ISSN 0974-763X
UGC-CARE Listed Journal

SOUTH ASIAN JOURNAL OF MANAGEMENT RESEARCH (SAJMR)

Volume 15, Issue No.1 January, 2025

CHHATRAPATI SHAHU INSTITUTE OF BUSINESS EDUCATION AND RESEARCH (CSIBER), KOLHAPUR, MAHARASHTRA, INDIA

(An Autonomous Institute)
University Road, Kolhapur - 416004, Maharashtra State, India.

website : www.siberindia.edu.in
E-mail : editorsajmr@siberindia.edu.in

Chhatrapati Shahu Institute of Business Education and Research (CSIBER)

South Asian Journal of Management Research (SAJMR)

Volume 15, Issue No. 1, January, 2025

Editor: Dr. Pooja M. Patil

Publisher

CSIBER Press

Central Library

Chhatrapati Shahu Institute of
Business Education & Research (CSIBER)
University Road, Kolhapur – 416004, Maharashtra, India.
Phone: 91-231-2535706/07, Fax: 91-231-2535708,
Website: www.siberindia.edu.in
Email: csiberpress@siberindia.edu.in
Editor Email: editorsajmr@siberindia.edu.in

Address:
CSIBER Press
Central Library Building
Chhatrapati Shahu Institute of Business Education and Research (CSIBER),
University Road Kolhapur, Maharashtra - 416004, India.

ISSN: 0974-763X

Price: INR ₹ 1,200/-

Editor: Dr. Pooja M. Patil

Distributed By

CSIBER Press

Central Library

Chhatrapati Shahu Institute of
Business Education & Research (CSIBER)
University Road, Kolhapur – 416004, Maharashtra, India.
Phone: 91-231-2535706/07, Fax: 91-231-2535708,
Website: www.siberindia.edu.in
Email: csiberpress@siberindia.edu.in

Unveiling Key Drivers of Capital Structure: A Sectoral Study of Indian Manufacturing Firms

Moses Prakash Fernandes
Assistant Professor,
Rosary College of Commerce and Arts
Navelim, Goa, India

Harip Rasulsab Khanapuri
Associate Professor,
Goa Business School, Goa University
Taleigao, Goa, India

Abstract

This research fills a need in the literature by examining, at the firm level, the factors that have a substantial impact on the capital structure decisions made by manufacturing enterprises in India, as opposed to developed economies. Despite extensive research on capital structure determinants in advanced markets, limited attention has been given to emerging economies like India, where the dynamics of corporate finance are influenced by unique institutional, economic, and market conditions. This research explores firm-specific factors impacting the capital structure of Indian manufacturing firms using data spanning the financial years 2010-11 to 2019-20. To ensure robust analysis, the study adopts an innovative methodological framework combining the generalized method of moments (GMM) technique and the Random Forest model, a machine-learning approach. GMM is utilized to address endogeneity issues often present in dynamic panel data, while the Random Forest model identifies and ranks the key determinants of capital structure, adding a novel dimension to the analysis. By employing these complementary techniques, the study provides deeper insights into the factors shaping leverage decisions in Indian manufacturing firms. A significant contribution of this study is its sector-wise analysis, which evaluates whether firm-specific determinants of capital structure vary across different manufacturing sectors. A more detailed comprehension of leverage decisions is provided by this method, which takes into account the fact that different sectors exhibit different financial behaviour and operational traits. Particularly for developing nations, the results highlight the need for sector-specific approaches to fiscal management and policymaking. In sum, by combining time-honoured econometric methods with state-of-the-art machine learning models, this study adds to our knowledge of the factors that influence capital structure in the Indian setting. The results offer valuable implications for corporate managers, policymakers, and investors seeking to optimize leverage decisions in dynamic and diverse market conditions. This study also lays the groundwork for future research exploring the interplay between firm-specific characteristics, sectoral dynamics, and capital structure in emerging economies.

Keywords: : Capital Structure, Corporate Finance, Firm Characteristics, Indian Manufacturing Firms, Leverage.

JEL Classification: G3, G32, L6, O16

Introduction

The decisions pertaining to capital structure of a firm have constantly been debatable. Every finance manager aims to achieve an optimal equilibrium between debt and equity in the firm's capital structure. According to Graham & Harvey, (2001) the need to preserve a certain degree of financial flexibility is a significant factor influencing corporate capital structure decisions for most chief financial officers.

The groundbreaking research of (Modigliani and Miller, 1958, 1963) The tax shield advantage and the irrelevance of capital structure have provided the groundwork for an extensive amount of empirical research and theory in the field of capital structure. These theories include the trade-off theory(Modigliani and Miller, 1958), the agency theory (Jensen and Meckling, 1976), and the pecking-order theory (Myers and Majluf, 1984). These and the other theories have been extensively established empirically, mainly in economically more developed countries(Harris and Raviv, 1991). Despite the extensive research, there is no conclusive evidence or consensus to suggest recommendations for an organization's optimal capital structure or set of rules to help financial managers strike the optimal balance between debt and equity funding. Maximizing corporate firm value while minimizing the cost of capital is the goal of every firm, which is why finding the appropriate capital structure is essential. Academics and practitioners have struggled to find the optimal debt-to-equity ratio for their respective firms. To what degree firm-specific qualities, as opposed to external influences, dictate a firm's financing decisions is one of the more pressing concerns in capital structure theory. (Rajan and Zingales, 1995; Hall, Hutchinson and Michaelas, 2004)

Many emerging economies are slowly inching towards the debt level in developed economies. However, problems with capital structure in a developing country cannot be solved by extending research done in developed countries. The level of economic development and the subsequent internal factors specific to firms that influence such decisions vary from country to country. To fully grasp the significance of firms' financing decisions in the Indian economy, India must be analysed as an isolated case. The decision to undertake this study is heavily influenced by the maturity level of the Indian economy and the distinctive set of business characteristics found in India. The present study aims to investigate the following research question:

RQ1- What are the key firm-specific attributes driving the capital structure of Indian manufacturing firms?

Objective of the Study: To identify the firm's characteristics and the degree to which they affect the firm's capital structure.

Specific Objectives of the study:

- To determine the sectoral variations of the impact of firm-specific factors on Indian manufacturing firms.
- To provide relevant insights for policymakers and corporate decision-makers concerning capital structure optimization in the Indian manufacturing sector.

Through this study, we shed some light on providing better insights into capital structure decisions and aiding financial managers in picking the right capital structure.

Most studies historically have studied capital structure decisions using panel regression models such as 'Ordinary Least Square (OLS)', 'Tobit regression', and various multiple regression models (Rajan and Zingales, 1995) and (Handoo and Sharma, 2014). More recent studies have moved to employing more advanced econometric techniques, such as the 'Generalised Method of Moments (GMM') and 'Instrumental Variable (IV)' approaches, which are also used to address endogeneity issues in capital structure research. Studies like those by (Flannery and Rangan, 2006) (Panda and Nanda, 2020)

This study utilises panel data approximations from a sample of 577 Indian manufacturing firms spanning from 2010-11 to 2019-20. 'Profitability,' 'market-to-book,' 'firm size,' 'Tangibility,' 'growth opportunity,' 'non-debt tax shield,' 'liquidity,' and 'age of the firm' are chosen as determinants of leverage, which were built on the prevailing literature. The paper focuses on a sectoral analysis. The study aims to use a different approach compared to existing literature. The study uses the 'generalized method of moments (GMM)' and the novel approach of a 'Random Forest model,' a machine learning technique, to analyze the key determinant of capital structure.

An examination of the factors that affect capital structure at individual firms, broken down by industry, is the study's main contribution. The study found that the most significant determinants of leverage were Growth, Profitability, Liquidity and Market-to-Book Ratio; and that they vary across manufacturing sectors in India. The results of this study will hold strategic importance for finance managers in the industrial sector and policymakers in India. The remainder of this paper is structured as follows. Section 2 presents a concise literature overview. Section 3 presents the data gathered for the study. Section 4 highlights the technique adopted alongside our econometric model. Section 5 presents the empirical findings and discusses the outcomes, while section 6 concludes the study.

Literature Review

The long-running discourse over what would be considered the optimal 'capital structure' for a firm and its consequent value originates from the literature, (Modigliani and Miller, 1958) found that the value of a company does not change regardless of its capital structure, meaning that the value of enterprises that use leverage and those that do not are equivalent. The original study was based on the postulation that, tax benefits do not exist. This assumption was deemed implausible, and in their subsequent research paper, (Modigliani and Miller, 1963) takes into consideration the tax advantages that come with a firm's debt structure. They came to the conclusion that a levered firm receives value equivalent to the value of the tax benefit it receives from loan capital, and that this value is greater than that of an unlevered firm. Further study by (Kraus and Litzenberger, 1973) established that, at the macro level alone, there is an optimal capital structure and maintained that a tax shield is the most significant benefit of debt capital. The ability to subtract interest paid on debt capital from a company's gross profits before calculating its tax burden is a major factor in this. However, there are costs to raising debt capital, including bankruptcy and liquidation expenses. Finding the best financial structure requires weighing the costs and advantages.

A great deal of research in developed markets have fixated on what influences or decides the firm's capital structure. The question of whether firm-level or country-level factors influence the capital setup of a firm's decisions has also been investigated. (Psillaki and Daskalakis, 2009) determined that firm-specific factors account for variations in the intensity of capital structure decisions rather than factors at the country level. The Firm's Size, Profitability, Asset Tangibility, and Growth Potential are the four most important factors in determining the firm's capital structure, according to a study conducted by (Rajan and Zingales, 1995). Other studies by (Titman and Wessels, 1988; Barclay, Smith, and Watts, 1995; Pandey, 2001) have found that risk and investment opportunities are crucial determinants of a firm's debt structure.

In the Indian context, research on capital structure is fairly limited compared to research in developed countries. Size, asset structure, profitability, and the cost of short-term financial distress are some of the variables that might be considered when determining the ideal capital structure (Guha-Khasnobis and Bhaduri, 2002). (Pal, 2014) discovered that a non-debt tax shield and growth potential also influence a firm's capital structure. (Handoo and Sharma, 2014) asserted that tax rate and debt servicing capabilities significantly influence a firm's leverage structure. However, at the sector level, each manufacturing sector was found to have its own unique set of capital structure determinants (Panda and Nanda, 2020).

It takes a certain finesse to design a capital structure for a company (Handoo and Sharma, 2014). The firm must strike a balance between financial flexibility and discipline. It is more essential than any tax benefits for determining a firm's capital structure, and it is especially important for larger firms, which often have very little debt. A robust long-run equilibrium link is supposedly believed to exist between the capital structure of non-financial Indian firms and several key firm-specific factors (Chakraborty, 2010; Panda and Nanda, 2020).

