**Individual Assignment**

**Analysis of Foreign Exchange Exposure of GSK PLC**

**Company Name: GSK PLC**

**1. Executive Summary**

This report provides an in depth evaluation of GlaxoSmithKline’s (GSK) financial performance, focusing on the complex relationships between its stock returns and key market variables. Using some of the advanced econometric techniques, this analysis is set to examines GSK's sensitivity towards the market dynamics, currency fluctuations, and macroeconomic factors, highlighting the company’s risk exposure and its strategic opportunities. Additionally, the study incorporates an Arbitrage Pricing Theory (APT)-style regression, integrating macroeconomic variables such as inflation and interest rates to assess their impact on GSK's stock performance along with that diagnostic evaluations, structural stability tests, and hedging considerations which further enhance the strength of the findings.

**Key** **Findings**

1. **Stock-Market Dynamics:**
   * GSK’s returns show a strong positive relationship with the FTSE 100 index (UKX), underlining its market sensitivity and alignment with the broader market movements.
   * Currency exposure, particularly the USD/GBP significantly influenced GSK’s returns, pointing the importance of managing foreign exchange risks.
2. **Diagnostics and Model Robustness:**
   * Residual analysis confirms there is no evidence of heteroscedasticity or autocorrelation which supports the reliability of the models.
   * Residuals deviate from the normality, reflecting the presence of extreme events or outliers typical in the financial data.
   * The RESET test highlights potential non-linear relationships, suggesting that the need for more flexible modeling approaches.
3. **Structural Breaks and Stability:**
   * The Chow test and recursive estimation reveal structural instability around the COVID-19 pandemic in 2020 which highlights the impact of unprecedented market disruptions.
   * This underscores the necessity of an adaptive and dynamic risk management strategies.
4. **APT-Style Regression:**
   * This Incorporates macroeconomic variables which marginally improves the model’s evaluative power, but inflation and interest rates do not significantly impact GSK’s returns over the given analyzed period.
5. **Hedging and Robust Estimation:**
   * Robust and Newey-West standard errors address the potential incorrect information, ensuring the strength of statistical inferences.
   * Hedging strategies remain critical over here, given the large influence of exchange rate fluctuations on GSK's performance.

**Recommendations**

1. **Currency Risk Management:**
   * Actively monitor and hedging the exchange rate exposures to reduce adverse impacts on returns.
2. **Dynamic Modeling:**
   * Updating and refining financial models regularly to accommodate structural shifts, especially during crises like the COVID-19 pandemic.
3. **Extended Analysis:**
   * Integrate additional macroeconomic indicators and nonlinear models to better capture complex market forces.

The report delivers insights into GSK’s financial performance and the interaction between market variables, currency risk, and structural changes. The suggested GSK strategies can help to protect the company against market fluctuations and ensure its stakeholders long-term value.

2. GSK is one of the world’s leading healthcare companies, with a presence in over 100 countries with a global headquarter in the UK. GSK has a rich legacy and has been innovating in the areas of pharmaceuticals, vaccines, and consumer healthcare for decades. The company is known for its work to help with important healthcare problems, like creating vaccines and life-saving drugs. GSK operates in a fast paced industry competing with global giants like Pfizer, Novartis, and Johnson & Johnson.

GSK has organized its operations into three segments.

**1. Pharmaceuticals.** This part is mainly on new medicines for the respiratory tract, cancer, and immune-inflammation diseases, etc.

**2. Vaccines**. GSK is globally one of the largest companies that manufactures vaccines for problems like flu, meningitis and shingles.

**3. Consumer Healthcare**. GSK has a range of products you can buy at a store, designed for daily health issues like pain and digestion.

Where does GSK stand financially?

GSK is a London Stock Exchange (LSE) listed company and a major constituent of the FTSE 100 index (UKX). The UKX is made up of the largest companies in the UK (by market capitalisation) that are listed on the LSE. Institutional and retail investors consider the stock of the company to be a basic. The stock has a defensive tilt and pays dividends consistently. But, being a multinational enterprise, GSK can expect to incur losses from exchange rates, macro, and sector-specific issues.

Stock Performance Influencers

**1. Market Activity**. GSK’s share price moves increasingly in line with the stock market as its share price shows a high correlation with the FTSE 100 index. There are factors that affect the crypto market like customer feelings, regulatory changes, and changes in the global economy.

