Financial Data Analytics – FIN9008

Investigating the Foreign Exchange Exposure of HIKMA PLC: An Econometric Analysis Using Time-Based and Robust Regression Models

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1. Introduction

Technological advancements, globalisation and shifting consumer preferences characterise the dynamic business environment of the 21st century, exposing going concerns to unprecedented challenges and opportunities, warranting organisations to actively adapt to this dynamicity. As organisations interact with shifting global landscapes, there is inherent exposure to macroeconomic and firm-specific factors, addressing which is imperative for borderless organisations to maintain sustainable operations. Markets and academia utilize a variety of tools to assess the performance of an organization or industry, while organizations themselves employ analytical and forecasting techniques to maintain competitiveness and profitability – prompting the development of complex models. Mirroring such models, this research attempts to study the influence of the foreign exchange exposure of Hikma Pharmaceuticals, a prominent international player in the industry. With operations spread across the UK, USA, and EMEA, they are exposed to oscillating macroeconomic and firm-specific factors, including currency fluctuations, regulatory environments, and market-specific risks. Understanding these determinants impact the quality of analysis by stakeholders and organisations alike, which is the scope of this study, specifically focusing on the impact of the pairs of chosen currencies with the British Pound Sterling. Listed on the FTSE 100, the pairs have been chosen after a thorough analysis of Hikma's global operations, aimed at reflecting the impact of the pairs on the excess returns of the stock. Additionally, the impact of the broader market, the FTSE 100 in this case has also been included to enhance the scope of the study. The returns are observed over a ten-year period, starting 2014. The study includes the evolutionary nature of these relationships over time and includes structural changes such as Brexit and COVID-19. The analysis builds on the econometric framework established by (Martin & Mauer , 2005), emphasizing methodological rigor and addressing key challenges such as multicollinearity, heteroscedasticity, non-normality, and structural breaks. This research builds on the Capital Asset Pricing Model (CAPM) framework, which links stock excess returns to market excess. Building on the foundations of CAPM, this research aims to incorporate features of multi-factor models to capture the dynamicity of global operations on Hikma's stock, blending traditional CAPM principles with advanced econometrics for robust model specification.

2. Methodology

An exhaustive model has been developed to study the impact of Hikma stock's excess returns (dependent variable in this case) by the fluctuations of different currencies relative to the Pound Sterling along with the impact of the broader market's excess returns (Independent Variables). The excess returns are derived from the daily returns of the stock less the three-month UK Treasury Bill yield, for a period of ten years starting 2014. Following the standards set by (Martin & Mauer , 2005) for methodological rigour, potential issues like multicollinearity, heteroscedasticity, autocorrelation, and residual normality were tested for and addressed. The currencies chosen to determine the impact of foreign exchange exposure on the stock's returns after meticulous analysis of Hikma's operations in key business environments globally. The market excess returns serve as a core explanatory variable, to highlight Hikma's sensitivity to broader market trends. The remaining variables are exchange rates of different countries relative to the GBP, categorised as having direct impact on its revenue or indirectly impacting via costs involving supply chain, production, or other such costs. The USDGBP variable reflects Hikma's revenue exposure to the US market, one of the largest sources of revenue, with a depreciating GBP resulting in higher returns for the company. The EURGBP reflects the company's key base of operations in the Eurozone, having a direct impact on its revenues and cost structures. With a prominent presence in the Middle East, particularly in Saudi Arabia, the company derives a substantial portion of its revenue from the region. The Saudi Riyal is pegged against the USD, suggesting the study of the SARGBP's influence on the revenues of Hikma. Founded in Jordan, the company continues to operate in Jordanian markets, and also has expanded presence in emerging markets such as Egypt. For the purposes of this study, the JODGBP and EGPGBP has been considered to reflect a comprehensive view of influences of exchange rate fluctuations on Hikma's stock returns, with the latter taken as a benchmark to study the effect of exchange rate fluctuations against the Pound for currencies of emerging markets. The company sources raw materials from Switzerland, prompting the inclusion of CHF/GBP to reflect the impact of costs driven by supply chain and production. The reliance on production, supply chains, and operations in the Chinese market prompted a similar rationale for inclusion as the Swiss Franc.

2.1 Description of Data

Data for the study comprises the daily closing price for Hikma PLC (LSE: HIK) spanning from 2014 to 2024, sourced from Bloomberg Terminal. Other key variables include daily market returns, FTSE 100 in this context, the three-month Treasury Bill Yield as the UK risk-free rate, and currency exchange rates, for the same period, to represent Hikma's global operating regions. The dependent variable is the difference between daily returns of the stock of Hikma and the UK risk-free rate, serving as a measure of excess returns. The independent variables include the market excess return, derived by subtracting the UK risk-free rate from the FTSE 100 daily returns, and the currency exchange rates. The variables were log-transformed to stabilise variance and aid in determining relationships with the dependent variable. The dataset consisted of 2483 observations after addressing missing values via median imputation, ensuring the retention of all key variables. To account for structural shifts, yearly time dummy variables were introduced to study patterns and addressing economic events like Brexit and the COVID-19 pandemic. These variables collectively provide a comprehensive framework for evaluating the macroeconomic, regional, and market factors influencing Hikma's stock performance.

2.2 Hypotheses

Hypothesis 1 – The performance of an individual stock is closely tied to the performance of the broader market.
The intent is to study the impact of systematic risk on an individual firm's returns, under the framework of the Capital Asset Pricing Model. As a publicly traded firm, Hikma is expected to be exposed to broader market movements, reflecting the influence of macroeconomic variables like investor sentiment and economic trends. In this study, the market excess returns and the UK risk-free rate are taken as proxies for such macroeconomic variables.

Hypothesis 2 – The performance of an individual stock is influenced by the fluctuations in currency exchange rates in the regions the firm operates, with varying magnitude and direction.
A company with widespread operations across regions such as USA and EMEA, its operations, revenue and sustainability is assumed to be influenced by the fluctuations in currency exchange rates in these regions. It is also assumed that the direction and magnitude of the impact on Hikma's performance will vary across currency pairs due to the company's varying dependencies across regions. While operations in some regions are revenue driven, others are focused on production and distribution aspects, hence the assumption of varying magnitude and direction in impact.

Hypothesis 3 - Structural shifts in macro environments substantially influence individual organisations and their relationship with other variables.
The dynamicity of any business environment is characterised by structural shifts, influencing the nature of relationship between organisations and their environment. Drawing from this, the study aims to broadly assess the impact of COVID-19, identified as a global breaking point and in the context of Hikma, also assess the influence of Brexit.

