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A Study on Stock-Bond Price Index in the US Market

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Abstract:- This paper attempts to find out the question of whether the benchmark bond yields affect thestock index in the US. To study the impact of the US bond market on the US stock indices, this study employs the Ordinary Least Square (OLS) technique, where the stock index of S&P 500, NYSE composite, and Dow Jones indices are used as the dependent variable, and US 10Yr Bond yield as the main independent variable. The time series used in this analysis were found non-stationary and the first difference is taken to convert them into stationary series. The Augmented Dickey Fuller(ADF) test statistics show that the series becomes stationary at first difference. Three separate regressions on S&P 500, NYSE Composite, and Dow Jones at first difference order are performed to analyze the effect of bond yield on stock indices with a reasonable set of control variables such as inflation, unemployment, crime rates, real effective exchange rate, etc. The statistical results show that the benchmark bond yield has a positive significant impact on the stock index of S&P 500, NYSE Composite, and Dow Jones. The economic implication of the results is that the benchmark bond yield predicts the stock index significantly and there is a moderate amount of correlation between the estimates and the time series as shown by the Variance Inflation Factor (VIF) respectively.

JEL classifications: C32; G14; G15.

Keywords:- *Bond yields; NYSE, Dow Jones; S&P 500; US.*

I. INTRODUCTION

Investors often look at the stock index performance as the rising stock index prices signal good investment opportunities in the company listed in the index. The government bond market indicates the country's fiscal health and acts as the mirror of GDP. For instance, the macroeconomists use macro indicators such as inflation, unemployment, and GDP growth to measure a country's fiscal performanceand are also considered benchmark bond yield due to their predictive power. The golden rule for yield curve is that the inverted yield curve, where the short-term yields are higher than the long-term or the benchmark yield could be a sign of recession in the economy(FRBC, 2019). The flat yield curve predicts slower economic growth while the steep yield curve indicates strong economic growth respectively. The benchmark bond yield is the leading yield curve in the bond market, which decides the yields of other bonds. The stock index on the other hand tells about the performance of the companies listed in it. A rising stock index indicates the favorable market condition for the investment and vice-versa.

An important question is related to the relationship between these two markets. Kim et al. (2006)studied the relationship between stocks and the government bond using daily data of selected countries in Europe using time-varying conditional correlation methods. The study concluded that the European Union monetary union significantly describes the co-integration between the stock and bond market respectively. Another research by (Norden & Weber, 2009) demonstrated the co-movements of bond, stock, and credit default swaps market using the VAR and granger causality test. The study concluded that the VAR model predicts the co-movements between these three variables while the granger causality test found that the credit default swaps are more sensitive than the stock and bond market. Patoda & Jain (2012) have used the stocks listed in the Indian stock index and bond market using the correlation and co-integration method. Their study concluded about conferring significant correlation between bond and stock prices respectively. The documented research (Johansson, 2010)analyzed the relationship between stock and bond markets in Asia using the data of nine countries with the model of bi-variate stochastic volatility and concluded that the relationship between stock and bond market changes over time. Lim et al.(1998) used international bond and stock market index to study the relationship between them using the co-integration and Granger causality test. They found a significant bi-directional relationship between bonds and the stock market over a period.Goyenko & Ukhov(2009) studied the relationship between the stock market and government bonds based on the liquidity issue using the lead-lag and granger causality model. They concluded that stock markets affectthe bond market and the bond market passes the shock to the stock market via bond liquidity. The previous literature has used advanced models to study the relationship between stock and bond markets. In this study, the stock index and bond yield are used to analyze the impact of benchmark bond yield on the stock index prices using OLS methods. This study simply test that the 10-year bond yield affects the US stock index prices or not.

The next section describes the theoretical model used in this study while the section data gives a glimpse of the data set obtained to conduct this research. The sections empirical model and empirical study demonstrates the model specification and results obtained by employing that model. The last section concludes the study and provides some future research gaps respectively. Appendix 1 contains all the graphs obtained from empirical results. References are provided at the end of the conclusion.