**2. Currency Exchange Rates**. The company earns significant amounts of money from international markets whose performance as indicated by the exchange rate move with USD/GBP and EUR/GBP. If the US Dollar gets stronger, for example, GSK will earn more through the increased worth of returned earnings.

**3. Macroeconomic Factors**. The company’s operations and financial results are indirectly affected by economic factors, these include inflation, interest rates, and global growth. The consumer purchasing power, healthcare budgets, and R&D investments impact these variables and, in turn, the long-term growth of the company. Objective of the Analysis

This report aims to evaluate GSK’s stock performance by analyzing:

1. Market Index Sensitivity: The relationship between GSK’s returns and the FTSE 100 index to understand its exposure to market trends.
2. Currency Risks: The impact of exchange rate fluctuations (USD/GBP and EUR/GBP) on GSK’s returns, given its global operations.
3. Macroeconomic Influences: The role of inflation and interest rates in shaping GSK’s stock dynamics through an Arbitrage Pricing Theory (APT) framework.
4. Structural Stability: this stability of relationships over time, particularly because of disruptions such as the COVID-19 pandemic.

**Significance of the Study**

In the fast-moving financial markets, understanding the determinants of GSK’s stock performance is essential for stakeholders, including:

* Investors: To optimize their portfolio strategies and risk management.
* Corporate Strategists: To align business operations with market and macroeconomic trends.
* Risk Analysts: To help design a effective hedging mechanisms against market and currency risks.
* This analysis of GSK’s financials offers actionable insights to facilitate data-driven decision-making. Moreover, it contributes to improving financial models and discovering new opportunities amidst escalating global uncertainties.

3. The analysis looks at the GSK stock return (dependent variable) and market variables from January 2014 to December 2023 data. The monthly and weekly frequency data enable a better understanding of the relationship between the returns and independent variables. This information contains daily observations of several financial and macroeconomic factors which gives an overall base for econometric analysis. Main factor are below the data.

* GSK's stock daily closing prices, which indicate market valuation and investor sentiment
* The FTSE 100 index, or UKX, measures the 100 largest companies by market capitalization in the London Stock Exchange (LSE). It is a stock market index from London, England.
* The exchange rate of the US dollar and euro against the pound can be evaluated with the use of designated exchange rates, respectively USD/GBP and EUR/GBP.
* As GSK is global, these factors are relevant to assessing the effect of currency changes on GSK's performance.
* To find out the effect of prices and interest rates on GSK, the prices and interest rate was measured as multiplied on change on GSK returns.
* Date: Timestamp for each observation, ensuring that the analysis captures temporal trends and structural changes over time.

By covering market, currency, and macroeconomic data, this dataset is well-suited for a multifaceted analysis of GSK's stock performance.

**3.2 Data Preparation**

A strong data preparation process was taken on to ensure the validity and consistency of the analysis. Key steps included:

1. **Continuous Compounding of Returns**: Stock prices and exchange rates were changed into logarithmic returns to standardize data and capture percentage changes. This method is widely used in financial modeling as it accounts for the compounding nature of asset returns.

Logarithmic returns are calculated using the formula:

Rt = ln(Pt) − ln(Pt−1)

Where:

* Rt = Return at time t,
* Pt = Price at time t, and
* Pt−1 = Price at time t−1.

​ are the prices at times pt and pt-1, respectively. Continuous compounding is essential for capturing small changes in financial data over time, particularly for daily observations.

1. **Handling Missing Values:** Observations which includes missing data were excluded to maintain the honesty of the regression models. Missing values can misrepresent regression estimates, so a consistent dataset was critical for strong analysis.
2. **Dummy Variable Construction**. To account for possible structural breaks in the return of GSK after January 2020, we introduce a binary dummy variable Post2020. The Post2020 variable is meant to capture the COVID-induced market disruption as well as the change in global healthcare dynamics and macroeconomic conditions post-2020.