In general, more established businesses would rather have lower levels of debt since more information about them is readily available and because they have more time to accumulate retained earnings. Firms that have more tangible assets tend to seek out additional debt, which supports the signaling hypothesis. A firm's inclination towards long-term debt financing is the sole one that diminishes as retained earnings rise, in keeping with the 'Pecking Order Theory', which states that retained profit has a significantly negative effect on the firm's debt structure (Bandyopadhyay and Barua, 2016).

Considering that research on firm-specific determinants is fairly limited in the Indian industrial sector, more studies are needed to fill the current gaps in the existing literature. More studies are needed to provide new evidence from emerging economies such as India, and more evidence on the effect of firm-specific factors and how they vary across sectors and impact capital structure decisions. Keeping this in mind, our study intends to focus on firm-specific factors that determine leverage in different industrial sectors in India.

Data for the study:

This research is exclusively empirical and utilises secondary data. The study sample comprises data from firms listed on the 'Bombay Stock Exchange (BSE)' and the 'National Stock Exchange (NSE).' Companies were chosen based on the presence of comprehensive records over a decade. The study period spans from the fiscal year 2010-2011 to 2019-2020, encompassing a duration of ten years. This study focuses on the industrial sectors in India. The firms selected for the study were classified sector-wise based on the National Industrial Classification (NIC). The study also excludes firms that have been engaged in M&As during the study period, primarily because during this period, the true picture of the firms under M&As can be inaccurate. Additionally, the sample does not include all firms that have been liquidated or stopped their operations and whose stocks are delisted in the BSE/NSE. The research additionally omits companies engaged in the banking and insurance industries. We used the CMIE Prowess IQ database to collect firm-level data for the study. The selected industrial sectors are listed in Table 1.

Table No 1: List of industrial sectors selected

Name of the industrial sector	Number of firms
Manufacture of Basic Iron and Steel	55
Manufacture of Transport Equipment	58
Manufacture of Textiles	69
Manufacture of Chemical and Chemical Products	110
Manufacture of Machinery and Equipment	36
Manufacture of Pharmaceuticals	65
Manufacture of Other Non-Metallic Mineral Products	39
Manufacture of Electrical Equipment	46
Manufacture of Food Products	40
Manufacture of Rubber & Plastic Products	59
Total	**577**

Source: Authors' compilation

Variables of the study:

Dependent variable

Long-term debt ratio (LTDR): One measure of a company's financial health is the ratio of its long-term debt to its total assets. Companies and industries are said to have different methods of valuations. The long-term debt ratio is classically calculated by dividing long-term debt capital by the company's total assets.

Long-term debt ratio (LTDR)= Long term debt/ Total Assets

Independent variables

This section concisely outlines the diverse factors of capital structure, as established in prior studies. The determinants include 'firm size,' 'tangibility,' 'non-debt tax shield,' 'profitability,' 'growth opportunity,' 'liquidity,' 'age of the firm,' and 'market-to-book ratio'. The hypotheses were developed from the literature, considering the factors and their relationship with capital structure for testing.

Age

An older firm's target leverage ratio will be larger, everything else being equal. Established firms have more time and experience to cultivate stronger ties with their credit providers. In addition, the firm's inventory, accounts receivable, and assets can be utilised as security for financing as it expands. A lack of collateral assets can make it much more difficult for younger firms to get external loans, which is already a difficulty due to knowledge asymmetries and possible agency issues stemming from a lack of trading history.(Berger and Udell, 1990; mac an Bhaird and Lucey, 2010; Handoo and Sharma, 2014)

H1. A firm's age is positively associated with its leverage.

Growth Opportunity

Prior research indicates that firms exhibiting more growth tend to possess a relatively lower level of leverage in their capital structure. According to(Baskin, 1989), the 'Trade-off Theory' posits that this variable has a detrimental effect, as more growth correlates with a heightened danger of bankruptcy. This indicates that a favorable effect aligns more closely with the 'Pecking-Order Theory.' Growth prospects are capital assets that significantly enhance a firm's value, although they cannot serve as collateral and do not generate current taxable income. We propose a favourable correlation between debt and growth potential based on this rationale. (Bauer, 2004; Črnigoj & Mramor, 2009; David Vicente-Lorente, 2001; Handoo & Sharma, 2014; Köksal & Orman, 2015; Malinić et al., 2013; Psillaki & Daskalakis, 2009.

H2. Growth opportunities exhibit a positive association with a firm's leverage.

Liquidity

A firm's liquidity can be defined as the speed with which it can turn its assets into cash. Companies that have a lot of cash on hand are better able to take on additional debt since they can pay back their short-term loans quickly. Accordingly, we anticipate a favourable correlation between liquidity and capital structure decisions (Malinić, Denčić-Mihajlov and Ljubenović, 2013; Handoo and Sharma, 2014; Ramli, Latan and Solovida, 2019).

H3. Liquidity is positively correlated with a firm's leverage.

Market-To-Book Ratio

The theory posits that managers strategically 'time the market' to benefit the organisation. Market timing is achievable in efficient markets for companies possessing financial flexibility. To evaluate this behaviour, we employed a market-to-book ratio identical to that utilised by (Baker and Wurgler, 2002) in our study. By dividing the security's book value by its market value, it aims to find undervalued or overvalued assets. To find out if managers try to "time the market" or if the capital structure decision takes advantage of the short-term mispricing behaviour, this proximate is found essential (Li & Islam, 2019).

H4. The market-to-book ratio is negatively related to a firm's leverage.

Non-Debt Tax Shields

A lower debt level is characteristic of a firm's capital structure that maintains an adequate amount of non-debt tax shield. Depreciation is a mechanism that companies can utilise to reduce their tax obligations without acquiring additional debt. The tax advantage of debt financing decreases when the utilisation of non-debt tax shields, such as depreciation, increases. As a result, it is expected that the non-debt tax shield will exhibit an inverse correlation with target leverage (Bauer, 2004; Guha-Khasnobis & Bhaduri, 2002; Köksal & Orman, 2015; Malinić et al., 2013; Titman & Wessels, 1988).

H5. Non-debt tax shields demonstrate a negative relationship with firm leverage.

Profitability

An increase in debt capital serves as a tax shield for a more lucrative firm. Since the cost of external financing is quite high, firms with great profitability and access to internal sources of financing are likely to favour using this source and borrowing significantly less. Less profitable businesses are more likely to take out relatively more external debt since they don't have enough money coming in from other sources. Profitability and the desired level of leverage are thus inversely related (Bauer, 2004; Črnigoj & Mramor, 2009; Guha-Khasnobis & Bhaduri, 2002; Handoo & Sharma, 2014; Köksal & Orman, 2015; Li & Islam, 2019; Malinić et al., 2013; Psillaki & Daskalakis, 2009).

H6. Profitability is inversely associated with a firm's leverage.

Firm Size

A substantial amount of research suggests a possible relationship between 'Firm Size' and leverage ratios. The main point is that larger firms have an easier time attracting long-term financing due to less severe informational asymmetries. A less likelihood of bankruptcy is associated with larger, more diversified firms. Firms with a larger market cap also have lower leverage costs since fixed direct bankruptcy expenses are a smaller percentage of market cap. When firms are larger, they are able to reap greater benefits from their assets and sales, which improves their financial performance by increasing the value of their production. Because of these factors, big companies tend to issue more debt (Bancel & Mittoo, 2004; Bauer, 2004; Guha-Khasnobis & Bhaduri, 2002; Handoo & Sharma, 2014; Köksal & Orman, 2015; Malinić et al., 2013; Psillaki & Daskalakis, 2009; Rajan & Zingales, 1995).

H7. Firm size is positively linked to leverage.

Tangibility

Increased tangible assets usually mean an increased degree of leverage for a firm. The 'Agency Cost Theory' states that a company's capital structure strategy is influenced by its total asset holdings. Firms with considerable fixed tangible assets may be perceived by creditors as having a safety net in the event of financial challenges. This is because, according to 'The Trade-Off Theory,' these assets can be used as collateral. Thus, the increase in the ratio of physical assets to total assets is seen as a positive indicator for the firm by investors (Bauer, 2004; Črnigoj & Mramor, 2009; Handoo & Sharma, 2014; Li & Islam, 2019; Malinić et al., 2013; Rajan & Zingales, 1995).

H8. Asset tangibility shows a positive correlation with a firm's leverage.

Table No. 2. Summary of the hypothesised Relationship of Independent variables with Leverage:

Firm-specific variables: (independent variables)	Relationship with leverage (positive/ negative)
Firm's Age (AGE)	Positive
Growth opportunity (GROWTH)	Positive
Liquidity (LIQ)	Positive
Market-to-Book (MTB)	Negative
Non-debt tax shield (NDTS)	Negative
Profitability (PROF)	Negative
Firm size (SIZE)	Positive
Tangibility (TANG)	Positive

Source: Authors' compilation

Research Methodology and econometric model:

Using panel data regression approaches, we determine the key factors influencing capital structure in several Indian industries. Panel data models function on the assumption that the data under study are linear, exogenous, homoscedastic, non-autocorrelated, have no evidence of multicollinearity, and are not cross-sectionally dependent. Although some of these assumptions are problematic, only if t> 20. Suitable diagnostics are undertaken to ensure model validity.

Generalized Method of Moments (GMM)

To study the significant determinants of a firm's capital structure, we establish a link between firm-specific variables and the firm's capital structure. In the Dynamic Panel data model below, the capital structure represented by Long-Term Leverage is depicted as a function of a group of firm-specific variables.

Dynamic Panel Regression Model:

$$Y_{it} = \alpha Y_{it-1} + \beta X_{it} + \omega_{it} + \varepsilon_{it} \quad (1)$$

Y_{it}= Dependent variable

Y_{it-1}= Lagged dependent variable

α = Autoregressive (persistence) parameter

βX_{it} = Independent Variables and corresponding coefficients

ω_{it} = Unobserved heterogeneity

ε_{it} = Idiosyncratic error term

Regression equations:

$$LTDR_{it} = \alpha LTDR_{it-1} + \beta_1 TANG_{it} + \beta_2 PROF_{it} + \beta_3 GROWTH_{it} + \beta_4 NDTS_{it} + \beta_5 LIQ_{it} + \beta_6 MTB_{it} + \beta_7 SIZE_{it} + \beta_8 AGE_{it} + \varepsilon_{it} \quad (2)$$

Where:

$LTDR_{i,t}$ = The Total Debt Ratio of a firm 'i' at time 't'

$\alpha LTDR_{it-1}$ = The lagged value of LTDR, capturing the persistence

β_1 to β_8 = different independent variables for the leverage of firm i at time t

$\varepsilon_{i,t}$ = Error term

LTRD (Long Term Debt Ratio), TANG (Tangibility), PROF (Profitability), GROWTH (Growth Opportunity), NDTS (Non-Debt Tax Shield), LIQ (Liquidity), MTB (Market to Book Ratio), SIZE (Firm size), AGE (Age of the firm).

