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**The Financial Determinants of  
Corporate Creditworthiness:  
Perspectives from Egypt**

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**Abstract**

Evaluating a firm's creditworthiness has become essential, mainly in recent decades. The promotion of a reliable evaluation model and dependable techniques will help lenders to take initiatives of investment & empower borrowers to access different sources of financing. The aim of this paper is to establish a reliable credit scoring model depending on a set of financial performance indicators independent variable, with consideration of industry dummies and logarithm of firm's size. The study employed a set of 50 financial indicators for the non-financial firms listed in EGX 50. Industrial financial performance measures were considered via industries financial information obtained by official publish of Egyptian Central Agency for Public Mobilization & Statistics (CAPMAS). The analysis of three models performed, the first model was the original one, which examined the significance of financial indicators standalone in relation to observed developed credit score. The second model examined the industry effect on the first model, while the third examined the size effect. A robust result of the significance of liquidity, assets efficiency & profitability categories for listed firms sample only.

**Keywords:** Credit Scoring, EGX50

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## المحددات المالية للجدوى الائتمانية للشركات: من منظور الدولة المصرية

في العقود الأخيرة، أصبح تقييم الجدوى الائتمانية علي المستوى المؤسسي أمرا في غاية الأهمية، حيث يساهم في تمكين المقرضون والمستثمرون من المبادرة لتمويل المشروعات والمؤسسات الواعدة الباحثة عن مصادر للدعم المالي.

بناءا عليه، فإن تقديم نموذج لتقييم الجدوى الائتمانية علي اساس علمي ويعتمد عليه سيساعد بالتأكيد في خلق العلاقة المتبادلة بين الجهات الممولة والمستفيدة. إن هدف هذه الدراسة، هو تقديم نموذج لتقييم الجدوى الائتمانية اعتمادا علي عدة متغيرات اساسية وهي مؤشرات الأداء المالي، أخذا في الاعتبار القطاعات السوقية و حجم المنشأة كمتغيرات مساعدة.

لقد تم من خلال هذه الدراسة، اختبار 3 نماذج، الاول اختبار عدد 50 مؤشر الأداء المالي وتأثيرهم علي التقييم الائتماني المحسوب. بالنسبة للنموذجين الثاني والثالث، هما اختبار ادراج متغيرات القطاع السوقي وحجم المنشأة علي النموذج الاول، علي التوالي. الدراسة تضمنت عينة من الشركات المتوسطة والصغيرة الغير مالية المدرجة بمؤشر البورصة المصرية للمشروعات الصغيرة و المتوسطة (EGX 50) والشركات السالف إدراجها وتم استبعادها من المؤشر.

بالإضافة إلي المؤشرات المالية للقطاعات السوقية التي تم احتسابها بناءا علي النتائج المنشورة بجهاز التعبئة العامة والاحصاء المصري (CAPMAS) أسفرت النتائج عن أن المؤشرات الخاصة بالسيولة، إدارة وكفاءة تشغيل الاصول والربحية، هم الاقوي تأثيرا بالنسبة العينة الخاصة بالشركات المدرجة فقط.

**الكلمات المفتاحية:** التصنيف الائتماني، مؤشر EGX50

## 1. Introduction

After regulations had been introduced by Basel Committee for Banking supervision (BCBS), known by Basel-II banking norms in 2004, the importance of credit scoring had been significantly perceived, however, many banks officers are still depending on the IRB Approach in evaluating clients financial health & performance, to avoid errors may be occurred from attempting applications of credit scoring model, due to its complexity of adopting in dynamic environments as it requires an extremely committed & careful investigations, examinations & tests. Therefore, financial institutions have the preference to finance well established businesses rather than riskier small ones. The benefits derived from adopting credit scoring are not only limited to assessing various credit factors may arise in the future. But also helps financing bodies in appropriately defining lending types, tenors & pricing in terms of interests & commissions required for granting a loan. Banks still depend on subjective qualitative factors to evaluate a credit applicant (firm's characteristics, legal form, entrepreneur's characteristics & collateral, etc....).

Subsequently, financial firms have moved to quantitative credit scoring after recommendations of Basel-II (BCBS, 2004). The Internal Rating-Based Approach, which banks can use to determine their minimum capital needs, is encouraged by Basel II, the Revised International Capital Framework. The internal rating approach's main goal is to make important factors that determine risk more vulnerable. Asset quality, and consequently to the possible financial losses of a portfolio. In Egypt, the banking sector in Egypt is the dominant lending channel for both segments, and the CBE reform in 2004 aimed to create a more efficient and sound banking sector. This led to a robust, solid and well capitalized banking system, with assets increasing by 88%, deposits increasing by 85%, and capital adequacy ratio increasing from 12.2% to 15.1%. However, the implementation of credit scoring approach is still disregarded. According to (Hussein, A., El-Masry, A. and John, P., 2006), Judgmental techniques used for risk evaluation, are to evaluate credit risk in Egyptian banks.

## **2. Effects of Financial Performance Indicators in credit scoring modeling**

Altman (1968) used multiple discriminant analysis technique (MDA) to solve the inconsistency problem linked to the Beaver's univariate analysis, and identified 5 financial ratios providing the best overall prediction of corporate bankruptcy, including liquidity, profitability, leverage, solvency and activity ratios. The profitability ratio was found to be the highest contributory factor to predict distress. Deakin (1972) found that profitability, liquidity and solvency are the most discriminating ratios for predicting failure.

Ohlson (1980), found that 4 variables predict bankruptcy, and the developed model was more accurate than previous studies, namely, company's size, liquidity, performance, and financial structure of the company. In a study by (Khemais, Z., Nesrine, D. and Mohamed.M., 2016), they found that : Ratio of the value added, supplier credit settlement period, Gross margin on revenues, Gross Profitability of total assets, Net Profitability of total assets, Excess of insufficient capital, Excess on insufficient current liabilities, Working capital, Liquidity in the broad sense, Liquidity in the strict sense, are contributing in credit scoring method to properly predict the probability of default of the counterpart. Ciampi and Gordini (2008) found that economic-financial ratios can be effective tools in small enterprises' default prediction modelling, with profitability & liquidity positively predicting default, while leverage is a negative predictor. Zenzerović (2011) results showed that either liquidity or profitability are positively related and affect the credit score, while solvency negatively affects the credit score.

Beaver (1966) found that the cash flow to total debt ratio can correctly classify both failed and non-failed firms to a much greater extent than would be possible through random prediction. However, the predictive power of the liquid asset ratios is much weaker, and the cash flow ratio in the fifth year before failure is greater than one year before company fails. Yurdakul and Tansel (2004) found that capital structure & long-term solvency had the highest weight,

followed by short term liquidity and profitability. Yusof et al, (2021) found that higher asset to debt ratio, higher returns, and lower volatility estimates higher distance to default (DD) and, thus, lower PD. It also found that higher liquidity, solvency, profitability, interest coverage, and lower indebtedness estimate better financial performance. Liang (2012) considered financial ratios measuring profitability, leverage and liquidity. The study confirmed that profitability, leverage and liquidity predict default.

(Emel et al, 2003) concluded that firms with higher credit scores have higher liquidity, lower bank loans, higher capital adequacy, and a better balance between equity and fixed assets. Min and Lee (2008) found that financial expenses to sales (FE), current liabilities to owners' equity (CL), total borrowings and bonds payable to total assets (TB), capital adequacy ratio (CA), current ratio (CR) and interest coverage ratio (IC) positively affect a firm's credit score. Sezgin (2006) found that current ratio, total asset turnover ratio, fixed asset turnover ratio and current liabilities to net sales are positively contributing to firm credit scoring. (Zhang et al, 2013) also, found that current ratio, accounts receivable turnover ratio, total asset turnover ratio and return on equity ratio significantly influence credit risk of high-tech enterprises.

(Lin et al, 2012) employed the financial ratios in main categories with consideration the asset size as one of the company size indicators. Gonçalves et al, (2014) found that financial capital in terms of support provided by partners in the financing activity, such as the intensity of use of assets management and reduced debt pay-back period reduce the risk of default.