**Methodology**

1. In this study’s methodology section, the author stated that regression analysis, diagnostic testing, and structural stability tests were performed. We will give details about each item.
2. Regression Models. The causes of GSK’s shares returns were studied based on three models.
3. The CAPM model uses segregation of GSK returns (RGSK) based on FTSE 100 index (RMarket). The model can be expressed as follows:- RGSK = α + β × RMarket + ϵ. The CAPM model is the basic model to understand the stock performance of GSK vis-a-vis the concerned market.
4. The multifactor model adds exchange rates (RUSDGBP and REURGBP) to the CAPM framework in order to estimate GSK’s exposure to currency risks as a result of its global operations. RGSK = α + β1 × RMarket + β2 × RUSDGBP + β3 × REURGBP + ϵ.
5. **APT Model:** This model which stands for Arbitrage Pricing Theory compares GSK’s vales with certain macroeconomic factors like inflation, interest rates along with market return and the return on the US dollar/ pound and euro/pound returns are gives by RGSK = α + β1 × RMarket + β2 × RUSDGBP + β3 × REURGBP + β4 × Inflation + β5 × Interest Rate + ϵ . This model is used to check if the GSK making could also be impacted by factors larger than its making or not.

* **Diagnostic Tests.** To ensure valid inference, many tests were performed to check the model assumptions.
  + The Breusch-Pagan test was employed to identify the problem of heteroscedasticity.
  + To check the correlation between the dependent and explanatory variables, a scatter plot was used.
  + To check for independence of residuals, we implemented the Durbin-Watson and Breusch-Godfrey tests which assess autocorrelation in the residuals of regression analysis.
  + Tests like Jarque-Bera and D’Agostino were applied to check the normality of residuals.

1. The regression models of the study were competence as validated by the RESET test.
   1. Structural Stability. To assess how a model's parameters altered over time, two approaches were used.

Tests of Chow and an R package strucchange did show some structural break points. Most were around big events, like COVID.

Time-varying estimates of the regression coefficients were analyzed to detect shifts in the relationships among variables.

1. **Visualization**. Along with the statistical tests, graphical outputs like histograms, QQ plots, Residual diagnostics were produced. The illustrations provided some obvious insights into data patterns and model performance..

**3.4 Tools and Software**

This test was conducted using R, which is a powerful tool used for statistical analysis. Key packages used include:

* readxl: For importing the data from Excel files.
* lmtest: For conducting the diagnostic tests and including Breusch-Pagan and Durbin-Watson tests.
* strucchange: For structural stability tests and such as breakpoints analysis and recursive estimation.
* moments: For calculating skewness and kurtosis.
* sandwich: For robust standard error estimation and addressing potential residual errors.

The combination of these tools confirm a rigorous test of GSK’s stock return dynamics while integrating theoretical models along with factual validation. By using advanced econometric techniques, this methodology provides robust insights into the complex factors influencing GSK’s financial performance.

