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# Statistical Consulting Service

**Statistical Consulting Service -  
2022**  
**University of Sri  
Jayewardenepura**



Report for  
Mrs Samanmali Dassanayake

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## **Phase 2: Data Analysis and Modelling**

### **0.1 Disclosure**

This report is a compendium of the data analysis and modelling procedure followed with respect to the research topic *Capital Structure and Profitability: Do Macro Economic Factors Matter?*. The report has been compiled relating to phase 2 of the client engagement of Ms. Samanmali Dassanyake on behalf of the Statistical Consultancy Services, USJ.

### **0.2 1. Introduction**

Capital structure can be seen as the specific combination of debt and equity used to finance a company's assets and operations. Many theories and views with regards to the optimal combination of debt to equity that will maximize a firm's profitability has been discussed across the years.

This study is an analytical research design that has been carried out to find evidence of the effect that macroeconomic variables might or might not have on the relationship between capital structure and profitability.

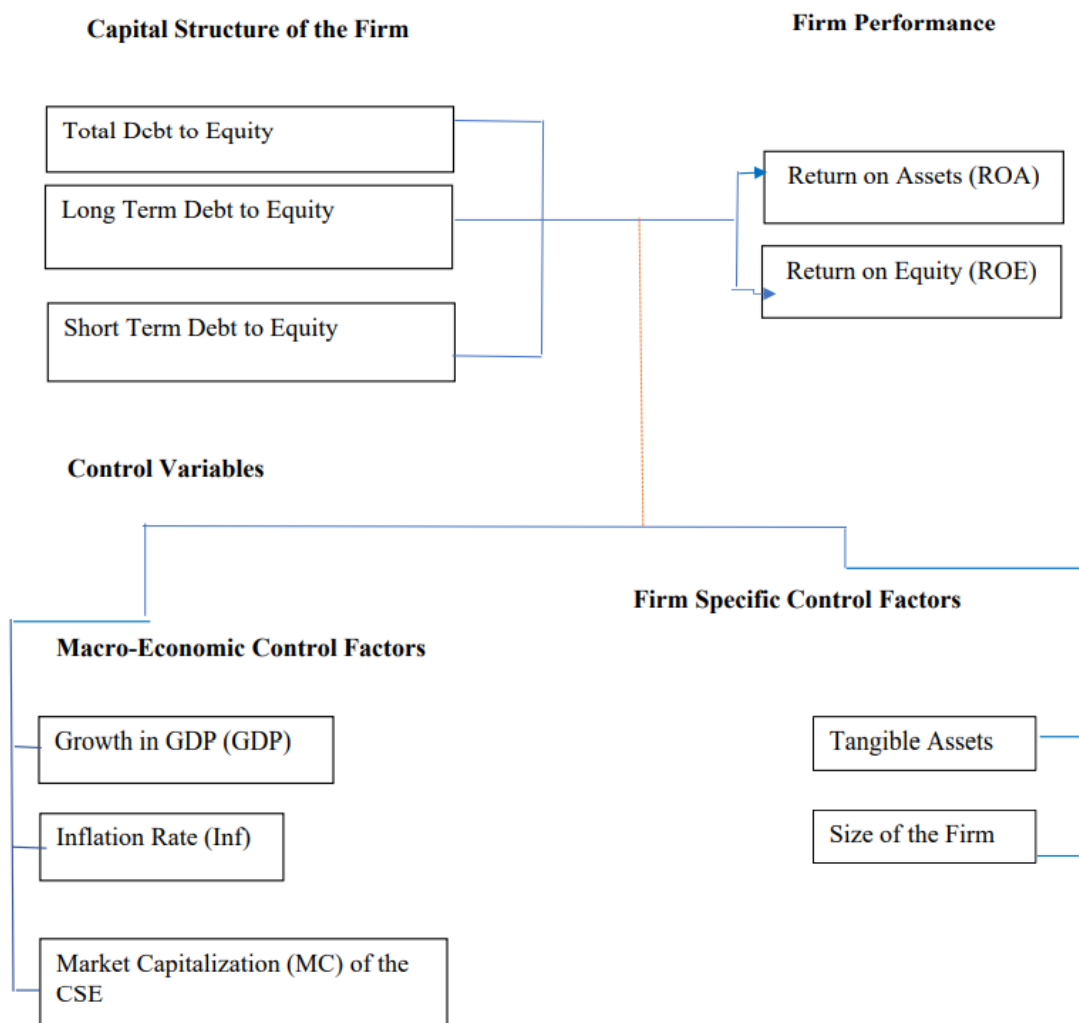
### **0.3 2. Research Objectives**

The defined research objectives are as follows;