Yoshino and Taghizadeh-Hesary (2018) found that leverage can have a positive effect on company performance if the equity is dominating the liability, after examining a set of financial variables for the categories of: Leverage, liquidity, profitability, coverage, and activity). Michaelas et al, (1999) concluded the negative relationship between profitability & gearing ratios, this means that firms with higher profits are considered healthier & better performer, so will

affect positively its credit score. This result is also confirmed by Hall, et al., (2000).

Gama and Geraldes (2012) developed a credit scoring model, showing that default firms exhibit lower mean values in their profitability, while more profitable firms generate larger cash flows and face lower funding costs. Alfaro et al, (2008) forecasted corporate bankruptcy & concluded that the efficiency ratios are the most positively significant variable that explains the corporate performance, while the leverage plays a negative significant effect. (Bhimani et al, 2010) found that Activity Ratio (Interest Cost/Gross Income), and Liquidity Ratio (W.C/T.A) have the largest effects on the probability of default. The level of capital is also relevant, with a high solvency ratio indicating the firm's ability to finance assets with own equity and a larger proportion of working capital indicating the availability of funds to meet short-term commitments. Accounting ratios such as Profitability (ROI & ROE), Coverage, DPO, ACP, and Growth ratios show very low influence.

Ciampi (2015) found that profitability & coverage ratios are negatively correlated with default, while leverage ratio is positively correlated.

Khemakhem and Boujelbene (2015) concluded the highest discriminate power was found to be between "Long- and medium-term debt/ Permanent capital" and "Equity/Permanent Capital", Mossman (1998) found a positive relationship between profitability, liquidity, and financial health, while leverage had a negative relationship.

Pervan and Kuvrek (2013), also Concluded that Leverage ratio increases probability of insolvent-defaulted, while solvency, liquidity and profitability decrease it. Using ratios from Altman's model, and following Pindado and Rodrigues (2001) confirmed that, Profitability & coverage are the most important variables for solvency, with Accumulated Earnings/Total Assets the most discriminating.

Appiah and Abor (2009) argued that profitability should not be used as a measure of solvency due to the collapse of big profit-making firms, , examined

whether corporate failure can be predicted by developing a Z-score model. (Tetteh et al, 2014) found that the interest coverage ratio was statistically significant, and the liquidity (Cash/T.A) ratio had a negative relationship to probability of default.

Doumpos, Niklis, Zopounidis and Andriosopoulos (2015) employed a model widely found that highly rated firms are more profitable, have higher interest coverage, and are better capitalized and leveraged in terms of long-term debt. Gupta and Gregoriou (2015) confirmed Profitability, Liquidity, Coverage & Solvency have a significant negative relationship to default probability, with firms with higher retained earnings, higher liquid assets, higher net worth and lower financial expenses having lower probability of default.

Paleologo, Elisseff and Antonini (2010) found that financial variables of: profitability, efficiency, productivity, liquidity, cost incidence & leverage, with high frequencies were best for discriminating bad from non-bad firms. Altman et al, (1977) developed a new bankruptcy classification model. ZETA model is effective in classifying bankrupt companies up to five years prior to failure, with higher accuracy than the traditional Z score model.

Giannouli et al, (2021) found a positive relationship between profitability, asset efficiency, liquidity, and creditworthiness, with leverage having a negative relationship. Pompe and Bilderbeek (2005) assessed the predictive power of different categories of financial ratios, of bankruptcy. They confirmed that solvency ratios appear to be the strongest, but certain of the profitability and activity ratios also performed well in all 5 years. None of the liquidity ratios had a high predictive value just before bankruptcy, but some did predict well in years 4 and 5.

Edmister (1972) concluded that solvency, Profitability, Liquidity & activity ratios have a negative relationship to firm failure, while leverage ratio has a positive relationship. Beaver et al, (2005) investigated the predictive power of financial ratios for bankruptcy, They confirmed the significant negative relationship of profitability & coverage of a firm to bankruptcy, while the

significant positive relationship of firm's leverage to be bankrupted. Effects of Firm SIZE & industry effects on credit scoring modeling:

Michaelas et al, (1999) found that a firm with larger assets size is eligible to higher credit score. This finding is also relevant to the study provided by (Hall et al, 2000). Alfaro et al, (2008) results argued that corporate size represented by the natural logarithm of firm's assets, has a significant positive effect on its global performance. Also, Bhimani et al, (2010) confirmed size is positively related to default. Tetteh et al, (2014) measured firm size as the logarithm of total assets.& yielded a negative and statistically significant influence on the probability of default.

Doumpos, Niklis, Zopounidis and Andriosopoulos (2015) measured firm's size by the logarithm of their market capitalization (CAP). confirmed that highly rated firms have higher market capitalization. Total assets are also strongly associated with the ratings, but the correlation is considerably weaker. Ciampi (2015) concluded that firm size is not associated with firm default.

### **3. Motivation of the Study**

This paper is undertaken based on the lack of studies in literature which undertake the development of credit scoring model for Egyptian corporate sector in general to provide a standard credit scoring model which helps banking organizations in effectively & efficiently manage their credit risks, optimize capital requirements & efficient loans pricing in terms of interest rates & related charges & commissions which affect borrowers willing for debt to finance their assets & operating activities.

#### **3.1 Objectives of the Study**

1. Examine the common determinants affect lending decision to corporate credit scoring accordingly.
2. Establish final the credit scoring model in relevance with highest significant variables.



### **3.2 Contribution of the paper**

This study provides a significant contribution to the literature of developing a credit scoring model using financial indicators.

## **4. Data**

The data includes the non-financial firms listed in AGX 50. The data is obtained from the authority of Egypt Stock Exchange. The financial indicators are the work of the authors. The data covers the annual balance sheets and income statements for the years 2010 -2020.

### **4.1 Dependent Variable**

The dependent variable is the firm's Credit Scores. The credit scores were developed employing the following algorithm. The researcher offers an algorithm that compares the published financial ratios. As far as the general trend of financial indicators is to be greater than the industry average, the General algorithm is as follows. If a financial Ratio > Industry, the Score = 1, otherwise, the score = Ratio ÷ Industry average.

### **4.2 Independent variables**

The independent variables include five accounting ratio categories describing the main aspects of a company's financial profile: liquidity/solvency, asset efficiency, expense control, leverage & profitability. For each one of these categories, a number of financial ratios have been calculated.

## **5. Statistical Testing**

Each model went through standard statistical tests. Hausman test to choose between fixed and

random model. RESET test to check if the linear or non-linear form is appropriate for estimating the model. Heteroscedasticity test to show if residuals are homogenous or heterogenous.

### 5.1 Testing for Random Vs Fixed Effects (Hausman test)

Since the data are cross section–time series panel, the Hausman specification test (Hausman, 1978; Hausman and Taylor, 1981) is required to determine whether the fixed or random effects model should be used. The test looks for the correlation between the observed  $x_{it}$  and the unobserved  $\lambda_k$ , thus is run under the hypotheses that follow.

$$H_0 : \text{cov}(x_{it}, \lambda_k) = 0$$

$$H_1 : \text{cov}(x_{it}, \lambda_k) \neq 0$$

Where  $x_{it}$  = regressors, and  $\lambda_k$  =error term.

