

Financial Ratios, Discriminant Analysis and the Prediction of Corporate Insolvency: Evidence from Indian Information Technology Companies

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Abstract

The present paper aims to predict the insolvency of Indian information technology companies. The four different parameters of solvency namely cash flow to total liabilities, total debts to total liabilities, debt to total assets, and equity shareholders' funds to total assets are used in the current study. These different solvency indicators have been categorized using three numerical values one, two, and three. One indicates those companies which are financially sound, two reflects companies with moderate solvency position, and three indicates weak companies having poor solvency ratios. The different financial ratios are used as a predictor or explanatory variables of insolvency of Indian IT companies. The empirical findings of the study show that there is significant discrimination in the solvency position of companies according to their different financial performance parameters. Since there are three categories of companies as per their solvency position, so two discriminant functions are created and both of these functions are found significant at 5% levels for two parameters of solvency namely, equity shareholders' funds to total assets and debt to total assets. In the remaining two measures of solvency (Debt to total liabilities and cash flow to total liabilities) only a single function is found significant. Classification results, canonical correlation, and Wilks' Lambda test confirm the statistical significance of research results. The outcomes of the study will be helpful to policymakers, different stakeholders. Society will also be benefitted by knowing the critical factors responsible for companies that are likely to become insolvent.

Keywords: Insolvency, solvency ratios, profitability ratios, activity ratios, leverage, multiple discriminant analysis

JEL Classification: G33, G32, G17, G01, C3

1.0 Introduction

Firms experience financial distress when they are illiquid and insolvent (Cook et al., 2014). The prime concern of every firm is its smooth functioning in short as well as long run. For its liquidity and solvency plays a crucial role. Solvency determines the ability of a company to survive over a longer-term period. Liquidity measures the company's ability to meet short term obligation of a company.

The latest data of IBBI (Insolvency and Bankruptcy Board of India) stated that around 378 companies with total creditor claims of 2576420 million Indian rupees have been sent into liquidation under insolvency and bankruptcy code till 31st March 2019. It has urged a need to do a detailed analysis of the factors affecting the solvency and liquidity of a firm.

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Citation: Sharma, R. K. & Bhalla, N. (2025). Financial Ratios, Discriminant Analysis and the Prediction of Corporate Insolvency: Evidence from Indian Information Technology Companies. *International Insurance Law Review*, 33 (S4), 342-363.

In the present study, we have opted for the Indian Information Technology sector. Indian IT sector is emerging out as one of the dominant players at the global level. As per the report issued by NASSCOM, the sector aggregated revenue of 160 billion US dollars in 2017, with export revenue of 99 billion and domestic revenue of 48 billion. The United States accounts for two-thirds of India's IT service exports. In the world economy, India is the largest exporter of IT services. Indian IT service export has experienced tremendous growth from 4% in 1998 to 25% in 2012. Moreover, it contributes around 40% in India's GDP, 30% in export earnings, and generating employment by about 25%. Indian Government has made few historical reforms in the past years: demonetization on 8th November 2016 and GST (Goods and Service Tax) on 1st July 2017. Both reforms have greatly impacted the whole economy as large, especially the solvency and liquidity of the firms. According to the India Rating Report by Reserve Bank of India (RBI), 2017 GST in the initial phase of four months has impacted the liquidity and working capital cycle of businesses. The spillover effect of demonetization on GST led to an acute liquidity crisis in the industry. It caused delayed/defaults in the inter-firm credit-based payment system. Businesses experienced a liquidity crunch (Chandak, 2018). Due to demonetization, the liquidity of every sector gets affected severely, impacting the GDP negatively. No doubt GST was implemented to boost the businesses but initially, it impacted the working capital adversely (Chakarvarty, 2017). Businesses faced a liquidity crunch in the post GST era, thereby increasing the demand for working capital from the banking system (Kumar, 2018).

The solvency of the IT sector is studied taking into account 21 years. Our research focuses on the impact of traditional solvency indicators i.e. profitability, liquidity, leverage, and activity ratios. Indicators are based on net profits, cash profits, and profit before and after-tax retained by the organization. The returns so achieved on assets, equity, sales throughout the period define the profit stability of a firm. The current and working capital ratios are determined to ascertain the liquidity position. To evaluate the solvency position Debt to total liabilities, Shareholder's fund to total assets, long term debt to total liabilities, and cash flow are taken into consideration.

The motive behind the study on the IT sector is that it dominantly influences the economy internationally and nationally. The research question that intrigued this study is 1) what are the factors that affect the solvency and liquidity of firms? 2) Whether demonetization and GST have impacted or not? This study will positively add to the existing body of knowledge. Presently, the financial decisions are majorly impacted by the solvency and liquidity positions of the organizations. The study will help to understand the factors that affect the solvency of the IT firms. The overall results will be beneficial to all the stakeholders and policymakers of the society. This paper is organized in the following parts- part 2 involves a review of all the factors and their respective relations that affect the solvency of any organization. Part 3 follows the research design and data used, part4 discusses the analysis and its implications, part 5 states the conclusion and part 6 includes all the references.

2.0 Literature Review

Investors use the solvency ratios and liquidity ratios as a tool to make their investment decisions. Solvency ratios measure the ability of the firm to meet its financial obligation. Most of the empirical study evidence the relationship that exists between profitability, liquidity, activity, and

leverage with the solvency of a firm. The following literature provides a deeper insight into the relationship of all the variables that impact the solvency of a firm.

2.1 Relation with Profitability

Favourable financial position and performance are required for business entities to operate in the future (Jeon, Amekudzi, and Guensler, 2010). To measure financial position and performance often solvency and profitability are used as yardsticks (Kiyosaki and Lechter, 2003). Profitability analysis is a valuable tool for management planning and decision making as it generates value for the firm (Penman, 2007). Vieria (2010) states that the assessment of profitability is generally done through return on assets (ROA) and return on equity (ROE). Khalid and Rehman, (2014) stated that a negative relationship exists between solvency and profitability inconsistency. Less profitable firms delay the payment of day-to-day expenses of the firm. The study conducted in Ghana by Addae, Nyarko-Bassi, and Hughes, (2013) stated that a positive relationship exists between profitability and short-term debt as compared to long term debts. Moreover, a positive relationship exists between the solvency levels as per the pecking order theory. A profitable firm can survive in any adverse situation as it can use its retained earnings well (Arvanitis et al., 2012). Bordeleau and Graham (2010) stated that at some point over liquidity has reduced the profitability level of firms. Mohanty and Mehrotra (2018) stated that a significant relationship exists between ROA and profitability and not statistically significant relationship between ROE and solvency of a firm. Solvency has no impact on profitability, but liquidity has a negative impact (Dahiyat, 2016).

H1: The different measures of profitability can distinguish between strong solvent, moderate solvent, and weakly solvent IT companies.