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II. THEORETICAL MODEL

To study the impact of the US bond market on the US stock indices, this study employs the Ordinary Least Square (OLS) technique, where the stock index of S&P 500, NYSE composite, and Dow Jones indices are used as the dependent variable, and US 10Yr Bond yield as the main independent variable. The different stock indexes in the US have different companies listed so this study chooses three major stock indices while the US 10 Year bond yield is the benchmark bond yield in the US treasury market. The benchmark yield is the leading yield on which other maturities yield iscalculated, it represents the risk-free rates to the market. The benchmark bond yield leading and the same as the stock indices respectively. The movement in the stock market is often observed by the index fluctuations as the prices of the index give the bigger picture of the stock market to the investors same as the benchmark bond yield for the treasury market.

Now, to study the relationship between these two, this study employsthe OLS technique where the stock indices are the dependent variables and US 10 yr benchmark yield is the main independent variable respectively. The reasonable set of control variables is used in the regression model explained in the empirical model section. The first control variable is the CPI of the US, which measures the US inflation in consumer prices. CPI might affect the stock indices as inflation is correlated with the stock market. Prime rates defined by the Federal Reservehave used another piece of the control variablethat affects the stock indices in the sense that stock market performance is dependent on the US interest rates. The variables such as unemployment, money supply, and real effective exchange rates also exert some degree of impact on the stock indices. The significance of the research aim & questions is that it narrows down the research theme and makes the research more specific to a particular point. Any research without research questions could not be possible as the focus of a researcher is to investigate the answers to the research question described in his paper. The hypothesis used in this study are as follows:

$H_0 =$ *There is no significant effect of US benchmark Bond yield on US stock Indices.*

$H_1 =$ *There is a significant effect of US benchmark Bond yield on US stock Indices.*

The hypothesis above will test using the OLS approach mentioned in the next section. The other potential variable such as GDP, population growth, and government gross expenditure might be useful as additional control variables while this study uses monthly data from Jan 2010 to Dec 2020, the daily frequency with firm-level data would be more the potential future research in this area respectively.

III. DATA

The study is based on the stock indices and Bond yield variables, which are employed to study whether benchmark bond yield predicts US stock indices. The stock indices variables such as S&P 500, NYSE-Composite, and Dow Jones industrial index data are obtained from the Yahoo Finance website. The data of close prices are considered as the stock prices. The benchmark bond in the US is the 10-year bond and that is why the 10-Yr Bond represents the treasury yield. In regression analysis, using some reasonable control is crucial and therefore, a wide range of macroeconomic indicators is employed in this study. The first control variable is CPI, which measures the consumer price index with the base year 2015 US. Prime Rate is the rate offered by Federal Reserve and therefore the leading rate in all banks in the US. The real effective exchange rate is the index with the base of 2015, Unemployment measures the rate of unemployment in the US, and the last M2 measures the broad money supply in US monetary policy respectively. 10-Yr Bond yield and all the control variables are obtained from the Federal Reserve Economic Database (FRED) of St. Louis with monthly frequency ranges from Jan 2010 to Dec 2020. The summary statistics are presented in Table 1.

Variables	Obs	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
S & P 500	132	2082.811	677.956	1030.71	3756.07	.296	2.121
10-Yr Bond	132	2.268	.69	.62	3.85	-.244	3.207
NYSE-Composite	132	10399.565	2014.923	6469.65	14524.8	-.163	1.961
Dow Jones	132	18486.629	5641.583	9774.02	30606.48	.311	1.868
CPI	132	108.073	2.843	103.9	114.8	.636	2.536
Prime Rate	132	3.714	.735	3.25	5.5	1.347	3.3
RealEff.Exch	132	107.285	9.117	93.06	123.92	-.03	1.414
Unemployment	132	5.911	1.812	3.8	10	1.214	3.187
M2	132	5096.477	828.061	3883.3	7329.5	.645	3.232

Table 1: Descriptive Statistic of Time-series

In Table 1 below, the summary statistics, and monthly timeseries is depicted, where the central tendency measures are presented. The table shows the mean, standard deviation, minimum, maximum, skewness, and kurtosis respectively. The time series must be stationary before performing any statistical modeling. This study has used Augmented Dickey-Fuller (ADF) test to perform unit root and found that the time series is non-stationary. Further to remove the unit root from the time series, the first difference of the series is obtained and found that the series becomes stationary. The ADF test statistic is presented in the empirical result section respectively.