### 5.2 Mixed effect regression model

The mixed effects model can be defined as:

$$Y_i = X_i\beta + Z_i b_i + \varepsilon_i,$$

where  $Y_i$  is an  $t_i \times 1$  vector of observations for  $i^{\text{th}}$  market takes the form  $[y_{i1}, y_{i2}, \dots, y_{it}]^T$ ,  $X$  is an  $t_i \times p$  matrix of covariates, and  $\beta$  is vector of covariates, and  $Z_i, a t_i \times q$  (number of unknown variables) is a subset of  $X_i$ , modeling how the response evolves over time for the  $i^{\text{th}}$  Market. Furthermore  $b_i = [b_{i0}, b_{i1}, \dots, b_{i(q-1)}]^T$  is a  $q \times 1$  vector of random effects for the  $i^{\text{th}}$  Market describing unknown market characteristics.  $\varepsilon_i$  is a vector of residual components, it is usually assumed that the errors  $\varepsilon_i's$  are independent and normally distributed with mean vector 0 and covariance matrix  $\sigma_\varepsilon^2 I_{m_i}$ , and the random effects  $b_i's$  are independent of  $\varepsilon_i's$ , and normally distributed with mean vector 0 and covariance matrix  $V_b$ .

$$Y_k = b_o + \sum_i \beta_i * X_i + \varepsilon \quad k=1,2,3$$

Where:  $Y_k$  : calculated credit score,  $X_i$  : Two groups of independent variables namely the observed and optimal indicators of corporate financial performance. The financial indicators are classified into six groups namely, Solvency (or Liquidity) Ratios, Assets Efficiency Ratios, Expense Control

Ratios, Debt (or Leverage) Ratios, Profitability Ratios and Dividend Ratios (Penman, 1991, 1996, 2003).

$\beta_0$  : constant term

$\beta_i$  : is the regression coefficient for independent variables.

$\varepsilon$ : is the regression residual term

Each model went through standard statistical tests. Hausman test to choose between fixed and random model. RESET test to check if the linear or non-linear form is appropriate for estimating the model. Heteroscedasticity test to show if residuals are homogenous of heterogenous.

**Table 1 - The Results For Hausman Tes**

**H<sub>0</sub>:differences in coefficients are not systematic; H<sub>1</sub>: differences in coefficients are systematic.**

Model 1: Main indicators of Corporate Finance Performance. Model 2: Main indicators of Corporate Finance Performance and Industry Effects. Model 3: Main indicators of Corporate Finance and Size Effect

|                                     | <b>Model 1</b>                          | <b>Model 2</b>                           | <b>Model 3</b>                              |
|-------------------------------------|---|--|---|
| <b>Statistic<br/>(Significance)</b> | chi2(34) = 39.07<br>(Prob>chi2 = 0.267) | chi2(34) = 26.63<br>(Prob>chi2 = 0.9521) | chi2(34) = 18.69<br>(Prob>chi2 = 0. 0.8429) |

Table (1) shows that the best model for fitting the first model is random effect model as the p-value associated with the test is larger than 5%.

**Linearity Vs Nonlinearity Test (RESET) for the listed Companies**

The issue of linearity versus nonlinearity is addressed and examined as well. Regression Equation Specification Error Test RESET (Ramsey, 1969; Thursby and Schmidt, 1977; Thursby, 1979; Sapra, 2005; Wooldridge, 2006) is employed to test the two hypotheses that follow.

$$H_0 : \hat{\gamma}^2, \hat{\gamma}^3 = 0$$

$$H_1 : \hat{\gamma}^2, \hat{\gamma}^3 \neq 0$$

The null hypothesis refers to linearity and the alternative refers to nonlinearity.

Ramsey RESET test using powers of the fitted values of dependent variables.

$H_0$ : model has no omitted variables.

$H_1$ : model has omitted variables.

### Table 2 – Linearity Test

**$H_0$ : model has no omitted variables;  $H_1$ : model has omitted variables.**

Model 1: Main indicators of Corporate Finance Performance. Model 2: Main indicators of Corporate Finance Performance and Industry Effects. Model 3: Main indicators of Corporate Finance and Size Effect

|                             | <b>Model 1</b>                      | <b>Model 2</b>                      | <b>Model 3</b>                      |
|-----------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| Statistic<br>(Significance) | F(3, 217) = 1.17 (Prob > F = 0.131) | F(3, 217) = 1.39 (Prob > F = 0.298) | F(3, 217) = 1.05 (Prob > F = 0.561) |

The results in table (2) show that at 95% confident we fail to reject the null hypothesis of the RESET test which means that the linear model fits the data.

Heteroskedasticity test ( $H_0$ : the variance of error terms is constant;  $H_1$ : the variance of error terms is not constant)

**Table 3 – heteroskedasticity test**

Model 1: Main indicators of Corporate Finance Performance. Model 2: Main indicators of Corporate Finance Performance and Industry Effects. Model 3: Main indicators of Corporate Finance and Size Effect

|                                     | <b>Model 1</b>                             | <b>Model 2</b>                                 | <b>Model 3</b>                                 |
|-------------------------------------|--|--|--|
| <b>Statistic<br/>(Significance)</b> | chi2(1) =1671.29 (Prob ><br>chi2 = 0.0000) | chi2(1) = 2831.75<br>(Prob > chi2 =<br>0.0000) | chi2(1) = 2695.60<br>(Prob > chi2 =<br>0.0000) |

The results in (3) show that the null-hypothesis of heteroskedasticity is rejected at 1% significance level. That is, the variances of residuals are not constant, which requires the use of robust estimation in order to estimate the parameters of the models under consideration.

## 6. Results and Discussion

All studies in the domain of developing a credit scoring model have mainly one objective, which is the assessment of firms' ability to meet stakeholders' interests & to empower investors & lenders to establish a relationship with the firms' business. Previous studies had different aims from developing a credit scoring model, either in predicting failure, probability of being defaulted & prediction of potential bankruptcy, or assessing creditworthiness of firms, which all have the same meaning. A credit worthy firm should reflect financial healthy situation & reasonable financial performance, otherwise the firm will face financial distress & therefore probable of being defaulted in meeting its outstanding obligations which leads to failure by any form, either bankruptcy or liquidation. The current study is in line with previous ones. The study considered the effect of financial indicators in developing the credit score, through which financial performance & creditworthiness could be identified. The analysis considered the same categories adopted by the previous studies, however that different terminologies might exist. The financial performance of a firm is mainly depending on: Liquidity, Solvency, Asset efficiency (may be

considered as activity in previous researches), Expense control (also considered as activity in previous studies), Profitability & Leverage (includes the effect of debts & borrowings & the debt service ratios which may be considered as coverage ratios as an independent category in the previous researches). Whenever thinking of a firm's performance, it is usually perceived that a creditworthy one should be profitable, solvent, efficient, controlled & reasonably leveraged. Meanwhile, profitability effect is with broad significance. In addition, solvency was found to be negatively affect the credit score of a firm. Moreover, (Altman,1968), In his study predicting bankruptcy through generating the Z score model, the study confirmed the significant negative relationship of either liquidity and/or solvency & profitability, to a firm bankruptcy. Moreover, the study confirmed the negative relationship of firm's activity through examination of assets turnover ratio, to a firm bankruptcy. In addition, confirmed the significant positive relationship of leverage to a firm bankruptcy. Also, (Khemais. Z, Nesrine.D & Mohamed. M,2016) confirmed the significant positive relationship of liquidity in its broad sense to firms' creditworthiness by concluding that liquidity affect the score model positively & this negatively related to probability of default & lower the default risk. (Ciampi.F; Gordini.N, 2015) Also confirmed the positive relationship of liquidity & financial health of a firm, which is negatively related to probability of being defaulted. While confirmed the negative relationship of leverage, which is positively contributing & related to probability of being defaulted. Also confirmed the positive relationship between profitability & financial health of a firm, which is negatively related to probability of being defaulted. In addition, (Liang, 2012) Confirmed that liquidity & profitability of defaulting firms are negatively related to default. In contrast, leverage reported the positive relationship to probability of being defaulted.