2.3 Model Specification

Various models were developed to help explain the scope of the study. Initially, a linear regression of the variables using the Ordinary Least Squares method was adopted, which offered relevant results signifying the influence of the predictors. However, relevant diagnostic testing such as heteroscedasticity and autocorrelation, gave unsatisfactory results. Furthermore, following a functional form test using the Ramsey RESET Test, it was evidenced that the model was not a good fit for the data, prompting further refinements.
Multicollinearity was detected by high VIF values for two variables, namely, the logged values of USD/GBP and SAR/GBP. A ridge regression was run to address this, with improved residuals vs. fitted values (Figure 1). The ridge regression mitigates instability by shrinking the coefficients, but its limitations for addressing outliers and reduced interpretability, which are core areas for the purposes of this study, the model was not addressed further. Financial data is inherently interrelated, with persistent correlation a feature of such

data, so under the assumption of multicollinearity, the model chosen finally is still expected to be the best linear unbiased model.
A Ramsey test indicated the presence of nonlinear relationships; hence, the introduction of polynomial terms was necessary to add more dynamism to the model. Periodic volatility was expected due to the chosen period, which refers to the influence of COVID-19 and Brexit, which were studied in correlation with annual time dummy variables. Initial tests such as the Breusch Pagan Test, suggested heteroscedasticity, so robust standard errors were applied, to ensure the reliability of the coefficient estimates. Residual diagnostics highlighted the influence of outliers, effects of which were attempted to be adjusted. Adjustment of outliers was justified by doing a comparative analysis of regression outputs preceding and following adjustments, which did not suggest any information loss. While some minor adjustments are observed, they align with expectations when addressing outliers, and the overall model integrity is maintained. The adjustments presented an improved model conforming to key regression inferences, also mitigating non-normality of residuals of the previous models. A test for normality, using the Jarque-Bera test, before and after adjustments for outliers, suggests improvements in residuals, substantiating the removal of outliers. The final model emerged after an iterative process of integrating polynomial terms, robust standard errors, and time-based effects to provide a comprehensive specification tailored to Hikma's data. This approach balances theoretical considerations and statistical rigor, addressing key diagnostic challenges. This model was chosen over simpler alternatives due to its ability to address the unique characteristics of the dataset, including multicollinearity, structural breaks, and non-linear relationships. A thorough refinement process to ensure goodness-of-fit fit and provide meaningful and interpretable insights aligns with best practices in econometric modelling, ensuring robust and reliable conclusions can be drawn tailored to Hikma's financial and operational context.

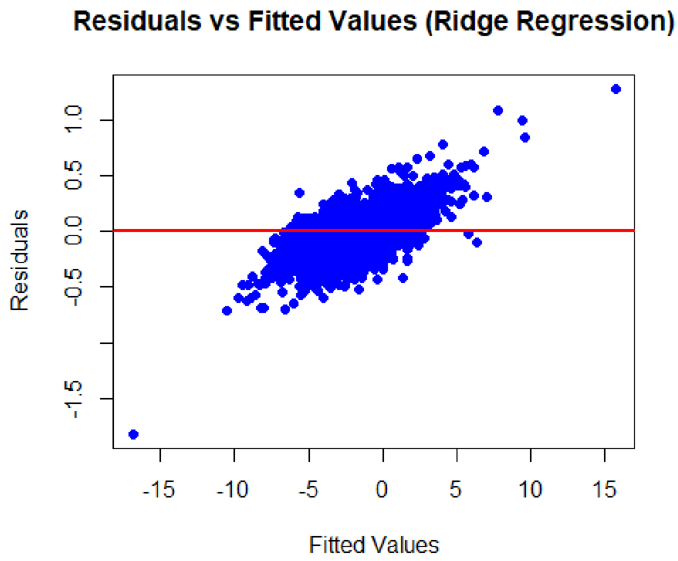


Figure 1

2.3.1 Initial Regression using Ordinary Least Squares (OLS)

Laying the foundation for subsequent models, the initial model studied the influence of excess returns of the market, alongside eight contextually relevant currency exchange rates on the excess returns of the stock. The purpose of the model was to study the relationships between these variables, establishing magnitude and direction whilst exposing inherent issues of dealing with financial data.
Upon fitting the model, the results evidenced the presence of several variables which were statistically significant in predicting Hikma's returns. The results of the regression depicted a strong and positive relationship between the excess returns of the market and that of Hikma's stock, indicated by a positive coefficient of 0.91584. With a t-value of 50.492 and a p-value of < 2.2e-16, the hypothesis that Hikma's returns are significantly influenced by broader market performance was strongly affirmed. The scatter plot (Figure 2) further supports this finding, illustrating a clear positive association between STKEXCSSRTNSYR (Hikma's stock excess returns) and INDXEXCSSRTNSYR (market excess returns), confirming the robustness

of the regression results. Among the currency exchange rates, the JOD/GBP, indicating the value of 1 Jordanian Dinar translated into Pound Sterling, showed a significant positive effect on stock returns, with a t-value of 2.4529 and a p-value of approximately 0.0142. This suggests that an appreciating Pound against the Jordanian Dinar leads to more favourable financial conditions for Hikma, potentially reducing local operational costs in Jordan. Similar observations were made for other currency pairs. However, high variance inflation factors (Figure 3) for the Dollar and Saudi Riyal against GBP, 139.2 and 132.9 respectively, exhibit severe multicollinearity present in the model, questioning the interpretability of the coefficients.

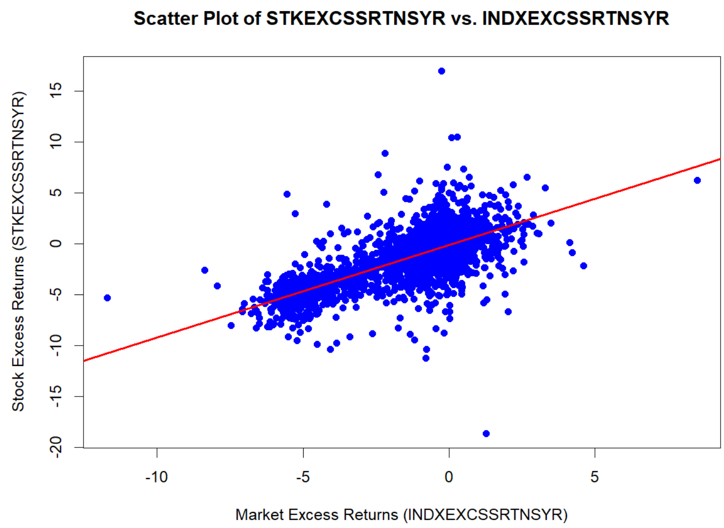


Figure 2

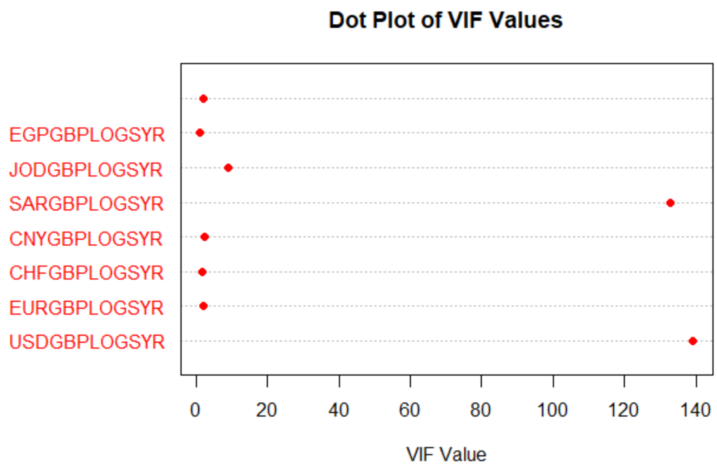


Figure 3

A robust f-statistic of 286.9 with a p-value of less than 2.2e-16, suggests that the predictors explain a substantial portion of Hikma's excess returns. The R^2 value indicated that 49.82% of the variation in the dependent variable is explained by the independent variables, while the adjusted R^2 is around 0.4964 penalised for the inclusion of variables which exhibit multicollinearity.