2.2 Relation with Liquidity

Liquidity ratios measure the Company's ability to meet short term obligations and to fulfill the cash requirements to operate the business smoothly (Hayes, 2019). The liquidity position is a measure to analyze the company's ability to pay off its current liabilities with current assets. The company's liquidity position is considered better if it is higher (Loncan and Caldeira, 2014). Working capital management is essential as it has a direct impact on the solvency of a firm (Singh and Pandey, 2008). Working capital directly influences the solvency of a firm. Negative working capital leads a firm to bankruptcy (Panigrahi, 2014). The financial structure is directly associated with high levels of profitability, liquidity, and solvency. Here, financial structure is implied by working capital management (Guimaraes and Nossa, 2010). Khalid and Rehman, (2014) stated that the higher the quick and current ratio, the more the company can handle the cash troubles easily. Moorthi, Ramesh, and Bhanupriya, (2012) stated that liquidity plays an important role in the survival of a business. It affects the solvency i.e. ability to survive in the long run. Silva (2019) stated that excessive liquidity has a negative implication on the solvency of a firm. A study conducted in Saudi Arabia by Eljelly (2004) identified that a relationship exists between profitability and solvency. Here profitability is measured by the current ratio and cash conversion cycle. Figlewicz and Zeller (1991), Carslaw and Mills (1991), Giacomino and Mielke (1993), and Rujoub et al., (1995) states that cash flow is used to ascertain short term financial stability. It is an indicator used to measure the financial risk a firm is exposed to. Ben-Caleb et al.,

(2013) states in the study conducted on the Nigeria Stock Exchange that current ratio and liquid ratio are positively related to the profitability of a firm. It helps to ascertain the solvency position of a firm. A study conducted on the Malaysian manufacturing sector measured the liquidity using the current ratio and working capital to total asset ratio. It states that a positive association prevails between liquidity and profitability of a firm (Zainudin, 2006).

H2: Liquidity of selected companies can discriminate them into very healthy, moderately healthy and unhealthy IT companies

2.3 Relation with Activity Ratios

Activity ratios are the performance measuring ratios of a firm. They express the organization's operational capabilities. Higher the ratio, better the utilization of resources. Since the financial crisis of 2008, the prediction of financial distress is a major concern. Activity ratios help in evaluating financial efficiency and performance. The study shows the direct relation of activity as well as profitability ratios on the solvency of the firms (Sankaran, 2019). The Serbian enterprise study uses cash flow operating margin and cash flow investing margin as indicators of liquidity. It showed cash flow operating margin has a negative impact and cash flow investing margin has a positive impact. The indicators used for the cash flow investing margin is the cash invested in fixed assets of a firm (Stevanovic, Minovic, and Lijumovic, 2019). Drobetz et al., (2013) stated that organizations with a higher ratio of fixed to total assets bear low financial distress. There is less chance of them to suffer higher losses at times of insolvency or bankruptcy. The turnover ratios analyze the enterprise's sales ability. Higher the TAT, the higher the benefit for the firm (Xia, 2019). The analysis of activity ratios helps to improve operational efficiency (Zhou et al., 2019).

H3: The different measures of activity ratios can distinguish between strong solvent, moderate solvent, and weakly solvent IT companies

2.4 Relation with Leverage Ratios

The survival of a company depends on the capital structure and not just the earning potential. Leverage ratios explain the extent of debt involved in the capital structure of the firm. Bhat (1980) examined the financial leverage on Indian Manufacturing Industries. He employed various factors such as firm size, variability in income, growth, and dividend payout ratio. The study concluded that financial leverage is not associated with the size of a firm. But the firm is riskier in terms of solvency when it is likely to employ more percentage of debt in comparison with financial leverage and EBIT. Abey and Velumurugan (2019) stated that capital structure not only determines the company's survival in the future but also long-term solvency. The study uses the variables of return on investment, size of the company, asset structure to determine the financial leverage of the Indian Automobile Industry. Yeo (2016) states that leverage is closely and directly related to solvency. A firm should only accelerate the intake of debts when it is affirmative to get higher returns. Moreover, the study identifies the variables like profitability and size of the firm also influence the leverage level. Durand (2019) stated that at a low level, capital has a positive impact on financial stability in terms of solvency. But when the capital increases, the solvency of a firm becomes weaker. The financial leverage ratio helps to assess the financial performance of operations. It is of great value to investors, creditors, and managers in

the longer run (Andrew and Schmidgall, 1993). The turnover ratios provide a holistic approach in the analysis of the solvency position of the companies (Kajananthan and Velnampy, 2014). A study done on manufacturing companies in Nigeria shows that solvency in terms of credit policies, cash conversion, and earnings plays an important role in corporate profitability (Owolabi, Obida, and Small, 2012). Graham et al., (2011) in the study stated that firms with more debt and lower bond ratings are more prone to insolvency and financial distress. Patti et al., (2015) states the two-fold effect of leverage on firms. First, firms default during economic contractions. Second, it increases the sensitivity of the firm.

H4: Leverage ratios of selected companies can separate them into very healthy, moderately healthy and unhealthy IT companies

3.0 Research Design or Research Methods

The study has been carried by procuring the data of the different explanatory and dependent variables from Prowess the database of the Centre for Monitoring India Economy (CMIE). The period of the study is from the last 26 years ranges from 1998 to 2023. The four different parameters of solvency have been used in the study namely, cash profit to total liabilities, total debt to total assets, and equity shareholders' funds to total assets of selected IT sector companies. There cannot be a single reason for insolvency; by keeping in mind the study has included the different financial ratios as explanatory variables. These ratios deal with profitability, short- and long-term financial position, and managerial of the Indian IT companies.

At the initial stage, a data total of 4495 companies were procured. But the companies that shut down their business during the study period are excluded from the sample. Similarly, the companies whose complete dataset of the last 21 years of different explanatory and dependent variables were not available are also excluded from the sample size. Finally, a sample of 80 companies is taken for the study. Data of all the above-mentioned variables are collected for the time of 1998 to 2018. The multiple discriminant analysis approaches (MDA) are used to predict the insolvency of selected IT companies. Multiple discriminant analysis (MDA) is like multiple regression analysis. The only point of difference is that in the case of MDA, the dependent variable is a qualitative variable, whereas in the case of multiple regressions this variable is quantitative. In the multiple regressions there are more than one independent variables. Similarly in the case of MDA there are multiple independent variables. In the multiple regressions there is single dependent variable whereas in the case of MDA the dependent variable is categorical variable. In the present paper, the dependent variables are the different categories of the solvency ratio of selected companies. These different insolvency indicators have been categorized using three numerical values one, two, and three. One indicates those companies which have sound financial position and overall health of companies are very good, two reflects those companies which have moderate solvency position and three indicates weak companies having poor solvency ratios. The different financial ratios viz., profitability, liquidity, leverage, and activity are used as a predictor or explanatory variables of insolvency of Indian IT companies. The study employs multiple discriminant analysis (MDA) to predict the factors responsible for the insolvency of IT sector companies.

The discriminant equation:

$$Z = b_0 + b_1X_1 + b_2X_2 + \dots + b_pX_p + e \dots \dots \dots 1$$

Where, Z is a latent variable formed by the linear combination of the dependent variable, Profitability, Liquidity, Leverage, and Activity are the independent variables, e is the error term and $b_0, b_1, b_2, \dots, b_p$ are the discriminant coefficients.