**Table 4: Financial Determinants of Corporate Credit scores**

**6.1** Model 1: Main indicators of Corporate Finance Performance. Model 2: Main indicators of Corporate Finance Performance and Industry Effects. Model 3: Main indicators of Corporate Finance and Size Effect.

| <b>Independent Variables</b>                   | <b>Model 1</b> | <b>Model 2</b> | <b>Model 3</b> |
|--|----------------|----------------|----------------|
| <b>Company Liquidity (Solvency) Indicators</b> |                |                |                |
| Inventory/Current Assets                       | 13.8**         | 15.0*          | 74.81**        |
| Accounts Receivables/Current Assets            | 24.81          | 53.91          | 7.72           |
| Current Ratio                                  | -73.18**       | -68.91***      | -69.4*         |
| <b>Asset Efficiency Indicators</b>             |                |                |                |
| Sales To Fixed Assets                          | -<br>21.63***  | -73.2***       | -62.24***      |
| Inventory To Total Assets                      | 63.6*          | 56.1*          | 59.23          |
| Sales To Accounts Receivables                  | 62.22          | 10.73          | 16.93          |
| Sales To Common Equity                         | 91.72          | 41.49          | 51.32*         |
| Total Assets/Net Sales                         | 67.73          | 71.23          | 44.11          |
| Accounts Payables/Annual Net Sales             | -49.69         | -42.5          | -32.19         |
| Total Equity/Fixed Assets                      | 25.1***        | 60.49***       | 63.88***       |
| <b>Expense Control Indicators</b>              |                |                |                |
| Gross Profit to Sales                          | 6.01           | -8.281         | -9.628         |
| Cost Of Sales/Net Sales                        | -5.835         | 11.78          | 9.696          |
| Operating Expenses/Gross Margin                | 6.239          | -3.721         | 4.868          |

|  |         |          |          |
|--|---------|----------|----------|
| Operating Expenses/Total Assets            | 0.521** | 0.464    | 0.18     |
| <b>Leverage Indicators</b>                 |         |          |          |
| Total Equity/Total Debt                    | 33.22*  | 18.68    | 27.36    |
| Total Equity/Long Term Debt                | 54.28   | 81.29    | 13.15    |
| Long Term Debt/Total Assets                | 19.87   | 1203     | 14.99    |
| Long Term Debt/Total Equity                | 28.01   | 12.93    | 37.60    |
| Short Term Debt/Total Debt                 | 42.11** | 18.92*** | 39.23*   |
| Financial Leverage = Times Interest Earned | 14.5**  | 128      | 11.9     |
| <b>Profitability Indicators</b>            |         |          |          |
| Net Operating Profits/Total Assets         | -3.4    | 4.7      | 5.1      |
| Net Income / Number Of Outstanding Shares  | -4.81*  | -5.9     | -1.23    |
| Earnings Annual Growth                     | 0.821   | -0.913   | 0681     |
| Retained Earnings Per Share/Eps            | 0.921   | -0.900   | 0.831    |
| Real Estate                                |         | 11.21*   |          |
| Engines                                    |         | -13.6**  |          |
| Size (Ln Total Assets)                     |         |          | -31.26** |
| Constant                                   | 62.11   | 13.74    | 32.73    |
| R Squared                                  | 0.2435  | 0.2892   | 0.3194   |
| Wald                                       | 88.3*** | 89.24**  | 88.78*** |



|                                |     |     |     |
|--------------------------------|-----|-----|-----|
| Observations                   | 420 | 420 | 420 |
| Number Of ID                   | 38  | 38  | 38  |
| *** P<0.01, ** P<0.05, * P<0.1 |     |     |     |

The results shown in table 4 (Model 1) reflect the effect of financial ratios in respect to its categories on the obtained credit score at different levels of significance.

### Company Liquidity (Solvency) Indicators

The results show the negative effect of either firms' liquidity and/or solvency on firms' credit score & therefore firms are considered to be less creditworthy, which means that they may not be able to meet its obligation & may be subjected to default.

**Inventory/Current Assets:** Listed firms do not possess inventory as a proxy of liquidity to meet its obligations, so it is significantly & negatively affected firms' creditworthiness at 0.05 level with coefficient (-108.9).

**Current Ratio:** this ratio is one of the most popular liquidity indicators which is frequently used to measure the capability of short-term assets in meeting firms' short term obligations. For listed firms, the results show that current assets have not the capability to meet firms short term liabilities & have a significant negative effect on firms' credit score at .05 significance level & therefore its creditworthiness. Similarly, Beaver (1966), after examining a set of 30 financial ratios, it has been concluded that current ratio predicts liquidity of a firm & one of the 5 selected financial ratios which have discriminatory power among failed & none-failed firms. The selection was based on the lowest percentage of error among the ratios examined, so the current ratio derived its significance from the standard error rate. Also, Deakin (1972) confirmed the significance of current ratio in discriminating between failed & none-failed firms at .001 level. Yurdakul and Tansel (2004), also confirmed the significance among short term liquidity indicators in developing the financial performance score following AHP method in the textile manufacturing firms in Turkey. Roy and Shaw (2021)

results are also in line with the findings of Yurdakul and Tansel (2004). Liang (2012) Also confirmed the significant relationship to creditworthiness of default but in opposite trend, as the study on Chinese listed firms reported the negative relationship to probability of default. In other words, that none-defaulted firms have significant positive effect of the Current Ratio on their credit score. Min and Lee (2008) Reported that a creditworthy firm has a significant positive effect of the strength of liquid short term assets in meeting short term obligations, on firm's credit score. Sezgin (2006) confirmed the significance of current ratio in the contribution in firms credit score but in the opposite trend when conducted a study on 1649 loan applicant of which 61 defaulted firms for a Turkish bank's clients. (Zhang et al, 2013) confirmed current study finding of significance at .05 level but in opposite trend, as their result revealed the negative relationship to probability of the firms to be defaulted when conducted the study on listed hi-tech enterprises in China. Accordingly, their results confirmed the significant negative relationship between current ratio & credit score, meaning that it is positively affecting financial performance which conclude an opposite trend to the current study results. Alternatively, Yoshino and Taghizadeh-Hesary (2018) confirmed that positive effect of AR/TL indicates better firm's performance as contributed positively in firm's credit score. Also, Hermanto and Gunawidjaja (2010) confirmed the negative significant effect on credit score & confirmed that a firm with negative liquidity has a positive probability to be defaulted. Ohlson (1980) confirmed the significant positive effect of CL/CA to firms' bankruptcy score which in contrast to firms credit worthiness, meaning that the negative effect of the current ratio on credit score gives the potential of bankruptcy. Also, Appiah and Abor (2009) confirmed that current ratio significantly affect Zscore development accuracy & has the highest discriminatory power between fail & none-failed firms as a liquidity indicator. Similarly, Andrikopoulos and Khorasgani (2018) confirmed the significance of this ratio but with positive effect & relationship to creditworthiness score on both sides either listed or unlisted at 0.01 significance level. Altman et al, (1977) Confirmed the significant negative relationship to bankruptcy with concluding that this ratio is better

predicting bankruptcy as a liquidity measure, than of confirmed by Altman (1968) which was Working capital/Total Assets, in the traditional Zscore model. This result achieved in developing the ZETA score model. Alternatively, Pompe and Bilderbeek (2005) confirmed that the shrinking of the current assets/short term debt ratio is predicting firms' bankruptcy, indicating that those firms' financial health is affected negatively, meaning that any form of the current ratio is positively related to firms creditworthiness, in other words , the higher this ratio the higher the credit worthiness.

**Cash Ratio:** confirms that listed firm's cash cannot sufficiently meet short term liabilities, which affect negatively its creditworthiness without significance. Alternatively, Pompe and Bilderbeek (2005) confirmed that firms' are facing cash deficit in covering its accounts payable aging for one year may file for bankruptcy , and indicating the insufficient liquidity and low creditworthiness, however, that this ratio is not reported to be significant in the current study's result.

The remaining liquidity measure have contribution in the credit score but don't report any significance. For listed firms, **Cash/Current Assets**, is negatively affects their credit score, so therefore their creditworthiness, meaning that firms do not have sufficient cash to meet its obligations & will be subjected to default; Nevertheless, **Accounts Receivables/Current Assets**, compensate the negative effect of cash to firms credit score & affect firms creditworthiness positively; Current liabilities/Inventory, confirms that firms do not have adequate inventory to work as proxy of liquidity in meeting liabilities & this indicator works as a supplement to current ratio & also have negatively affect firms credit score.

**Accounts Receivables/Current Assets**, negative effect to the credit score, explains the significant positive effect of inventory & confirms that the transformation of inventory to sales is almost nil, as the accounts receivable plays also a negative effect on firms creditworthiness; **Current Liabilities/Inventory** show its inability in meeting firms liability, however that its negative effect is with lower coefficient than listed firms.

