Currency Exchange Rate Fluctuations and their Impact on Container Imports into Kenya: A Data-Driven Analysis

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Abstract

The relationship between currency exchange rate fluctuations and cargo import volumes is a critical area of study for trade-dependent economies like Kenya. This research investigates whether fluctuations in the Kenyan Shilling (KES) against the US Dollar (USD) significantly influence the number of containers imported into Kenya. Using 2024 data from Yahoo Finance and Import Volume statistics, this study tests the hypothesis that currency fluctuations have little to no effect on import volumes or that there exists only a weak positive correlation. The sampling period focuses on January to November 2024, a time characterized by significant USD/KES volatility with notable hikes and dips, particularly in the first half of the year. By leveraging statistical analysis and data visualization techniques, the findings aim to provide insights into the interplay between exchange rates and trade volumes with implications for policymakers and import-dependent businesses. Preliminary analysis suggests no significant relationship, challenging the intuitive assumption that currency depreciation directly reduces import activity.

Keywords: currency exchange rates, cargo imports, Kenya, data science, econometrics

1. Introduction

Kenya's economy is heavily reliant on imports, with the Port of Mombasa serving as the primary gateway for goods entering the country. In 2023, Kenya imported goods worth approximately USD 15 billion, with over 70% of these transactions denominated in USD, KNBS (2023). The Kenyan Shilling (KES) has experienced increased volatility against the US Dollar in recent years, with fluctuations attributed to external factors such as rising global interest rates, geopolitical tensions, and internal fiscal pressures. Understanding the impact of exchange rate fluctuations on cargo imports is critical for policymakers and businesses to make informed decisions. While it is commonly believed that currency depreciation increases the cost of imports and thus reduces volumes, anecdotal evidence suggests that certain essential imports remain unaffected due to inelastic demand. This study seeks to empirically investigate this relationship using data from 2024, a year characterized by pronounced KES-USD volatility. The study makes several key contributions. First, it provides a comprehensive analysis of the relationship between exchange rate fluctuations and import volumes. Second, it tests the hypothesis of a negligible correlation using robust statistical techniques. Finally, it offers actionable insights for stakeholders in the import and policy-making sectors, helping them better understand the dynamics of trade in a volatile currency environment.

2. Literature Review

Exchange rate volatility has long been recognized as a critical factor influencing international trade. However, the magnitude and direction of its impact vary depending on the nature of goods traded, the elasticity of demand, and the economic context. This section reviews global, regional, and theoretical perspectives on the relationship between exchange rate fluctuations and trade, with a focus on cargo imports in Kenya.

2.1. Global Perspectives

The impact of exchange rate volatility on trade has been extensively studied in global contexts. Bahmani-Oskooee and Rhee (2010) analyzed the effects of exchange rate fluctuations on trade flows across various economies, noting that the impact is more pronounced for luxury goods compared to essential commodities. Similarly, Rose (2000) found that stable exchange rates significantly enhance trade volumes by reducing transaction costs and uncertainties. However, the study highlighted that the effects are not uniform across countries or industries. Obstfeld and Rogoff (2009) examined the interplay between financial crises and exchange rate volatility, demonstrating that sharp currency depreciations can temporarily disrupt trade due to heightened risk perceptions. On the other hand, Akhtar et al. (2013) argued that emerging economies often exhibit resilience to moderate currency fluctuations due to their dependence on essential imports. These studies suggest that the relationship between exchange rates and trade is complex and context-dependent.

2.2. Regional Perspectives

In the African context, Ndungu (2021) investigated the effects of exchange rate movements on Kenya's import and export ac-

tivities. The study concluded that essential imports, such as fuel and medical supplies, show limited elasticity to exchange rate changes while luxury goods are more sensitive. Similarly, Kiraka (2019) emphasized the role of regional trade agreements in cushioning the impact of currency fluctuations on intra-African trade. In a comparative study of East African economies, Onyango (2020) observed that exchange rate volatility negatively affects trade volumes in countries with weak monetary policies. The study also highlighted the importance of stabilizing macroeconomic conditions to mitigate adverse effects. These findings underscore the need for region-specific analyses to understand the nuances of exchange rate impacts on trade.

2.3. Theoretical Framework

The theoretical foundation for this study is rooted in the **Marshall-Lerner condition**, which posits that currency depreciation will improve the trade balance if the sum of the price elasticities of demand for exports and imports is greater than one. However, this condition assumes that trade volumes respond significantly to price changes, which may not hold for essential goods with inelastic demand. Additionally, the **J-curve effect** suggests that trade balances may initially worsen following a currency depreciation before improving over time. This phenomenon is attributed to the time lag between price changes and adjustments in trade volumes. These theoretical frameworks provide a basis for understanding the potential short- and long-term effects of exchange rate fluctuations on cargo imports.