In the present study, the following model equation can be formed:

$$Y = b_0 + b_1(\text{Profitability}) + b_2(\text{Liquidity}) + b_3(\text{Leverage}) + b_4(\text{Activity}) + e \dots \dots \dots 2$$

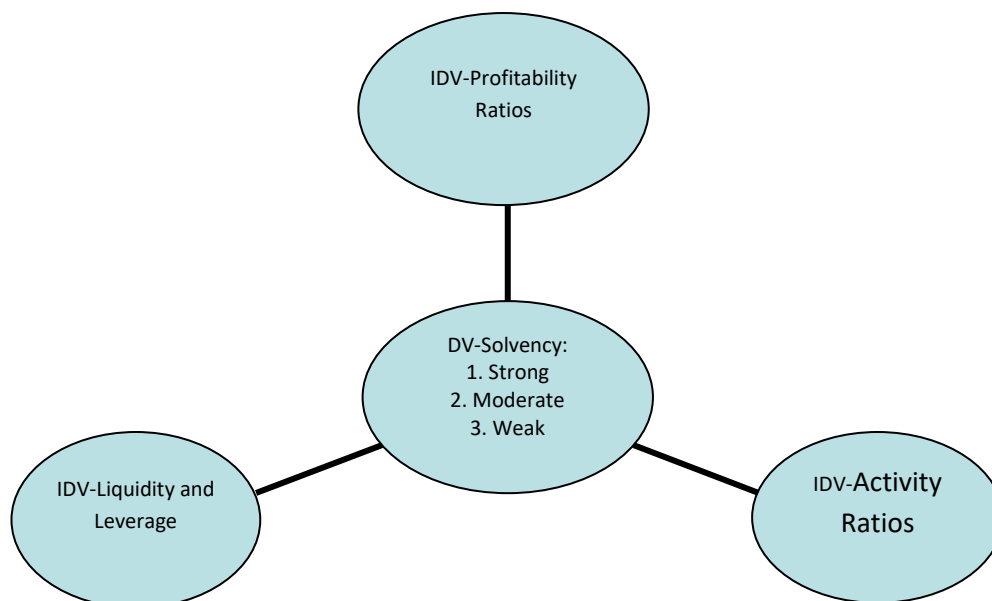
Table1: Definition of Financial Ratios used as Explanatory and Dependent Variables

Ratios		Calculation	Citations
Profitability Ratios	Net Profit Ratio (NPR)	Net Profit/ Net sales	Jeon, Amekudzi and Guensler (2010); Kiyosaki and Lechter (2003); Penman (2007); Viera (2010); Khalid and Rehman (2014); Addae, Nyarkao-Bassi and Hughes (2013); Arvanitis et al., (2012); Bordeleau and Graham (2010); Mohanty and Mehrotra (2018); Dahiyat (2016)
	Profit Before Tax Ratio (PBTR)	Profit Before Tax / Net Sales	
	Profit After Tax Ratio (PATR)	Profit After Tax / Net Sales	
	Cash Profit Ratio (CPR)	Profit after tax +Non-cash Expenses-Non ash incomes/ Net Sales	
	Return on Assets (ROA)	EBIT/ Total Assets	
	Return on Common Equity (ROE)	Profit Available to equity shareholders/ Equity Shareholders funds	
	Return on sales or Operating Profit Ratio (ROS)	Operating Profit /Net Sales	
	Total Income to Total Asset (TITA)	Total Income/ Total Assets	
Liquidity Ratio	Current Ratio	Current Assets/ Current liabilities	Loncan and Calderia (2014); Singh and Pandey, (2008); Panigrahi, (2014); Khalid and Rahman, (2014); Moorthi, Ramesh and Bhanupriya, (2012); Silva (2019) ; Eljelly, (2004); Figlewicz and Zeller, (1991); Carslaw and Mills, (1991); Giacomino and Mills, (1993); Rajjoub et al., (1995); Ben Caleb et al., (2013); Zainudin (2006); Guimaraes and Noss, (2010)
	Working capital Ratio	Net working Capital/ Current assets	
Activity Ratios	Total Assets Turnover	Net Sales/ Total Assets	Sankaran, (2019); Stevanovic, Minovic and Lijumovic, (2019); Drobetz et al., (2013); Xia,(2019); Zhou et al., (2019)
	Fixed Assets Turnover	Net Sales/ Fixed Assets	
	Working capital Assets Turnover	Net Sales/ Net Working capital	
	Current Assets Turnover	Net Sales/ Current Assets	
Leverage	Financial Leverage	Debt to Equity Ratio	Bhat,(1980); Abey and Velumurugan, (2019); Yeo, (2016); Durand,(2019); Andrew and Schmidgall,(1993); Kajanathan and Velnampy,(2014); Owolabi, Obida and Small,(2012); Graham et al.,(2011); Patti et al.,(2015)
		Earnings before interest and tax / Earning Before Tax	
		Total Debt to Sales	

Solvency Ratios	Debt to Total Liabilities (DTL)	Debts/ Total Liabilities	Cook et al., (2014); Yeo (2016); Hayes, (2019); Global Banking and Finance Review, 2018; Mohanty and Mehrotra,(2018); Silva,(2019); Xia, (2019); Yeo (2019); Durand, (2019).
	Total Shareholders' funds to Total Assets (ETTA)	Total Shareholders' Funds/ Total Assets	
	Long term Debt to Total Liabilities (DTA)	Total Long-Term Debts/ Total Liabilities	
	Cash Flows after Tax to Total Liabilities	Profit After Tax+ Non-Cash Expenses-Non Cash incomes / Total Liabilities	

Table 2: Categorisation of companies as per solvency ratios

	Debt to total liabilities (DTL)		No. of Companies	Equity shareholders' funds to total assets (EETA)		No. of Companies	Debt to Total assets (DTA)		No. of Companies	Cash profit to total liabilities (CFTL)		No. of Companies
	Ratio	Category		Ratio	Category		Ratio	Category		Ratio	Category	
Strong solvent position	<0.40	1	51	>0.70	1	41	<0.30	1	40	>0.15	1	34
Moderate solvent position	>0.40 and up to 0.60	2	15	<0.70 and up to 0.40	2	26	>0.30 and up to 0.60	2	28	<0.15 and up to 0.05	2	22
Very Weak Solvent position	> 0.60	3	12	< 0.40	3	11	> 0.60	3	10	< 0.05	3	22

Figure 1: Multiple Discriminant Analysis (Conceptual Model)**Note: IDV- Independent and DV-Dependent Variables**

4.0 Analysis and Interpretation

Table 3: Tests of Equality of Group Means

	ETTA			DTA			DTL			CFTL		
	Wilks' Lambda	F Sig	Sig	Wilks' Lambda	F	Sig	Wilks' Lambda	F	(Sig)	Wilks' Lambda	F	(Sig)
DER	0.899	4.197	0.019	0.852	6.491	0.003	0.879	5.155	0.008	0.974	1.008	0.370
ROE	0.885	4.865	0.010	0.870	5.608	0.005	0.855	6.353	0.003	0.954	1.823	0.169
ROA	0.867	5.776	0.005	0.880	5.112	0.008	0.862	6.010	0.004	0.919	3.321	0.042
TITA	0.868	5.695	0.005	0.883	4.992	0.009	0.847	6.791	0.002	0.929	2.845	0.064
ROS	0.982	0.706	0.497	0.995	0.203	0.817	0.977	0.885	0.417	0.914	3.519	0.035
PATR	0.987	0.499	0.609	0.993	0.267	0.767	0.981	0.710	0.495	0.919	3.326	0.041
PBTR	0.983	0.641	0.529	0.991	0.359	0.700	0.983	0.655	0.522	0.981	0.739	0.481
NPR	0.944	2.242	0.113	0.931	2.768	0.069	0.986	0.525	0.593	0.983	0.646	0.527
FATR	0.892	4.532	0.014	0.882	5.028	0.009	0.958	1.655	0.198	0.874	5.392	0.006
CR	0.988	0.441	0.645	0.988	0.465	0.630	0.993	0.257	0.774	0.983	0.646	0.527
WCR	0.978	0.847	0.433	0.966	1.321	0.273	0.981	0.731	0.485	0.978	0.832	0.439
EBIT/EBT	0.964	1.403	0.252	0.968	1.259	0.290	0.997	0.118	0.889	0.983	0.633	0.534
CATR	0.933	2.713	0.073	0.954	1.827	0.168	0.931	2.774	0.069	0.992	0.308	0.736
WCTR	0.831	7.624	0.001	0.829	7.745	0.001	0.857	6.234	0.003	0.981	0.727	0.487
TATR	0.877	5.243	0.007	0.878	5.227	0.007	0.820	8.255	0.001	0.873	5.462	0.006
TDTS	0.904	3.962	0.023	0.897	4.303	0.017	0.917	3.395	0.039	0.984	0.606	0.548
CPR	0.929	2.866	0.063	0.942	2.319	0.105	0.928	2.911	0.061	0.969	1.190	0.310