**4. Results and Analysis**

1. The descriptive statistics gave better insight into key aspects that affect GSK stock returns in the market. The data statistics provide indications of size, spread and central trends thus give us an insight on data. GSK's stock returns revealed that they did not show positive or negative mean returns over the sample period. This is characteristic of stock markets mean-reverting behaviour. GSK's returns have a standard deviation of 1.023%, which is indicative of moderate level volatility being an opportunity and risk. A skewness value of -0.838 indicates that more returns are closer to the left of the mean. Therefore, undesirable returns are likely. The high kurtosis of 15.31 indicates that the returns have heavy tails meaning that extreme returns are likely due to market disruptions or firm statements.
2. On ave, the UK stock market returns represented by the FTSE 100 index were close to zero. As it turns out, there was less volatility on the FTSE 100 than on GSK, you would expect that because the index is diversified. This means GSK’s stock is more risky than the stock market. The USD/GBP and EUR/GBP exchange rate returns showed low volatility, which means that foreign exchange markets did not see much fluctuation during the sample period. The regression results found that the USD/GBP returns strongly affect the returns of GSK. The company is sensitive to USD fluctuations. The simulated macroeconomic variables like inflation (mean ~2%) and interest rates (mean ~1.5%) had low variability. Even though they held no statistics relevance in the APT model, they were useful as proxies of economic conditions, which further helped GSK to identify risks and sensitivities.
3. The regression analysis started with a baseline CAPM model, which looked at GSK's relationship with the wider market, represented by the FTSE 100 index. The CAPM regression result for the Stock Beta of GSK was 0.7388. Thus, the Stock Beta is less than 1. Therefore, GSK’s returns have a strong positive correlation with market returns. Yet, GSK’s stock is less volatile than the FTSE 100, as the beta is less than one. The CAPM model had an adjusted R-squared of 31.9%. This means that GSK’s returns varied due to the market’s returns. Therefore, some of GSK’s returns must be due to other factors like currency and firm-specific factors. The intercept for this model was not significant implying that GSK returns have no inherent trend when market returns are zero.
4. Using the CAPM model as a base, a multifactor model was built with USD/GBP and EUR/GBP exchange rate variables. The new model performed better than the CAPM model in terms of prediction. GSK’s Market Beta is Positive and Almost Constant at 0.7516, while the rate of Return of USD/GBP Impacted GSK positively on Delivery with 0.3811. The reason for this is likely because GSK has a relatively large revenue base in the US. On the other hand the EUR/GBP return was not statistically significant indicating effective hedging or balanced operations in the Eurozone. The multifactor model’s adjusted R² increased to 34.9%, lending more credibility to the ability of the multifactor model to explain the return dynamics of GSK.
5. The APT model took the multifactor framework and added a few other things, such as inflation and interest rates. The significance of market beta (0.7522) and return of USD/GBP (0.3794) reemphasised. But inflation and interest rates did not provide statistically significant meaning, suggesting that these two variables did not affect GSK’s returns. Still, these variables may have indirect effects through market and currency forces. The APT model had an adjusted R² of 34.99% suggesting a marginal improvement over the multifactor model.
6. Several diagnostic tests were performed to validate the robustness of regression models. The analysis of the CAPM and multifactor model’s Breusch-Pagan tests displayed no evidence of heteroscedasticity. Thus confirming an assumption of constant variance. The Durbin-Watson test showed that residuals of all models did not suffer from autocorrelation. Thus, the errors are independent. The VIF values were all below 1.54, meaning no issues with multicollinearity with these explanatory variables. However, tests for normality, including Jarque-Bera, D’Agostino, and Anscombe-Glynn, revealed significant skewness and kurtosis, highlighting the non-normality of residuals. This result is a common occurrence in financial data but isn’t a statistical inference.
7. Structural stability was tested by Chow test and with the help of recursive estimation. The Chow test found a major structure change in January 2020, when the COVID-19 pandemic broke out. This result highligthed the importance of structural break modelling particularly during global financial meltdown in financial market models. With recursive estimation, we see that the coefficients are unstable around the structural break, which shows the relationship is dynamic. This shows that our models need to adapt to be able to catch these changes.
8. In other words, GSK’s returns are particularly sensitive to the market, as shown by its high market beta.
9. The USD/GBP rate was important as the company had a exposure towards the exchange rate risk. The macro effects are not directly significant but may have indirect effects. So, we need to keep watch of these variables. The diagnostic tests confirmed the robustness of the regression models, with only the residuals’ non-normality being a problem. Finally, the structural break in January-2020 had a reinforcing effect on the stock price dependencies at the global level.

**5. Discussion and Interpretation of Results**

The descriptive statistics give us some insights about the nature of GSK’s stock returns, market indices and exchange rate. In addition, they clarify the behaviour of the three which may help in making critical decisions. The mean return of GSK that is close to zero indicates that it does not maintain a regular upward or downward tendency over the analysis period as per efficient market behaviour. The standard deviation of 1.023% is what one would expect from a large-cap pharmaceutical company. It does provide some opportunities for returns but also plenty of risks. The "higher probability of getting extreme negative returns" (negative skewness -0.838 signifies this) is either caused by some adverse events like regulatory issues or product failures. Also, the fat tails in the return distribution is indicated by excess kurtosis (15.31). Further, the presence of extreme events in the market occurs.

The indicator for the UK – the FTSE 100 – has a mean return standing at around zero. It is also less volatile than GSK. The exchange rate fluctuations for USD/GBP and EUR/GBP remained low indicating that the foreign exchange was stable during the sample period. GSK’s returns are affected greatly USD/GBP movements, and hence the importance of the US market. On the other hand, the insensitivity to EUR/GBP moves shows effective hedging or balanced Eurozone operations. The variations of the simulated macroeconomic variables inflation (mean ~2%) and interest (mean ~1.5%) are low. Although they did not reach statistical significance in either regression model, they help to contextualize GSK’s broader operating environment that may have impacted sentiment or currencies.

The GSK regression models start with a basic CAPM model and then go to a multi-factor model and lastly to the APT model, which capture various aspects of GSK return behaviour.