1. To examine the impact of Growth of Gross Domestic Product (GDP) on the relationship between Capital Structure and Profitability of manufacturing firms listed in Colombo Stock Exchange.
2. To examine the impact of Inflation on the relationship between Capital Structure and Profitability of manufacturing firms listed in Colombo Stock Exchange.
3. To examine the impact of Market Capitalization on the relationship between Capital Structure and Profitability of manufacturing firms listed in Colombo Stock Exchange.
4. To examine the relationship between Capital Structure and Profitability of manufacturing firms listed in Colombo Stock Exchange.

### **0.4 3. Data and Variables**

The variables of interest has been identified as per the below given conceptual framework.



The Return on Equity (ROE) and Return on Assets (ROA) has been considered as the measure for firm's performance (profitability) and the Debt ratios (Total, Long Term and Short Term) has been considered as the measure of capital structure of a firm. The considered macro-economic variables are Gross Domestic Product (GDP), Inflation and Market capitalization of the Colombo Stock Exchange. Tangible assets and Size of the firm have been considered as firm specific control variables.

Accordingly the variables considered for the study are as follows;

Dependent Variable	Independent Variables	Control Variables
ROE	Total Debt to Equity, Long term Debt to Equity, Short term Debt to Equity	Tangible Assets
ROA	GDP , Inflation , Market Capitalization	Size of firm

The data has been derived with respect to 31 manufacturing firms listed in Colombo Stock Exchange. The data is available for a period of 10 years from 2011-2020. This data set is a combination of cross sectional

data (with respect to the firms) and time series data (with respect to the year) and hence the data set is a panel data set.

#### 4. Data Analysis methodology

Data analysis has been carried out via R programming language. The data analysis process consists of mainly two stages, namely; preliminary analysis and advanced analysis. *Please refer Annexure 1 and Annexure 2 to explore the workflow of the preliminary and advanced analysis.*

Prior to the analysis the data set has been wrangled to obtain the required format to apply panel regression. A preview of the dataset is as shown below.

```

      Firm Year      LTDE      STDE      TDE      ROE
1 Royal Ceramics Lanka 2020 0.2010034 0.32831372 0.5293171 0.044340455
2 Royal Ceramics Lanka 2019 0.2029009 0.13198976 0.3348907 0.006110009
3 Royal Ceramics Lanka 2018 0.2272342 0.22723422 0.4544684 0.209894762
4 Royal Ceramics Lanka 2017 0.2267467 0.07089519 0.2976419 0.169321027
5 Royal Ceramics Lanka 2016 0.1985159 0.10044141 0.2989573 0.155771728
6 Royal Ceramics Lanka 2015 0.2273328 0.09584299 0.3231758 0.109364039
      ROA      TA      Size      GDP      INF      MKTCAP
1 0.11804649 0.3314056 17.06487 -0.036 0.042 0.1977360
2 0.08774306 0.3396337 16.82539 0.023 0.048 0.1899227
3 0.27728631 0.3425338 16.76784 0.033 0.028 0.1986928
4 0.23380898 0.2679300 16.53472 0.036 0.071 0.2175328
5 0.20088017 0.2247927 16.47100 0.045 0.045 0.2288580
6 0.14200163 0.2195530 16.45092 0.050 0.046 0.2627150

```

Warning: use of 'plm.data' is discouraged, better use 'pdata.frame' instead

#### 5. Preliminary Analysis

The summary statistics of the data is as follows;

	Firm	Year	LTDE
Abans Electricals	: 10	2011 : 31	Min. :0.000000
Acl Cables	: 10	2012 : 31	1st Qu.:0.000000
Acl Plastics	: 10	2013 : 31	Median :0.008563
Acme Printing & Packaging	: 10	2014 : 31	Mean :0.066995
Agstar	: 10	2015 : 31	3rd Qu.:0.082190
Blue Diamonds Jewellery Worldwide	: 10	2016 : 31	Max. :0.582234
(Other)	:250	(Other):124	

STDE	TDE	ROE	ROA
Min. :0.00000	Min. :0.00000	Min. : -1.19391	Min. : -0.28480
1st Qu.:0.04723	1st Qu.:0.06782	1st Qu.: 0.01672	1st Qu.: 0.04363
Median :0.12753	Median :0.21853	Median : 0.10680	Median : 0.09833
Mean :0.22872	Mean :0.29516	Mean : 0.09643	Mean : 0.14856
3rd Qu.:0.33121	3rd Qu.:0.42757	3rd Qu.: 0.18363	3rd Qu.: 0.15203
Max. :1.78352	Max. :2.08688	Max. : 1.53471	Max. : 7.76063