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IV. EMPIRICAL MODEL

The section describes the empirical model used in the study. The Ordinary Least Square Method is used to analyze the relationship between Stock Index and Bond yield. The time series of the stock Index of three different indices, US 10-year benchmark bond yield, and control variables such as CPI, unemployment rate, Prime rates, real effective rates, and M2 money supply is obtained with monthly frequency respectively. Before using OLS for the time series, The Augmented Dickey-Fuller (ADF) statistics were obtained to check for the Unit root and the equation is defined as:

$$\Delta\varepsilon_t = \varphi\varepsilon_{t-1} + \sum_{j=1}^{n} b_j \Delta\varepsilon_{t-j} + v_t$$

Where, $\Delta\varepsilon_t$ is the first difference of timeseries.$\Delta\varepsilon_{t-j}$is j lag ordered first difference of the dependent variable. $v_t$is the error term. The null hypothesis is tested which indicates that the time series is not stationary against the alternative hypothesis which declares that the time series is stationary. If the null hypothesis is accepted, generally it is advisable to convert the time series at the first-order difference and conduct further analysis.

The Ordinary Least Square model is used to analyze the relationship between Stock Index and benchmark Bond yield with an additional set of control variables that can be expressed as

$$S_{i,t} = \beta_0 + \beta_1(10yr\ Bond) + \beta_2 CPI + \beta_3 PrimeRates + \beta_4 RealEffectiveER + \beta_5 Uemployment + \beta_6 M2 + \varepsilon_t$$

Where, $S_{i,t}$ represents the US stock index i= S&P 500, NYSE Composite, and Dow Jones at time t. $10yr\ Bond$ is the US 10-year benchmark bond yield. CPI is the US consumer price index with the base year 2015. $PrimeRates$ is the Federal Reserve rates. $RealEffectiveER$ is the US real effective exchange rate with the base year of 2015.$Uemployment$measures the US unemployment rate and at last,$M2$ is the US broad money supply. $\varepsilon_t$is the error term. This study has conducted three different regression models based on three different stock Index S&P 500, NYSE Composite, and Dow Jones respectively. If the original time series has a unit root issue diagnosed in the ADF test, then the first difference in OLS specification is as follows:

$$\Delta S_{i,t} = \beta_0 + \beta_1\Delta(10yr\ Bond) + \beta_2\Delta CPI + \beta_3\Delta PrimeRates + \beta_4\Delta RealEffectiveER + \beta_5\Delta Uemployment + \beta_6\Delta M2 + \varepsilon_t$$

Where Δ represents the first difference of each time series.

V. EMPIRICAL RESULTS

The ADF test statistics of the first difference series and the results of regression analysis are presented in this section. Table 2 represents the ADF test statistics of the time series at the first difference used in the regression analysis. FD represents the first difference of time-series respectively. It is observed from the table below that after the first difference, the all-timeseries become stationary as the ADF test statistics are significant at the 1% level.

Variable(s)	ADF
ΔS&P 500	-11.35***
Δ NYSE Composite	-11.61***
Δ Dow Jones	-11.43***
Δ 10-Yr Bond	-8.35***
Δ CPI	-10.92***
Δ Prime Rate	-7.16***
Δ Real_Effective_ER	-7.28***
Δ Unemployment	-7.88***
Δ M2	-4.38***

Table 2: ADF Test Statistic of Time-series at First Difference

Note: *** , ** and * represents significance level at 1, 5 and 10 % respectively

Table 3, 4, and 5 represents the regression analysis and Variance in Factor (VIF) for different stock indices. In this study, three stock index is employed to test that the benchmark bond yield has some significant effects on stock indices with a set of the control variable. To do this, three separate regression is performed with S&P 500, NYSE Composite, and Dow Jones inthe first difference order. Table 3 represents the regression analysis between S&P 500 and 10-Yr Bond, while Tables 4 and 5 demonstrate the regression analysis of NYSE Composite and Dow Jones respectively. In Table 3, it is observed that the coefficient of Δ a 10-Yr Bond is positive and significant at the 1% level, the value of the coefficient is 152.95, which means that one unit change in the benchmark bond yield will change the S&P 500 stock index price difference by $152.95. At the same Variance in Factor (VIF) is conducted with the estimated coefficients and found a moderate amount of positive correlations between variables and their estimates as the VIF is greater than 1 but less than 5.