To address potential endogeneity issues arising from the inclusion of the lagged dependent variable and other regressors, we estimate the model using the Generalized Method of Moments (GMM) (Difference GMM and System GMM) approach, following the framework proposed by (Arellano and Bond, 1991) and (Blundell and

Bond, 1998). It is a semi-parametric method of estimating the coefficients under panel data methods. This method uses lagged values of the dependent variable and other independent variables as instruments to achieve consistent and efficient parameter estimates. Dynamic panel data models also effectively handle unobserved heterogeneity, Heteroskedasticity, autocorrelation, and possible Endogeneity by including the lagged dependent variable as a regressor and mitigating omitted variable bias. All these, together, make GMM a robust method for analyzing complex panel data structures.

Generalized Method of Moments (GMM) is a complex technique and comes with its inherent set of flaws. 1st is the possible autocorrelation in the errors that is if residuals are serially correlated, the moment conditions may become invalid. This is mitigated by Performing the Arellano-Bond test for autocorrelation (AR(1) and AR(2)). For valid GMM results, the AR(1) test should show significant autocorrelation (p-value < 0.05), while the AR(2) test should show no significant autocorrelation (p-value > 0.05).

The 2nd common problem is the overfitting of instruments, which can lead to misspecification of the model, leading to biased estimates and weak identification. Limit the number of instruments relative to the number of cross-sectional units a good rule of thumb is that the instruments should not be more than 75% of the number of groups in the panel. We can also use the Hansen J test to check the validity of the instruments. A p-value that is too high might indicate overfitting. Instrument validity is established when p-value is above Roodman's common sense minimum threshold of 0.25 but < 1.0 (Roodman, 2009).

Multicollinearity Test Variance Inflation Factor (VIF)

In order to check if the linear regression model was multicollinear, the Variance Inflation Factor (VIF) was used. When the VIF is more than five, it indicates a significant amount of multicollinearity; at this point, the coefficients are considered to be poorly assessed and the p-values are cause for concern (Frost, 2019). A VIF of up to 5 was found to be acceptable by most researchers. The VIF of the variables in the study was less than five, signifying the absence of a multicollinearity issue.

Random Forest Model

The Random Forest analysis was conducted using 'Orange Data Mining' software to predict the 'Long Term Debt Ratio (LTDR),' which was set as the target variable. The models were configured with 500 trees to enhance prediction accuracy and reliability. A maximum of 5 features was considered at each split to balance model performance and computational efficiency. The tree depth was unlimited, allowing the trees to grow fully unless constrained by other stopping criteria, such as a minimum of 5 data instances required to split a node. The dataset used for the analysis consisted of firm-level indicators as independent variables which are defined as features. Additionally, company name and year were included as meta-attributes for identification but were not directly utilized in model predictions. The analysis focused on identifying key determinants influencing firms' capital structure. The model was trained with 70% of the data and was tested on the balance 30% of the data. The model training was replicable to ensure consistency, allowing the results to be reproduced across different runs. This comprehensive approach provided valuable insights into the interaction between firm-level factors and leverage in shaping debt-related decisions. The output was generated from the feature rank widget provided by 'Orange Data Mining,' which showed the most significant variables for prediction.

Empirical findings and discussion of the results

Descriptive statistics

Understanding the summary statistics of the primary variables utilised in the study is vital before evaluating the results of the econometric analysis of the firm-specific determinants of Indian manufacturing firms. This will help us obtain a better grasp of the data under consideration. The descriptive statistics, including the mean, standard deviation, minimum, and maximum, of the study's variables across all sectors are presented in Table V.

Table No. 3. Results of the descriptive analysis

Manufacture of Basic Iron and Steel					
Variable	**Observations**	**Mean**	**Standard Deviation**	**Minimum**	**maximum**
LTDR	550	0.1963	0.1339	0.0143	0.7131
TANG	550	0.3429	0.1420	0.0666	0.7358
PROF	550	0.0951	0.0704	-0.1742	0.4333
GROWTH	550	8.0573	19.2029	-78.7108	273.9483

NDTS	550	0.0293	0.0148	0.0054	0.0928
LIQ	550	0.0352	0.0521	0.0000	0.0521
MTB	550	1.4571	5.3173	0.0629	120.2096
SIZE	550	3.7025	1.7743	-1.9470	8.3985
AGE	550	1.6380	0.1611	1.1761	2.1461
Manufacture of Electrical Equipment					
LTDR	460	0.1272	0.0885	0.0021	0.5634
TANG	460	0.2494	0.1384	0.0242	0.7235
PROF	460	0.1111	0.0832	-0.2029	0.4774
GROWTH	460	10.5350	17.2116	36.4302	137.3380
NDTS	460	0.0241	0.0123	0.0033	0.0769
LIQ	460	0.0775	0.1265	0.0004	0.8034
MTB	460	2.7418	3.2207	0.0848	27.2833
SIZE	460	3.4206	1.6357	1.4663	6.4818
AGE	460	1.6879	0.1625	1.1461	1.9777
Manufacture of Pharmaceuticals					
LTDR	650	0.1700	0.1344	0.0050	0.6473
TANG	650	0.2903	0.1543	0.0119	0.8218
PROF	650	0.1279	0.1259	-0.2935	1.5841
GROWTH	650	13.5727	23.2460	59.7509	273.7241
NDTS	650	0.0251	0.0129	0.0030	0.0899
LIQ	650	0.0725	0.1151	0.0000	0.6890
MTB	650	2.8845	2.8995	0.1668	21.0150
SIZE	650	3.0637	2.0117	7.2989	6.6784
AGE	650	1.6362	0.1542	1.3424	2.0212
Manufacture of Textiles					
LTDR	690	0.2512	0.1415	0.0049	0.6595
TANG	690	0.3963	0.1473	0.0319	0.7005
PROF	690	0.0918	0.0599	-0.1565	0.3864
GROWTH	690	7.6864	19.2899	35.2088	288.9711
NDTS	690	0.0414	0.0248	0.0026	0.1767
LIQ	690	0.0289	0.0625	0.0002	0.5381
MTB	690	1.2708	1.5895	0.0123	21.8942
SIZE	690	3.0715	1.3728	0.2088	5.9620
AGE	690	1.6747	0.1854	1.2304	2.1206
Manufacture of Chemical and Chemical Products					
LTDR	1100	0.1867	0.1187	0.0000	0.8502
TANG	1100	0.3147	0.1582	0.0146	0.8154
PROF	1100	0.1281	0.1007	-0.3875	1.1311
GROWTH	1100	12.0150	29.7926	53.9115	724.7977
NDTS	1100	0.0268	0.0173	0.0012	0.1687
LIQ	1100	0.0498	0.0747	0.0000	0.6001
MTB	1100	2.9043	5.0717	0.1111	61.9549
SIZE	1100	3.5484	1.6161	0.9358	7.7021
AGE	1100	1.6503	0.1732	1.1139	2.1761
Manufacture of Rubber & Plastic Products					
LTDR	590	0.1817	0.1131	0.0002	0.5793
TANG	590	0.3606	0.1458	0.0300	0.7709
PROF	590	0.1094	0.0795	-0.1492	0.5846
GROWTH	590	10.1917	16.1299	28.5149	102.5542
NDTS	590	0.0373	0.0210	0.0048	0.1753
LIQ	590	0.0391	0.0611	0.0000	0.3748
MTB	590	1.8227	2.1517	0.0389	15.1706
SIZE	590	3.2073	1.6801	1.1733	7.3124
AGE	590	1.6044	0.1356	1.0792	1.9395
Manufacture of Transport Equipment					
LTDR	580	0.1701	0.0922	0.0179	0.4240
TANG	580	0.3331	0.1449	0.0413	0.7470

PROF	580	0.1180	0.0950	-0.1461	0.7118
GROWTH	580	11.8983	31.1355	-34.2580	603.5876
NDTS	580	0.0371	0.0191	0.0065	0.1108
LIQ	580	0.0336	0.0476	0.0003	0.3330
MTB	580	2.5816	2.9398	0.1268	29.7992
SIZE	580	3.9392	1.6748	0.2257	8.4987
AGE	580	1.6254	0.1537	1.1139	1.9243
Manufacture of Food Products					
LTDR	400	0.1889	0.1110	0.0062	0.6247
TANG	400	0.3563	0.1486	0.0075	0.7307
PROF	400	0.1040	0.0956	-0.1290	0.8807
GROWTH	400	10.0107	32.8429	-72.6830	568.0572
NDTS	400	0.0262	0.0169	0.0005	0.1296
LIQ	400	0.0432	0.0766	0.0001	0.6025
MTB	400	2.8158	4.3216	0.0157	28.5028
SIZE	400	3.6459	1.3943	0.6228	6.4075
AGE	400	1.7359	0.2178	1.3424	2.1106
Manufacture of Machinery and Equipment					
LTDR	360	0.1530	0.1103	0.0112	0.4536
TANG	360	0.2313	0.1262	0.0160	0.5855
PROF	360	0.1128	0.1024	-0.1366	1.4236
GROWTH	360	8.6007	18.5553	35.7109	203.6336
NDTS	360	0.0280	0.0182	0.0018	0.0979
LIQ	360	0.0780	0.0974	0.0000	0.5162
MTB	360	2.9972	2.2528	0.1430	13.6536
SIZE	360	4.0206	1.3259	0.3702	7.0263
AGE	360	1.7234	0.1736	1.0414	2.0828
Manufacture of Other Non-Metallic Mineral Products					
LTDR	390	0.2363012	0.1433979	0.006097	0.608808
TANG	390	0.4341943	0.1469248	0.012077	0.721445
PROF	390	0.1120319	0.1505308	-0.262069	2.138113
GROWTH	390	11.36031	35.73692	-52.20233	623.0554
NDTS	390	0.0370375	0.0189088	0.000882	0.148233
LIQ	390	0.0448396	0.0566421	0.000034	0.384216
MTB	390	2.326775	2.177238	0.157421	15.09061
SIZE	390	4.08243	1.824755	-3.952881	7.731651
AGE	390	1.691534	0.1663858	1.30103	2.04139

Source: Authors' computation

Regression Results of the generalized method of moments (GMM)

The table below contains the coefficient estimates of the independent variables across all sectors and their significance level. The Wald Chi2 test statistic, AR (2) Statistic and Hansen Test statistic are listed at the bottom of each column, along with the Mean VIF of each panel of the regression.

