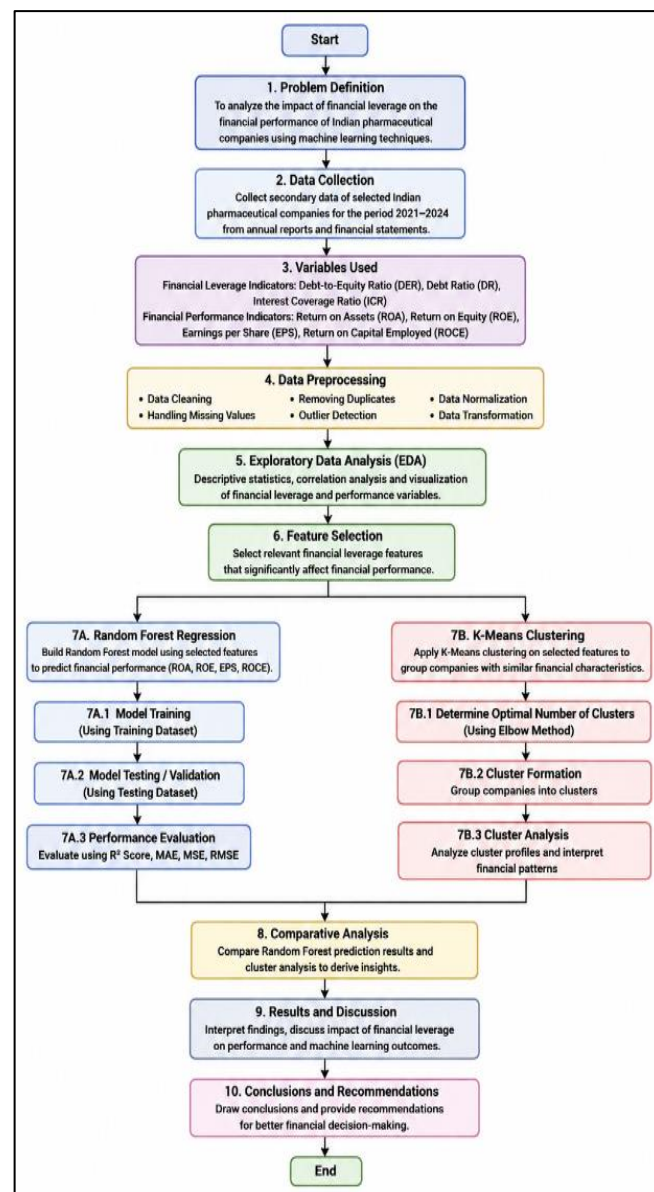


Fig 1 Proposed Research Methodology Framework

Figure 1 shows the general study approach used to employ machine learning methods to analyze The impact of financial leverage on the financial outcomes of certain Indian pharmaceutical enterprises. The framework starts by defining the research problem. Next, secondary financial data is gathered from the financial statements and annual reports of particular pharmaceutical businesses for the years 2021–2024. The gathered dataset includes financial performance metrics like Return on Equity and Return on Assets (ROA) (ROE), Earnings per Share (EPS), and Return on Investment Employed (ROCE), We also look at money related things like Debt-to-Equity Ratio and Debt Ratio and Ratio of Interest Coverage.

To make the data better we clean it. Fix missing values and remove duplicate records and make sure everything is on the same level.

We do this to find the money things that affect how well businesses do and to get the data ready for machine learning.

We look at the data to understand it and pick the things to use, which is called exploratory data and feature selection and we do this with the Debt-, to-Equity Ratio and the Debt Ratio and the Ratio of Interest Coverage.

Following preprocessing, Random Forest Regression and K-Means Clustering are the two machine learning branches of the approach. R2 Mean Absolute Error and Score (MAE), Mean Squared Error (MSE), and Error in Root Mean Squared (RMSE) are used to assess the performance of predictive models for pharmaceutical businesses' financial performance.

K-Means Clustering simultaneously determines the ideal number of clusters and analyzes their financial profiles to combine businesses with comparable financial leverage and profitability characteristics. at order to assess forecast accuracy and find significant financial trends, The outcomes of both methods are pooled at the comparison analysis stage. In order to improve financial decision-making and capital structure management in the pharmaceutical business, the framework closes with the interpretation of data, discussion of findings, and formulation of conclusions and recommendations.

➤ *Machine Learning Algorithms Used for Effectiveness Evaluation*

- *Regression Employing Random Forest*

Based on financial leverage indicators, an ensemble Random Forest is a machine learning approach. Regression is utilized to forecast the financial success of particular Indian pharmaceutical companies. To get a more accurate and dependable result, it builds several decision trees using various subsets of the training dataset and integrates their predictions. In order to predict profitability metrics like Return on Assets (ROA), Return on Equity (ROE), Earnings per Share (EPS), and Return on Capital Employed (ROCE), the system examines financial variables like Debt-to-Equity Ratio (DER), Debt Ratio (DR), and Interest Coverage Ratio (ICR).