2.4. Gaps in the Literature

Despite the extensive body of research on exchange rate volatility and trade, few studies have specifically examined its impact on containerized cargo imports in Kenya. Most existing studies focus on aggregate trade data, overlooking the nuances of containerized imports, which represent a significant portion of Kenya's international trade. This study seeks to address this gap by analyzing the relationship between KES-USD exchange rate volatility and container import volumes using granular data from 2024.

3. Methodology

3.1. Data Collection

The study uses two primary datasets: daily exchange rate data for KES-USD obtained from Yahoo Finance and monthly container import volumes sourced from the Kenya Ports Authority (KPA). The sampling period covers January to November 2024, chosen due to significant currency volatility during this time.

3.2. Data Preprocessing

Data preprocessing involved cleaning missing or erroneous entries in the datasets, aggregating daily exchange rate data to monthly averages for consistency, and normalizing the data to

enable meaningful comparisons.

3.3. Analysis Techniques

The analysis was conducted in three stages. First, monthly trends for exchange rates and import volumes were visualized to identify patterns. Second, Pearson correlation coefficients were calculated to measure the strength of the relationship between exchange rates and import volumes. Finally, a simple linear regression model was used to predict import volumes based on exchange rates.

3.4. Tools

Python was used for data analysis and visualization with libraries such as pandas, matplotlib, and seaborn. These tools enabled the generation of insightful visualizations and robust statistical analyses.

4. Results and Discussion

4.1. Visualization of Key Trends

The visualization of key trends provides critical insights into the behavior of the USD/KES exchange rate and its potential impact on cargo import volumes. Figure 1 illustrates the fluctuations in the USD/KES exchange rate over the sampled period from January to November 2024. The data reveals significant volatility, with notable peaks and troughs, particularly in the first half of the year.
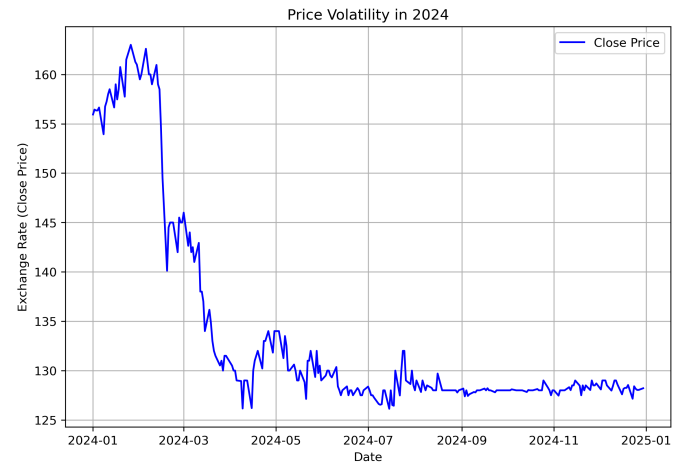

Figure 1: Price Volatility in 2024. This figure illustrates the fluctuations in the USD/KES exchange rate over the sampled period.

The exchange rate exhibited a sharp decline in March 2024, reaching its lowest point of 145 USD/KES, likely due to external factors such as rising global interest rates and geopolitical tensions. This was followed by a gradual recovery, with the rate stabilizing around 155 USD/KES in the latter half of the year. The volatility observed during this period underscores the sensitivity of the Kenyan Shilling to both global and domestic economic conditions. To further analyze the distribution

of exchange rates, Figure 2 presents a histogram of the daily exchange rates. The distribution is slightly right-skewed, indicating that the exchange rate spent more time at lower values, with occasional spikes to higher values. This pattern aligns with the observed volatility and highlights the challenges faced by import-dependent businesses in predicting and managing currency risks.
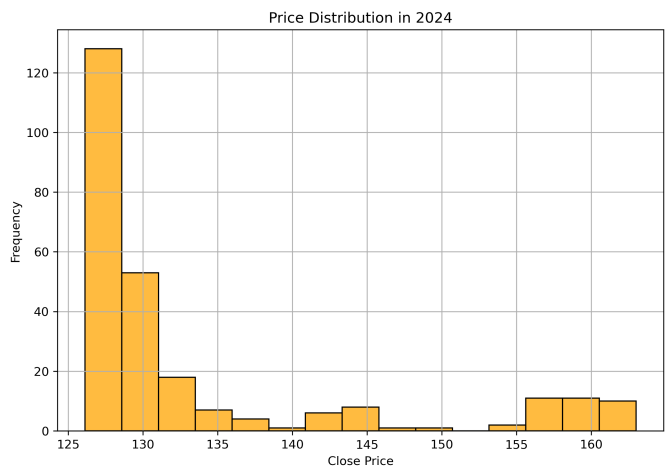

Figure 2: Price Distribution in 2024. This histogram shows the distribution of exchange rates over the sampled period.