*Significant at 1% level (p value <0.01)

** Significant at 5% level (P value <0.05)

Table 3 shows the results of tests of equality of group means. This table embodies the value of Wilks' lambda along with F statistics and corresponding P-value. Wilks' lambda is a test statistic used in multivariate analysis of variance (MANOVA) to know whether there is a difference in group means of indistinguishable groups' area under discussion with a blend of dependent variables. Later, the value of Wilks' lambda statistic is transformed into F distribution or ANOVA value to know the significant difference among the groups' means. The p-value < significance level indicates the rejection of null and acceptance of alternate hypotheses (Bartlett et. al., 2000). In the case of the first indicator of Insolvency equity shareholders' funds to total assets (ETTA), the four variables namely, debt equity ratio (DER), return on equity (ROE), total debt to total sales (TDTS), and fixed assets turnover ratio (FATR) are found to be statistically significant at a 5% level ((p-value <0.05).

The variables return on assets (ROA), total incomes to total assets (TITA), working capital turnover ratio (WCTR), and total assets turnover ratio (TATR) are found significant at a 1% level of significance. In the case, the second indicator of insolvency debt to total assets (DTA), the variables namely, debt-equity ratio (DER), return on equity (ROE), return on assets (ROA), total incomes to total assets (TITA), working capital turnover ratio (WCTR), fixed assets turnover ratio (FATR), total assets turnover ratio (TATR) found significant at 1 % level (P-value <0.01). Total

debt to total sales (TDTS) is found to be significant at 5 % level (P value < 0.05). The third indicator of insolvency debt to total liabilities (DTL) represents similar results like debt to total assets (DTA) except for one variable fixed assets turnover ratio (FATR) which is not found to be significant in DTL. The results of the last measure of insolvency cash profit to total liabilities (CFTL) are quite different from the earlier three measures. The variables namely, return on assets (ROA), return on sales (ROS), profit after tax ratio (PATR) are the significant variables at a 5 % level (P -value < 0.05), and only two variables (FATR and TATR) at 1% level. All the significant variables reflect the rejection of the null hypothesis and acceptance of the alternate hypothesis that there is a significant difference in group means.

Table 4: Box's Test of Equality of Covariance Matrices

		ETTA	DTA	DTL	CFTL
Box's M		2231.134	2120.386	1881.798	44.099
F	Approx.	11.698	11.328	4.625	3.449
	df1	136	136	272	12
	df2	8881.392	10500.638	11339.492	19935.758
	Sig.	0.000	0.000	0.000	0.000

Table 4 depicts the Box's Test to check the equality of Covariance. Acceptance of null hypothesis indicates that there is equality of covariance of selected variables and rejection reflects that there is a lack of equality of covariance across the sample. **Box's Test** of all the four measures of insolvency (ETTA, DTA, DTL and CFTL) indicates that there is a lack of equality of covariance. As the stated P value of Box's test is less than 0.05 which means rejection of the null hypothesis.

Table 5: Summary of Canonical Discriminant Functions

Function	ETTA		DTA		DTL		CFTL	
	1	2	1	2	1	2	1	2
Eigen value	1.455 ^a	.595 ^a	2.054 ^a	0.555 ^a	1.243 ^a	.367 ^a	0.355 ^a	0.035 ^a
% of Variance	71.0	29.0	78.7	21.3	77.2	22.8	091.0	9.0
Cumulative %	71.0	100.0	78.7	100.0	77.2	100.0	0.91.0	100.0
Canonical Correlation	0.770	0.611	0.820	0.597	0.744	0.518	0.512	0.184
Test of Function(s)	1 through 2	2	1 through 2	2	1 through 2	2	1 through 2	2
Wilks' Lambda	0.255	0.627	0.211	0.643	0.326	0.731	0.713	0.966
Chi-square(Df)	92.109	31.494	105.140	29.790	75.643	21.121	25.034	2.545
DF	32	15	32	15	32	15	6	2
Sig.	0.000	0.008	0.000	0.013	0.000	0.133	0.000	0.280

Table 5 shows the canonical correlation discriminant functions and Wilks' Lambda. Since in the present study, there are three categorical variables of each measure of insolvency, the two discriminant functions are created for each measure. The first function of ETTA's (Insolvency indicator) associated Eigen value is 1.455 and this function contributes to 71 % of the explained variance. For the second function of equity shareholders' funds to total assets (EETA), the associated Eigen value is 0.595 and this function contributes only 29% of the explained variance. The first function has quite a higher Eigenvalue as compare to the second function. So, the first

function may be considered superior over the second function. Canonical correlation analysis studies the linear relation between two sets of variables. It is the multivariate extension of correlation analysis (Tabachnick, 1989). Canonical correlation analysis (CCA) term is used to analyze the linear relationship between latent variables that represent multiple variables in multivariate analysis. It is the multivariate extension of correlation analysis and ranges from 0 to 1. A latent variable is a variable that is not directly observed. This term is also used in canonical regression and multivariate discriminant analysis (Statistics Solution, 2018). For the first and second function of ETTA, the associated canonical correlation analysis (CCA) are 0.77 and 0.611 respectively. Higher the value of CCA considered as good in multivariate analysis. In the present study, the value of CCA of the first function is larger than the second function. CCA value of 0.77 indicates 77 % degree of linear relationship among the latent variables that represent multiple variables.

Similarly, the first function of the second measure of insolvency (debt to total assets) reflects quite a higher Eigen value (2.054) as compared to the second function (0.555). The first and second functions explain 78.7 % and 21.3% of the variance respectively. The CCA of the first function is also quite higher (0.820) in comparison to the second function (0.597). The third and fourth measures of insolvency are a debt to total liabilities and cash profit to total liabilities. Again in both the measures the associated Eigenvalue of the first function is quite higher as compare to function two. Similarly, the function first explains more variance than function two. The associated CCA of the first function of these two measures is also quite higher as compare to function two. The function one is also considered superior in the third and fourth measures of insolvency.

To test the null hypothesis of equal group centroids, both functions must be considered simultaneously. Table 5 also reports the Wilks' Lambda value along with Chi-square and p-value. The associated Wilks' Lambda and Chi-square values of 1 through 2 functions (no function is removed) of ETTA are 0.255 and 92.109 (with 32 degrees of freedom) respectively. The corresponding p-value is significant (<0.05), this indicates that two functions taken together significantly discriminate among the three groups. The Second function of equity shareholders' funds to total assets (EETA) reflects that when the first function is removed, the Wilks' Lambda and Chi-square values associated with the second function are 0.627 and 31.494 respectively at 15 degrees of freedom. Since the corresponding p-value of the second function is less than 0.05, so this value is significant. This indicates that the second function is also significantly contributed to group differences.

The associated Wilks' Lambda and Chi-square values of 1 through 2 functions (no function is removed) of debt to total assets (DTA) (Second Measure of insolvency) are 0.211 and 105.140 respectively and p value<0.05. It means when no function is removed or the two functions taken together significantly discriminate among the three groups. The function two of DTA reports that when the first function is removed. Since the associated p-value of Chi-square of the second function is less than 0.05, it means the second function is also significantly contributed to group differences.