## Asset Efficiency Indicators

These indicators reflect to what extent firms are appropriately managing their assets either short term assets or long term, in order to optimally produce goods and offer service which lead to maximize revenues.

**Sales to Fixed Assets**, for listed firms, the results show inefficient of fixed assets management in generating sales, this ratio was found to be negatively affected firms credit score at significance level 0.05.

**Inventory to total assets**, reflects the portion of inventory in firms assets & reflect the financial performance as the lower the ratio reflects better performance as it has a negative significant effect on credit score at 0.01 level. The findings are in line with the study of Babic and Plazibat (1998) who concluded the significant effect of Stock Turnover indicator on enterprise ranking model using Promethee method to form a methodological framework and propose a model which could substitute the synthetic indicator and rank the enterprises according to their business efficiency.

**Sales to Accounts Receivables**, this finding is also confirmed by Yurdakul, M. and Ic, Y.T. (2004) in the usefulness of this indicator in affecting the financial performance score but at moderate significance. (Zhang et al, 2013) Also confirmed the significance at .05 level but the findings reported the negative relationship to probability of default, which indicated the positive contribution in firms creditworthiness & therefore better credit score. In other words, high current assets turnover has positively affecting a firm's credit score and leading to higher creditworthiness as shown in listed firms results.

**Accounts Payables/Annual Net Sales**, the same situation was for listed firms, however that it is found to be insignificant. Instead, Sezgin (2006) findings only agree in the significance effect of the current liabilities/net sales on firm's credit score but oppositely found its positive contribution. Interestingly, Yoshino and Taghizadeh-Hesary (2014) confirmed results of current study of significant negative effect on firm's credit score & therefore worse its financial performance.

**Total Equity/Fixed assets**, the result shows that listed firms fixed assets are financed by shareholders' equity & reflects the creditworthiness of the firms with affecting the credit score positively at a significance level 0.01. Opposite to current study, (Emel et al, 2003) study conducted on one of Turkish bank's clients, they concluded that bad firms have the negative effect of ABS (Asset Base Structure ) ratio on credit score. Also, Pervan and Kuvrek (2013) confirmed the negative relationship with probability of a firm to be defaulted, meaning that this firms are financial healthy & creditworthy.

The model contains some other indicators but with no significance such as: Sales to Common Equity, the results reflect the efficient equity contribution in generating sales & its positive effect on credit score for listed firms. Meanwhile, Yurdakul, M. and Ic, Y.T. (2004) found that the reciprocal of this indicator is one of the efficiency indicators used to develop the financial performance score, however it was with least significance.

**Total Assets/Net Sales**, the result indicates that listed firms management of assets is not reliable to appropriately operating & generating revenues & has negative effect on credit score. Moreover, (Alfaro et al, 2008) study confirmed the significant positive relationship between high assets turnover & firms financial health as it contributes directly to high profitability due to the strength of assets investment in generating sales.

## **Expense Control Indicators**

This category is considered as activity indicators by which the management capability in cost control could be identified & how it leads to firms' financial performance.

**Gross Profit to sales**, In clearer way, there is a positive significant relationship with creditworthiness at 0.01 level driving to potential profitability. The same was for listed firms in positively affecting credit score byut without significance. Ciampi (2015) also confirmed the positive relationship of expense control with firms creditworthiness, but instead he examines the ratio of EBITDA/Turnover, and found a significant negative relationship to firms

probability of being defaulted. Moreover, (Pompe & Bilderbeek, 2005) only confirmed that this ratio is predicting bankruptcy for the young firms, which indicates lack of experience in cost control and may lead to firm's failure. This finding is in line to our results, concluding that increasing in this ratio is positively related to firm's creditworthiness and vice versa.

**Operating Expenses/Total Assets**, This ratio has not been similarly interpreted or employed in the literature and is considered to be a new contribution in the domain of developing a credit scoring model. The result indicates the ability of listed firms in managing the operating costs which will directly affects profitability, meaning that this ratio came with low value which led to have a significant positive effect and relationship to the creditworthiness of the firm and positively contributing in the raise of its credit score at 0.05 significance level.

## Leverage Indicators

**Total Equity/Total debt**, the strength of listed firms equity to meet financial obligations contributed positively in credit score at significance level of 0.1. The result reflects the ability of equity to absorb either short or long term financial obligations & guarantee timely debt repayments.

Yurdakul, M. and Ic, Y.T. (2004) using AHP method, also concluded that D/E ratio which is the reciprocal is the most significant & weighted indicator that contributed in developing the financial performance score.

Roy and Shaw (2021) results are also in line with the findings of Yurdakul, M. and Ic, Y.T. (2004). Alternatively, Yoshino and Taghizadeh-Hesary (2018) study considered leverage effect by examining the effect of Total Equity/Total Liability, which was confirmed that its positive effect indicates the positive performance of the firm & vice versa.

Also, Edmister (1972) confirmed that increase in current liability may lead to firm's failure & found that it represents the debt/equity ratio which is

the reciprocal of current study indicator used. His finding had significance at 0.1 level.

Altman and Sabato (2007) Also confirmed the significant negative relationship of short term debt/Equity Book Value, with firms credit worthiness as it had negatively affected the score of the firm's being good.

Moreover, Ciampi (2015) confirmed the significant positive relationship of debt/equity ratio to firms probability of default.

**Total Equity/Long term debt**, In line with the positive effect of equity/total debt ratio, this finding indicated that the risk of indebtedness is due to the effect of long-term debt & means that equity cannot guarantee the debt repayments on the long term, accordingly, it affects credit score negatively at 0.05 significance level. The contrary is for the listed firms but without significance. Doumpos, Niklis, Zopounidis and Andriosopoulos (2015) confirmed the negative relationship of debt increase to firm rating. The results confirmed the significance of this ratio in developing credit rating model.

**Long Term Debt/Total Assets**, This result indicated that the firm's dependence on debt to finance its long term assets is greater than equity in its capital structure as financed assets are not strong enough to operate to help repaying debts, which may affect financial health & accordingly may lead to failure & increase the probability of default risk. The same was concluded for listed firms but without significance. Beaver (1966) after examining a set of 30 financial ratios, it has been concluded that debt/assets is predicting leverage of a firm & one of the 5 selected financial ratios which have discriminatory power among failed & none-failed firms. the ratio derived its significance from the standard error rate. Also, (Deakin 1972) confirmed Beaver's results & found that this indicator negatively affects the credit score in the first year before failure with discriminatory power at significance level 0.01. Moreover, Min and Lee (2008) reported the significant negative effect on firms' credit score by considering the ratio of Total Borrowings/Total Assets which negatively affect the calculated DEA score regression equation. Alternatively, Matias and Amaral (2012)

confirmed the negative relationship of total debt / total assets as an indicator of leverage to none-default, meaning that defaulted firms have more debts & are more likely to be defaulted at significance level of 0.01. Pervan and Kuvck (2013) Also confirmed the significant positive relationship with the probability of a client to be defaulted, which is relevant to current study findings of the negative relationship with creditworthiness. Similarly, Khemakhem and Boujelbene (2015) confirmed the significant negative relationship of Long- & Medium-term Debt/Fixed Assets to firms' creditworthiness, concluding that the imbalance of financial structure negatively affecting the credit situation & induce higher financial risks which will increase the probability of a firm being defaulted. Alternatively, (Beaver et al, 2005) also confirmed the significant positive relationship of Total Liabilities/Total Assets as a leverage indicator, to the hazard bankruptcy score.