TA	Size	GDP	INF
Min. :0.01481	Min. :12.14	Min. : -0.0360	Min. :0.0280
1st Qu.:0.14077	1st Qu.:13.89	1st Qu.: 0.0330	1st Qu.:0.0420
Median :0.32029	Median :14.52	Median : 0.0405	Median :0.0470
Mean :0.30770	Mean :14.64	Mean : 0.0410	Mean :0.0525
3rd Qu.:0.43602	3rd Qu.:15.60	3rd Qu.: 0.0500	3rd Qu.:0.0690
Max. :0.74258	Max. :17.31	Max. : 0.0910	Max. :0.0760

MKTCAP  
Min. :0.1899  
1st Qu.:0.1987  
Median :0.2385  
Mean :0.2404  
3rd Qu.:0.2627  
Max. :0.3067

### Missing Values

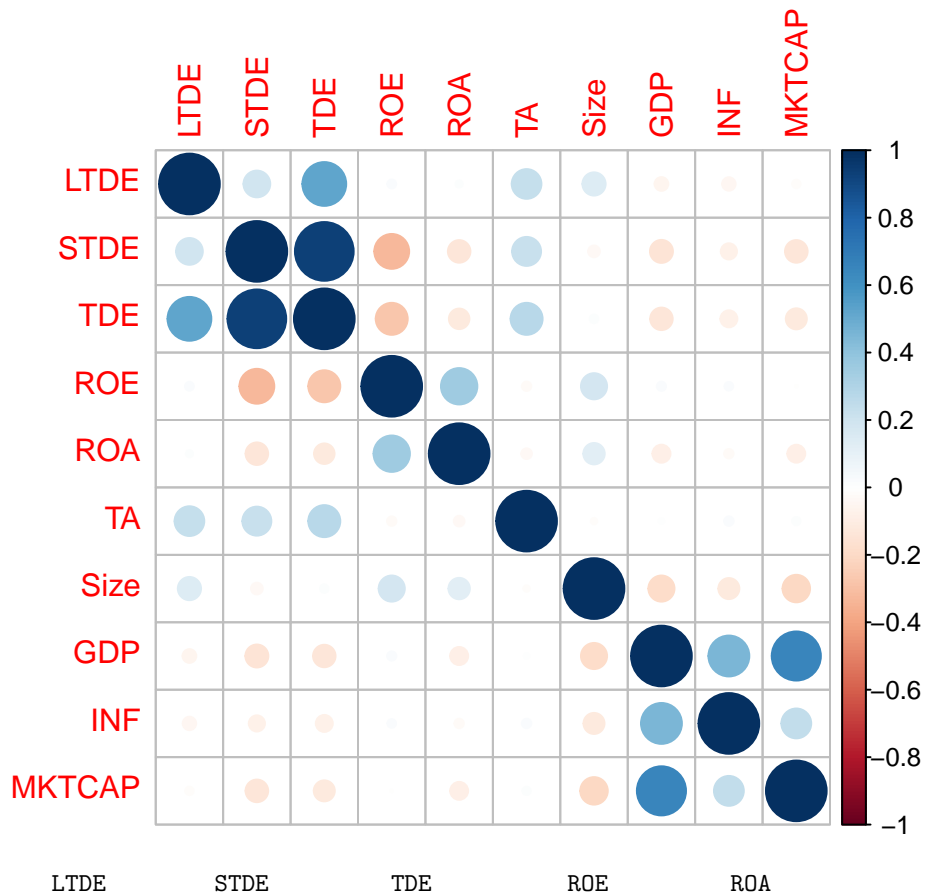
As shown below, it can be seen that there the missing value count with respect to each variable is zero. Therefore, no precautions for the treatment of missing values is necessary.

Firm	Year	LTDE	STDE	TDE	ROE	ROA	TA	Size	GDP	INF
0	0	0	0	0	0	0	0	0	0	0

MKTCAP  
0

**Correlation** According to the correlation plot, it can be seen that there is a very high correlation (0.93) between Short term debt to Equity (STDE) and Total Debt to Equity (TDE) and; additionally there is also marginally a positive relationship (0.52) between Long term debt to Equity (LTDE) and Total Debt to Equity (TDE). Considering that the loss of information is minimum given that both long term and short term debt to equity ratios are considered for the model; the variable TDE is removed from the dataset.