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Dependent variable:	**S&P 500**
Δ 10-Yr Bond	**152.965*** (43.565)**
Δ CPI	-28.038 (24.064)
Δ PrimeRates	60.889 (82.282)
Δ Real_Effective_ER	-26.839)*** (6.158)
Δ Unemployment	35.107 (44.543)
Δ M2	0.517*** (0.167)
Constant	13.686) (9.001)
Observations	131
R-Square	0.255

Table 3: Regression analysis and VIF with S&P500

Note: standard errors are in parenthesis. Significance level *p<0.1; **p<0.05; ***p<0.01

VIF

10-Yr Bond_FD	CPI_FD	PrimeRates_FD	Real ER_FD	Unemployment_FD	M2_FD
1.183	1.060	1.643	1.167	1.085	1.517

In Table 4, it is observed that the coefficient of Δ 10-Yr Bond is positive and significant at 1% level, the value of the coefficient is 800.915 with SE 196., which means that one unit change in the benchmark bond yield will change the Dow Jones stock index price difference by $800.915. At the same Variance in Factor (VIF) is conducted with the estimated coefficients and found a moderate amount of positive correlations between variables and their estimates as the VIF is greater than 1 but less than 5

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Dependent variable:	**NYSE-Composite**
Δ 10-Yr Bond	**800.915*** (196.403)**
Δ CPI	-97.756 (108.490)
Δ PrimeRates	474.537 (370.956)
Δ Real_Effective_ER	-143.013*** (27.762)
Δ Unemployment	185.574 (200.816)
Δ M2	2.035*** (0.754)
Constant	36.511 (40.578)
Observations	131
R-Square	0.320

Table 4: Regression analysis and VIF with NYSE-Composite

Note: standard errors are in parenthesis. Significance level *p<0.1; **p<0.05; ***p<0.01

VIF

10Yr-Bond_FD	CPI_FD	PrimeRates_FD	Real_ER_FD	Unemployment_FD	M2_FD
1.183	1.060	1.643	1.167	1.085	1.517

In Table 5, it is observed that the coefficient of Δ *a* 10-Yr Bond is positive and significant at the 1% level, the value of the coefficient is 1436.15, which means that one unit change in the benchmark bond yield will change the Dow Jones stock index price difference by $1436.15. At the same

Variance in Factor (VIF) is conducted with the estimated coefficients and found a moderate amount of positive correlations between variables and their estimates as the VIF is greater than 1 but less than 5

:

Dependent variable	**Dow Jones**
Δ 10-Yr Bond	**1,436.154*** (383.624)**
Δ CPI	-264.710 (211.908)
Δ PrimeRates	795.605 (724.567)
Δ Real_Effective_ER	-235.541*** (54.226)
Δ Unemployment	406.271 (392.242)
Δ M2	4.227*** (1.474)
Constant	104.879 (79.259)
Observations	131
R-Square	0.267

Table 5: Regression analysis and VIF with Dow Jones

Note: standard errors are in parenthesis. Significance level *p<0.1; **p<0.05; ***p<0.01

VIF

10-Yr Bond	CPI_FD	PrimeRates_FD	Real_ER_FD	Unemployment_FD	M2_FD
1.183	1.060	1.643	1.167	1.085	1.517

Appendix 1 contains all the residual graphs such as the residual fitted graph, QQ Plot for normality of the error term, and Density plot of residuals. The plots for all three regressions can be concluded that the predicted values and fitted values lie close to each other while the QQ and density plots show that the residuals are normal in distribution for all three models respectively.