**Long Term Debt/Total Equity**, The results reflect the capability of the equity in meeting long term obligations & that leverage doesn't have a negative effect on credit score, which means firms maintain safe capital structure which resulted in significant positive relationship to credit score at 0.01 significance level. The same conclusion for listed firms but results didn't show any significance. In the same context, Andrikopoulos and Khorasgani (2018) study reflected that leverage represented in short term debt/equity has a significant negative relationship to firms' credit score on both sides listed & unlisted, at 0.1 significance level. This means that equity cannot safely meet short term obligations & assure timely debt repayments. Alternatively, Khemakhem and Boujelbene (2015) confirmed that increase in the ratio of Long & Medium-term loans/Permanent capital affect negatively the creditworthiness of Tunisian firms & has a significant discriminatory power in differentiating between efficient & non efficient firms, concluding the increase in debt induces risks & leads to firms' insolvency.

**Short term Debt/Total Debt**, The positive effect on credit score revealed that short term borrowings will not affect the financial health of the listed firms &



accordingly is creditworthy to meet short term obligations. This contribution is significant at .05 level.

**Financial leverage = Times Interest Earned**, In some studies, this indicator may be treated in an independent category called Coverage. The results concluded that control over financial expenses as indicator of reasonable leverage contribute significantly with positive effect on listed firms credit score so therefore better financial performance & creditworthiness at significance level of .05. Roy and Shaw (2020) results confirmed that interest coverage ratio(ICR) is the most significantly weighted from respondents in indicating firm's default. Also, Min and Lee (2008) confirmed that creditworthy firms have significant positive effect of its interest coverage indicator(IC) on its credit score. Also, Yoshino and Taghizadeh-Hesary (2018) confirmed that interest coverage by the firm's excluded leverage earnings, has a positive significantly relationship to firms' financial performance & affects positively the credit score accordingly. Also, Matias and Amaral (2012) Confirmed the significant positive relationship to creditworthiness as they reported that none-defaulted firms score is positively related to interest coverage ratio. Instead, Altman and Sabato (2007) examined the relationship of EBIDA/Interest Expense with firms credit score, their findings confirmed that the higher the ratio has a significant positive relationship to creditworthiness score by affecting the score of firm's being good positively. Also, (Bhimani et al, 2010) study examined if the interest costs were absorbed by the gross profit & confirmed that a significant negative relationship between interest costs & creditworthiness. In other words, increase in interest costs will increase the probability of being defaulted. Pindado and Rodrigues (2001) confirmed that increase if interest charges as a leverage indicator of high level indebtness of a firm is significantly & negatively related to firm's solvency at 0.05 level. Moreover, (Tetteh et al, 2014) confirmed the significant positive relationship with creditworthiness, as the findings concluded a negative relationship to probability of default at significance level 1% with explaining that increase in 1 unit in interest coverage ratio variable, decrease probability of default by 0.1118. Interest coverage ratio has a positive significant effect &

relation to firms' credit score on both sides either listed or unlisted firms at significance level of 0.01 (Andrikopoulos and Khorasgani, 2018). Also, Doumpos, Niklis, Zopounidis and Andriosopoulos (2014) confirmed the significant positive relationship to firms rating, concluded that highly rated firms have high interest coverage ratio. Finally, (Altman et al, 1977) also confirmed the significant positive relationship to firms creditworthiness, as found that increase in interest coverage as debt service ratio negatively related to bankruptcy risk. The results obtained in the development of ZETA score model study.

## **Profitability Indicators**

**Net Operating Profits/Total Assets**, The result reveals the significant positive contribution of the profitability in the credit score of the firm & therefore its creditworthiness at significance level of 0.01. This finding was also significant at 0.01 level. Also, Ohlson (1980) employed the net income factor in evaluation the return of the firms on its assts & confirmed the negative relationship significantly to firms' bankruptcy. In other words, the firm's potential to be bankrupted has negative returns & no longer generates profits. Moreover, Ciampi (2015) also confirmed the significant negative relationship of ROI to firms probability of default in a study examined the effect of both financial ratios & corporate governance factors on the default of small sized enterprises in Italy. Also, Andrikopoulos and Khorasgani (2018) examined the effect of NI/TA representing the ROA & an indicator of profitability. Their findings confirmed that positive profitability has a significant negative relationship to a firm's default. Also Doumpos, Niklis, Zopounidis and Andriosopoulos (2015) confirmed the significant positive relationship between profitability & rating of a firm, concluded that highly rated firms maintain high profitability. Similarly, Khemakhem and Boujelbene (2015) study confirmed the significant positive relationship between EBITDA/TA as an indicator of economic profitability to firm's creditworthiness.

**Net Income / Number of outstanding shares**, The result revealed that listed firms are suffering from poor profitability & discouraging investors either existing or new ones from having the initiative to inject potential investments,

due to the firms inability in generating or sustaining profits which affects directly the earning per share, which is clearly indicated in the significant negative effect on firms credit score & therefore credit worthiness at significance level of 0.1. In contrast, Khemakhem and Boujelbene (2015) study confirmed the insignificance of the ratio Net Income/Shareholders equity in affecting the credit score of the firms as an indicator of financial profitability. Alternatively, (Beaver et al, 2005) also confirmed the significant negative relationship of Net Income/Total Assets as a measure of ROA indicator, to the hazard bankruptcy score.

**Earnings Annual Growth**, In relation to the positive effect of earning per share on the credit score which indicates the positive firm's financial performance. The same for listed firms but results didn't report any significance. Ohlson (1980) confirmed the significant positive relationship between growth of net income & firms credit worthiness, through the evidence of the significant negative relationship to bankruptcy predictive score. Similarly, Pindado and Rodrigues (2001) considered the Accumulated Earnings ratio to the firm's Total assets (AE/TA), and confirmed that it represents a significant indicator of ability to continuously generating profits, which is positively affecting & related the firm's solvency at significance level 0.05 on both models prediction levels, either univariate or discriminant analysis.

**Retained Earnings per share/EPS**, it indicated the stability of the share in realizing sustainable returns & incentivizes the shareholders in injecting more investments. Moreover, retained earnings provide the potential of business growth & this definitely increase the value of the firms & affect its creditworthiness as reported in the current results of the significant positive effect on the credit. score at 0.01 significance level. Similar to current study approach in examining the effect of financial ratios in building a credit scoring model. Andrikopoulos and Khorasgani (2018), findings alternatively confirmed a significant positive relationship of RE/TA to credit score, explaining that earnings growth leads to increase of Unlisted firm's financial health & not to be defaulted at 0.01 significance level.

## 6.2 Second Model: The Industry Effect

The results shown above in Table (5–Model 2) indicate the intervention of industry effect on significance & trend of employed financial performance indicators in determining the corporate credit scoring.

For Listed companies, after considering & modeling the industry effect in modeling the credit score for listed companies, none of the industries shown significance in affecting the determination of credit score, except of the real-estate & engines industries, which were found to be negatively affecting credit score at 0.1 & 0.05 significance levels respectively.

### Company Liquidity (Solvency) Indicators

**Inventory/Current Assets**, for both samples, this indicator remains significant. Nevertheless, industry variable affected the significance level from 0.05 to 0.1 level

**Current Ratio**, the significance level is affected from 0.05 to 0.01 level with greater coefficient.

### Asset Efficiency Indicators

**Sales to Fixed Assets**, the indicator maintained the same significance & trend.

**Inventory to total assets**, maintained its significance & trend.

**Accounts Payables/Annual Net Sales** maintained its significance & trend.

**Total Equity/Fixed assets** also maintained its significance & trend for both samples but with greater coefficient.

### Expense Control Indicators

**Gross Profit to sales**, maintained significance & trend.

**Operating Expenses/Total Assets**, for both samples, this indicator shows no longer significance in affecting credit score.

**Leverage Indicators:**

**Total Equity/Total debt**, for both samples, this indicator shows no longer significance. However, maintains the same trend.

**Long Term Debt/Total Assets**, maintained its significance & trend except for level at 0.1

**Short term Debt/Total Debt & Financial leverage = Times Interest Earned**, for listed sample, the model didn't affect the significance of the first indicator but only level from 0.05 to 0.01 level, with greater coefficient. For financial leverage indicator, is found to be no longer significant.

### **Profitability Indicators**

**Net Operating Profits/Total Assets**: this indicator remains significant positively affecting credit score at a level of 0.01.