However, residual diagnostics uncover challenges of the model. The Breusch-Pagan test for heteroscedasticity returned a p-value of less than 2.2e-16, indicating the presence of non-constant variance in residuals (Figure 4). Further testing for residual normality using Jarque-Bera test, reveals deviations from the normal distribution (Figures 5 and 6), returning a result of JB = 11678, $p < 2.2e-16$. Functional form tests using Ramsey's RESET test, gave a result of 13.019 with a p-value of 2.365e-06, indicating that the model does not capture the non-linear relationships.

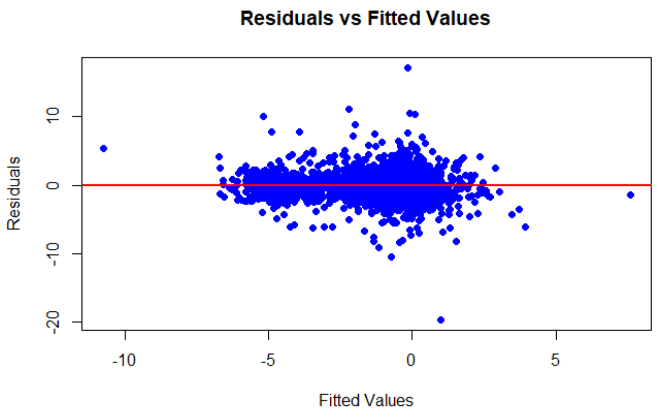


Figure 4

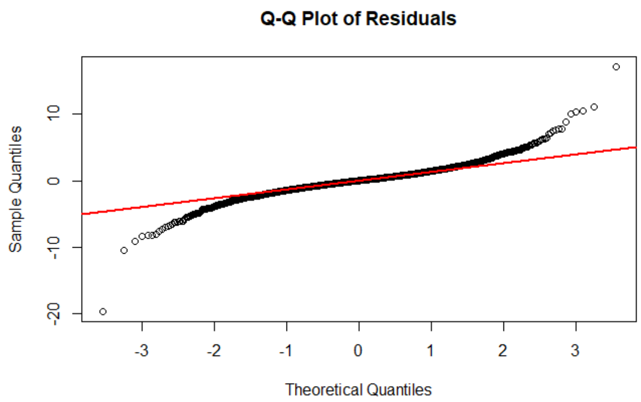


Figure 5

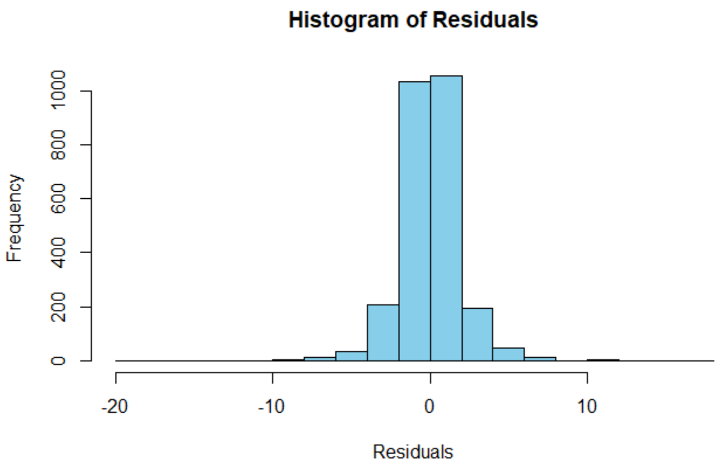


Figure 6

Deviations from the ideal bell-shaped distribution, the patterns indicate non-constant variance of the errors, violating one of the core assumptions of the OLS method. In conclusion, the initial OLS model helped identify key predictors such as market's excess returns and the multiple currency pairs, but due to issues of heteroscedasticity, multicollinearity, and non-normality, the creation of more robust models were prompted.

2.3.2 Robust Time Dummy Model

The main objective was to account for potential non-linear relationships between the variables, highlighted by the initial OLS model. Based on the residual diagnostics, polynomial terms were introduced for the market excess returns variable to capture potential non-linear relationships between the variable with the stock's excess returns. Since, currency related variables empirically exhibit a linear relationship with stock returns, adding polynomial terms does not necessarily ehance preditive or interpretability power and instead may result in overfitting. Thus, adhereing to the principles of model parsimony, such terms were not introduced for currency related variables. The model was first fitted for robust regression to handle non-normality, heteroscedasticity and overall improvement of model stability. Outliers were adjusted by identifying and removal of influential observations using Cook's distance.

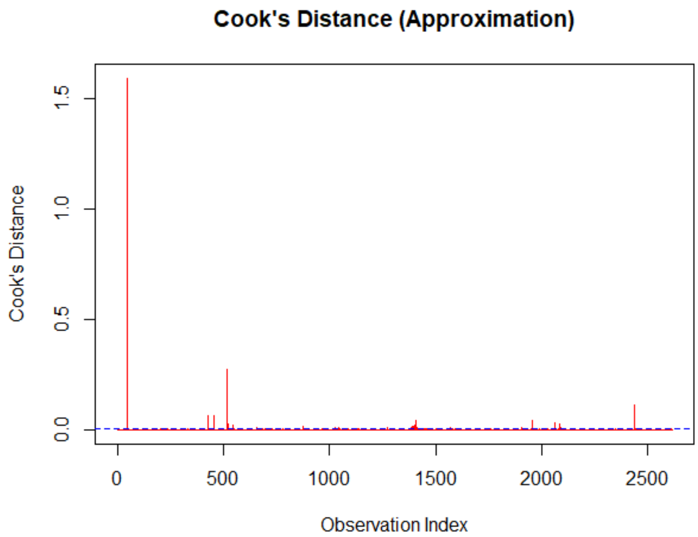


Figure 7

The Cook's Distance plot (Figure 7), identified influential observations which were unduly affecting the model estimates. The red line in the plot marks the threshold beyond which data points were considered as influential, helping adjust for the skewed results intially. Subsequently, polynomial terms for market excess returns variable were introduced to capture the non-linear relationships, as suggested by economic theory and earlier regression diagnostics. The robust time dummy model makes improvements over the initial OLS model, adjusting for heteroscedasticity, non-normality and multicollinearity. Figure 8 compares residuals vs fitted values for the Initial OLS model and the Robust Time Dummy model. The plot shows that the residuals for the robust model are more evenly distributed around zero, indicating a better overall fit and adjusted for heteroscedasticity. Its superiority over the OLS model is evident by the red plot depicting patterns, allowing for the robust model to emerge as a more reliable fit.