The CAPM model determines the relation between GSK returns and the overall market (FTSE 100 index). GSK is less volatile than the market, making it less risky. It has a beta of 0.7388. Many pharmaceutical businesses do not experience many shocks to their plans even during recessions because, unlike many sectors, the demand for health care is outside the economic cycle. The value of 31.9% for the adjusted R² indicates that market movements’ explained the variability in GSK’s returns and some room is left for other factors, currency impacts and firm-specific development. These outcomes position GSK as a stabilizing asset in diversified portfolios.

GSK is sensitive to the global environment and the exchange rate variables (USD/GBP and EUR/GBP) will help. The large positive coefficient found for USD/GBP (β = 0.3811) suggests that the US market is likely important, with a strong US Dollar benefiting repatriated earnings. On the other hand, the EUR/GBP coefficient (β = 0.0021) is insignificant. As such, Euro fluctuations have a minimal direct impact on revenues of US banks. This may be due to successful hedging strategies. It may also be due to operations taking place in the Eurozone being balanced. With the addition of currency dynamics, the model’s adjusted R² improves to 34.9%.

The APT framework of multifactor models in finance is said to include macroeconomic variables, especially interest and inflation rates. While the market beta and USD/GBP variables are still statistically significant, inflation and interest rates are not statistically significant during this period. As a result, we can say that inflation and interest rates probably do not directly influence GSK’s returns. The improved adjusted R² of 34.99% of the model compared to the multifactor model suggests dominance of market and currency factors in determining GSK returns. Macroeconomic aspects exhibit less importance in predicting commodity price movements, although they may still shed light on them.

Results of Diagnostic Tests Confirm the models are robust but also point to issues that require further consideration. The Breusch–Pagan test doesn't indicate any problem of heteroscedasticity. The Durbin-Watson test results indicate that there is no significant autocorrelation, which means the residuals are independent, and the coefficients are unbiased. The variance inflation factor is low for all variables since the vif value is less than 1.54 which means there are no multicollinearity issues. Thus, the coefficient of each variable can be interpreted accurately. Tests to check whether the model residuals are normally distributed show significant skewness and kurtosis as per Jarque-Bera and D’Agostino tests, suggesting model residual non-normality. This is common in many financial datasets due to extreme market events. Even though it does not mean that the models are invalid, it does imply the need for either robust estimation or different distributions.

Tests on structural stability shows important changes in relationship between various variables. According to the Chow test, there has been a break in structure in January 2020 during the initiation of COVID-19, which pushes the argument that relationships have been affected on the back of global disruptions. The results of recursive estimation also show that over critical periods the coefficients become instable. Thus, there is a need for adaptive financial models during stressed period.

The examination reveals valuable insights for GSK and its stakeholders. GSK’s alignment with the FTSE 100 reflects its defensive nature, making it a reliable asset in diversified portfolios. But USD/GBP has a strong influence which emphasises to manage currency risk (e.g. hedging the currency risk and/or making operational adjustments). Even though inflation and interest rate might not have a direct effect, attempting to monitor them and how they can impact performance in future is essential. Lastly, the structural break identified during the COVID-19 pandemic highlights the necessity of adaptive financial models capable of responding to such disruptions, ensuring resilience and informed decision-making in future market shocks.

**6. Conclusion and Recommendations**

The results were analyzed using a range of models, including CAPM, multi-factor models and APT-style regressions. These models were supported by diagnostic tests and tests of structural stability. The examination shows several main findings. GSK’s stock returns have a beta of around 0.74 indicating that they are fairly sensitive to movements in the FTSE 100 index. Nevertheless, a beta of less than one shows it is rather defensive in character, like pharmaceuticals. Among the exchange rate variables, USD/GBP has a significant positive impact on GSK, which shows the extent to which GSK relies on the US market for revenue generation. EUR/GBP however has minor reaction and may stress that there are either no functional hedging inside the Eurozone or along the British corridor.

Although they are important in theory, macroeconomic variables such as inflation and interest rates do not appear to be statistically significant in the APT model. GSK stock does not show much effect of these factors during the period observed. However, these variables can have indirect effects through overall economic or market conditions. According to the analysis, there was also a structural break in January 2020 which is when the pandemic started. This shows the need for flexible models that can adapt to market shocks and global disasters. The models are further validated through diagnostic tests that detect the absence of heteroscedasticity and autocorrelation in the residuals, confirming their credibility estimates. Nonetheless, residual non-normality often found in financial data may arise from outliers having an isolated impact on statistical properties.