Table No. 4. Results of the generalized method of moments (GMM)

	Manufacture of Basic Iron and Steel	**Manufacture of Electrical Equipment**	**Manufacture of Pharmaceuticals**	**Manufacture of Textiles**	**Manufacture of Chemical and Chemical Products**
L.LTDR	0.7782106***	0.7978045***	0.7369416***	0.875096***	0.7683061***
TANG	0.1245242**	-0.2181531**	0.012627	-0.0081942	-0.0644849
PROF	-0.1240214	-0.242091***	-0.0800879**	-0.2379652***	-0.1136337***
GROWTH	0.0005857***	0.0015369***	0.0009462***	0.0010849***	0.0006218***
NDTS	-1.131675***	-0.1073607	0.2595537	-0.2226632	-0.1564422
LIQ	0.168744**	-0.1339569**	-0.1837533***	-0.1231336	-0.1717328**

MTB	-0.0008986***	0.0049194**	-0.0023378	-0.0035707***	-0.001062
SIZE	-0.0017522	-0.0103915	-0.0203846**	-0.0399598**	-0.0235191
AGE	0.1198553	0.0189564	-0.0443226	-0.3133459	-0.0239399
Constant	-0.1563899	0.0921452	0.183609		0.2051892
Wald chi2	6096.40	836.27	313.78	233.00	1131.49
No of groups	55	46	65	69	110
No of Instruments	33	21	29	10	33
AR(2) statistic (p-value)	-0.42(0.672)	-1.20(0.229)	-0.81(0.417)	-1.06(0.291)	-0.58(0.563)
Hansen test statistic (p-value)	24.58(0.372)	9.68(0.559)	18.78(0.471)	0.36(0.548)	17.89(0.763)
Mean VIF	1.26	1.42	1.40	1.23	1.42
Note: The figures in the enclosed parentheses are the significance of the z-statistics, where *** p < 0.01 and ** p < 0.05; p-values reported for AR(2) statistic and Hansen test statistic are at a significance level of 5%.					

Source: Authors' computation

	Manufacture of Rubber & Plastic Products	**Manufacture of Transport Equipment**	**Manufacture of Food Products**	**Manufacture of Machinery and Equipment**	**Manufacture of Other Non-Metallic Mineral Products**
L.LTDR	0.6689276***	0.8338826***	0.7782278***	0.5783905***	0.9602055***
TANG	0.0120244	-0.1219728	-0.095658	-0.2015019	-0.1091255
PROF	-0.2513942***	-0.260856**	-0.1663262***	-0.3587405***	-0.2592073***
GROWTH	0.0013582***	-0.0001233	0.0005294***	0.0012034***	0.0017039***
NDTS	-0.2352474	-0.8705731**	0.4351999	-0.1135256	0.2221617
LIQ	-0.1993223**	0.010236	0.0024819	-0.1793954***	-0.0769708
MTB	0.0017437	0.0021397	-0.0026951	0.016691**	0.0014595
SIZE	0.0393402**	0.0042922	-0.0120756	0.0116166	0.0090759
AGE	0.0674537	-0.0201828	-0.2618488***	-0.2999001	0.1315299
Constant		0.1375874	0.568932	0.5669442	-0.2012855
Wald chi2	71.79	2649.49	1192.11	358.32	3561.58
No of groups	59	58	40	36	39
No of Instruments	13	24	29	24	16
AR(2) statistic (p-value)	-0.78(0.438)	0.74(0.459)	-0.25(0.801)	-0.46(0.648)	0.80(0.424)
Hansen test statistic (p-value)	4.94(0.294)	12.03(0.604)	16.86(0.600)	10.80(0.702)	7.49(0.278)
Mean VIF	1.36	1.36	1.37	1.33	1.50
Note: The figures in the enclosed parentheses are the significance of the z-statistics, where *** p < 0.01 and ** p < 0.05; p-values reported for AR(2) statistic and Hansen test statistic are at a significance level of 5%.					

Source: Authors' computation

Table No. 5. Summary of the results

Industrial Sectors	**Long Term Debt**
Manufacture of Basic Iron and Steel	(+) TANG, (+) GROWTH, (-) NDTS, (+) LIQ, (-) MTB
Manufacture of Electrical Equipment	(-) TANG, (-) PROF, (+) GROWTH, (-) LIQ, (+) MTB
Manufacture of Pharmaceuticals	(-) PROF, (+) GROWTH, (-) LIQ, (-) SIZE
Manufacture of Textiles	(-) PROF, (+) GROWTH, (-) MTB, (-) SIZE
Manufacture of Chemical and Chemical Products	(-) PROF, (+) GROWTH, (-) LIQ
Manufacture of Rubber & Plastic Products	(-) PROF, (+) GROWTH, (-) LIQ, (+) SIZE
Manufacture of Transport Equipment	(-) PROF, (-) NDTS
Manufacture of Food Products	(-) PROF, (+) GROWTH, (-) AGE
Manufacture of Machinery and Equipment	(-) PROF, (+) GROWTH, (-) LIQ, (+) MTB
Manufacture of Other Non-Metallic Mineral Products	(-) PROF, (+) GROWTH

Source: Authors' compilation

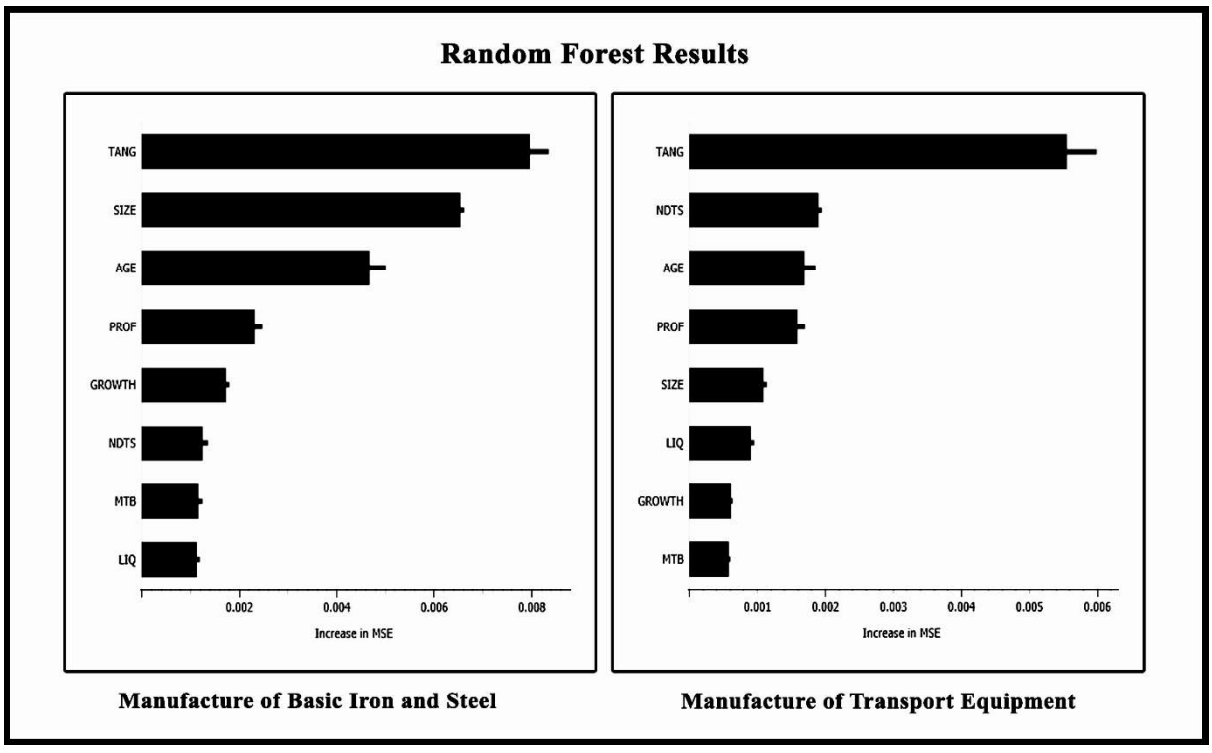
Table No. 6. Sector-wise results of hypotheses testing across Indian manufacturing firms

Hypotheses	Manufacture of Basic Iron and Steel	Manufacture of Electrical Equipment	Manufacture of Pharmaceuticals	Manufacture of Textiles	Manufacture of Chemical and Chemical Products	Manufacture of Rubber & Plastic Products	Manufacture of Transport Equipment	Manufacture of Food Products	Manufacture of Machinery and Equipment	Manufacture of Other Non-Metallic Mineral Products
H1. There is a Positive relationship between age and leverage of the firms.	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected
H2. A positive relationship exists between growth opportunities and firm leverage.	Accepted	Accepted	Accepted	Accepted	Accepted	Accepted	Rejected	Accepted	Accepted	Accepted
H3. There is a positive relationship between liquidity and leverage of the firm.	Accepted	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected
H4. There is a Negative relationship between market-to-book ratio and firm leverage	Accepted	Rejected	Rejected	Accepted	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected
H5. There is a Negative relationship between non-debt tax shield and firm leverage.	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Accepted	Rejected	Rejected	Rejected
H6. There is a Negative relationship between profitability and leverage of the firm.	Rejected	Accepted	Accepted	Accepted	Accepted	Accepted	Accepted	Accepted	Accepted	Accepted
H7. A positive relationship exists between firm size and leverage.	Rejected	Rejected	Rejected	Rejected	Rejected	Accepted	Rejected	Rejected	Rejected	Rejected
H8. A positive relationship exists between asset tangibility and leverage.	Accepted	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected

Results of the Random Forest Model

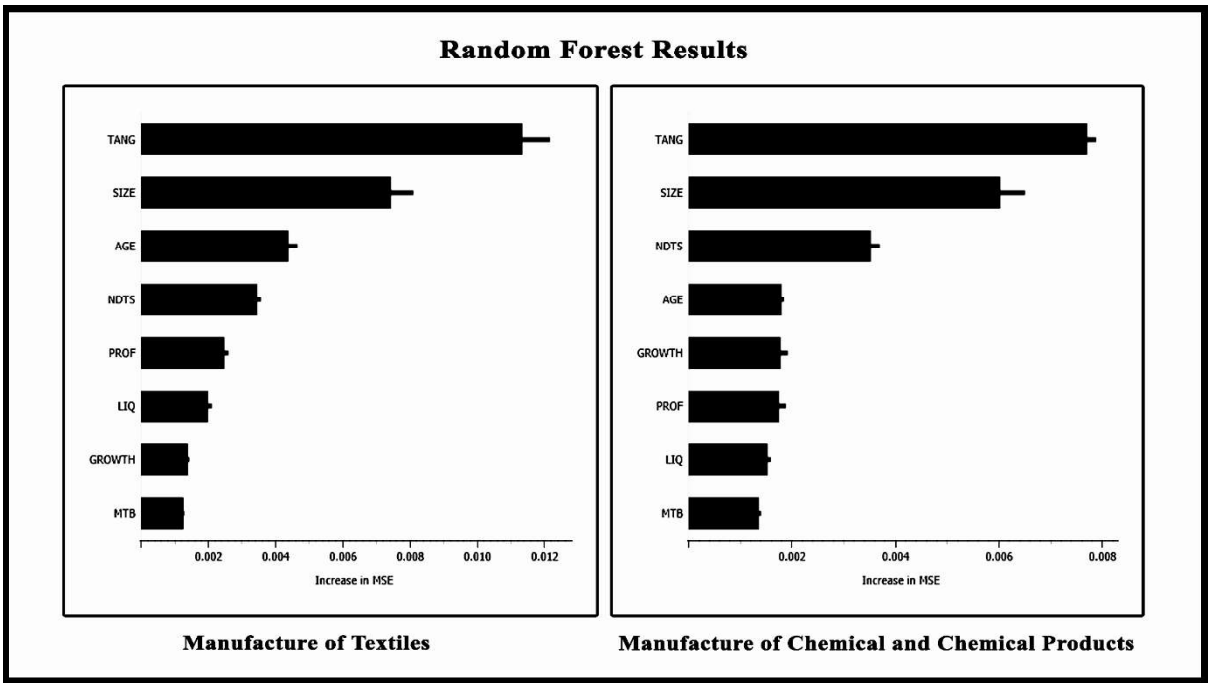
Below are the feature importance graphs generated as the output of the Random Forest Model, which shows which are the most important predictors for each of the sectors.