Hence the variable TDe is removed from the analysis.



LTDE	1.00000000	0.19430392	0.52090901	0.021029497	0.01354390
STDE	0.19430392	1.00000000	0.93639715	-0.329951674	-0.13806271
TDE	0.52090901	0.93639715	1.00000000	-0.277753090	-0.11429054
ROE	0.02102950	-0.32995167	-0.27775309	1.000000000	0.35937282
ROA	0.01354390	-0.13806271	-0.11429054	0.359372823	1.00000000
TA	0.23956077	0.22796396	0.27823012	-0.023996389	-0.03085796
Size	0.14606190	-0.03752489	0.01934744	0.185335508	0.12430130
GDP	-0.05122248	-0.14330812	-0.13714376	0.022744676	-0.08833532
INF	-0.04921857	-0.07091410	-0.07825767	0.020108798	-0.02387141
MKTCAP	-0.01914529	-0.13878515	-0.11970972	-0.001817899	-0.08709494
	TA	Size	GDP	INF	MKTCAP
LTDE	0.239560768	0.14606190	-0.051222481	-0.04921857	-0.019145294
STDE	0.227963965	-0.03752489	-0.143308120	-0.07091410	-0.138785155
TDE	0.278230120	0.01934744	-0.137143765	-0.07825767	-0.119709716
ROE	-0.023996389	0.18533551	0.022744676	0.02010880	-0.001817899
ROA	-0.030857962	0.12430130	-0.088335318	-0.02387141	-0.087094941
TA	1.000000000	-0.01101439	0.008191082	0.02427266	0.018693336
Size	-0.011014386	1.000000000	-0.185064264	-0.11982420	-0.205448350
GDP	0.008191082	-0.18506426	1.000000000	0.45388885	0.654950392
INF	0.024272664	-0.11982420	0.453888853	1.00000000	0.242168536
MKTCAP	0.018693336	-0.20544835	0.654950392	0.24216854	1.000000000

## 6. Advanced Analysis

Note: For all the hypothesis testing carried out in the study, the decision rule that applies is as follows; *Reject H0 and accept H1 if p-value < 0.05 where; 0.05 is the considered level of significance and H0 is the null hypothesis and H1 is the alternate hypothesis*

### Stationarity: Unit Root test

The stationarity of the considered variables can be tested via the **Unit Root test**

The considered null and alternate hypothesis are as follows;

H0 : The series is not stationary

H1 : The series is stationary

The results of the test is as follows:

Variable	p-value	Conclusion
ROE	< 2.2e-16	Reject H0 at 5% level of significance
ROA	2.16e-15	Reject H0 at 5% level of significance

Therefore, it can be seen that both the response variables are stationary.

### Pooled Regression model

The pooled OLS regression model is initially fitted and the model assumptions are further validated to ensure the accurate model is fitted.

Accordingly the following modela are fitted with respect to ROE and ROA;

$$ROE = \beta_0 + \beta_1 STDE + \beta_2 LTDE + \beta_3 Size + \beta_4 GDP + \beta_5 INF + \beta_6 MKTCAP$$

$$ROA = \beta_0 + \beta_1 STDE + \beta_2 LTDE + \beta_3 Size + \beta_4 GDP + \beta_5 INF + \beta_6 MKTCAP$$

The model assumptions and the corresponding statistical tests are as follows;

1. *Homoskedasticity - Breusch-Pagan-Test*

H0 : Variances are equal

H1: Variances are not equal

Response Variable	p-value	Conclusion
ROE	0.06254	Do not reject H0 at 5% level of significance
ROA	0.4304	Do not reject H0 at 5% level of significance

Therefore, it can be seen that the assumption of constant variance is valid for both the models.

hence irrespective of the autocorrelation test a fixed or random effects model should be fitted.

2. *Non-autocorrelation - Durbin-Watson-Test*

H0 : OLS regression residuals are not auto-correlated

H1 : OLS regression residuals are auto-correlated

Response Variable	p-value	Conclusion
ROE	0	Reject H0 at 5% level of significance
ROA	0	Reject H0 at 5% level of significance

Therefore, it can be seen that there is auto-correlation within both the models. Hence despite having constant variance, a fixed or random effects model should be fitted.