The trends in container import volumes, as shown in Figure 3, reveal a relatively stable pattern despite the exchange rate fluctuations. This suggests that import volumes may be less sensitive to short-term currency movements, possibly due to the inelastic demand for essential goods such as fuel, machinery, and medical supplies. However, further analysis is required to explore the underlying factors driving this relationship.
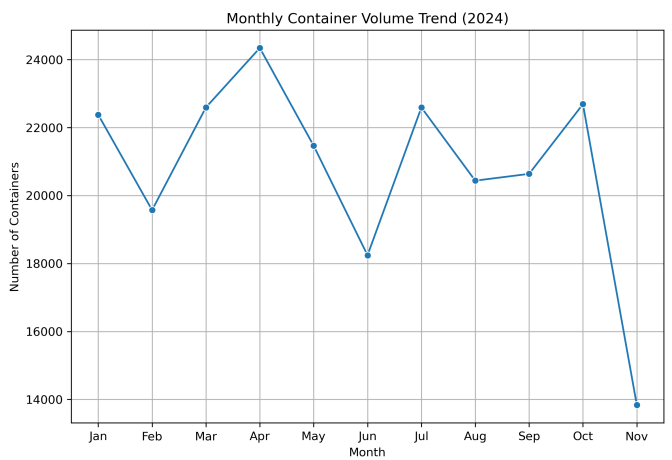

Figure 3: Monthly Container Volume Trend (2024). This plot shows the trend in container import volumes over the sampled months.
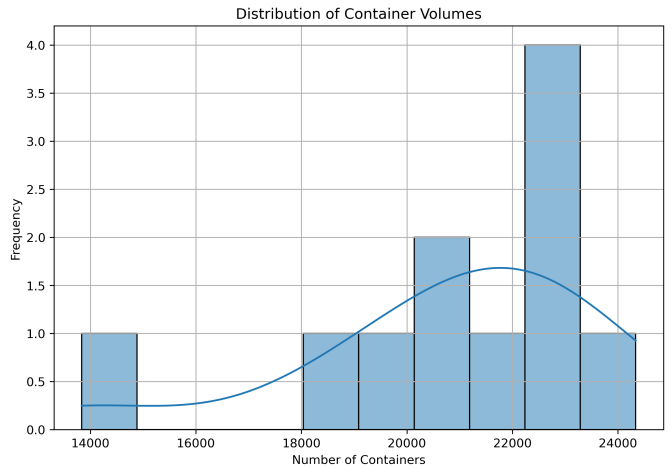

Figure 4: Distribution of Container Volumes. This histogram shows the distribution of container import volumes.
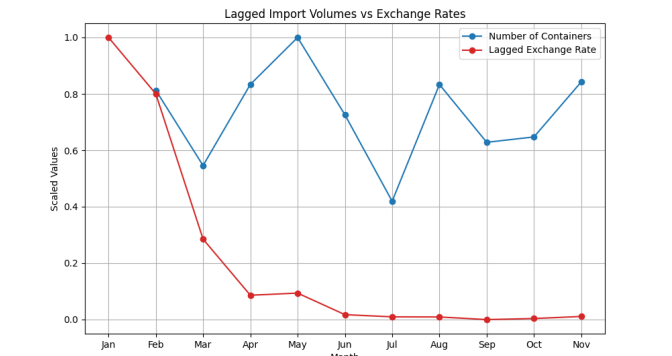

Figure 5: Lagged Import Volumes vs Exchange Rates. This plot compares Lagged import volumes with monthly exchange rates.
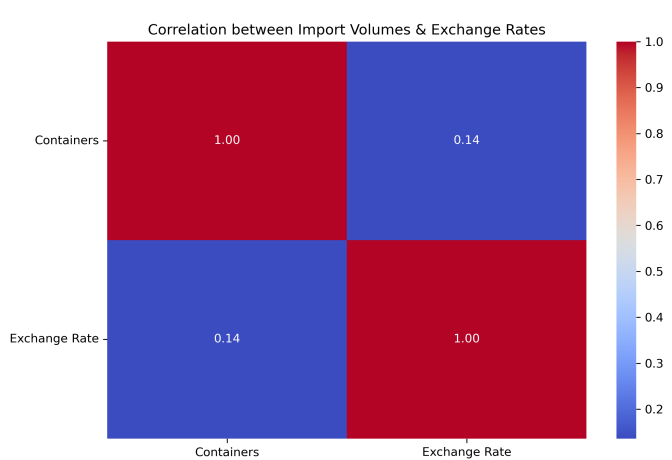

Figure 6: Correlation between Import Volumes and Exchange Rates. This heatmap shows the correlation between import volumes and exchange rates.