Figure No 1: Feature Importance Graph of Random Forest Model



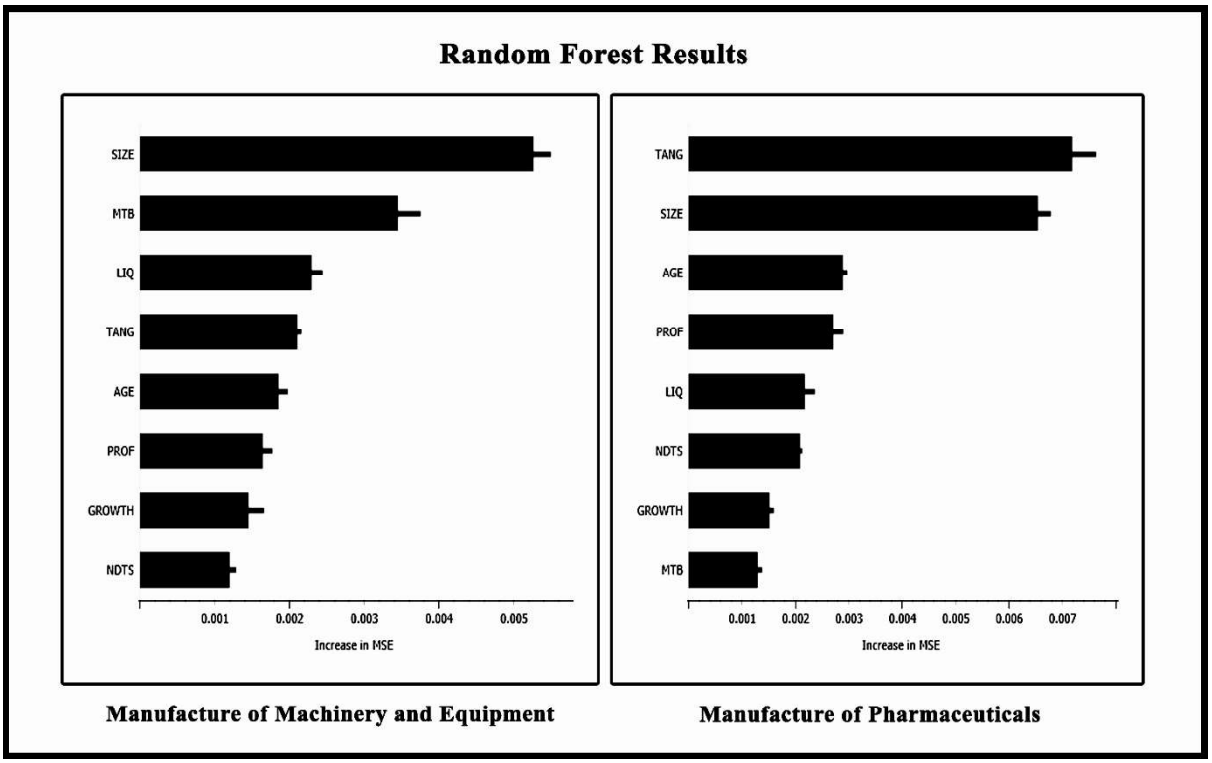
Source: Authors' computation

Figure No 2: Feature Importance Graph of Random Forest Model



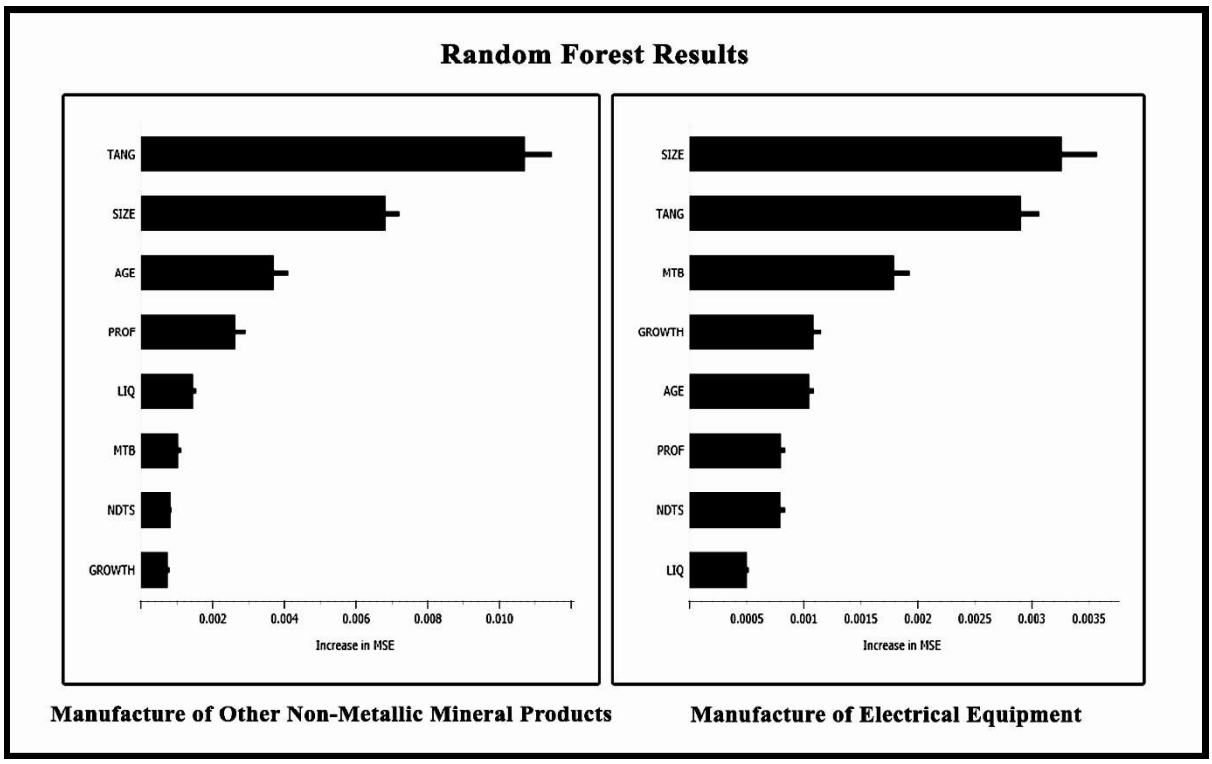
Source: Authors' computation

Figure No 3: Feature Importance Graph of Random Forest Model



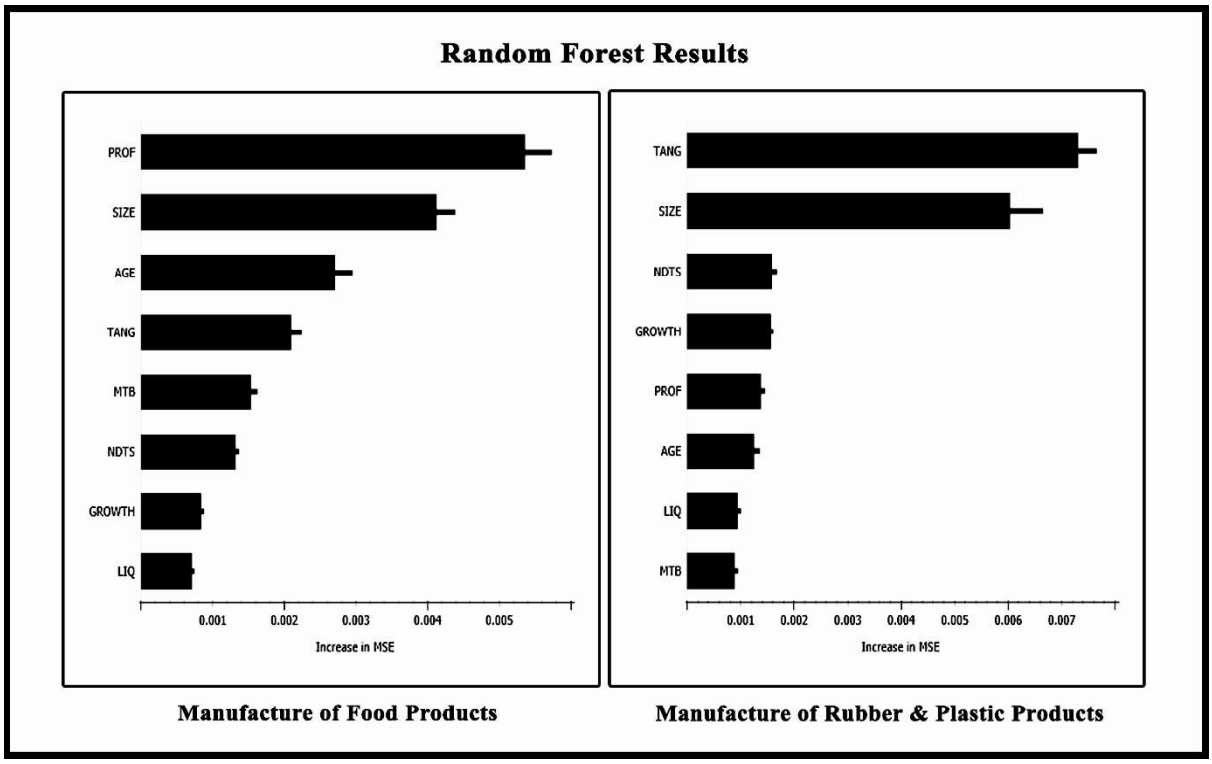
Source: Authors' computation

Figure No 4: Feature Importance Graph of Random Forest Model



Source: Authors' computation

Figure No 5: Feature Importance Graph of Random Forest Model



Source: Authors' computation

Results and Interpretation

Table No. 4 presents the dynamic panel data regression model results, Table No. 5 presents the summary of the regression results, and Figure No. 1 to Figure No. 5 presents the feature importance output of the Random Forest Model. We find that each sector has a unique set of factors that determine its leverage. Through our analysis, the

most significant leverage determinants were Growth, Profitability, Liquidity and Market-to-Book Ratio as per the regression analysis and Tangibility and Firm Size as per the Machine Learning Model. These findings are found to be in line with the international literature on the subject (Rajan and Zingales, 1995; Pandey, 2001) and as well as Indian literature (Bhaduri, 2002; Mukherjee and Mahakud, 2010; Handoo and Sharma, 2014; Ghose and Kabra, 2016). The variables found to be the least significant from the regression analysis results were Tangibility, Non- Debt Tax Shield, Size, and Age of the firm.