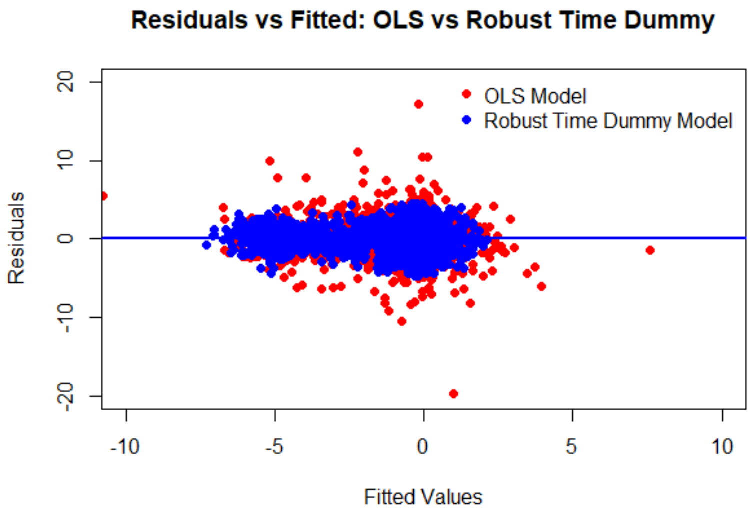


Figure 8

The introduction of the time dummy variable for each year, the model is deisgned to represent annual patterns, including structural breaks in 2020 as identified by the Chow Test (Figure9). The Robust Time Dummy Model outperforms the Initial OLS Model in multiple aspects. It has a lower AIC (10737.59 vs. 10772.04), indicating better model fit and fewer penalized errors, and a higher Adjusted R-squared (0.6570 vs. 0.4964413), suggesting a more accurate representation of the data, and superior in terms of capturing variance.

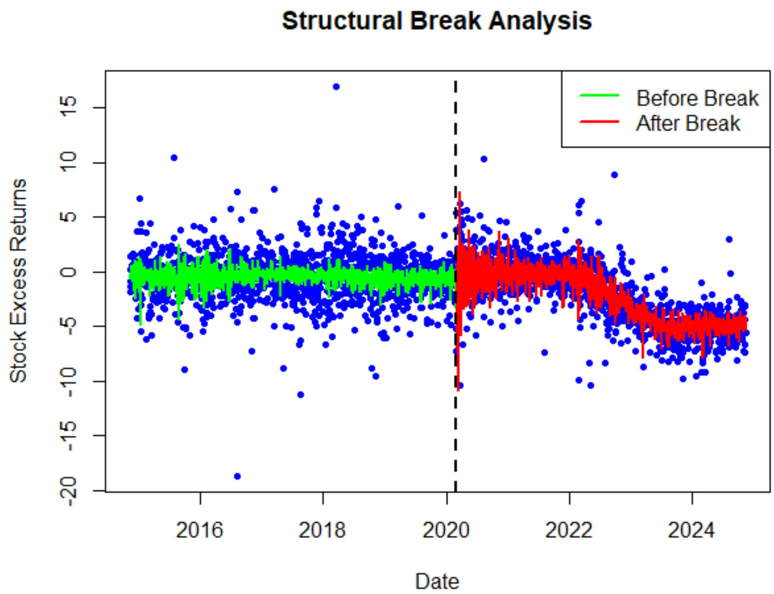
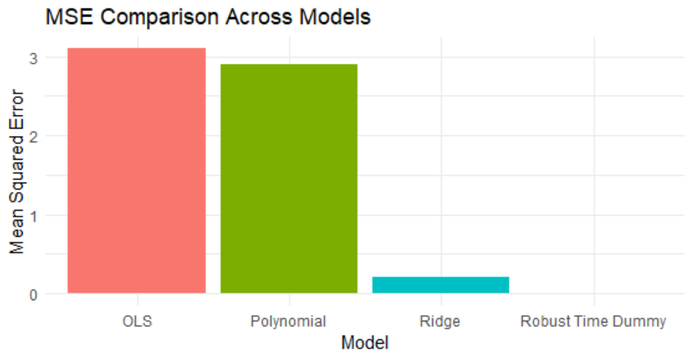


Figure 9

Additionally, a MSE Comparison (Figure 10) shows that the robust model achieves near-zero error, indicating better predictive performance compared to both the OLS and polynomial models. Overall, the robust model addresses heteroscedasticity, multicollinearity, and outliers more effectively, leading to a more reliable and efficient model. It effectively explains influence of macroeconomic factors, exchange rate fluctuations and structural shifts on Hikma's performance, making it the best model for the model's objectives.



	Metric	OLS	Robust_Time_Dummy
1	AIC	1.077204e+04	1.073759e+04
2	BIC	1.083658e+04	1.086081e+04
3	Adjusted R-squared	4.964413e-01	5.055237e-01

Figure 10

3. Hypothesis Testing and Results

3.1 Hypothesis 1: The performance of an individual stock is closely tied to the performance of the broader market

Test of Hypothesis : This posits that the broader market influences the stock returns of companies, in this context, Hikma Pharmaceutical's. The market excess return variable represents the performance of the market and it is expected to have a positive relationship with Hikma stock's excess returns.

Results : The coefficient for the market excess return is 0.6892, depicting a high significance with a t-value of 21.0381 and a p-value of less than 0.001. The positive sign of the coefficient indicates that as the market performs well, the stock is also going to perform in a similar manner. This can be interpreted as for every 1% increase in the market excess return, Hikma's stock excess return increases by 0.6892%, confirming that the broader market movements are significantly related to Hikma's performance. The Structural Break Analysis supports this Hypothesis, (Figure 9), clearly demonstrating a decline in stock performance around 2020. Prior to 2020, the stock returns were releatively stable (green and blue dots), aligning with the market's performance, but the advent of the pandemic exposed the company to volatility and a downward trend (indicated by the red dots). Although, this was not an observable trend in all pharmaceutical companies, possible supply chain disruptions due to Hikma's reliance on China could be a factor in it's decline. 2020 was also significant in terms of a 11% decline in net profit for Hikma, driven by increased competition in the U.S. Generics Market, a significant revenue driver for the company. The company faced delayed approvales for some of its pipeline products. This coupled with manufacturing challenges, resulted in inflated costs and lost market share. The pandemic onslaught brought with it market volaitility and investors already wary with a declining profit, did not show confidence in the company. Despite, the behaviour is consistent with the company's exposure to market dynamics, given that its operations are globalised and is sensitive to global investor sentiment and macroeconomic factors. This relationship aligns with the Capital Asset Pricing Model (CAPM), reflecting Hikma's sensitivity to broader market dynamics.

3.2 Hypothesis 2: The performance of an individual stock is influenced by fluctuations in currency exchange rates in the regions the firm operates, with arying magnitude and direction.

Test of Hypothesis : Hikma Pharmaceuticals operate in diverse regions, spanning across USA, Europe, Jordan, Switzerland, China, and Egypt. This hypotheis tests the influence of currency fluctuations of these regions with the British Pound Sterling, to make inferences on their impact on the stock's excess returns.