VI. DISCUSSION AND CONCLUSION

This study attempts to find the relationship between stock index and benchmark bond yield using three different stock indexesinthe US. The stock index is the min indicator for investment in the stock market, higher stock index meansa higher return to the investors and vice-versa. On the other hand, benchmark bond yield is the yield at which the bond yields of other maturities are decided and therefore, benchmark bond is the leading indicator of the bond market for any country. The previous studies have shown the cross-linkage between these two markets with the help of some advanced statistical models such as VAR, GARCH, etc. This study has used a simple linear model to predict the relationship between stock index and benchmark bond yield respectively. The statistical results support our hypothesis that indicates that there is a significant effect of benchmark bond yield on stock indices in the US. The time series used in this analysis were found non-stationary and the first difference is taken to convert them into stationary series. The ADF test statistics show that the series becomes stationary at first difference. Three separate regressions on S&P 500, NYSE Composite, and Dow Jones at first difference order are performed to analyze the effect of bond yield on stock indices with a reasonable set of control variables such as inflation, unemployment, crime rates, real effective exchange rate, etc. The statistical results in Tables 3, 4, and 5 show that the benchmark bond yield has a positive significant impact on the stock index of S&P 500, NYSE Composite, and Dow Jones. The economic implication of the results is that the benchmark bond yield predicts the stock index significantly and there is a moderate

amount of correlation between the estimates and the time series as shown in the VIF table respectively.

This study is based on the simple linear regression model, which tries to analyze the stock-bond market relationship with some combination of control variables. The data set used in this study is of monthly frequency. Furthermore, some advanced time-series models should be incorporated for future study with an additional set of control variables and with large samples respectively.