Our analysis found that the leverage of firms in the 'pharmaceuticals' and 'textiles' sectors declines as the size of the firm increases. A plausible reason is that larger firms exhibit greater diversification, possess a significantly reduced likelihood of encountering financial difficulties, and hence, likely to engage in higher borrowing (Li and Islam, 2019). Lower anticipated bankruptcy costs enable firms to employ more leverage(Rajan and Zingales, 1995). Leverage has a negative correlation with profitability. We found that profitability was a major factor in nearly every industry. If investments and dividends remain constant in the near future and debt financing remains the main source of outside capital, then shifts in leverage will be bound to have a negative impact on profitability. It appears that larger firms often do not issue as much equity. As a firm grows larger, the negative impact of profitability on leverage becomes more evident (Rajan and Zingales, 1995). Consistent with the Pecking Order hypothesis, which states that enterprises often favour internally generated funds over external funds to satisfy their financing needs, the coefficient of profitability is highly significant and has a negative sign (Frank *et al.*, 2003; Flannery and Rangan, 2006; Dang, Kim and Shin, 2012; Ganguli, 2013; Handoo and Sharma, 2014; Ghose and Kabra, 2016). According to the pecking order theory, this result supports the idea that capital is typically used in a way that keeps outside interference to a minimum in the operation of the business.

Capital structure theory predicts a negative correlation since high market-to-book ratios are associated with higher financial distress costs for enterprises. Companies issue equity when its price is high compared to its earnings or book value, which is another reason why the market-to-book ratio is negatively connected with leverage. The connection between leverage and the market-to-book ratio is driven by companies with a high equity ratio (Rajan and Zingales, 1995). However, the market-to-book ratios of firms, identified as significant in the electrical equipment and machinery & equipment sectors, where it positively influenced the firm's leverage, thereby contradicting the prevailing theory that asserts that the market-to-book ratio as a proxy for Market Timing, which is anticipated to have a negative correlation with leverage (Li and Islam, 2019). (Ghose and Kabra, 2016) reported an insignificant relationship between market-to-book ratio and leverage for Indian firms, which was also affirmed by our study.

While there is strong theoretical support for a non-debt tax shield as a crucial factor in determining leverage, additional empirical evidence is required to support this claim. Consistent with research conducted in the Indian context, the Non-debt tax shield was determined to be minimal in the majority of sectors with an exception of two sectors (Bhaduri, 2002), and (Titman and Wessels, 1988) who in their study also found the non-debt tax shield to be insignificant in determining the leverage of the firm. If the growth coefficient is positive, it means that companies are benefiting from increased prospects for expansion, which in turn increases their ability to take on debt (Titman and Wessels, 1988)**.** This is also consistent with the argument (Bhaduri, 2002; Chakraborty, 2010) that In situations where information costs are more closely tied to equity difficulties, expanding businesses often turn to debt financing to fulfil their financing need.

From the capital structure theory perspective, our results are in tandem with the Pecking Order Theory; which asserts that high-growth enterprises must enhance their long-term operating assets, and our results support it. Since internal sources of funding rarely match their needs, corporations borrow significantly. Our data confirms our hypothesis that growth possibilities increase leverage across all industries. Our results are also confirmed by other empirical research findings (Titman and Wessels, 1988; Bauer, 2004; Hall, Hutchinson and Michaelas, 2004)**.** Growth opportunities were not significant in the transport equipment manufacturing sector. This could be due to relatively high R&D costs, long product cycles, and uncertain cash flows; this sector depends largely on equity financing and retained earnings.

Surprisingly, the age of the firm was determined to be a significant determinant in only the "Manufacture of Food Products" sector, despite its significance in numerous international research. The study indicated that the longer a company has been in business, the more leverage it has and the lower the correlation it has with the amount of debt it has (Kieschnick and Moussawi, 2018). Despite being statistically insignificant across most industries, aging was determined to have an adverse impact on leverage. This is due to the fact that when businesses expand, they become well-established and are able to retain enough of their profits to fund themselves internally instead of seeking out debt.

Due to the general consensus that more liquid companies can better take on debt, most theoretical analyses of the link between the two variables find a positive correlation between them (Morellec, 2001). However, the

Pecking order theory posits that debt is bad for a company's finances and that liquid assets, such as cash on hand, could be a better option for internal financing. (Lipson and Mortal, 2009) confirmed this relationship between liquidity and leverage, showing that firms with more liquidity tend to be less leveraged. This is also true for the majority of manufacturing firms in India, and our research shows that liquidity significantly reduces leverage across many different industries.

When a firm's profits are inadequate and current cash flows fail to meet capital investments, service debt, and fulfil operating responsibilities, in the absence of alternative financing sources, firms resort to bank loans. Which is evidenced by (Chakraborty, 2010), (Malinić et al., 2013), which could also account for the statistically significant negative correlation between liquidity and financial leverage. Also, according to the Pecking Order Theory and Agency Theory, companies that are highly liquid may be less interested in seeking funding from third parties and more likely to rely on internal sources of funds (Ramli, Latan and Solovida, 2019).

The feature selection results of the Random Forest model highlight the most influential predictors in the model. Of the 10 manufacturing sectors studied, Tangibility (TANG) and Firm Size (SIZE) were the most important predictors. Tangibility was found to be particularly dominant amongst the capital-intensive sectors such as Basic Iron and Steel, Transport Equipment, textiles, and Non-Metallic Minerals, emphasizing the important role physical assets play in the financial decision of a firm. Firm Size (SIZE) was also a significant predictor in sectors such as Machinery and Equipment, Pharmaceuticals, and Electrical Equipment, reflecting the firm's economies of scale and financial stability. The variable Profitability (PROF) significantly impacted consumer-oriented sectors such as Food Products and Rubber and Plastic Products. At the same time, the Age of the firm was found to play a role in Pharmaceuticals, Iron and Steel, and Food Products, highlighting the firm's maturity and influence on its financial structure. Non-Debt Tax Shields (NDTS) were found relevant in sectors such as Chemical Products and Textiles, showcasing the significance of tax benefits. Market-to-book ratio (MTB) and Liquidity (LIQ) contribute particularly to the Machinery and Equipment and Electrical Equipment for investment signaling and working capital management. Overall, the results indicate that Tangibility (TANG) and Firm Size (SIZE) are the most universally significant predictors. In contrast, the others vary across sectors, emphasizing the need for financial strategies tailor-made to each industrial sector.

Conclusion

This research aimed to use panel data and Machine Learning methods to examine the factors that influence the capital structure of Indian manufacturing firms. This study's results provide important insight into manufacturing firms' financing operations, helping researchers to understand better the factors that impact a firm's debt and equity capital offerings and whether or not capital structure differs across different industrial sectors.

This study distinguishes itself from prior research by incorporating several crucial variables some of which have not been thoroughly examined in the context of Indian manufacturing firms. This study identified 'Growth Opportunity,' 'Profitability,' 'Liquidity,' and 'Market-to-Book Ratio (MTB)' as the primary leverage determinants across various sectors via 'Generalised Method of Moments (GMM)' analysis, while 'Firm's Size' and 'Tangibility' emerged as the most significant features according to 'Random Forest Model' analysis. This was determined to be consistent with current international and Indian literature.

The existing literature on capital structure is aligned with our study's findings. None of the three dominant theories of capital structure—"The Pecking Order Theory," "The Static Trade-Off Theory," and "The Agency Cost Theory"—can adequately describe the financial arrangements of Indian manufacturing companies. The 'Static Trade-Off Theory' and 'The Pecking Order Theory,' when taken together, provide the most satisfactory explanation for the capital structure of Indian enterprises. Instead of looking outside the company for funding, most Indian companies opt for raising funds from internal sources (Chakraborty, 2010; Chadha and Sharma, 2015). However, little evidence is available to support 'Agency Cost Theory'(Chakraborty, 2010). Studies have also (Rani, Yadav and Tripathy, 2020) provided sufficient empirical evidence to support 'Trade-Off Theory,' 'Agency Theory,' and 'The Pecking Order Theory' of capital structure in the Indian corporate sector. Our study also provides evidence to support the above narrative that no theory can explain the capital structure of Indian firms.