**Choosing between fixed and random effects model**

The **Haussmann Test** can be used to choose between the Random and Fixed effects model as follows

H0 : Preferred model is Random effects model H1: Preferred model is fixed effects model

Whereby; if H0 is rejected, fixed effects model is selected otherwise a random effects model is selected.

Response Variable	p-value	Conclusion
ROE	0.9065	Do not reject H0 at 5% level of significance
ROA	0.6582	Do not reject H0 at 5% level of significance

Therefore, it can be concluded that a Random effects model is the best fit.

**Random Effects model**

The summary results of the model fitted with respect to ROE is as follows;

Oneway (individual) effect Random Effect Model  
(Swamy-Arora's transformation)

Call:

```
plm(formula = ROE ~ STDE + LTDE + Size + GDP + INF + MKTCAP,
     data = paneldf, model = "random")
```

Balanced Panel: n = 31, T = 10, N = 310

Effects:

```
              var std.dev share
idiosyncratic 0.01979 0.14067 0.292
individual    0.04801 0.21912 0.708
theta: 0.801
```

Residuals:

```
      Min.      1st Qu.      Median      3rd Qu.      Max.
-0.68786423 -0.05576081 -0.00023364  0.06993511  0.73978995
```

Coefficients:

```
      Estimate Std. Error z-value Pr(>|z|)
(Intercept) -0.936686   0.458242 -2.0441  0.040945 *
STDE         -0.283259   0.061724 -4.5891  4.451e-06 ***
LTDE         -0.020456   0.107506 -0.1903  0.849089
Size          0.073608   0.028547  2.5785  0.009924 **
GDP           0.237953   0.354918  0.6704  0.502574
INF           0.385283   0.568575  0.6776  0.498007
MKTCAP       -0.035884   0.299170 -0.1199  0.904527
```

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares: 6.5208

Residual Sum of Squares: 5.9793

R-Squared: 0.083044

Adj. R-Squared: 0.064886

Chisq: 27.441 on 6 DF, p-value: 0.00011969

It can be seen that the variables STDE and Size are statistically significant within the model.

The summary results of the model fitted with respect to ROA is as follows;

Oneway (individual) effect Random Effect Model  
(Swamy-Arora's transformation)

Call:

```
plm(formula = ROA ~ STDE + LTDE + Size + GDP + INF + MKTCAP,
     data = paneldf, model = "random")
```

Balanced Panel: n = 31, T = 10, N = 310

Effects:

```
              var std.dev share
idiosyncratic 0.2309  0.4805 0.741
individual    0.0805  0.2837 0.259
theta: 0.5279
```

Residuals:

```
      Min.      1st Qu.      Median      3rd Qu.      Max.
-0.629364 -0.105699 -0.026606  0.044264  6.613621
```

Coefficients:

```
      Estimate Std. Error z-value Pr(>|z|)
(Intercept)  0.158474   0.857771  0.1848  0.85342
STDE         -0.345883   0.165513 -2.0898  0.03664 *
```



```

LTDE      0.367487  0.331571  1.1083  0.26772
Size      0.018038  0.051781  0.3483  0.72758
GDP      -1.217647  1.205887 -1.0098  0.31261
INF       0.661975  1.924721  0.3439  0.73090
MKTCAP   -0.850274  0.964018 -0.8820  0.37777
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    72.288
Residual Sum of Squares: 70.211
R-Squared:               0.02873
Adj. R-Squared:          0.0094974
Chisq: 8.96284 on 6 DF, p-value: 0.17568

```

It can be seen that only the variable STDE is statistically significant within the model.