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APPENDIX 1

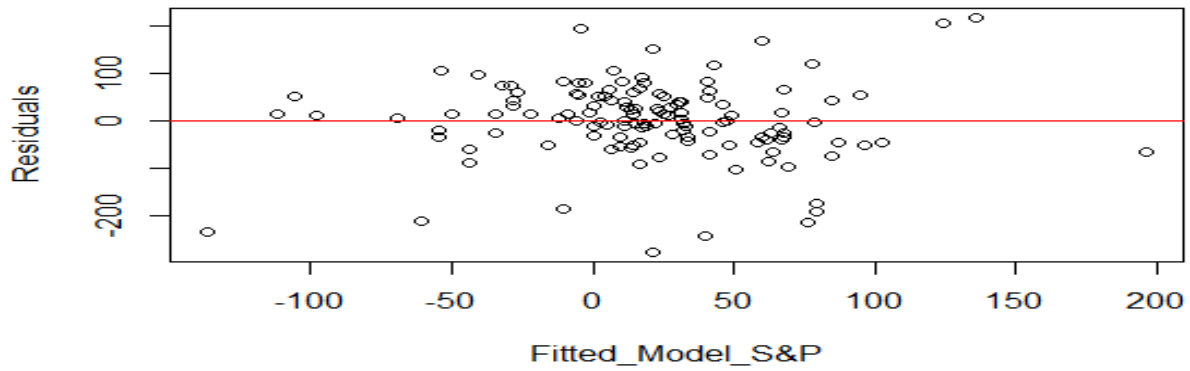

Fig. 1: Residuals vs Fitted Model of S&P 500 Regression Model

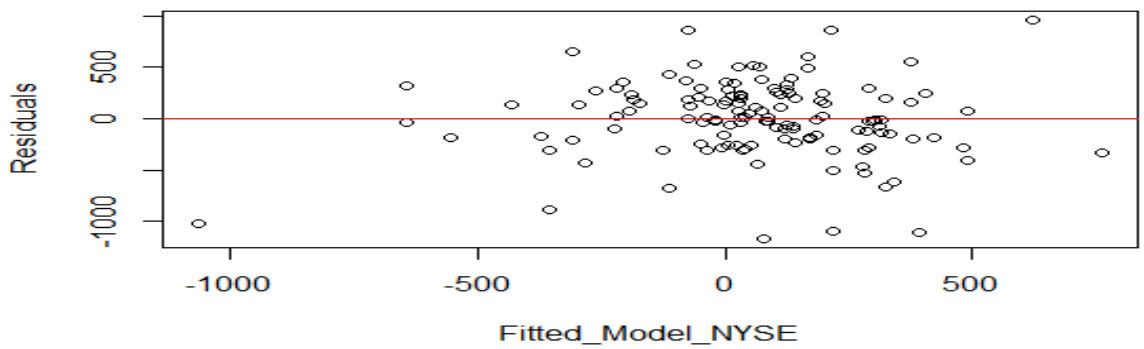

Fig. 2: Residuals vs Fitted Model of NYSE Composite Regression Model

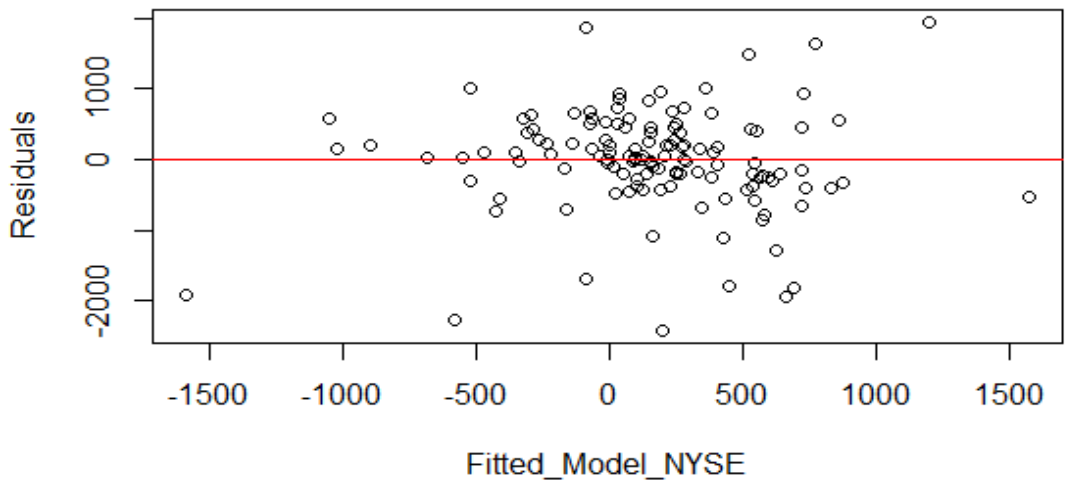

Fig. 3: Residuals vs Fitted Model of Dow Jones Regression Model

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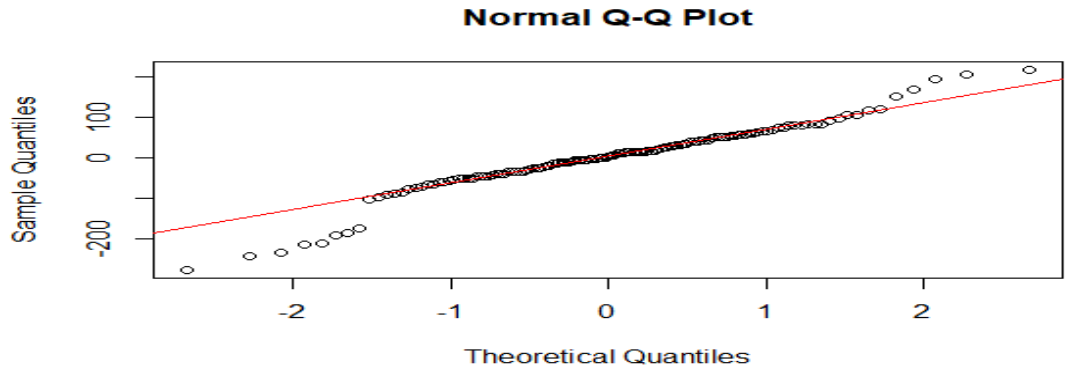