References

Arellano, M. and Bond, S. (1991) 'Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations', The Review of Economic Studies, 58(2), **p. 277. Available at: https://doi.org/10.2307/2297968.**

Baker, M. and Wurgler, J. (2002) 'Market Timing and Capital Structure', The Journal of Finance, 57(1), **pp. 1–32.**

Bancel, F. and Mittoo, U. (2004) 'Cross-Country Determinants of Capital Structure Choice: A Survey of European Firms', Financial Management, 33(4), **pp. 103–132.**

Bandyopadhyay, A. and Barua, N.M. (2016) 'Factors determining capital structure and corporate performance in India: Studying the business cycle effects', Quarterly Review of Economics and Finance, 61**, pp. 160–172. Available at: https://doi.org/10.1016/j.qref.2016.01.004.**

Barclay, M.J., Smith, C.W. and Watts, R.L. (1995) 'The Determinants of Corporate Leverage and Dividend Policies', Journal of Applied Corporate Finance, 7(4), **pp. 4–19.**

Baskin, J. (1989) 'An Empirical Investigation of the Pecking Order Hypothesis', Financial Management, 18(1), **pp. 26–35. Available at: https://www.jstor.org/stable/3665695.**

Bauer, P. (2004) 'Determinants of Capital Structure Empirical Evidence from the Czech Republic', Finance a úvûr-Czech Journal of Economics and Finance, 54, **pp. 1–2.**

Berger, A.N. and Udell, G.F. (1990) 'Collateral, Loan Quality, And Bank Risk', Journal of Monetary Economics, 25, **pp. 21–42.**

Bhaduri, S.N. (2002) 'Determinants of capital structure choice: A study of the Indian corporate sector', Applied Financial Economics, 12(9), **pp. 655–665. Available at: https://doi.org/10.1080/09603100010017705.**

Blundell, R. and Bond, S. (1998) 'Initial conditions and moment restrictions in dynamic panel data models', Journal of Econometrics, 87(1), **pp. 115–143. Available at: https://doi.org/10.1016/S0304-4076(98)00009-8.**

Chadha, S. and Sharma, A.K. (2015) 'Determinants of capital structure: an empirical evaluation from India', Journal of Advances in Management Research, 12(1), **pp. 3–14. Available at: https://doi.org/10.1108/JAMR-08-2014-0051.**

Chakraborty, I. (2010) 'Capital structure in an emerging stock market: The case of India', Research in International Business and Finance, 24(3), **pp. 295–314. Available at: https://doi.org/10.1016/j.ribaf.2010.02.001.**

Črnigoj, M. and Mramor, D. (2009) 'Determinants of capital structure in emerging European economies: Evidence from Slovenian firms', Emerging Markets Finance and Trade, 45(1), **pp. 72–89. Available at: https://doi.org/10.2753/REE1540-496X450105.**

Dang, V.A., Kim, M. and Shin, Y. (2012) 'Asymmetric capital structure adjustments: New evidence from dynamic panel threshold models', Journal of Empirical Finance, 19(4), **pp. 465–482. Available at: https://doi.org/10.1016/j.jempfin.2012.04.004.**

David Vicente-Lorente, J. (2001) 'Specificity and Opacity as Resource-Based Determinants of Capital Structure: Evidence for Spanish Manufacturing firms', Management Journal, 22(2), **pp. 157–177**.

Flannery, M.J. and Rangan, K.P. (2006) 'Partial adjustment toward target capital structures', Journal of Financial Economics, 79(3), **pp. 469–506. Available at: https://doi.org/10.1016/j.jfineco.2005.03.004.**

Frank, M.Z. et al. (2003) 'Testing the pecking order theory of capital structure', Journal of Financial Economics, 67, **pp. 217–248.**

Frost, J. (2019) Regression Analysis: An Intuitive Guide for Using and Interpreting Linear Models. 1st edn. Statistics By Jim Publishing.

Ganguli, S.K. (2013) 'Capital structure - does ownership structure matter? Theory and Indian evidence', Studies in Economics and Finance, 30(1), **pp. 56–72. Available at: https://doi.org/10.1108/10867371311300982.**

Ghose, B. and Kabra, K.C. (2016) 'What determines firms' zero-leverage policy in India?', Managerial Finance, 42(12), **pp. 1138–1158. Available at: https://doi.org/10.1108/MF-01-2016-0029.**

Graham, J.R. and Harvey, C.R. (2001) 'The theory and practice of corporate finance: evidence from the field', Journal of Financial Economics, 60, **pp. 187–243. Available at: http://www.duke.edu/&charvey/Research/indexr.htm.**

Guha-Khasnobis, B. and Bhaduri, S.N. (2002) 'A Dynamic Panel Data Approach', Source: Journal of Economic Integration, 17(4), **pp. 761–776.**

Hall, G.C., Hutchinson, P.J. and Michaelas, N. (2004) 'Determinants of the capital structures of European SMEs', Journal of Business Finance and Accounting, 31(5–6), **pp. 711–728. Available at: https://doi.org/10.1111/j.0306-686X.2004.00554.x.**

Handoo, A. and Sharma, K. (2014) 'A study on determinants of capital structure in India', IIMB Management Review, 26(3), **pp. 170–182. Available at: https://doi.org/10.1016/j.iimb.2014.07.009.**

Harris, M. and Raviv, A. (1991) 'The Theory of Capital Structure', The Journal of Finance, 46(1), **pp. 297–355.**

Jensen, M.C. and Meckling, W.H. (1976) 'Theory of the firm: Managerial Behavior, Agency Costs and Ownership Structure', Journal of Financial Economics, 3, **pp. 305–360.**

Kieschnick, R. and Moussawi, R. (2018) 'Firm age, corporate governance, and capital structure choices', Journal of Corporate Finance, 48, **pp. 597–614. Available at: https://doi.org/10.1016/j.jcorpfin.2017.12.011.**

Köksal, B. and Orman, C. (2015) 'Determinants of capital structure: evidence from a major developing economy', Small Business Economics, 44(2), **pp. 255–282. Available at: https://doi.org/10.1007/s11187-014-9597-x.**

Kraus, A. and Litzenberger, R.H. (1973) 'A State-Preference Model of Optimal Financial Leverage', The Journal of Finance, 28(4), **pp. 911–922. Available at: https://doi.org/10.1111/j.1540-6261.1973.tb01415.x.**

Li, L. and Islam, S.Z. (2019) 'Firm and industry specific determinants of capital structure: Evidence from the Australian market', International Review of Economics and Finance, 59, **pp. 425–437. Available at: https://doi.org/10.1016/j.iref.2018.10.007.**

Lipson, M.L. and Mortal, S. (2009) 'Liquidity and capital structure', Journal of Financial Markets, 12(4), **pp. 611–644. Available at: https://doi.org/10.1016/j.finmar.2009.04.002.**

Mac an Bhaird, C. and Lucey, B. (2010) 'Determinants of capital structure in Irish SMEs', Small Business Economics, 35(3), **pp. 357–375. Available at: https://about.jstor.org/terms.**

Malinić, D., Denčić-Mihajlov, K. and Ljubenović, E. (2013) 'The Determinants of Capital Structure in Emerging Capital Markets: Evidence from Serbia', European Research Studies, XVI(2), **pp. 98–119.**

Modigliani, F. and Miller, M.H. (1958) 'The Cost of Capital, Corporation Finance and the Theory of Investment', The American Economic Review, 48(3), **pp. 261–297.**

Modigliani, F. and Miller, M.H. (1963) 'Corporate Income Taxes and the Cost of Capital: A Correction', The American Economic Review, 53(3), **pp. 433–443. Available at: http://www.jstor.orgURL:http://www.jstor.org/stable/1809167**.

Morellec, E. (2001) 'Asset liquidity, capital structure, and secured debt', Journal of Financial Economics, 61(2), **pp. 173–206. Available at: https://doi.org/10.1016/S0304-405X(01)00059-9.**

Mukherjee, S. and Mahakud, J. (2010) 'Dynamic adjustment towards target capital structure: evidence from Indian companies', Journal of Advances in Management Research, 7(2), **pp. 250–266. Available at: https://doi.org/10.1108/09727981011085020.**

Myers, S.C. and Majluf, N.S. (1984) 'Corporate financing and investment decisions when firms have information that investors do not have', Journal of Financial Economics, 13(2), **pp. 187–221. Available at: https://doi.org/10.1016/0304-405X(84)90023-0.**

Pal, S. (2014) 'A study on capital structure determinants of Indian steel companies', International Journal of Business Management and Research, 4(4), **pp. 89–98. Available at: www.tjprc.org.**

Panda, A.K. and Nanda, S. (2020) 'Determinants of capital structure; a sector-level analysis for Indian manufacturing firms', International Journal of Productivity and Performance Management, 69(5), **pp. 1033–1060. Available at: https://doi.org/10.1108/IJPPM-12-2018-0451.**

Pandey, I.M. (2001) 'Capital Structure and The Firm Characteristics: Evidence From An Emerging Market'.

Pandey, I.M. (2002) 'Capital Structure and Market Power Interaction: Evidence from Malaysia', SSRN Electronic Journal [Preprint]. Available at: http://dx.doi.org/10.2139/ssrn.322700 (Accessed: 20 May 2023).

Psillaki, M. and Daskalakis, N. (2009) 'Are the Determinants of Capital Structure Country or Firm Specific?', Small Business Economics, 33(3), **pp. 319–333. Available at: https://doi.org/10.1007/sl.**

Rajan, R.G. and Zingales, L. (1995) 'What Do We Know about Capital Structure? Some Evidence from International Data', The Journal of Finance, 50(5), **pp. 1421–1460. Available at: https://doi.org/10.1111/j.1540-6261.1995.tb05184.x.**

Ramli, N.A., Latan, H. and Solovida, G.T. (2019) 'Determinants of capital structure and firm financial performance—A PLS-SEM approach: Evidence from Malaysia and Indonesia', Quarterly Review of Economics and Finance, 71, **pp. 148–160. Available at: https://doi.org/10.1016/j.qref.2018.07.001.**

Rani, N., Yadav, S.S. and Tripathy, N. (2020) 'Capital structure dynamics of Indian corporates', Journal of Advances in Management Research, 17(2), **pp. 212–225. Available at: https://doi.org/10.1108/JAMR-12-2017-0125.**

Roodman, D. (2009) 'How to do Xtabond2: An Introduction to Difference and System GMM in Stata', The Stata Journal: Promoting communications on statistics and Stata, 9(1), **pp. 86–136. Available at: https://doi.org/10.1177/1536867X0900900106.**

Serghiescu, L. and Văidean, V.-L. (2014) 'Determinant Factors of the Capital Structure of a Firm- an Empirical Analysis', Procedia Economics and Finance, 15, **pp. 1447–1457. Available at: https://doi.org/10.1016/s2212-5671(14)00610-8.**

Taub, A.J. (1975) 'Determinants of the Firm's Capital Structure', The Review of Economics and Statistics, 57(4), **pp. 410–416.**

Titman, S. and Wessels, R. (1988) 'The Determinants of Capital Structure Choice', The Journal of Finance, 43(1), **pp. 1–19.**

Digital Transformation in Road Toll Systems: Analyzing User Perceptions of NETC Fastag in Kerala

Sukritha K R
Research Scholar
Department of Commerce, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore,
Tamil Nadu, India

Dr. V. Vimala
Assistant Professor
Department of Commerce, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore,
Tamil Nadu, India

Abstract

According to the Global Innovation Index (2020), India ranks 48th globally in innovation and is among the top 15 countries for information and communication technology (ICT) and R&D-intensive global firms. This dynamic technological environment has enabled India to rapidly move ahead in its digital evolution, with one of the largest and fastest-growing digital consumer populations around the world. The present study looks at the technological developments within the toll collection system of India, which have seen great change from traditional manual techniques to automated and electronic systems. The Radio Frequency Identification (RFID) technology-based electronic toll collection systems, such as FASTag, have recently been launched by the National Payments Corporation of India (NPCI) in collaboration with financial institutions to address the limitations inherent in traditional modes of collecting tolls. The study provides a comprehensive overview of the toll system in India, highlighting the transition to more sophisticated technologies aimed at enhancing efficiency and user satisfaction. Data was collected from 400 users of FASTag within the Palakkad district of Kerala, enabling a detailed analysis of user perceptions regarding this contemporary tolling method. With the help of factor analysis, the study identified four key factors that affect the perception of users about National Electronic Toll Collection (NETC) FASTag. The results indicate that the efficiency, time-saving attributes, and overall convenience related to the usage of FASTag greatly improve user satisfaction. Nonetheless, the study also identifies areas that need improvement, primarily concerning technical issues experienced by users. Additionally, service accessibility plays a crucial role in shaping user perceptions, encompassing aspects such as recharging options, customer support, and the cost-effectiveness of using FASTag. Although these factors are significant, it seems that their impact on the perception of users is low as compared to the core benefits of efficiency and convenience. Therefore, these results indicate that there is a need for continuous improvement in the FASTag system so that there is smooth and user-centric tolling experience. As India advances towards adopting more digital technologies, it must work around all these barriers to facilitate further adoption across the country.