In the last two measures of solvency (DTL and CFTL), when both functions (1 and 2) taken together than their associated Chi-square values are 75.643 and 25.034 with Wilks' Lambda values 0.326 and 0.713 respectively. Since the p-value of the joint function of both debt to total

liabilities (DTL) and cash flow to total liabilities (CFTL) is less than 0.05. It means both of these functions taken together contribute to the group differences. But when the first function is removed in both these measures of insolvency (DTL and CFTL), the related Chi-Square values are quite low and the p-value is greater than 0.05. It means the second function of both of these (DTL and CFTL) measures is not found to be significant and it does not contribute to the group differences.

Table 6: Standardized Canonical Discriminant Function Coefficients

	ETTA		TDA		DTL		CFTL	
	Function		Function	Function	Function	Function	Function	Function
	1	2	1	2	1	2	1	2
DER	0.695	-0.250	0.715	-0.298	0.607	-0.228	-.0369	-.015
ROE	0.004	0.726	0.046	0.808	0.123	0.814	0.175	.601
ROA	9.011	3.537	10.000	3.488	8.049	4.293	3.559	1.731
TITA	-13.632	-4.082	-15.016	-4.039	-11.917	-5.116	-4.574	-2.181
ROS	0.309	-0.375	-0.913	-0.210	-0.541	0.315	0.095	-1.898
PATR	-1.597	-3.914	-9.117	-2.511	-6.082	2.895	1.740	-6.915
PBTR	1.569	4.439	9.979	2.894	6.435	-3.317	-1.248	8.550
FATR	-0.140	-0.526	-0.136	-0.558	0.051	-0.439	0.510	0.567
CR	0.113	-0.053	0.134	-0.065	0.147	-0.035	0.219	0.042
WCR	0.214	0.099	0.203	0.035	0.077	0.107	-0.178	-0.278
EBIT/EBT	0.139	0.244	0.127	0.232	-0.007	-0.111	-0.086	0.330
CATR	-0.234	0.276	-0.116	0.209	-0.100	0.199	0.175	-0.339
WCTR	0.409	-0.477	0.510	-0.526	0.486	-0.584	0.204	-0.357
TATR	5.814	0.909	6.185	0.814	4.974	1.307	0.888	0.467
TDTS	-0.374	-0.200	-0.525	-0.086	-0.409	-0.024	0.145	0.360
CPR	0.488	0.288	0.461	0.297	0.423	0.392	-0.309	0.480

Table 6 exhibits the coefficients of standardized canonical discriminant function. The value these coefficients are used to calculate the score (Known as Z score) of discriminant functions. Discriminant score or Z score is calculated similarly as we calculate in the case of multiple regression analysis using the value of standardized coefficients and explanatory variables.

In the present study, different profitability, liquidity, leverages and activity ratios are the variables created by standardizing our discriminating variables. Then, for each case, the function scores would be calculated using the following equations:

ETTA Discriminant Score $1 = 0.695(\text{DER}) + 0.004(\text{ROE}) + 9.011(\text{ROA}) - 13.632 (\text{TITA}) + 0.309(\text{ROS}) - 1.597 (\text{PATR}) + 1.569 (\text{PBTR}) - 0.140(\text{FATR}) + 0.113(\text{CR}) + 0.214 (\text{WCR}) + 0.139(\text{EBIT/EBT}) + 0.234(\text{CATR}) + 0.409 (\text{WCTR}) + 5.814(\text{TATR}) - 0.374(\text{TDTS}) + 0.488 (\text{CPR})$

EETA Discriminant Score 2 = $-0.250(\text{DER}) + 0.726(\text{ROE}) + 3.537(\text{ROA}) - 4.082(\text{TITA}) - 0.375(\text{ROS}) - 3.914(\text{PATR}) + 4.439(\text{PBTR}) - 0.526(\text{FATR}) - 0.053(\text{CR}) + 0.099(\text{WCR}) + 0.244(\text{EBIT/EBT}) + 0.276(\text{CATR}) + 0.477(\text{WCTR}) + 0.909(\text{TATR}) - 0.200(\text{TDTS}) + 0.488(\text{CPR})$

DTA Discriminant Score 1 = $0.715(\text{DER}) + 0.046(\text{ROE}) + 10.000(\text{ROA}) - 15.016(\text{TITA}) - 0.913(\text{ROS}) - 9.117(\text{PATR}) + 9.979(\text{PBTR}) - 0.136(\text{FATR}) + 0.134(\text{CR}) + 0.203(\text{WCR}) + 0.127(\text{EBIT/EBT}) - 0.116(\text{CATR}) + 0.510(\text{WCTR}) + 6.185(\text{TATR}) - 0.5254(\text{TDTS}) + 0.461(\text{CPR})$

DTA Discriminant Score 2 = $-0.298(\text{DER}) + 0.808(\text{ROE}) + 3.488(\text{ROA}) - 4.039(\text{TITA}) - 0.210(\text{ROS}) - 2.511(\text{PATR}) + 2.894(\text{PBTR}) - 0.558(\text{FATR}) - 0.065(\text{CR}) + 0.035(\text{WCR}) + 0.232(\text{EBIT/EBT}) + 0.209(\text{CATR}) - 0.526(\text{WCTR}) + 0.814(\text{TATR}) - 0.086(\text{TDTS}) + 0.297(\text{CPR})$

DTL Discriminant Score 1 = $0.607(\text{DER}) + 0.123(\text{ROE}) + 8.049(\text{ROA}) - 11.917(\text{TITA}) - 0.541(\text{ROS}) - 6.082(\text{PATR}) + 6.435(\text{PBTR}) + 0.051(\text{FATR}) + 0.147(\text{CR}) + 0.077(\text{WCR}) - 0.007(\text{EBIT/EBT}) - 0.100(\text{CATR}) + 0.486(\text{WCTR}) + 4.9744(\text{TATR}) - 0.409(\text{TDTS}) + 0.423(\text{CPR})$

DTL Discriminant Score 2 = $-0.228(\text{DER}) + 0.814(\text{ROE}) + 4.293(\text{ROA}) - 5.116(\text{TITA}) + 0.315(\text{ROS}) - 2.895(\text{PATR}) - 3.317(\text{PBTR}) - 0.439(\text{FATR}) - 0.035(\text{CR}) + 0.107(\text{WCR}) - 0.111(\text{EBIT/EBT}) + 0.199(\text{CATR}) + 0.584(\text{WCTR}) + 1.307(\text{TATR}) - 0.024(\text{TDTS}) + 0.392(\text{CPR})$

CFTL Discriminant Score 1 = $-0.0369(\text{DER}) + 0.175(\text{ROE}) + 3.559(\text{ROA}) - 4.574(\text{TITA}) + 0.095(\text{ROS}) + 1.740(\text{PATR}) - 1.248(\text{PBTR}) + 0.510(\text{FATR}) + 0.219(\text{CR}) - 0.178(\text{WCR}) - 0.086(\text{EBIT/EBT}) + 0.175(\text{CATR}) + 0.204(\text{WCTR}) + 0.888(\text{TATR}) + 0.145(\text{TDTS}) + 0.309(\text{CPR})$

CFTL Discriminant Score 2 = $-0.015(\text{DER}) + 0.601(\text{ROE}) + 1.731(\text{ROA}) - 2.181(\text{TITA}) - 1.898(\text{ROS}) - 6.915(\text{PATR}) + 8.550(\text{PBTR}) + 0.567(\text{FATR}) + 0.042(\text{CR}) - 0.278(\text{WCR}) + 0.330(\text{EBIT/EBT}) - 0.339(\text{CATR}) - 0.357(\text{WCTR}) + 0.467(\text{TATR}) + 0.360(\text{TDTS}) + 0.480(\text{CPR})$

The distribution of the discriminant scores obtained from each discriminant function is standardized with a mean zero and the standard deviation is equal to 1. The degree of the coefficient of different explanatory variables indicates that how robustly the discriminating explanatory variables affect the discriminant score.