4.2. Regression Analysis

The following table summarizes the results of the Ordinary Least Squares (OLS) regression analysis:

Table 1: OLS Regression Results

Dep. Variable:	NumberOfContainers	R-squared:	0.018			
Model:	OLS	Adj. R-squared:	-0.091			
Method:	Least Squares	F-statistic:	0.1692			
Date:	Sun, 19 Jan 2025	Prob (F-statistic):	0.690			
Time:	19:58:18	Log-Likelihood:	-102.55			
No. Observations:	11	AIC:	209.1			
Df Residuals:	9	BIC:	209.9			
Df Model:	1					
Covariance Type:	nonrobust					
	coef	std err	t	P$>$|t|	[0.025	0.975]
const	1.597e+04	1.18e+04	1.359	0.207	-1.06e+04	4.26e+04
Close	35.8741	87.223	0.411	0.690	-161.439	233.187
Omnibus:	6.814	Prob(Omnibus):	0.033			
Skew:	-1.157	Kurtosis:	3.955			
Durbin-Watson:	1.835	Jarque-Bera (JB):	2.870			
Prob(JB):	0.238	Cond. No.:	1.76e+03			

4.3. Discussion of Regression Results

The regression analysis provides insights into the relationship between exchange rate fluctuations and container import volumes in Kenya. The results are summarized in Table 1, and the key findings are discussed below. The regression results indicate a weak positive relationship between the exchange rate ('Close') and the number of containers imported ('NumberOfContainers'). The coefficient for 'Close' is 35.8741, suggesting that a one-unit increase in the exchange rate is associated with an increase of approximately 35.87 containers. However, this relationship is not statistically significant (p-value = 0.690), meaning we cannot confidently conclude that exchange rate fluctuations have a meaningful impact on import volumes. The model explains only 1.8% of the variation in container import volumes, as indicated by the R-squared value of 0.018. This extremely low value suggests that exchange rate fluctuations alone are not a strong predictor of import volumes. The negative adjusted R-squared (-0.091) further confirms that the model does not fit the data well and that adding more relevant variables might be necessary to improve its explanatory power. The p-values for both the intercept ('const') and the slope ('Close') are greater than 0.05 (0.207 and 0.690, respectively), indicating that neither the intercept nor the slope is statistically significant. The intercept (1.597e+04) suggests that when the exchange rate is zero, the predicted number of containers imported is approximately 15,970. However, this interpretation is not meaningful in the context of exchange rates, as a zero exchange rate is unrealistic. The slope coefficient (35.8741) suggests a positive relationship, but the lack of statistical significance implies that this relationship could be due to random variation in the data. Several diagnostic tests were conducted to assess the validity of the regression model. The Omnibus test (p-value = 0.033) indicates that the residuals are not normally distributed, violating one of the key assumptions of OLS regression. Non-normal residuals can affect the reliability of the regression results. The Durbin-Watson statistic (1.835) is close to 2, suggesting that there is no significant autocorrelation in the residuals. This is a positive sign, as autocorrelation can lead to biased standard errors and unreliable hypothesis tests. The large condition number (1.76e+03) indicates potential numerical instability in the model. While multicollinearity is not an issue here (since there is only one independent variable), the large condition number might be due to scaling issues or other numerical problems. The regression results support the hypothesis that exchange rate fluctuations have little to no effect on container import volumes in Kenya. This finding challenges the intuitive assumption that currency depreciation directly reduces import activity. Several factors could explain this result. Many of Kenya's imports, such as fuel, machinery, and medical supplies, are essential and have inelastic demand. As a result, import volumes may remain stable even when exchange rate fluctuations increase the cost of imports. Additionally, import-dependent businesses may use hedging strategies to mitigate the impact of exchange rate volatility, thereby stabilizing import volumes. The impact of exchange rate fluctuations on import volumes might not be immediate. The J-curve effect suggests that trade balances may worsen in the short term before improving in the long term, which could explain the lack of a significant relationship in the sampled period. These findings align with studies such as Ndungu (2021), which found that essential imports in Kenya show limited sensitivity to exchange rate changes. However, they contradict studies like Bahmani-Oskooee and Rhee (2010), which emphasize strong currency effects on trade. This discrepancy highlights the importance of context-specific analyses, as the impact of exchange rate volatility may vary depending on the nature of goods traded and the economic environment. The study has several limitations. The analysis is based on only 11 months of data, which limits the generalizability of the results. The Augmented Dickey-Fuller (ADF) test results indicate that the exchange rate data is non-stationary, which can lead to spurious regression results. The model includes only one independent variable (exchange rate), which may oversimplify the relationship between exchange rates and import volumes. To address these limitations, future research could expand the sample size to include more data points, use differencing or transformation techniques to address non-stationarity, and include additional independent variables, such as GDP, inflation, and trade policies, to improve the model's explanatory power.