Results :

The USD/GBP rate has a coefficient of -0.1988 and a t-value of -1.2525, which is not statistically significant. This suggests that the USD/GBP exchange rate does not have a substantial impact on Hikma's stock returns. Hikma's stock returns seem unaffected by USD/GBP exchange rate changes, despite its strong U.S. presence. The company likely offsets U.S. revenues with costs in USD, naturally reducing the impact of currency fluctuations. It may also use hedging strategies to manage exchange rate risks and stabilize cash flows. Hikma's global operations spread revenue across multiple currencies, lessening its reliance on any single exchange rate. Lastly, broader market trends or disruptions, like those post-2020, may overshadow the immediate effects of USD/GBP changes on its stock performance.

EUR/GBP has a coefficient of 0.1072, with a t-value of 1.2504. While this is positive, it is not statistically significant, indicating a weak but postiive relationship between the fluctuations and Hikma's stock returns. The direction of the influence on Hikma's stock performance is consistent with the company's operations in Europe, as it is likely to benefit from currency appreciation, indicated by higher revenues in the region directly improving profitability.

JOD/GBP shows a significant positive relationship, with a coefficient of 0.2524 and a t-value of 1.5947, implying a stronger Jordanian Dinar boosts Hikma's stock performance. This is expected given their origins in Jordan and continued substantial operations in the country.

EGP/GBP has a coefficient of 0.363 with a t-value of 1.8364, which is significant at the 5% level, suggesting fluctuations have influence on the stock returns, substantiated by its significant operations in Egypt. CHF/GBP has a coefficient of -0.1671 and a t-value of -2.9117 is statistically signifiant. The negative relationship suggests a stronger Swiss Franc reudces Hikma's returns, linking to operational costs or revenue impacts from Switzerland.

SAR/GBP has a significant negative coefficient of – 0.8648 and a t-value of -1.5173. This indicates a stronger SAR tens to reduce returns. Saudi Arabia is an important market for Hikma, and this relationship likely captures the impact of inreased operational costs, when SAR strengthens. These costs may outweigh revenue offsets in the same currency.

CNY/GBP has a small positive coefficient 0.0335 but is statistically insignificant (t = 0.3956, p = 0.7330). This suggests that fluctuations in the Yuan relative to GBP have little to no impact on Hikma's stock returns. Hikma's limited exposure in China, coupled with potential hedging or balanced revenues and costs, likely minimizes the effect of CNY/GBP movements. As a result, the Chinese yuan is not a significant driver of Hikma's financial performance or stock returns.

The lack of significance of currency flucutations significance could be explained by the relative weight of Hikma's operations in these regions. For example, despite Hikma's presence in China, its dependency on the Chinese yuan (CNY) may not be as high as its exposure to European currencies like the euro or the pound. Additionally, the relative market size and the nature of Hikma's operations in these countries, which include both distribution and manufacturing, may not result in large enough currency effects to affect its stock returns significantly.

3.3 Hypothesis 3 : Structural shifts in macro environments substantially influence individual organisations and their relationship with other variables

Test of Hypothesis : This hypothesis explores the impact of significant global events, such as COVID and Brexit on Hikma's stock returns, with the use of the time dummy variables to capture the effects of structural breaks.

Results :

TimeDummy 2015 to TimeDummy2019 had coefficientt values close to zero, indicating they are statistically insignificant. These years did not depict any significant impact on Hikma's stock returns relative to the base year 2014.

TimeDummy 2020 reprensenting the year of the pandemic has a coefficient of 0.233 with a t-value of 0.0937, indicating a non-significant effect. Despite global shocks, Hikma's stock may have been buffered by the company's strategic responses or the broader pharmaceuticals sector's resisilience during the pandemic may have mitigated headwinds. A Box Plot of Hikma's stock returns (Figure 11) for the period between 2014-2024 shows a reduction in stock returns after 2020. The disparity between the Box Plot results and the TimeDummy results may suggest that although there is a change, the output of the regression model does not strongly support that the effect was large enough to be distinguished separately. **TimeDummy 2022** shows a negative coefficient of -0.6440 with a t-value of -2.4582, which is statistically significant. This negative impact could reflect the economic uncertainities following the peak of the pandemic such as supply chain disruptions, inflationary pressures and shifts in demand patters. **TimeDummy 2024** shows a large negative coefficient of -1.3801 with a t-value of -4.5392, which is highly significant. This could be primarily due to recent legal troubles prompted by the company's failure to report illegal opiod orders and distributors.

The results support the hypothesis that structural shifts particularly from the pandemic and Brexit have influenced Hikma's returns. The time dummies for 2022 and 2024 are significant, indicating a negative impact on returns likely due to recovery challenges presented post-pandemic.

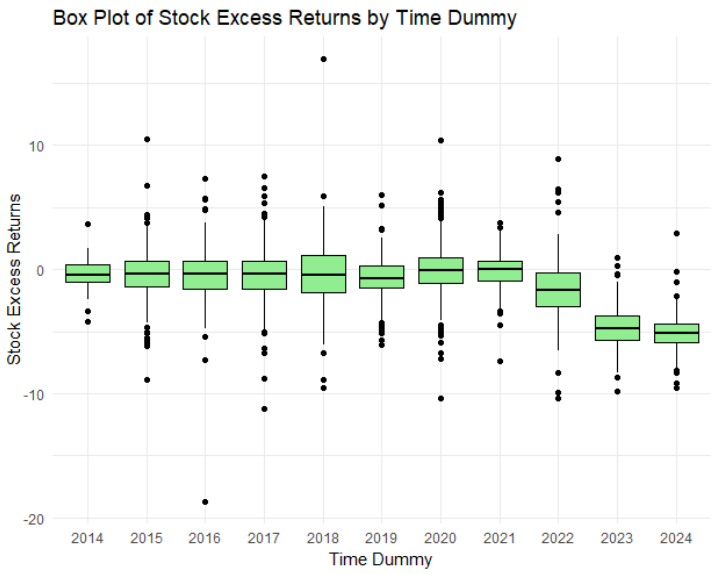


Figure 11

Conclusion

The model provides a robust framework for understanding factors driving Hikma's returns. For this study, the primary focus was to address the impact of foreign exchange exposure through their global operations, involving sourcing of materials, sale of services or goods in foreign currencies, as well as revenue generation in foreign markets. The capital market approach examines the sensitivity of stock returns to fluctuations in exchange rates while controlling for market movements, helping estimate the degree of this exposure. In the case of Hikma, the analysis revealed mixed results regarding the influence of exhange rates on stock performance. For instance, the USD/GBP, despite Hikma's strong presence, shows no statistically significant effect. This suggests that they likely offsets U.S. revenues with U.S. denominated costs, reducing the impact of fluctuations, as would any oranisation with significant operations in a country. In contrast, the JOD/GBP and EGP/GBP show postiive and statistically significant relationships indicating a stronger currency in these regions boost their performance, which performed as per expectations. Varying significance, magnitude and direction of results help infer that the exposure to such fluctuations in dependent on the scope, nature and magnitude of operations in the countries. Furthermore, employment of hedging strategies via forward contracts, options and currency swaps, may mitigate their exposure to fluctuations, which may explain the statistically insignificant results for certain currency pairs despite operations in those regions.