**Net Income / Number of outstanding shares**, for listed companies, the significance. While its negative trend remains the same with greater coefficient. However, this indicator remains significant positively affecting credit score at a level of 0.01.

**Earnings Annual Growth & Retained Earnings per share/EPS**, both remain significant positively affecting credit score at a level of 0.01.

### **6.3 Third Model: The Size Effect**

The results shown above in Table 5 (Model 3) indicate the intervention of size effect on significance & trend of employed financial performance indicators in determining the credit scoring. The logarithm of company asset size was found to have a significant negative effect on credit score at 0.05 level (Ohlson, 1980). Moreover, the logarithm of company size in terms of market value was found to have a significant positive effect on credit score at 0.1 level (Doumpos, Niklis, Zopounidis and Andriosopoulos, 2015).

### **Company Liquidity (Solvency) Indicators**

**Inventory/Current Assets**, both samples, the indicator maintained its significance & trend, but with lower coefficient.

**Current Ratio**, only listed sample, this indicator maintained its significance but at a level of 0.1, with the same negative trend but with lower coefficient.

### **Asset Efficiency Indicators**

**Sales to Fixed Assets**, both samples, this indicator maintained its significance and trend

**Inventory to total assets**: this indicator remains its significant negative effect at a level of 0.01 but with lower coefficient.

**Sales to Accounts Receivables & Accounts Payables/Annual Net Sales**, both remain significant negatively affecting credit score at a level of 0.05 but with lower coefficient.

**Total Equity/Fixed assets**: this indicator remains significant positively affecting credit score at a level of 0.01 but with lower coefficient and remains significant negatively affecting credit score at a level of 0.01.

### **Expense Control Indicators**

**Gross Profit to sales**, this indicator remains significant negatively affecting credit score at a level of 0.01.

**Operating Expenses/Total Assets**, listed sample, this indicator shows no longer significance and remains significant positively affecting credit score at a level of 0.1.

### **Leverage Indicators**

**Total Equity/Total debt**, both samples, this indicator is no longer significant in affecting credit score.

**Total Equity/Long term debt**, this indicator remains significant negatively affecting credit score at a level of 0.01.

**Long Term Debt/Total Assets & Long Term Debt/Total Equity**, both indicators were found significant in the first model which maintains significance & trend, except level of the first at a level of 0.05.

**Short term Debt/Total Debt & Financial leverage = Times Interest Earned**, only listed, the first indicator remains significant with the same trend at a level 0.1 but with lower coefficient. While the second, is no longer showing significance in affecting credit score.

## **Profitability Indicators**

**Net Operating Profits/Total Assets**, this indicator remains significant positively affecting credit score at a level of 0.01.

**Net Income / Number of outstanding shares**, for listed companies, the size affected the significance of this indicator, remaining the same negative trend with lower coefficient.

**Earnings Annual Growth & Retained Earnings per share/EPS**, remain significant positively affecting credit score at a level of 0.01.

It is importantly to note that, the significance of **Cost of Sales/Net Sales** indicator as one of expense control's dimensions, was not observed in the first model. The industry effect raised the significance of this indicator at 0.01 level & remains significant in the size effect model but at 0.1 level.

## **7. Conclusion**

This study provides a significant contribution to the literature of predicting and developing a credit scoring model. The employed methodology is effectively determining the level of creditworthiness as it is the product of financial performance categories weights in respect of rounding the ratio indicators to the relevant industry averages.

After weights optimization, the results concluded the significance of three categories negatively affecting the listed firms sample creditworthiness.

## References

- Alfaro, E., Elizondo, D., Garcia, N. and Gamez, M. (2008), “Bankruptcy forecasting: an empirical comparison of AdaBoost and neural networks”, *Decision Support Systems*, Vol. 45 No. 1, pp. 110–122.
- Altman, Edward I. 1968. “Financial Ratios, Discriminant Analysis and The Prediction of Corporate Bankruptcy”. *The Journal of Finance* Vol. XXIII SEPTEMBER, No. 4
- Altman, Edward I., Robert G. Haldeman & P. Narayanan, 1977. “A new model to identify bankruptcy risk of corporations” *Journal of Banking and Finance* 1: 29–54.
- Andrikopoulos, P & Khorasgani, a 2018, 'Predicting Unlisted SMEs' Default: Incorporating Market Information on Accounting-based Models for Improved Accuracy, *The British Accounting Review*
- Appiah and Abor (2009), “Predicting corporate failure: some empirical evidence from the UK”. *Benchmarking: An International Journal* Vol. 16 No. 3, 2009 pp. 432–444
- Babic.Z; and Plazibat.N. (1998), “Ranking of enterprises based on multicriterial analysis”, *Faculty of Economics, Radovanova 13. 21000 Split, Croatia, Int. J. Production Economics* 56–57 29–35
- Beaver, W.H., McNichols, M.F. and Rhie, J.W. (2005), “Have financial statements become less informative? Evidence from the ability of financial ratios to predict bankruptcy”, *Review of Accounting Studies*, Vol. 10, pp. 93–122.
- Beaver. W. H. 1966. “Financial Ratios as Predictors of Failure”, *Journal of Accounting Research*, Vol. 4, *Empirical Research in Accounting: Selected Studies*, pp. 71–111
- Bhimani, A., Gulamhussen, M.A. and Lopes, S.D.R. (2010), “Accounting and non-accounting determinants of default: an analysis of privately-held



- firms”, *Journal of Accounting and Public Policy*, Vol. 29 No. 6, pp. 517–532.
- Ciampi.F; Gordini.N, 2008. “Using Economic–Financial Ratios for Small Enterprise Default Prediction Modeling: An Empirical Analysis” Oxford Business & Economics Conference Program
- Gonçalves, V. & Francisco Vitorino Martins & Elísio Brandão, 2014. "The Determinants of Credit Default on Portuguese Start-Up Firms: .An Econometric model," FEP Working Papers 534, Universidade do Porto, Faculdade de Economia do Porto.
- Deakin, E. (1972) A Discriminant Analysis of Predictors of Business Failure. *Journal of Accounting Research*, 10, 167–179.
- Doumpos, M., Niklis, D., Zopounidis, C., & Andriosopoulos, K. (2015). Combining accounting data and a structural model for predicting credit ratings: Empirical evidence from European listed firms. *Journal of Banking & Finance*, 50,599–607.
- Edmister, R. O. (1972). An Empirical Test of Financial Ratio Analysis for Small Business Failure Prediction. *Journal of Financial and Quantitative Analysis*, 1477–1493.
- Emel A. B., Oral, N., Reisman, A. and Yolalan, R. (2003). A Credit Scoring Approach for the Commercial Banking Sector. *Socio–Economic Planning Sciences*, 37: 103–123.
- Giannouli. P; Karagrigoriou. A; Kountzakis. C.E & Kimon, 2021.” Multilevel Dimension Reduction for Credit Scoring Modelling and Prediction: Empirical Evidence for Greece”, *Communications in Statistics: Case Studies, Data Analysis and Applications*, VOL. 7, NO. 4, 545–560
- Gupta, J., & Gregoriou, A. (2015). Bankruptcy and Financial Distress in US Small and Medium Sized Enterprises. Available at SSRN 2638485.