Fig. 4: Normal QQ Plot of S&P 500 Regression Model

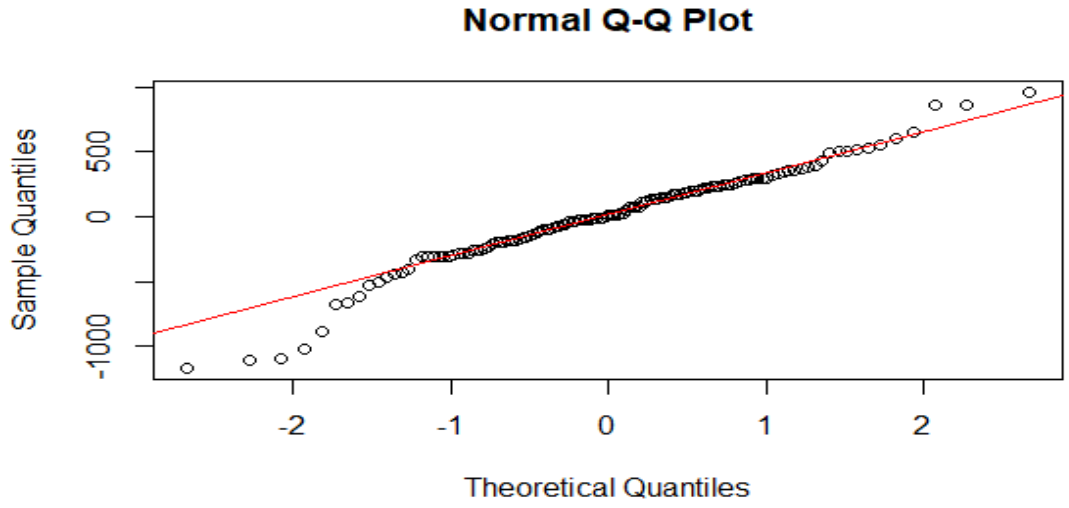

Fig. 5: Normal QQ Plot of NYSE Composite Regression Model

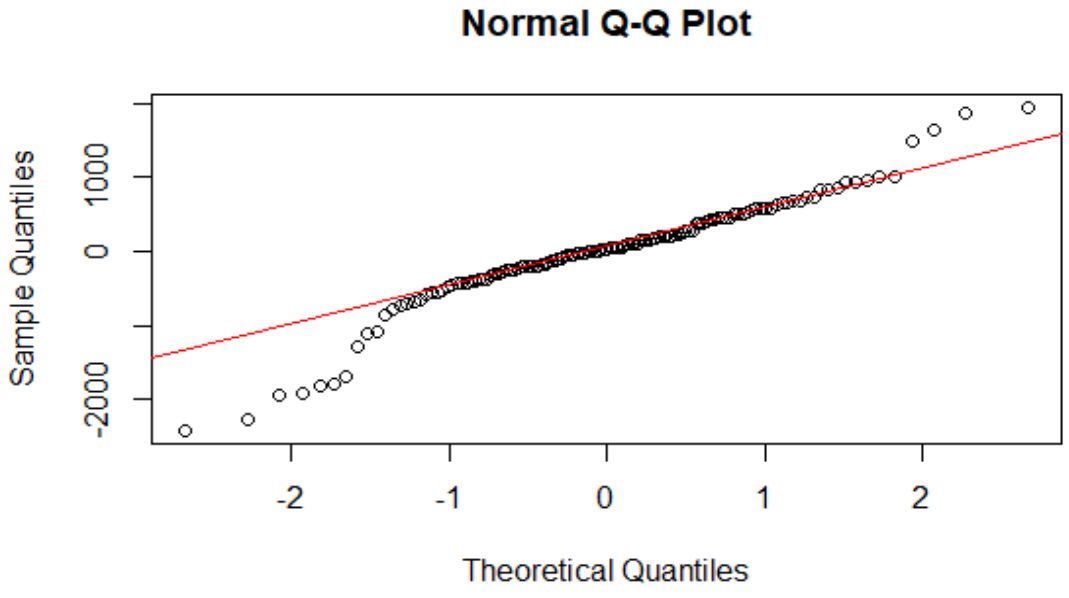

Fig. 6: Normal QQ Plot of Dow Jones Regression Model

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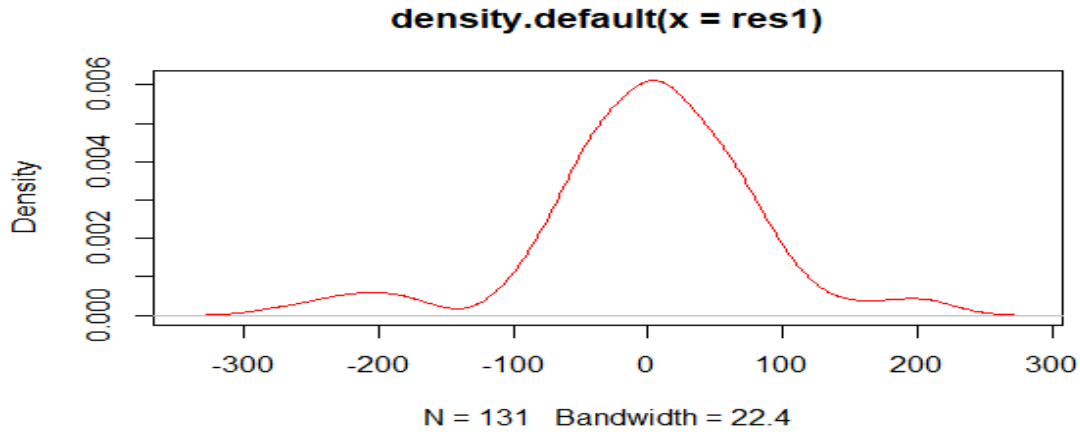