5. Conclusion

The study on the relationship between currency exchange rate fluctuations and container imports into Kenya provides valuable insights into the dynamics of trade in a volatile economic environment. The research, which analyzed data from January to November 2024, aimed to determine whether fluctuations in the Kenyan Shilling (KES) against the US Dollar (USD) significantly influence the number of containers imported into the country. The findings challenge the common assumption that currency depreciation directly reduces import activity, suggesting instead that other factors may play a more significant role.

5.1. Key Findings

1. **Statistical Analysis**: The Pearson correlation coefficient revealed a weak positive correlation between the KES-USD exchange rate and container import volumes, indicating that

while there is a slight tendency for import volumes to increase with a stronger KES, this relationship is not strong. The Ordinary Least Squares (OLS) regression analysis further supported these findings, showing a non-significant positive relationship between the exchange rate and import volumes. The R-squared value of 0.018 indicates that only 1.8% of the variation in import volumes can be explained by exchange rate fluctuations alone. This low explanatory power suggests that other variables are likely more influential in determining import volumes.

2. **Visual Insights**: Visualizations of the USD/KES exchange rate over the sampled period highlighted significant volatility, with notable peaks and troughs, particularly in the first half of 2024. Despite this volatility, the trends in container import volumes remained relatively stable, suggesting that short-term currency movements have limited impact on import volumes. The distribution of exchange rates was slightly right-skewed, indicating periods of lower values with occasional spikes, reflecting the challenges faced by import-dependent businesses in managing currency risks.

3. **Economic Context**: The stability of import volumes despite exchange rate fluctuations can be attributed to the inelastic demand for essential goods such as fuel, machinery, and medical supplies. These goods are critical for the functioning of the economy and are less sensitive to price changes. Import-dependent businesses may employ hedging strategies to mitigate the impact of exchange rate volatility, thereby stabilizing import volumes. Additionally, the J-curve effect suggests that any negative impact of currency depreciation on trade balances may be temporary, with improvements occurring over time.

5.2. Implications

The findings of this study have several implications for policymakers and import-dependent businesses in Kenya:

1. **Policy Implications**: Policymakers should focus on stabilizing macroeconomic conditions and implementing policies that support essential imports. Given the limited sensitivity of these imports to exchange rate changes, efforts should be directed towards ensuring their availability rather than solely targeting exchange rate stability. Regional trade agreements can play a crucial role in cushioning the impact of intra-African trade. Strengthening these agreements can help stabilize trade volumes and reduce dependency on external currencies.

2. **Business Strategies**: Import-dependent businesses should consider adopting hedging strategies to manage currency risks effectively. This can include using financial instruments such as forward contracts or options to lock in favorable exchange rates. Businesses should also diversify their supply chains to reduce reliance on a single currency. By sourcing goods from multiple countries, they can mitigate the impact of exchange rate fluctuations on their operations.

5.3. Limitations and Future Research

While the study provides valuable insights, it has certain limitations that should be addressed in future research:

1. **Data Constraints**: The analysis is based on only 11 months of data, which limits the generalizability of the results. Expanding the sample size to include more data points would provide a more comprehensive understanding of the relationship between exchange rates and import volumes. The Augmented Dickey-Fuller (ADF) test results indicate that the exchange rate data is non-stationary, which can lead to spurious regression results. Future studies should use differencing or transformation techniques to address non-stationarity.

2. **Model Complexity**: The current model includes only one independent variable (exchange rate), which may oversimplify the relationship between exchange rates and import volumes. Including additional independent variables such as GDP, inflation, and trade policies could improve the model's explanatory power and provide a more nuanced understanding of the factors influencing import volumes.

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