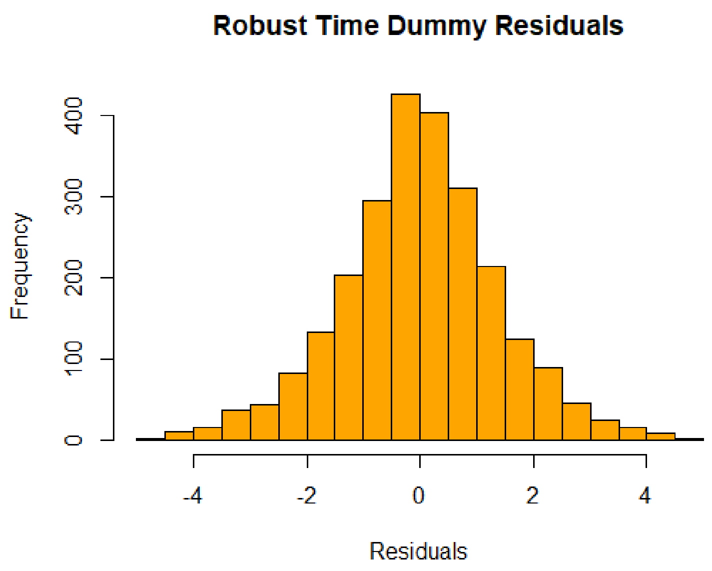


Figure 12

A Histogram of Residuals (Figure 12) visually supports the model's goodness of fit. The distribution of residuals is approximately normal, ideal for validating assumptions of the model. The histogram shows a peak near zero, and relatively symmmetric tails indicating that errors are fairly even in spread and do not exhibit severe skewness or kurtosis, suggesting well-behaved residuals. This supports the assumption of normally distributed errors. The Q-Q plot (Figure 13) corroborates this by showing residuals closely following the 45-degree line, indicating that they are approximately normally distributed.

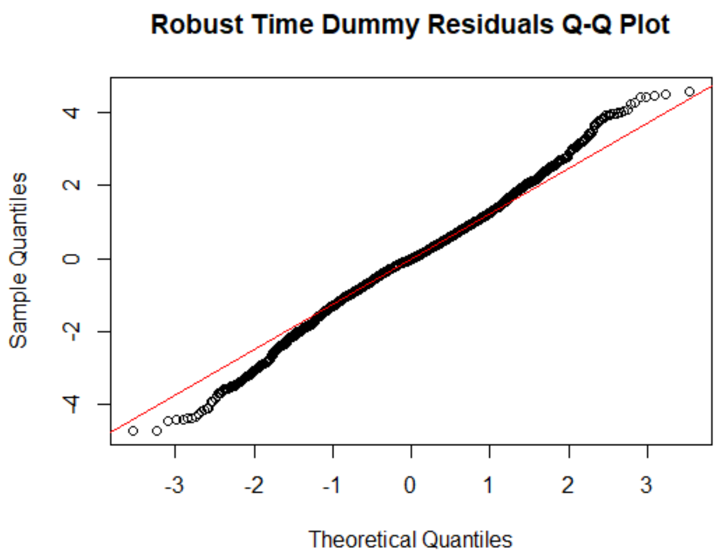


Figure 13

The Adjusted R-squared value for the Robust Time Dummy Model is 0.6570, indicating that approximately 65.7% of the variation in the dependent variable is explained by the independent variables included in the model. This suggests that the model captures the key relationships effectively, while still leaving some variability unexplained. A RESET test performed gave a p-value of 0.1772, indicating no significant evidence of model misspecification. This suggests that the model is well-specified, with no significant need for structural adjustments or additional non-linear terms.

Despite the thorough analysis, the study faces several limitations inherent in financial data, such as missing data and assumptions of linearity, which could affect the robustness of the results. Additionally, the volatility of exchange rates and market returns may impact the reliability of long-term predictions. While the Breusch-Pagan test and other diagnostics addressed some of these issues, further refinements could include exploring additional predictors or interactions between exchange rate fluctuations and structural changes. Future research could delve deeper into non-linear relationships, interactions between macroeconomic variables (e.g., inflation and interest rates), and other such dynamic modeling approaches to improve predictive accuracy, particularly in post-pandemic recovery contexts.

This study confirms that Hikma Pharmaceuticals' stock returns are significantly influenced by both market-wide factors and currency fluctuations, particularly from currencies like JODGBP and EGPGBP. Structural shifts, notably from COVID-19 and Brexit, underscore the importance of adapting to evolving macroeconomic conditions. The final model, incorporating polynomial terms, robust standard errors, and time dummy effects, provides a reliable framework for understanding Hikma’s stock returns, despite the identified data limitations.

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Martin, A., & Mauer , L. J. (2005). A Note on Common Methods Used to Estimate Foreign Exchange Exposure. *Journal of International Financial Markets Institutions and Money*.
This paper focuses on empirical methods to estimate foreign exchange exposure, particularly regression-based models, and evaluates the impact of currency fluctuations on firm value. It also discusses theories of exposure and risk management, emphasizing the role of hedging strategies in mitigating exchange rate sensitivity.

Appendix

Initial OLS

1. Log Transformation

```
HIKMA_40455377$STKLOGSYR = c(NA, 100*diff(log(HIKMA_40455377$`HIK LN Equity`)))
HIKMA_40455377$INDXLOGSYR = c(NA, 100*diff(log(HIKMA_40455377$`UKX Index`)))
HIKMA_40455377$USDGBPLOGSYR = c(NA, 100*diff(log(HIKMA_40455377$`USDGBP Curncy`)))
HIKMA_40455377$EURGBPLOGSYR = c(NA, 100*diff(log(HIKMA_40455377$`EURGBP Curncy`)))
HIKMA_40455377$CNYGBPLOGSYR = c(NA, 100*diff(log(HIKMA_40455377$`CNYGBP Curncy`)))
HIKMA_40455377$JODGBPLOGSYR = c(NA, 100*diff(log(HIKMA_40455377$`JODGBP Curncy`)))
HIKMA_40455377$EGPGBPLOGSYR = c(NA, 100*diff(log(HIKMA_40455377$`EGPGBP Curncy`)))
HIKMA_40455377$SARGBPLOGSYR = c(NA, 100*diff(log(HIKMA_40455377$`SARGBP Curncy`)))
HIKMA_40455377$CHFGBPLOGSYR = c(NA, 100*diff(log(HIKMA_40455377$`CHFGBP Curncy`)))
HIKMA_40455377$STKEXCSSRTNSYR = HIKMA_40455377$STKLOGSYR - HIKMA_40455377$`UKGTB3M Index`
HIKMA_40455377$INDXEXCSSRTNSYR = HIKMA_40455377$INDXLOGSYR - HIKMA_40455377$`UKGTB3M Index`
```