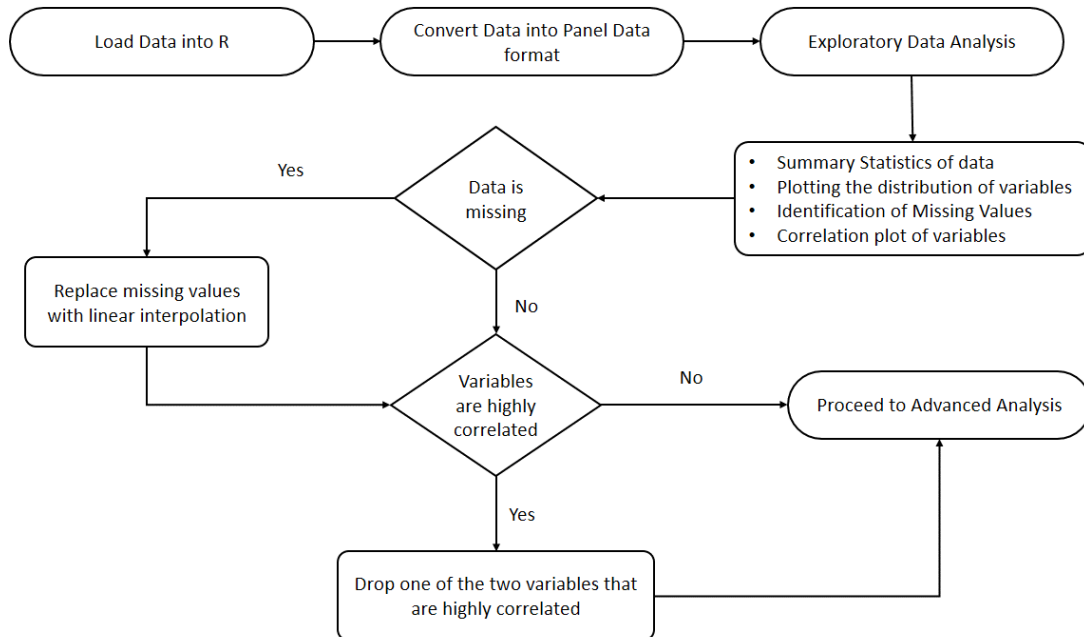
## 7. Model Interpretation & Conclusions

It can be seen that when modeled with respect to ROE, the performance of manufacturing firms depends on the short term debt to equity ratio and Size of the Firm. When modeled with respect to ROA, the performance of manufacturing firms depends only on the short term debt to equity ratio. Conclusively, it can be said that Short term debt ratio has a statistically significant effect on the performance of the Firm.

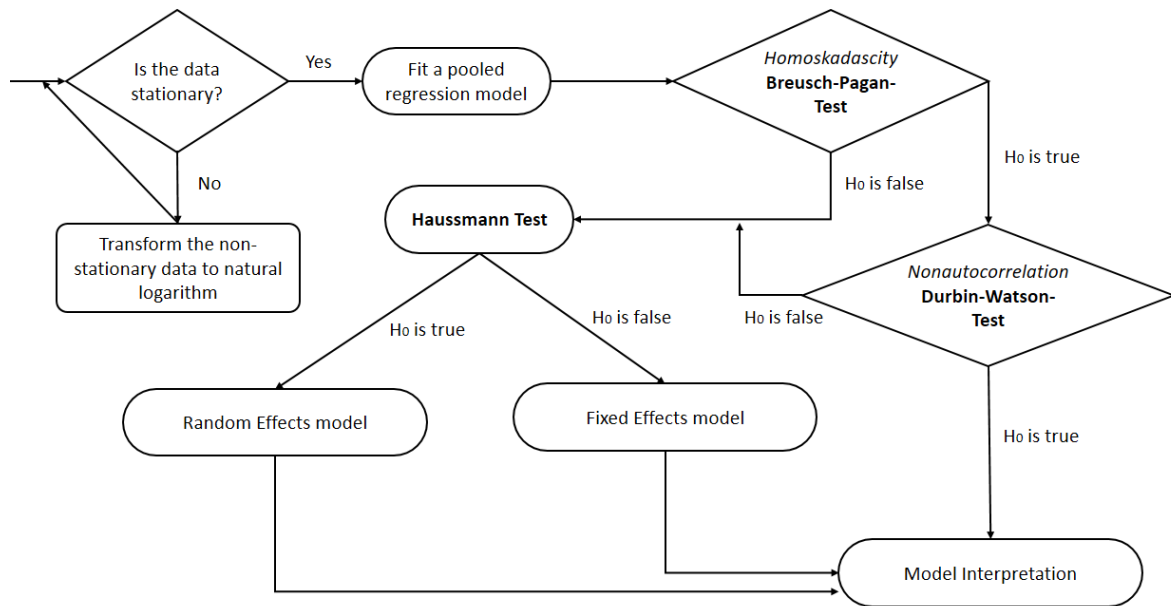
### *Limitations of the study*

The Coefficient of determination of both the models are very low despite the validation of the model assumptions. This can be due to lack of data as well as not condiering proper explanatory variables. Therefore, in future studies the possibility of other variables apart from the above used variables to model firm performance can be explored.

## Annexure 1 : Workflow of Preliminary analysis



## Annexure 2 : Workflow of Advanced analysis



Hope the above documentation is easily comprehensible and if there is need for any further clarification, please do reach out to us.

Thank you.

Kind regards,

Statistical Consulting Service – USJ