Fig. 7: Residuals Density plot of S&P 500 Regression Model

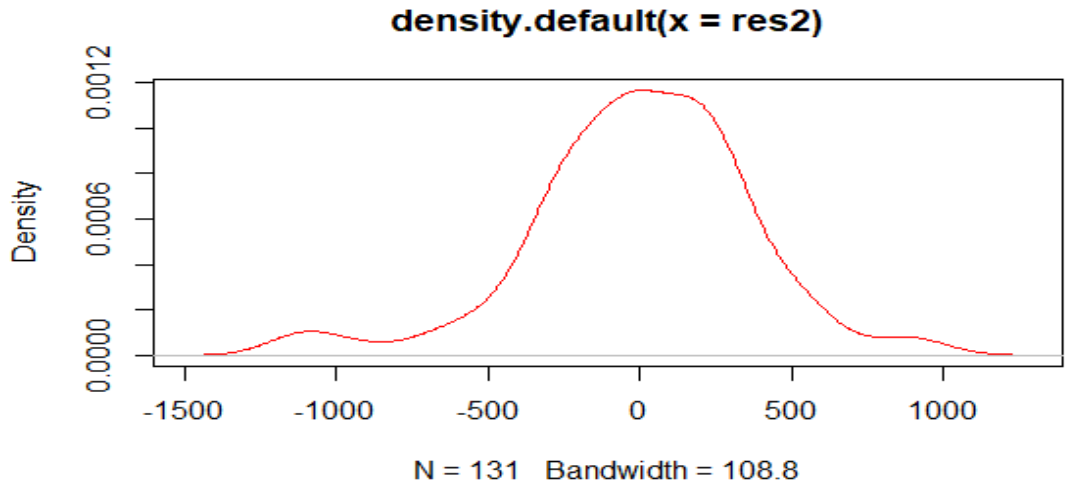

Fig. 8: Residuals Density plot of NYSE Composite Regression Model

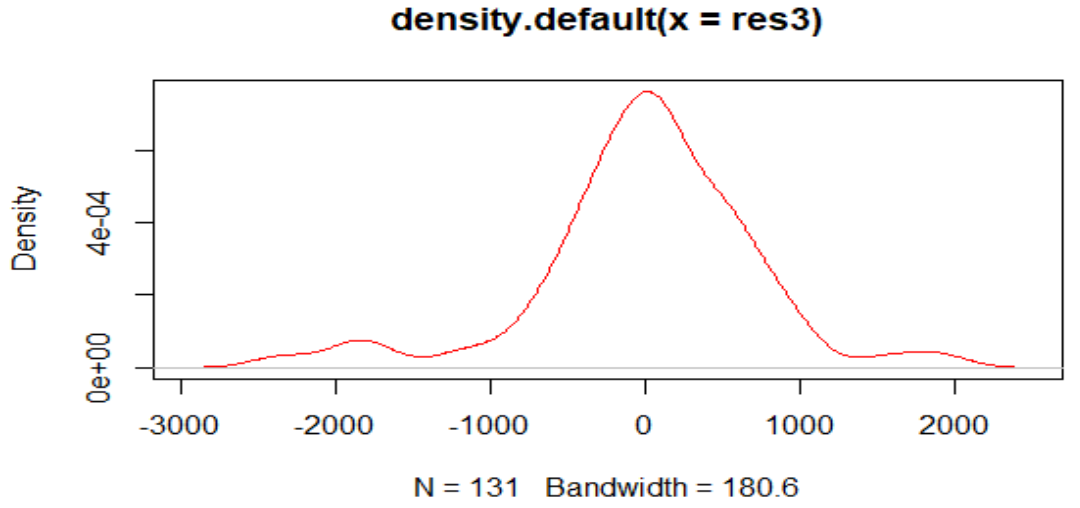

Fig. 9: Residuals Density plot of Dow Jones Regression Model