Recommendation has been made for Currency risk management as variation in USD/GBP greatly influence GSK’s returns. Instruments include the use of forward contracts, options, natural hedging etc. to reduce or eliminate the adverse effects of fluctuations in the exchange rate. In focus on monitoring exchange rate trends and forecasting the impact, financial establishment stability and revenue maximization are ensured.

GSK Should be in Your Portfolio: Investors should view GSK as a defensive stock and include it in a diversified investment portfolio. Being less sensitive to market volatility indicates that it can offer protection in an economic downturn. Also, portfolio managers can use GSK’s ever-increasing correlation to the FTSE 100 as a hedge against everything else.

The break observed in the COVID-19 epidemic highlights the need for dynamic modeling approaches. When times are unstable, it may be a good idea to incorporate models that can adjust to changing market conditions, e.g. time-varying coefficients or recursive estimation etc. These are particularly important in terms of dealing with disruptions caused by global events or economic changes.

GSK's Financial Performance Critical For US Market, Due to USD/GBP Impact On GSK’s Financial Performance. The company needs to give more importance to strategic initiatives to expand and strengthen presence in the US, whilst taking measures to mitigate operational risks. Taking advantage of the growth potential of US markets can boost the revenue of GSK and improve its competitiveness.

Observing how inflation may help keep track of wider economic conditions. Although not particularly significant in the present context, interest rate changes may be useful in understanding how efficiently the economy allocates resources. GSK should keep a close watch on these variables as they may indirectly affect results, perhaps through market sentiment, consumer behavior, and/or currency.

After COVID-19, the healthcare sector and the global supply chain underwent structural changes. GSK must measure the long-term impact of these changes on its operations and finance choices. After the pandemic, companies may have to change their products, distribution channels, and business investment priorities.

Further research may also consider other macroeconomic and firm-specific variables (e.g. GDP growth, sector performance, research and development investments, etc.) to understand better the behaviour of GSK’s stock. We can explore other methods like machine learning. This might help to pick up non-linear relationships while improving our predictions which we can use in future analysis.

Final Remarks This analysis highlights the complex factors affecting the stock returns of GSK while emphasizing the relationship between the movement of the market, alters in currency and structural shift taking place. The results emphasize the importance of taking action when a risk needs to be managed, such as dynamic modeling and strategic adaptation. By leveraging these insights, GSK and its stakeholders can make well-informed decisions to enhance performance, manage risks effectively, and maintain resilience in an increasingly complex financial landscape.

**APPINDEX:**

**Logarithmic Returns**  
Formula:  
Rt = ln(Pt) - ln(Pt-1)  
Where:

* Rt: Return at time t
* Pt: Price at time t
* Pt-1: Price at time t-1

**Output Results:**  
The first few calculated log returns for GSK and FTSE 100 are:

| **Date** | **GSK** | **UKX** | **GSK Return** | **UKX Return** |
| --- | --- | --- | --- | --- |
| 2014-01-01 | 1630.00 | 6718.00 | NA | NA |
| 2014-01-02 | 1618.00 | 6718.00 | -0.007470 | 0.000000 |
| 2014-01-03 | 1623.00 | 6731.00 | 0.003120 | 0.001900 |
| 2014-01-06 | 1636.00 | 6731.00 | 0.007760 | 0.000009 |

**CAPM Regression Formula**  
Formula:  
RGSK = α + β \* RMarket + ϵ  
Where:

* RGSK: Return of GSK stock
* RMarket: Return of the FTSE 100 index
* α: Intercept term
* β: Market beta, measuring sensitivity to market returns
* ϵ: Error term

**Output Results:**  
Regression summary for the CAPM model:

| **Coefficients** | **Estimate** | **Std. Error** | **t-value** | **p-value** |
| --- | --- | --- | --- | --- |
| Intercept (α) | -0.0000558 | 0.0002005 | -0.278 | 0.781 |
| Market Beta (β) | 0.7388 | 0.02067 | 35.747 | < 2e-16 |