2. Class and Dimensions

```
> str(HIKMA_40455377)
tibble [2,612 × 24] (S3: tbl_df/tbl/data.frame)
 $ Dates           : POSIXct[1:2612], format: "2014-11-10" "2014-11-11" ...
 $ HIK LN Equity   : num [1:2612] 1900 1914 1898 1934 1907 ...
 $ UKX Index       : num [1:2612] 6611 6627 6611 6635 6654 ...
 $ UKGTB3M Index   : num [1:2612] 0.455 0.455 0.455 0.454 0.454 0.466 0.465 0.464 0.464
0.466 ...
 $ USDGBP Curncy   : num [1:2612] 0.631 0.628 0.634 0.636 0.638 ...
 $ EURGBP Curncy   : num [1:2612] 0.784 0.784 0.788 0.794 0.799 ...
 $ CNYGBP Curncy   : num [1:2612] 0.103 0.103 0.103 0.104 0.104 ...
 $ JODGBP Curncy   : num [1:2612] 0.89 0.887 0.895 0.899 0.903 ...
 $ EGPGBP Curncy   : num [1:2612] 0.0883 0.0878 0.0886 0.089 0.0893 ...
 $ SARGBP Curncy   : num [1:2612] 0.168 0.167 0.169 0.17 0.17 ...
 $ CHFGBP Curncy   : num [1:2612] 0.652 0.651 0.656 0.661 0.665 ...
 $ JPYGBP Curncy   : num [1:2612] 0.0055 0.00543 0.00549 0.0055 0.00549 ...
 $ STKLOGSYR       : num [1:2612] NA 0.734 -0.839 1.879 -1.406 ...
 $ INDXLOGSYR      : num [1:2612] NA 0.244 -0.247 0.369 0.285 ...
 $ JPYGBPLOGSYR    : num [1:2612] NA -1.278 1.134 0.184 -0.177 ...
 $ USDGBPLOGSYR    : num [1:2612] NA -0.485 0.883 0.432 0.268 ...
 $ EURGBPLOGSYR    : num [1:2612] NA -0.0392 0.5816 0.7358 0.6293 ...
 $ CNYGBPLOGSYR    : num [1:2612] NA -0.566 0.9 0.415 0.176 ...
 $ JODGBPLOGSYR    : num [1:2612] NA -0.338 0.953 0.422 0.46 ...
 $ EGPGBPLOGSYR    : num [1:2612] NA -0.487 0.906 0.435 0.256 ...
 $ SARGBPLOGSYR    : num [1:2612] NA -0.487 0.891 0.442 0.258 ...
 $ CHFGBPLOGSYR    : num [1:2612] NA -0.111 0.686 0.737 0.736 ...
 $ STKEXCSSRTNSYR  : num [1:2612] NA 0.279 -1.294 1.425 -1.86 ...
 $ INDXEXCSSRTNSYR: num [1:2612] NA -0.211 -0.7022 -0.0854 -0.1693 ...
> 
```

3.Regression Results

```
> summary(model_returnsSYR)

Call:
lm(formula = STKEXCSSRTNSYR ~ INDXEXCSSRTNSYR + USDGBPLOGSYR + 
    EURGBPLOGSYR + CHFGBPLOGSYR + CNYGBPLOGSYR + SARGBPLOGSYR + 
    JODGBPLOGSYR + EGPGBPLOGSYR + JPYGBPLOGSYR, data = HIKMA_40455377)

Residuals:
     Min       1Q   Median       3Q      Max 
-19.6725  -0.9197   0.0144   0.8762  17.1430 

Coefficients:
                Estimate Std. Error t value Pr(>|t|)    
(Intercept)     -0.11401    0.04431  -2.573 0.010133 *  
INDXEXCSSRTNSYR  0.91584    0.01814  50.499  < 2e-16 ***
USDGBPLOGSYR     0.60814    0.74102   0.821 0.411900    
EURGBPLOGSYR     0.01170    0.11118   0.105 0.916186    
CHFGBPLOGSYR    -0.21529    0.07534  -2.858 0.004303 ** 
CNYGBPLOGSYR    -0.10789    0.10786  -1.000 0.317267    
SARGBPLOGSYR    -1.12026    0.72256  -1.550 0.121165    
JODGBPLOGSYR     0.48762    0.18460   2.642 0.008302 ** 
EGPGBPLOGSYR     0.04354    0.02508   1.736 0.082643 .  
JPYGBPLOGSYR     0.27647    0.07597   3.639 0.000279 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.899 on 2601 degrees of freedom
  (1 observation deleted due to missingness)
Multiple R-squared:  0.4982,	Adjusted R-squared:  0.4964 
F-statistic: 286.9 on 9 and 2601 DF,  p-value: < 2.2e-16

> 
```

4.Heteroscedasticity Test

```
> bptest(model_returnsSYR)

	studentized Breusch-Pagan test

data:  model_returnsSYR
BP = 18.309, df = 9, p-value = 0.03175

> 
```

5. VIF Values

```
> vif(model_returnsSYR)
INDXEXCSSRTNSYR    USDGBPLOGSYR    EURGBPLOGSYR    CHFGBPLOGSYR    CNYGBPLOGSYR    SARGBPLOGSYR    JODGBPLOGSY
       1.015076      139.205403        2.083907        1.889551        2.582577      132.926574        9.19071
   EGPGBPLOGSYR    JPYGBPLOGSYR
       1.169729        2.066764
>
```

Robust Time Dummy Model

1. Regression Results

```
> summary(robust_time_dummy_model)

Call: rlm(formula = STKEXCSSRTNSYR ~ INDXEXCSSRTNSYR + USDGBPLOGSYR +
    EURGBPLOGSYR + CNYGBPLOGSYR + JODGBPLOGSYR + EGPGBPLOGSYR +
    SARGBPLOGSYR + CHFGBPLOGSYR + INDXEXCSSRTNSYR_poly + TimeDummy,
    data = data_clean)
Residuals:
      Min        1Q    Median        3Q       Max
-4.717188 -0.840628 -0.008238  0.838036  4.585897

Coefficients:
                     Value   Std. Error t value
(Intercept)           0.1540  0.2462     0.6254
INDXEXCSSRTNSYR       0.7059  0.0363    19.4406
USDGBPLOGSYR          0.4673  0.6624     0.7055
EURGBPLOGSYR         -0.0142  0.0976    -0.1454
CNYGBPLOGSYR          0.0760  0.0828     0.9188
JODGBPLOGSYR          0.3556  0.1450     2.4529
EGPGBPLOGSYR          0.0147  0.0384     0.3816
SARGBPLOGSYR         -0.8684  0.6517    -1.3325
CHFGBPLOGSYR         -0.0294  0.0877    -0.3348
INDXEXCSSRTNSYR_poly -0.0239  0.0084    -2.8240
TimeDummy2015        -0.1533  0.2606    -0.5882
TimeDummy2016        -0.3650  0.2608    -1.3995
TimeDummy2017        -0.4271  0.2608    -1.6380
TimeDummy2018        -0.0408  0.2607    -0.1565
TimeDummy2019        -0.3010  0.2600    -1.1575
TimeDummy2020        -0.0848  0.2624    -0.3232
TimeDummy2021        -0.1952  0.2607    -0.7490
TimeDummy2022        -0.6783  0.2623    -2.5857
TimeDummy2023        -0.9744  0.3043    -3.2027
TimeDummy2024        -1.0381  0.3157    -3.2886

Residual standard error: 1.246 on 2463 degrees of freedom
>
```

2. Heteroscedasticity Test

```
> bptest(robust_time_dummy_model)

        studentized Breusch-Pagan test

data:  robust_time_dummy_model
BP = 81.363, df = 19, p-value = 1.081e-09

>
```