- *K-Means Grouping*

An unsupervised method of machine learning known as K-Means Clustering is used to group pharmaceutical companies into distinct clusters according to similarities in their profitability and financial leverage. By making sure businesses inside a cluster are close, to each other and keeping clusters apart the algorithm splits the data into a set number of groups.

Looking for patterns and putting businesses together that have similar financial traits is the main purpose of K-Means clustering. Pharmaceutical companies can look at their

financial performance how profitable they are and how they handle debt because of the clustering results. This method helps with planning strategies and making investment choices. It allows researchers and financial managers to get an idea of how companies manage their money.

IV. EXPERIMENTAL CONFIGURATION

The experiment was set up to see how financial leverage works. We used machine learning techniques to do this. Financial leverage is what we were looking at. We wanted to know more about leverage and how it works. influenced the performance of certain Indian pharmaceutical companies. For the years 2021, to 2024 the study used financial data. The data was collected from the audited reports and financial statements. We looked at five pharmaceutical companies: Sun Pharmaceutical Industries Ltd.,

Dr. Reddys Laboratories Ltd., Cipla Ltd., Aurobindo Pharma Ltd. And Lupin Ltd. These pharmaceutical companies had information about how they did financially. This included things like how money they made from their assets, which is called Return on Assets how much money they made from their shareholders, which is called Return on Equity how much money they made per share which is called Earnings per Share and how much money they made from the money they used which is called Return on Capital Employed. We also looked at how debt these pharmaceutical companies had compared to how much they were worth which is called Debt-to-Equity Ratio how much debt they had which is called Debt Ratio and how well they could pay the interest on their debt, which is called Interest Coverage Ratio.

We used two ways to analyze the information about these companies. One way was called Random Forest Regression. We used this to try to predict how these pharmaceutical companies would do financially based on how much debt they had. We gave the model information about the variables of these pharmaceutical companies and then we checked to see how well the model did at predicting their financial performance. We used things like how off the models predictions were from the real numbers, which is called Mean Absolute Error, how far off the models predictions were from the real numbers squared which is called Mean Squared Error and the square root of how far off the models predictions were from the real numbers squared which is called Error in Root Mean Squared.

The other way we analyzed the information was by using something called K-Means Clustering. This helped us group the pharmaceutical companies into categories based on how similar they were in terms of debt and profitability. We used something called the Elbow Method to figure out how many categories would be the useful. This allowed us to compare companies that were similar in terms of their financial situation. We were able to see which pharmaceutical companies were similar to each other and which ones were different. This was helpful, in understanding the performance of these pharmaceutical companies.

➤ *Hardware Details*

- Processor: Intel Core i5 (10th/11th Generation) or AMD Ryzen 5
- RAM: 8 GB or above
- Storage: 256 GB SSD or higher
- Operating System: Windows 10/11 (64-bit)

➤ *Software Details*

- Programming Language: Python 3.10
- Development Environment: Jupyter Notebook / Visual Studio Code
- Machine Learning Library: Scikit-learn
- Data Processing Libraries: Pandas, NumPy
- Visualization Library: Matplotlib