* Adjusted R²: 31.9%
* Residual Standard Error: 0.01046

**Multifactor Regression Formula**  
Formula:  
RGSK = α + β1 \* RMarket + β2 \* RUSDGBP + β3 \* REURGBP + ϵ  
Where:

* RUSDGBP: Return on the USD/GBP exchange rate
* REURGBP: Return on the EUR/GBP exchange rate
* β1, β2, β3: Coefficients measuring sensitivity to market and exchange rate movements

**Output Results:**  
Regression summary for the Multifactor model:

| **Coefficients** | **Estimate** | **Std. Error** | **t-value** | **p-value** |
| --- | --- | --- | --- | --- |
| Intercept (α) | -0.0000925 | 0.0001960 | -0.472 | 0.637 |
| Market Beta (β1) | 0.7516 | 0.02026 | 37.091 | < 2e-16 |
| USD/GBP (β2) | 0.3811 | 0.04178 | 9.123 | < 2e-16 |
| EUR/GBP (β3) | 0.0021 | 0.05078 | 0.041 | 0.967 |

* Adjusted R²: 34.9%
* Residual Standard Error: 0.01023

**APT Regression Formula**  
Formula:  
RGSK = α + β1 \* RMarket + β2 \* RUSDGBP + β3 \* REURGBP + β4 \* Inflation + β5 \* Interest Rate + ϵ  
Where:

* Inflation: Simulated inflation rate
* Interest Rate: Simulated interest rate
* β4, β5: Coefficients for macroeconomic variables

**Output Results:**  
Regression summary for the APT model:

| **Coefficients** | **Estimate** | **Std. Error** | **t-value** | **p-value** |
| --- | --- | --- | --- | --- |
| Intercept (α) | 0.002405 | 0.001267 | 1.898 | 0.0578 |
| Market Beta (β1) | 0.7522 | 0.02027 | 37.102 | < 2e-16 |
| USD/GBP (β2) | 0.3794 | 0.04178 | 9.082 | < 2e-16 |
| EUR/GBP (β3) | 0.0022 | 0.05078 | 0.044 | 0.965 |
| Inflation (β4) | -0.000611 | 0.000399 | -1.530 | 0.1261 |
| Interest Rate (β5) | -0.000838 | 0.000631 | -1.329 | 0.1839 |

* Adjusted R²: 34.99%
* Residual Standard Error: 0.01023

**Breusch-Pagan Test for Heteroscedasticity**  
Formula:  
H0: Var(ϵi) = σ²

**Output Results:**

* Test Statistic (BP): 1.9269
* p-value: 0.5877
* Interpretation: No evidence of heteroscedasticity.

**Durbin-Watson Test for Autocorrelation**  
Formula:  
DW = Σ(t=2 to n)((ϵt - ϵt-1)^2) / Σ(t=1 to n)(ϵt^2)

**Output Results:**

* DW Statistic: 2.0827
* p-value: 0.9846
* Interpretation: No significant autocorrelation in residuals.

**Variance Inflation Factor (VIF)**  
Formula:  
VIF = 1 / (1 - R²)

**Output Results:**

| **Variable** | **VIF** |
| --- | --- |
| Market Beta | 1.0058 |
| USD/GBP | 1.5360 |
| EUR/GBP | 1.5398 |

* Interpretation: No multicollinearity issues.

**Chow Test for Structural Breaks**  
Formula:  
F = ((RSS1 + RSS2 - RSSp) / k) / (RSSp / (n1 + n2 - 2k))

**Output Results:**

* F-Statistic: 3.9144
* p-value: 0.003577
* Interpretation: Significant structural break identified in January 2020.

**Jarque-Bera Test for Normality**  
Formula:  
JB = n \* ((S² / 6) + ((K - 3)² / 24))

**Output Results:**

* JB Statistic: 17525
* p-value: < 2.2e-16
* Interpretation: Residuals are not normally distributed due to skewness and kurtosis.

A group of graphs showing the results of a market return

Description automatically generated

**Caption:**  
*Comprehensive Residual Diagnostics: This figure presents a set of diagnostic plots, including a histogram of residuals for distribution analysis, a Q-Q plot to assess normality, a scatter plot of residuals versus fitted values to identify patterns or systematic deviations, and a residuals versus market return plot to examine potential dependencies.*

A graph with lines and numbers

Description automatically generated

**Caption:**  
*Recursive Coefficient Estimates: This plot illustrates the stability of the regression coefficients over time using recursive estimation, highlighting periods of parameter fluctuation and potential structural changes in the model.*