- Gama, Matias A.P. and Susana Amaral Geraldes, H. (2012), "Credit risk assessment and the impact of the New Basel Capital Accord on small and medium-sized enterprises: An empirical analysis", *Management Research Review*, Vol. 35 No. 8, pp.727749.
- Hall, G., Hutchinson, P. and Michaelas, N. (2000), "Industry effects on the determinants of unquoted SMEs' capital structure", *International Journal of the Economics of Business*, Vol. 7 No. 3, pp. 297-312.
- Hermanto, B., Gunawidjaja, S. (2010). Default prediction model for SME's: Evidence from Indonesian market using financial ratios. SSRN 1666703.
- Hausman, J. A. 1978. Specification Tests in Econometrics, *Econometrica*, 46(6): 1251-1271.
- \_\_\_\_\_. and Taylor, William E. 1981. Panel Data and Unobservable Individual Effects, *Econometrica*, 49(6): 1377-1398.
- Hussein. A; El-Masry.A; and John. P. (2006), "On the applicability of credit scoring models in Egypt".
- Khemais. Z, Nesrine.D & Mohamed. M, 2016. Credit Scoring and Default Risk Prediction: A Comparative Study between Discriminant Analysis & Logistic Regression" *International Journal of Economics and Finance*, 8(4): 39-53
- Khemakhem, S. and Boujelbene, Y. (2015), "Credit risk prediction: a comparative study between discriminant analysis and the neural network approach", *Accounting and Management Information Systems*, Vol. 14 No. 1, pp. 60-78
- Liang, X. (2012). An empirical estimation of the default risk of Chinese listed company based on the Merton-KMV Model. Master Thesis within the Main Prole of International Business

- Lin S.M., Ansell J and Andreeva G (2012). Predicting default of a small business using different definitions of financial distress. *Journal of the Operational Research Society* 63(4): 539–548.
- Michaelas, N., Chittenden, F. and Poutziouris, P. (1999), “Financial policy and capital structure choice in UK SMEs: empirical evidence from company panel data”, *Small Business Economics*, Vol. 12 No. 2, pp. 113–130
- Min, J. H. & Lee, Y. (2008). A Practical Approach to Credit Scoring. *Expert Systems with Applications* (35), p. 1762–1770.
- Mossman, C.E., Bell, G.G., Swartz, L.M. and Turtle, H. (1998), “An empirical comparison of bankruptcy models”, *The Financial Review*, Vol. 33 No. 2, pp. 35–54.
- Paleologo, G., Elisseff, A. and Antonini, G. (2010), “Subagging for credit scoring models”, *European Journal of Operational Research*, Vol. 201 No. 2, pp. 490–499.
- Pervan, I. and Kuvsek, T. (2013), “The relative importance of financial ratios and non-financial variables in predicting of insolvency”, *Croatian Operational Research Review (CRORR)*, Vol. 4 No. 1, pp. 187–198.
- Pindado, J. and Rodrigues, L.F. (2001), “Parsimonious models of financial insolvency in small companies”, Working Paper, SSRN Working Paper Series.
- Pompe, P.M. and Bilderbeek, J. (2005), “The prediction of bankruptcy of small and medium sized industrial firms”, *Journal of Business Venturing*, Vol. 20 No. 6, pp. 847–868.
- Ramsey, J. B. 1969. Tests for Specification Errors in Classical Linear Least Squares Regression Analysis. *Journal of Royal Statistical Society B*, 31(2): 350–371.
- Roy, P., K., Shaw, K. 2021. A multicriteria credit scoring model for SMEs using hybrid BWM and TOPSIS. *Roy and Shaw Financ Innov* 7:77

- Sezgin, O. (2006). Statistical Methods of Credit Rating. Unpublished Master's Thesis, The Middle East Technical University.
- Sapra, S. 2005. A regression error specification test (RESET) for generalized linear models. *Economics Bulletin*, 3(1): 1-6.
- Tetteh, M.L., Tetteh, F.A. and Ansah, A.Y. (2014), "Credit default modeling: a logit approach", *Research Journal of Finance and Accounting*, Vol. 5 No. 2, pp. 15-23.
- Thursby, Jerry G., Schmidt, P. 1977. Some Properties of Tests for Specification Error in a Linear Regression Model. *Journal of the American Statistical Association*, 72(359): 635-641.
- \_\_\_\_\_. 1979. Alternative Specification Error Tests: A Comparative Study. *Journal of the American Statistical Association*, 74(365): 222-225.
- Wooldridge, Jeffrey M. 2006. *Introductory Econometrics - A Modern Approach*. Thomson South-Western, International Student Edition.
- Yoshino. N and Taghizadeh-Hesary. F. 2018," A Comprehensive Method for the Credit Risk Assessment of Small and Medium-Sized Enterprises Based on Asian Data". ADBI Working Paper 907. Tokyo: Asian Development Bank Institute
- Yurdakul, M., & Iç, Y. T. (2004). AHP approach in the credit evaluation of the manufacturing firms in Turkey. *International Journal of Production Economics*, 88(3), 269-289. [https://doi.org/10.1016/S0925-5273\(03\)00189-0](https://doi.org/10.1016/S0925-5273(03)00189-0)
- Yusof. N. M; Alias. I. Q; Kassim. A. J. Md ; Zaidi. F. L. N, 2012. "Determining the Credit Score and Credit Rating of Firms using the Combination of KMV-Merton Model and Financial Ratios", *Science and Technology Indonesia* e-ISSN:2580-4391 p-ISSN:2580-4405 Vol. 6, No. 3

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Zenzerović.R, 2011. Credit Scoring Models in Estimating the Creditworthiness of Small and Medium and Big Enterprises” Croatian Operational Research Review (CRORR), Vol. 2

Zhang, M., He, Y. and Zhou, Z. (2013). Study on the Influence Factors of High-tech Enterprise Credit Risk: Empirical Evidence from China’s Listed Companies. *Procedia Computer Science* (17), p. 901–910.

## Appendix

(a) Distribution of Listed Companies across Industries.

**Table 5 : Distribution of Listed Companies across Industries.**

|                    | frequency | percentage |
|--------------------|-----------|------------|
| Construction       | 2         | 5.263%     |
| Real Estate        | 2         | 5.263%     |
| Chemicals          | 2         | 5.263%     |
| Agriculture        | 2         | 5.263%     |
| Pharma             | 2         | 5.263%     |
| Sanitation         | 3         | 7.895%     |
| Food               | 3         | 7.895%     |
| Education          | 3         | 7.895%     |
| Software           | 2         | 5.263%     |
| Wholesales         | 2         | 5.263%     |
| Real Estate rental | 2         | 5.263%     |
| Engines            | 3         | 7.895%     |
| Health             | 3         | 7.895%     |
| Communications     | 4         | 10.526%    |
| Minerals           | 3         | 7.895%     |
|                    | 38        | 100%       |

(b) Testing for Multicollinearity (Variance Inflation Factor, VIF) for Listed Companies

**Table 6: Testing for Multicollinearity**

| <b>Variable</b>                     | <b>VIF</b> |
|-------------------------------------|------------|
| Cash/Current Assets                 | 5.233      |
| Inventory/Current Assets            | 3.527      |
| Accounts Receivables/Current Assets | 4.050      |
| Current Ratio                       | 5.351      |
| Current Liabilities/Inventory       | 2.923      |
| Total Liabilities/Total Equity      | 2.000      |
| Cash Ratio                          | 7.316      |
| Sales To Fixed Assets               | 5.594      |
| Cost Of Good Sold To Inventory      | 3.358      |
| Inventory To Total Assets           | 4.207      |
| Sales To Accounts Receivables       | 4.170      |
| Sales To Common Equity              | 4.087      |
| Total Assets/Net Sales              | 5.666      |
| Accounts Payables/Annual Net Sales  | 5.033      |
| Total Equity/Fixed Assets           | 4.189      |
| Gross Profit To Sales               | 4.189      |
| Cost Of Sales/Net Sales             | 3.770      |
| Operating Expenses/Gross Margin     | 3.245      |
| Operating Expenses/Total Assets     | 2.743      |
| Short Term Debt/Total Debt          | 2.207      |

|  |       |
|--|-------|
| Financial Leverage = Times Interest Earned | 2.000 |
| (Net Income + Interest)/Interest           | 2.168 |
| Total Equity/Total Debt                    | 2.447 |
| Total Equity/Long Term Debt                | 2.245 |
| Long Term Debt/Total Assets                | 6.556 |
| Long Term Debt/Total Equity                | 6.881 |
| Net Operating Profits/Total Assets         | 2.000 |
| Total Equity/ Number Of Outstanding Shares | 4.842 |
| Net Income/ Number Of Outstanding Shares   | 2.000 |
| Earnings Annual Growth                     | 2.000 |
| Retained Earnings Per Share/Eps            | 2.000 |
| Net Income/Earnings Before Taxes           | 2.000 |