Keywords: *Toll Collection, NETC FASTag, RFID Technology, Digital, User Perceptions*
JEL Code: *L91, O32, O33, R41, R42*

Introduction

Today, technological advancements are indispensable for societal growth and adaptation. As "Necessity is the mother of invention", every technology has been built in order to meet societal demands, and as a result, it is inextricably related to the culture and behaviour of the people who inhabit the civilization. India is making notable strides in the realm of technology, positioning itself as a key player in global technological development. Despite uneven business adoption, India currently has one of the biggest and rapidly expanding digitized consumer marketplaces. An advanced knowledge economy requires a digitally empowered society. India's story of digital transformation is one of empowerment and inclusion, built on technology that is accessible, inclusive, and continuously evolving. Technology to transform a connected nation: Digital India, a report from the McKinsey Global Institute, emphasises the nation's hasty adoption of electronic technologies and their potential economic worth by 2025. If the public and commercial sectors collaborate to establish new digital ecosystems, these technologies could significantly impact the Indian economy. As part of India's Digital Transformation, the government also promotes the adoption of new technologies or upgrades while offering high-speed broadband connectivity to every nook and cranny of the nation.

The abundance of opportunities that have emerged in the world of payments over the past few years has been mostly driven by technology and digitization. The digital revolution has reshaped media, retail, and transportation industries. A new technology has been implemented in India's toll collection system with support from banks. It has been made mandatory for passengers to use that technology to cross the toll booths. A toll,

also called a toll tax, is a levy motorists must pay while navigating certain tunnels, bridges, and national and state roads. The National Highway Authority of India (NHAI) is in charge of maintaining these toll roads. By virtue of their presence, they create obstructions to the efficient flow of traffic; this inherent ineffectiveness must be reduced (Chakroborty, Gill & Chakraborty, 2016). The presence of mixed traffic conditions in a single toll lane at toll plazas, coupled with the use of manual toll collection (MTC), results in significant congestion and subsequent delays at these locations (Bari et al., 2021). Traffic congestion rises in most regions as travel demand outperforms infrastructural and managerial advancements (Gupta & Kalmanje 2006). The transportation sector generates around one-seventh of global pollution, necessitating reduction efforts (Aktar et al., 2021). To save costs and wait times, electronic toll collection technology is widely used to collect tolls; it automatically connects to toll payers' bank accounts to charge cars by debiting those accounts. The Electronic Toll Collection (ETC) system is now widely adopted across the globe. Countries such as Canada, Poland, Japan, Italy, and Singapore are among the many that have implemented ETC systems, streamlining toll collection processes and improving efficiency in transportation networks (Joshi et al., 2017).

Toll System in India

Toll Tax

The Indian Government levies taxes on every highway in India, whether state or national, to raise money for maintenance. Toll tax is collected to recoup the whole capital outlay, which covers the cost of construction, maintenance, repairs, toll operation charges, and interest on the outlay. Most highway projects in India are awarded based on a public-private partnership. In this scenario, a private company finances and builds the facility and then collects capital from customers in the form of toll taxes. A suitable amount of time is allowed for this tax to be collected before the facility is made accessible to the general public. To reduce traffic congestion and pollution in metropolitan areas, tolls are now being imposed for parking vehicles in high-traffic zones, a concept known as congestion pricing. Furthermore, safety on these highways is crucial due to the high rate of highway robberies in several regions of India. Road tax, in turn, aids in maintaining the expense of maintaining road security and safety. Based on variables including engine power, seating capacity, unladen weight, and cost, the road tax is computed. However, there will be differences in the laws and standards that apply to taxes in each state. Toll roads face criticism for the time required to stop and pay, as well as the operational costs of toll plaza management, which can account for up to one-third of the revenue in some cases. Automated toll collection systems help mitigate both of these issues, improving efficiency and reducing costs.

Types of Toll Collection

Two different kinds of toll collection systems are:

i. Open Toll System

In this system, tolls are not applied to every customer. The toll plaza is generally located at the edge of the urban area, where most long-distance drivers are committed to the facility, with a low possibility of moving to the parallel free route. Customers are categorized, and each category is assigned a specific toll rate. Local traffic around the plaza can use a service lane or receive a rebate.

ii. Closed Toll System

Customers pay the toll in a closed toll system according to their vehicle's type and the distance they travel to the facility. Free rides are not permitted. A closed toll system has plazas at every point of entry and exit, and users are given tickets as they enter the system. When leaving, the customer surrenders the ticket to the collector, who then charges them the appropriate amount based on the type of vehicle and the distance travelled. Unlike an open system, which allows for multiple stops, it only has two stops for automobiles. However, it costs more to build a closed system than an open system.

Methods of Toll Collection

The three different kinds of toll collection in India are,

Manual Toll Collection

In India, the most common toll collection method is manual toll collection. There must be an attendant or toll collector. The cash toll is paid to the collector based on the categorization of the vehicle. In addition to providing change, the collector can receive and sell cash, tickets, and coupons. They also enter the customer's vehicle into the system and give them a receipt. Processing takes the longest due to manual involvement.

Automatic Toll Collection

The usage of Automated Coin Machines (ACM) is the basis of automatic toll collection. These accept operating agency-issued tokens as well as coins. Depending on the toll rate, using automated coin

or token collection as opposed to manual collection cuts down on both operating costs and transaction and processing times.

Electronic Toll Collection System

A vehicle equipped with a properly encoded data tag or transponder is automatically recognised by an Electronic Toll Collection (ETC) system as it passes through a toll lane or checkpoint. Without the user needing to stop and pay the toll, the ETC system subsequently records a debit or charge to the user's account. ETC speeds up traffic, as there is no need to stop and pay the toll (Shahrier & Huq, 2021).

NETC FASTag: Insights into Implementation and Operation

FASTag, an Electronic Toll Collection (ETC) system in India operates and manages by the National Highway Authority of India, through its subsidiary Indian Highway Management Co. Ltd. (IHMCL). The National Payments Corporation of India (NPCI) oversees FASTag transactions within its extensive digital payment framework, facilitating instantaneous toll payments straight from the user's associated bank account or digital wallet. NPCI is a comprehensive entity that manages most retail payment systems in India. In 2014, FASTags were first installed as a demonstration project at the Golden Quadrilateral between Ahmedabad and Mumbai (Joshi et al. 2017). By 2017, 370 toll plazas under NHAI's jurisdiction had a FASTag lane installed. The government mandated the use of FASTag for all new vehicles sold in India that year. Later, the NHAI mandated the use of FASTags beginning on February 15, 2021. FASTag enables direct toll payments on National Highways through Radio Frequency Identification (RFID) technology, which uses radio waves to identify tagged objects linked to prepaid or savings accounts. With a FASTag card affixed to the vehicle's windshield and a scanner positioned at highway toll booths, vehicles can pass through toll plazas without human interaction (The Statesman, 2020). Using RFID technology, the card on the vehicle communicates with the scanner at the toll booth. Once the vehicle reaches the toll plaza, the necessary toll amount is promptly debited from a prepaid wallet or bank account connected to the FASTag. The FASTag owner receives an SMS notification whenever money is deducted from their account or wallet. There is no expiration date for the balance amount on a FASTag; it remains valid as long as the tag is intact and can be read at toll booths. If a vehicle does not have a FASTag or if the tag's balance is insufficient, the driver must pay double the toll amount in cash to pass through the toll booth. Additionally, vehicle owners are liable to pay double the toll even if the FASTag is malfunctioning due to card damage. Waiting times, fuel costs, and vehicle running expenses will be minimized with the aid of FASTag. It will prevent accelerating, idling, and emitting hazardous vehicle emissions. It helps to lessen the congestion, pollution, and usage of paper. Using centralised user accounts avoids cash handling, which improves audit control. It will promote digital payments and enhanced information and data gathering to track traffic and revise the toll policy of government. In comparison to conventional toll collection, FASTag offers numerous benefits to the society, government, general public etc.

FASTags are issued by 37 certified banks via a variety of channels, including point-of-sale (POS) terminals at some bank branches and National Highway toll plazas. They are also offered on mobile wallets like Paytm and e-commerce sites like Amazon. State Bank of India, Axis Bank, HDFC Bank, IDFC Bank, ICICI Bank, Punjab National Bank, Federal Bank, Kotak Mahindra Bank, IndusInd Bank, Syndicate Bank, Yes Bank, Union Bank, etc and payments banks like Fino Payment Bank and PayTm are some of the leading banks in issuing FASTags. The technology was successfully adopted by offering its services through banks. By utilizing technical advancements to upgrade payment systems and develop new payment methods, banks have created strategies and policies to promote growth through innovative electronic payment methods. Electronic technologies that are tailored to the digital economy are being introduced alongside other communication channels as part of a policy to make services more accessible to the client (Walid 2020).

Review of Literature

Electronic Toll Collection (ETC) is an automated system for toll collection that has been widely researched and implemented on highways, bridges, and tunnels worldwide. Through data exchange between RFID tags placed on vehicles and antennas installed along the roadside or on toll gates, the central control computer identifies the road user by the information stored in the tag. It then deducts the toll fee from a prepaid card or linked bank account. The key benefit of ETC is that vehicles can pass without stopping, greatly enhancing toll station efficiency and improving traffic flow on toll roads (Xiao, Guan, & Zheng, 2008). The implementation of the E-toll system has significantly reduced traffic congestion, a growing issue in major metropolitan areas. This system offers an efficient solution for managing heavy traffic by eliminating the need for travelers to wait in long queues at traditional toll booths. Conventional toll payments result in wasted fuel, time, and increased pollution, along with the inconvenience of carrying cash. In contrast, the E-toll system streamlines the payment process, reducing fuel consumption and eliminating the need for cash, offering a more convenient and eco-friendly travel experience (Algonda, Sonar, & Bhutada, 2018). (Chauhan & Chauhan, 2022) analyze the automated toll collection system aimed at deducting toll fees from moving vehicles at toll plazas in