We can see that the standardized returns on assets (ROA), profit before tax ratio (PBTR) and total assets turnover ratio (TATR) in the first function of equity shareholders' funds to total assets (EETA) are greater in enormity than the coefficients for the other thirteen variables. Thus these three variables will have a high impact on the first function discriminant score. Total income to total assets (TITA) has the highest negative coefficient value in the first function of EETA followed by profit after tax ratio (PATR). In the second function of equity shareholders' funds to total assets (EETA), profit before tax ratio (PBTR) and return on assets (ROA) have the highest positive coefficient value. Thus these three variables will have a high impact on the second function discriminant score of EETA.

In the case of the second measure of insolvency debt to total assets (DTA), standardized return on assets (ROA) in the first function has the highest coefficient value followed by profit before tax ratio (PBTR) and total assets turnover ratio (TATR). It means these three variables have a great influence on the discriminant score of the first function of DTA. Again in the second function of DTA, the variables namely, return on assets (ROA), profit before tax ratio (PBTR), and total assets turnover ratio (TATR) has a high impact on the discriminant score. As we know that in the last two measures of insolvency debt to total liabilities and cash profit to total liabilities (DTL and CFTL), the only first function is found to be significant. In the case, the first function of debt to

total liabilities (DTL), the coefficients of return on assets (ROA), profit before tax ratio (PBTR), and total assets turnover ratio (TATR) show high value as compared to the remaining thirteen variables. Again these three variables have more influence on the discriminant score in the first significant function. In the first function of the last measure of insolvency cash profit to total liabilities (CFTL), return on assets (ROA) and profit after tax ratio (PATR) show more impact in the discriminant score.

Table 7: Structure Matrix

	ETTA		TDA		DTL		CFTL	
	Function		Function		Function		Function	
	1	2	1	2	1	2	1	2
TDTS	-0.269*	-0.021	0.288*	0.077	-.0270*	0.015	-0.0043	0.256*
DER	0.268*	0.114	-0.235*	0.042	0.328*	0.096	-.0215*	0.149
CPR	0.229*	0.020	0.174*	-0.001	0.247*	0.068	-0.207	0.222*
ROS	0.104*	0.071	0.033	0.076*	-0.066	-0.222*	0.388*	-0.149
TITA	0.002	0.505*	0.028	0.487*	0.129	0.661*	-0.406*	0.219
ROA	-0.060	0.500*	-0.031	0.492*	0.049	0.654*	-0.288*	0.203
ROE	0.105	0.437*	0.164	0.412*	0.249	0.501*	-0.291*	0.187
FATR	-0.075	-0.435*	-0.071	-0.472*	-0.008	-0.346*	0.513*	0.294
TATR	0.162	0.414*	0.169	0.381*	0.300	0.543*	-0.537*	0.207
CATR	-0.061	0.336*	0.009	0.296*	0.075	0.427*	-0.098	0.126*
WCTR	0.309	-0.329*	0.252	-0.371*	0.310	-0.358*	0.047	-0.280*
NPR	0.088	0.225*	0.065	0.200*	0.034	-0.091*	0.218*	0.078
EBIT/EBT	0.111	0.181*	0.090	0.174*	0.044	-0.045*	-0.087	0.239*
CR	-0.007	-0.140*	-0.011	-0.148*	0.002	-0.137*	0.189*	0.043
PBTR	0.075	0.123*	0.018	0.127*	-0.086	-0.149*	0.434*	0.024
PATR	0.067	0.107*	0.005	0.113*	-0.096	-0.143*	0.446*	0.022
WCR	0.105	-0.105*	0.107	-0.145*	0.077	-0.182*	0.081	-0.286*

The analysis of the results obtained from the discriminant analysis is approximately similar to the extraction of two functions and some additional plots. The structure matrix (table 7) displays the within-group correlation of each explanatory variable with the canonical function. An asterisk mark associated with each variable shows its highest absolute correlation with one of the functions.

In the first measure of insolvency equity shareholders' funds to total assets (ETTA), the working capital turnover (WCTR) (0.309), debt-equity ratio (DER) (0.268) and cash profit ratio (0.229) have the highest positive correlation with function one. Total income to total assets (TITA) (0.505) has the highest positive correlation with function two followed by return on assets (ROA) (0.500) and return on equity (ROE) (0.437).

In the second measure of insolvency (DTA), total debt to total sales (TDTS) (0.288) and working capital turnover (WCTR) (0.252) has a more strong relationship with function one as compare to other remaining variables. The variables namely, return on assets (ROA) (0.497), total income to

total assets (TITA) (0.487), and return on equity (ROE) (0.412) show a high positive correlation with function two as compare to the remaining thirteen variables. In the third measure debt to total liabilities (DTL) of insolvency, the variables debt-equity ratio (DER), working capital turnover ratio (WCTR) and total assets turnover ratio (TATR) are highly correlated with function one and total income to total assets (TITA), return on assets (ROA) and total assets turnover ratio (TATR) with function two. In the last measure of insolvency cash profit to total liabilities (CFTL), fixed assets turnover ratio (FATR), profit after tax ratio (PATR) and profit before tax ratio (PBTR) show a high positive correlation with function one and fixed assets turnover ratio (FATR), total debts to total sales (TDTS) and cash profit ratio (CPR) in function two.

Table 8 Functions at Group Centroids

	ETTA		DTA		DTL		CFTL	
	Function		Function		Function		Function	
	1	2	1	2	1	2	1	2
1	-0.067	-0.717	-0.168	-0.707	0.030	-0.432	0.663	0.017
2	1.190	0.752	1.371	0.667	1.603	0.851	-0.449	-0.256
3	-2.561	0.896	-3.166	0.958	-2.133	0.773	-0.575	0.230

Table 8 reports the functions at Group Centroids for combined groups for discriminant analysis. The centroid is the concept used in multivariate analysis for the mean. Just like the mean, the centroid of obscure points reduces the total of the squared distances from the points of the cloud to a point in the space (Abdi, 2009). Functions at group centroids are the means of the discriminant function scores by the group for each function calculated.

If we calculated the scores of the first function for each group, and they seem to be at the means of the scores by group, we would find that the companies in the first group (Strong Solvent position) in the case of equity shareholders' funds to total assets (ETTA) has a mean of -0.067, the companies in the second group (Moderate solvent position) has a mean of 1.190, and the companies in the third group (Weak solvent position or likely to fail) has a mean of -2.56. We know that the function scores have a mean of zero, and we can check this by looking at the sum of the group means multiplied by the number of cases in each group: $(41 \times -0.067) + (26 \times 1.190) + (11 \times -2.56) = 0$. Similarly, for the second function of EETA three groups of companies (first, second, and third) have mean -0.717, 0.752, and -0.896 and respectively. So sum of group means will be $(41 \times -0.717) + (26 \times 0.752) + (11 \times 0.896) = 0$. Similarly, group means of the remaining three measures of insolvency (DTA, DTL, and CFTL) can be computed for function one and function two

Figure 2 reports a combined group plot of multiple discriminant analysis (MDA) for equity shareholders' funds to total assets (ETTA). This depicts that group three has the highest value in function two. Whereas group two has a high value in function one. Group one has the lowest value in function two. Figures 3 and figure 4 report the combined group plot of MDA for debt to total assets (DTA) and debt to total liabilities (DTL). In the case of debt to total assets (DTA), groups two and three have peak value in function one and function two respectively. The first group has the lowest value in function two just like the previous case. The combined group plot (Figure 4 of DTL) shows that groups two and three have the highest value in function one and function

two respectively. But group one has slightly more value in function one. Figure 5 shows the combined group plot of CFTL. In the last measure of insolvency, the companies in groups one and three have more value in functions one and two respectively. Group two has a high negative value in function two.