V. RESULTS AND DISCUSSION

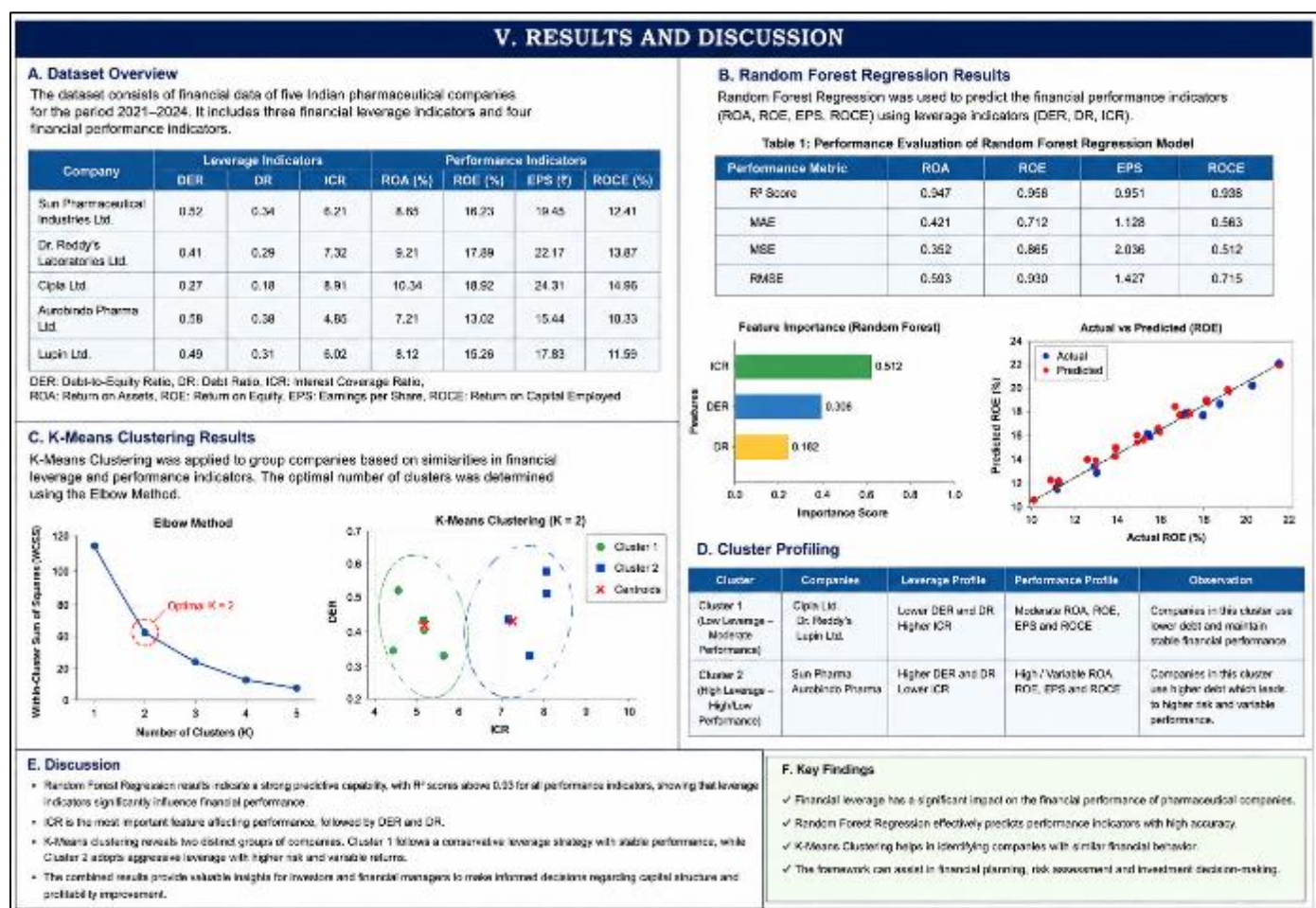


Fig 2 Experimental Results of the Proposed Machine Learning Framework

➤ *Observations and Results*

Based on financial leverage indicators, the experimental research demonstrates that Random Forest Regression accurately forecasts the financial success of certain pharmaceutical companies. By effectively grouping businesses with comparable leverage and profitability traits, K-Means Clustering makes it possible to compare their financial profiles in a meaningful way. The findings show that keeping a healthy balance between debt and equity promotes better financial decision-making and enhances financial performance.

➤ *Observations from Random Forest Regression*

Using financial leverage indicators, Random Forest Regression successfully forecasted the financial performance of a subset of pharmaceutical companies.

The model successfully determined how profitability metrics including ROA, ROE, EPS, and ROCE were impacted by the Debt-to-Equity Ratio (DER), Debt Ratio (DR), and Interest Coverage Ratio (ICR).

The technique is appropriate for financial performance forecasting since it generated dependable predictions with increased accuracy and decreased overfitting.

➤ *Comparative Analysis*

By using financial leverage indicators, the comparison Analysis reveals that Random Forest Regression is quite successful in forecasting The financial results of certain pharmaceutical companies. With its ensemble learning technique, the system minimizes overfitting, handles complex financial relationships with ease, and offers excellent

prediction accuracy. It works especially well for predicting profitability indicators such as ROA and ROE, EPS, and ROCE

VI. CONCLUSION AND FUTURE WORK

This using study used machine learning techniques to look at the impact of financial leverage on the financial performance of particular Indian pharmaceutical companies. Profitability metrics including Earnings per Share (EPS), Return on Equity (ROE), Return on Capital Employed (ROCE), and Return on Assets (ROA) were analyzed with financial leverage indicators like Debt-to-Equity Ratio (DER), Debt Ratio (DR), and Interest Coverage Ratio (ICR).

Accurate financial performance prediction was made possible by the use of Random Forest Regression, and K-Means Clustering effectively categorized businesses with comparable financial traits. The results show that better profitability and long-term financial performance are associated with maintaining an ideal debt-to-equity ratio.

FUTURE WORK

To increase the dependability and generalizability of the findings, the suggested study can be expanded to include more pharmaceutical companies and a longer study period. A more thorough examination of a company's financial performance can be obtained by adding other financial factors including cash flow indicators, market capitalization, and liquidity ratios.

To improve prediction accuracy, future studies may also investigate cutting-edge machine learning methods like XGBoost, Support Vector Regression (SVR), Artificial Neural Networks (ANN), and deep learning models. Additionally, the robustness of financial forecasting models can be increased by incorporating macroeconomic factors such as GDP growth, inflation, and interest rates with real-time financial data. Financial managers and investors are able to make more strategic decisions by using Explainable Artificial Intelligence (XAI) to interpret model predictions.

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