3. Jarque-Bera Test

```
> jarque.bera.test(residuals_values)

	Jarque Bera Test

data:  residuals_values
X-squared = 37.138, df = 2, p-value = 8.62e-09
```

4. Reset Test for Functional Form

```
> print(reset_test)

	RESET test

data:  robust_time_dummy_model
RESET = 1.8221, df1 = 1, df2 = 2462, p-value = 0.1772

>
```

5. Autocorrelation

```
> dwtest(robust_time_dummy_model)

	Durbin-Watson test

data:  robust_time_dummy_model
DW = 1.9882, p-value = 0.3143
alternative hypothesis: true autocorrelation is greater than 0

>
```

6. Coefficients after Heteroscedasticity Adjustment using Robust Standard Errors

```
> coeftest(robust_time_dummy_model, vcov = vcovHC(robust_time_dummy_model, type = "HC1"))

z test of coefficients:

                       Estimate Std. Error z value  Pr(>|z|)    
(Intercept)           0.1539835  0.1709614  0.9007 0.3677523    
INDXEXCSSRTNSYR       0.7058537  0.0366518 19.2584 < 2.2e-16 ***
USDGBPLOGSYR          0.4673230  0.5218601  0.8955 0.3705226    
EURGBPLOGSYR         -0.0141952  0.0998389 -0.1422 0.8869368    
CNYGBPLOGSYR          0.0760356  0.0844903  0.8999 0.3681559    
JODGBPLOGSYR          0.3555912  0.1514452  2.3480 0.0188752 *  
EGPGBPLOGSYR          0.0146593  0.0323280  0.4535 0.6502205    
SARGBPLOGSYR         -0.8683797  0.5181834 -1.6758 0.0937743 .  
CHFGBPLOGSYR         -0.0293594  0.0853442 -0.3440 0.7308372    
INDXEXCSSRTNSYR_poly -0.0238575  0.0075338 -3.1667 0.0015417 ** 
TimeDummy2015        -0.1532674  0.1887217 -0.8121 0.4167143    
TimeDummy2016        -0.3649699  0.1925568 -1.8954 0.0580410 .  
TimeDummy2017        -0.4271452  0.1995243 -2.1408 0.0322887 *  
TimeDummy2018        -0.0407978  0.2057458 -0.1983 0.8428165    
TimeDummy2019        -0.3009788  0.1861175 -1.6171 0.1058473    
TimeDummy2020        -0.0848118  0.1980802 -0.4282 0.6685279    
TimeDummy2021        -0.1952172  0.1876611 -1.0403 0.2982170    
TimeDummy2022        -0.6783354  0.1905402 -3.5601 0.0003708 ***
TimeDummy2023        -0.9744423  0.2249489 -4.3318 1.479e-05 ***
TimeDummy2024        -1.0380877  0.2433843 -4.2652 1.997e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

7. Adjusted R^2

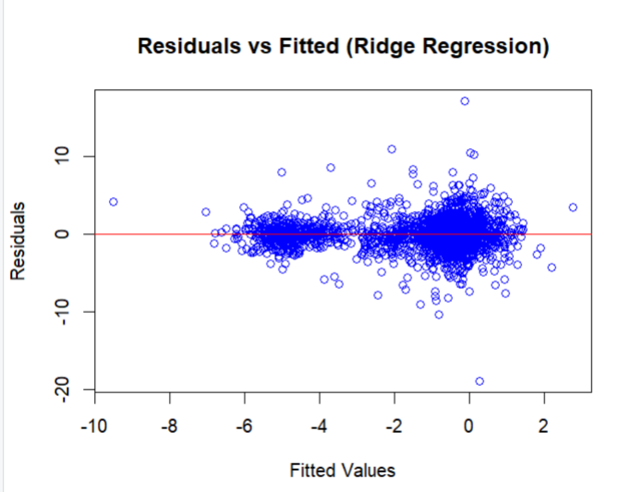
```
> cat("Adjusted R-squared for Robust Time Dummy Model: ", Adjusted_R_squared, "\n")
Adjusted R-squared for Robust Time Dummy Model:  0.657026
```

Ridge Regression

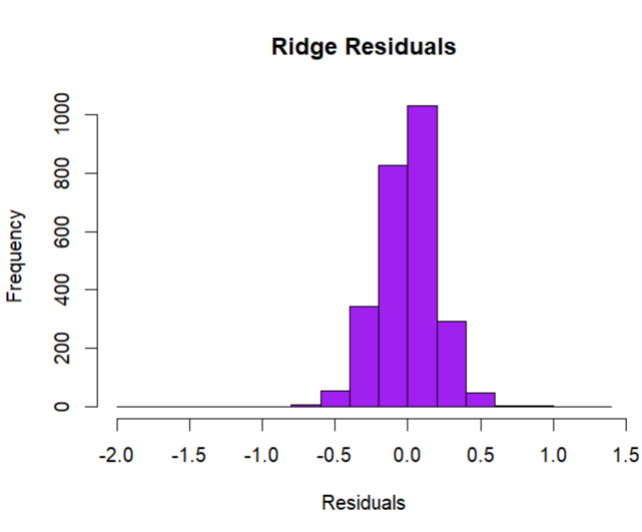
1. Coefficients

```
> print(coef(ridge_model))
20 x 1 sparse Matrix of class "dgCMatrix"
                              s0
(Intercept)          -0.41801584
INDXEXCSSRTNSYR       0.52142147
USDGBPLOGSYR         -0.04861710
EURGBPLOGSYR          0.04733398
CNYGBPLOGSYR         -0.00183233
JODGBPLOGSYR          0.24335863
EGPGBPLOGSYR          0.03479662
SARGBPLOGSYR         -0.15446424
CHFGBPLOGSYR         -0.16974785
INDXEXCSSRTNSYR_poly -0.02547817
TimeDummy2015         0.28354013
TimeDummy2016         0.17701699
TimeDummy2017         0.09667225
TimeDummy2018         0.34640365
TimeDummy2019         0.11721429
TimeDummy2020         0.53063062
TimeDummy2021         0.33396464
TimeDummy2022        -0.31935419
TimeDummy2023        -1.14112310
TimeDummy2024        -1.27412609
```

2. Residuals vs. Fitted Values



3. Residuals



Joint Hypothesis Test

```
> print(joint_hypothesis)

Linear hypothesis test:
INDXEXCSSRTNSYR = 0
USDGBPLOGSYR = 0
EURGBPLOGSYR = 0
CHFGBPLOGSYR = 0
CNYGBPLOGSYR = 0
SARGBPLOGSYR = 0
JODGBPLOGSYR = 0
EGPGBPLOGSYR = 0
JPYGBPLOGSYR = 0

Model 1: restricted model
Model 2: STKEXCSSRTNSYR ~ INDXEXCSSRTNSYR + USDGBPLOGSYR + EURGBPLOGSYR +
    CHFGBPLOGSYR + CNYGBPLOGSYR + SARGBPLOGSYR + JODGBPLOGSYR +
    EGPGBPLOGSYR + JPYGBPLOGSYR

  Res.Df     RSS Df Sum of Sq     F    Pr(>F)
1   2610 18701.0
2   2601  9384.6  9    9316.4 286.9 < 2.2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
```