Table 9: Classification Function Coefficients (Fisher's linear discriminant functions)

	ETTA			DTA			DTL			CFTL		
	1	2	3	1	2	3	1	2	3	1	2	3
DER	1.487	1.913	-0.308	1.570	2.166	-0.709	1.630	2.192	0.279	1.133	1.499	1.568
ROE	-2.549	-1.545	-1.460	-2.658	-1.541	-1.516	-2.350	-1.169	-1.669	-1.991	-2.600	-1.969
ROA	-29.518	3.008	-62.52	-28.90	10.52	-76.13	-21.96	13.90	-46.12	-21.69	-32.21	-30.05
TITA	49.398	-4.344	113.07	48.170	-17.87	136.43	36.788	-22.75	82.948	39.046	55.23	52.01
ROS	0.319	0.275	-0.054	0.260	-0.198	0.905	0.143	0.021	0.566	0.109	0.488	-0.181
PATR	0.001	-0.019	-0.005	-0.003	-0.048	0.057	-0.016	-0.03	0.028	-0.008	0.001	-0.023
PBTR	-0.003	0.017	0.005	0.001	0.045	-0.056	0.014	0.027	-0.028	0.007	-0.005	0.021
FATR	0.778	0.396	0.577	0.802	0.407	0.591	0.719	0.531	0.471	0.804	0.377	0.606
CR	2.512E-5	4.861E-5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WCR	0.939	1.442	0.486	0.998	1.438	0.324	0.993	1.307	0.947	0.757	1.279	0.918
EBIT/EBT	0.028	0.079	0.033	0.027	0.077	0.028	0.046	0.032	0.035	0.044	0.030	0.071
CATR	0.250	0.347	1.149	0.278	0.372	0.881	0.313	0.399	0.713	0.557	0.602	0.201
WCTR	0.035	0.017	-0.136	0.045	0.051	-0.185	0.046	0.047	-0.120	0.012	0.015	-0.030
TATR	-11.098	10.274	-43.324	-10.316	15.978	-52.817	-5.898	18.407	-29.401	-9.817	-13.35	-12.53
TDS	0.060	-0.032	0.133	0.048	-0.064	0.220	0.025	-0.055	0.128	0.054	0.002	0.049
CPR	-0.282	0.009	-0.493	-0.284	0.028	-0.532	-0.225	0.103	-0.349	-0.276	-0.276	-0.087
(Constant)	-5.475	-6.728	-8.577	-5.635	-7.074	-9.445	-5.559	-8.561	-6.488	-5.329	-5.467	-6.635

Table 9 reports the function coefficients of the three categories of companies based on their solvency position. Fisher's linear discriminant (1936), although it is not a discriminant but rather a specific choice of direction for the projection of the data down to one dimension

In our study, discriminant analysis involving three categories of companies and sixteen explanatory variables related to profitability, liquidity, leverage, and activity ratios. Through the Fisher linear function, we not only wanted to determine if the categories differ significantly on the sixteen continuous variables, but we are also interested in predicting variety classification for an unknown variable.

High Solvent Position = Intercept + b1(DER)+ b2(ROE)+ b3 (ROA)+ b4(TITA)+ b5(ROS) + b6(PATR)+ b7 (PBTR)+ b8(FATR)+ b9(CR)+ b10 (WCR) + b11(EBIT/EBT) + b12 (CATR)+ b13(WCTR)+ b14(TATR) + b15 (TDTS)+ b16(CPR)

Medium Solvent Position =- Intercept + b1(DER)+ b2(ROE)+ b3 (ROA)+ b4(TITA)+ b5(ROS) + b6(PATR)+ b7 (PBTR)+ b8(FATR)+ b9(CR)+ b10 (WCR) + b11(EBIT/EBT) + b12 (CATR)+ b13(WCTR)+ b14(TATR) + b15 (TDTS)+ b16(CPR)

Weak Solvent Position = Intercept + b1(DER)+ b2(ROE)+ b3 (ROA)+ b4(TITA)+ b5(ROS) + b6(PATR)+ b7 (PBTR)+ b8(FATR)+ b9(CR)+ b10 (WCR) + b11(EBIT/EBT) + b12 (CATR)+ b13(WCTR)+ b14(TATR) + b15 (TDTS)+ b16(CPR)

In the present study, b1 to b16 is the regression coefficient of associated explanatory variables. The interpretation of the results of a two-group problem is straightforward and closely follows the logic of multiple regressions:

The companies with a strong solvent position (Group 1) according to equity shareholders' funds to total assets (EETA), the variable total income to total assets (TITA) has the highest positive value of regression coefficient followed by working capital turnover ratio (WCR) and fixed assets turnover ratio (FATR). The variables return on assets (ROA) and total assets turnover ratio (TATR) in this group have a high negative value of the regression coefficient. Medium solvent companies according to equity shareholders' funds to total assets (EETA), the variables return on assets (ROA) and total assets to turnover ratio (TATR) show high impact as revealed from their regression coefficients. The weak solvent companies' regression coefficients of total income to total assets (TITA) and return on assets (ROA) show high positive and negative values respectively.

According to debt to total assets (DTA) criterion, the companies with a strong solvent position have higher value regression coefficients namely., total income to total assets (TITA) and debt equity ratio (DER). The companies with medium solvent positions have a higher impact of total assets turnover ratio (TATR), debt equity ratio (DER) and working capital turnover ratio (WCR) respectively. The companies with weak solvent positions have a highly positive and negative value of regression coefficients namely, total income to total assets (TITA) and total assets turnover ratio (TATR).

As per the third criterion of solvency debt to total liabilities (DTL), the companies with a very strong solvent position have a high positive impact of variables namely, income to total assets (TITA) and debt equity ratio (DER). The return to assets (ROA) and total assets turnover (TATR) have a high negative value of standardizing regression coefficients. The companies with moderate solvent position show that return to assets (ROA) and total income to total assets (TITA) are comparatively much higher values of regression coefficients. The companies with very weak solvent positions have high positive and negative values of regression coefficients of total income to total assets (TITA) and total assets turnover ratio (TATR) respectively.

In the last measure of solvency cash flow to total liabilities (CFTL), the companies are in strong solvent position the variables total income to total assets (TITA) and return on assets (ROA) have a much higher positive and negative value of standardizing regression coefficient. According to this criterion, the companies with medium and very weak solvent positions have a much more positive and negative impact on total income to total assets (TITA) and return on assets (ROA) respectively.

The variables with the largest (standardized) positive regression coefficients are the ones that contribute most to the prediction of a group membership. Similarly, negative values of regression coefficients show negative involvement for the prediction of a group membership.

Figure 2: Canonical Discriminant Function (EETA)

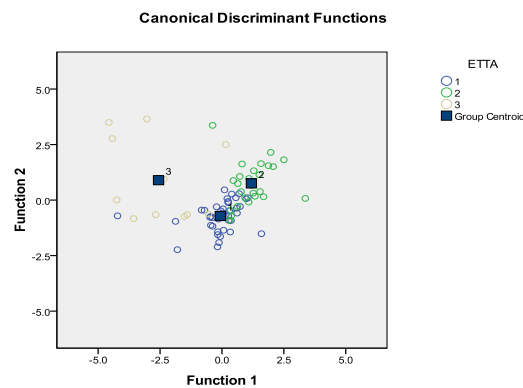


Figure 3: Canonical Discriminant Function (DTA)

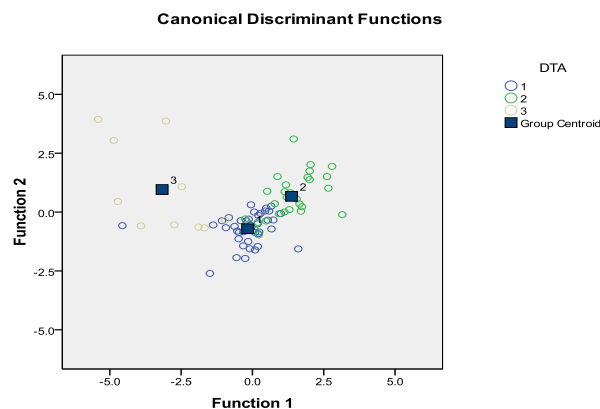


Figure 4: Canonical Discriminant Function (DTL)

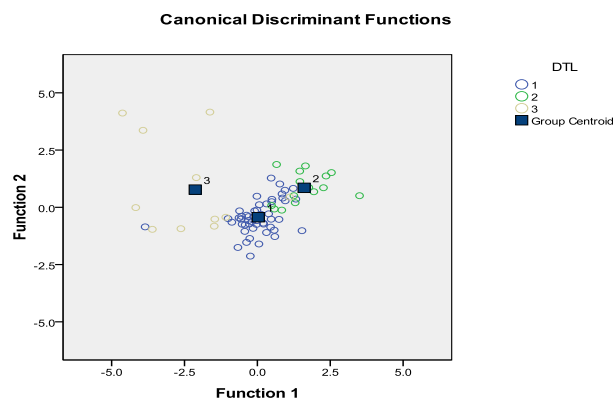
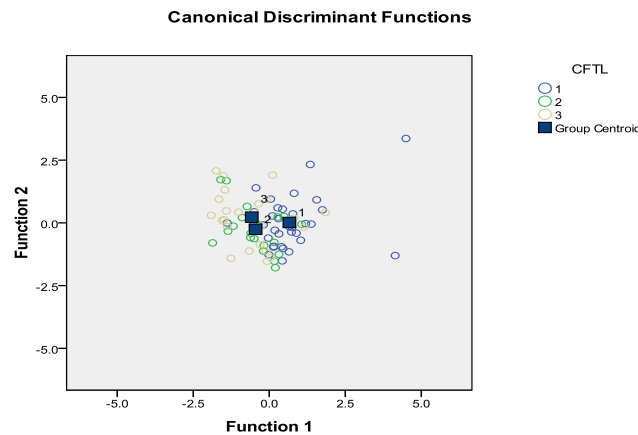


Figure 5: Canonical Discriminant Function (CFTL)**Table 10: Acceptance and Rejection of hypotheses**

S.NO.	Hypothesis	Decision
H1:	The different measures of profitability can distinguish between strong solvent, moderate solvent and weakly solvent IT companies	Accepted
H2:	Liquidity of selected companies can discriminate them into very healthy, moderately healthy and unhealthy IT companies	Rejected
H3:	Leverage ratios of selected companies can separate them into very healthy, moderately healthy and unhealthy IT companies	Accepted
H4:	The different measures of activity ratios are able to distinguish between strong solvent, moderate solvent and weakly solvent IT companies	Accepted

5.0 Conclusion:

The present study aims to develop models to predict the insolvency in Information Technology sector companies. The study uses the four measures of insolvency namely, equity shareholders' funds to total assets (EETA), debt to total assets, (DTA), debt to total liabilities (DTL), and cash flow after tax to total liabilities (CFTL). Later, all the companies have been categorized into three groups using the different measures of insolvency namely, strong, medium, and very weak solvent position. Numerical values are assigned one to three to companies having strong, medium, and very weak solvent positions. The companies those who are in the third group are likely to fail in the coming years. The different financial ratios of four major headings namely, profitability, liquidity, leverages, and activities are used as explanatory variables. Out of these ratios, the seven ratios are related to profitability, two for liquidity, four for activity, and the remaining three of leverage. All these parameters have been identified from the previous study. The objective of using these different financial ratios is to identify the comprehensive impact on the insolvency of four major areas of finance. Moreover, there could not be a single reason for the insolvency of failed companies. Due to this, the four different financial ratios have been used as explanatory variables. Data of all the stated explanatory and dependent variables have been procured from the Prowessiq database of CMIE for the period 1998 to 2023. Out of 4495 companies, only 80 companies are part of the study. The companies that have been shut down

during the study period and companies have not consistent data of different variables are dropped.

The study employs multiple discriminant analysis (MDA) to forecast the factors responsible for the insolvency of IT sector companies. Since there are three groups of companies as per their solvency position, so two discriminant function is created and both of these functions are found significant 5% levels using all different criterion of solvency Classification results, higher canonical correlation and Wilks' Lambda test confirm the statistical significance of research results. Altogether, the discriminant analysis turns out to be a suitable statistical method for solving the presented research problem. Overall, the results of MDA indicate that there is a significant difference in financial ratios or predictors variables of financial sound, moderate, and weak companies.

The results of the univariate analysis of discriminant functions depict the ability of different explanatory variables to separate the companies in strong, moderate, and very weak solvent positions. Using the first and second criterion of solvency (EETA and DTA), the profitability ratios namely, return on equity (ROE), return on assets (ROA), total incomes to total assets (TITA) significantly separate the three groups (Strong, moderate and weak) of IT companies. Similarly, the study by (Vieria 2010; Dhaiyat, 2016) used the same factors for the assessment of profitability and stated that these impact the profitability of the firm very strongly. The debt-equity ratio (DER) and total debt to total sales (TDTS) the measures of leverage are also significantly discriminating the three categories (Strong, moderate, and weak) of companies according to their solvent position. The study by (Bhat 1980) used all the stated factors except the size of the firms that showed insignificant results related to the solvency position of the firm. The significant values of F statistics of activity ratios (WCTR, TATR, and FATR) are also significantly separate between healthy, moderately healthy, and unhealthy IT companies. The study by (Singh and Pandey, 2008; Guimaraes and Nossa, 2010) depicted that working capital is the most influential ratio that strongly impacts the short term liquidity of the firm and daily working condition. The third measure of solvency depicts that all the above-stated measures of profitability and leverage are again significantly discriminate between three sets of companies (Strong, Medium, and very weak). But only two measures of activity ratios (TATR and WCTR) can divide the three different groups of companies. Similarly, (Xia, 2019) used the same variables and inferred the strong relation of total asset turnover ratio and working capital ratio. The study stated that it enhances the sales capacity of the firm largely. The overall empirical findings of the study show that there is significant discrimination in the solvency position of companies according to their three financial performance criteria (profitability, leverage, and activity). But the liquidity is not able to discriminate against the solvency position of companies. The same results are shown in the research by (Dahiyat, 2016). In the case of the last measure of insolvency cash flow to total liabilities (CFTL), the profitability measures (Return on assets and sales, profit after tax ratio) can significantly distinguish between very healthy, moderately healthy, and unhealthy companies. All the measures of leverage (DER, TDTS, and PBT/PBIT) are not able to split the three groups of companies. The activity ratios (FATR and TATR) are also significantly differentiated between three sets of companies.

The outcomes of the study will be helpful to concerned authorities to take necessary actions to revive the companies which are likely to fail in the upcoming period. Policymakers will also be

benefitted from knowing the critical factors responsible for companies that are likely to become bankrupt. Accordingly, the policymakers may issue financial assistance, subsidies, and advice to concerned companies. Moreover, different stakeholders or society will be benefitted by knowing the outcomes of the study and formulate a future strategy to deal with these companies.

Data Availability Statement:

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Received: 21 Aug 2025 | Accepted: 18 Sep 2025 | Published: 23 Sep 2025