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VOLATILITY MODELING AND VALUE AT RISK ANALYSIS OF THE ALL/ EUR EXCHANGE RATE

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Abstract

This study estimates exchange rate risk between the Albanian Lek (ALL) and the Euro (EUR) using a GARCH(1,1) model and Value at Risk (VaR). Monthly data from January 2012 to October 2024 are used to model time-varying volatility in exchange rate returns. VaR is computed at the 95% and 99% confidence levels based on the conditional mean and variance. The results show strong volatility persistence, indicating continued exchange rate risk for EUR-denominated assets. Increased uncertainty from monetary policy shifts, geopolitical factors, and pandemic-related inflation has raised downside risk. Although estimated losses are moderate, they remain economically significant, highlighting the need for effective exchange rate risk management.

Key words*: GARCH, Value at Risk, Volatility*

JEL classification: C22, G32, G17

1. Introduction

Understanding financial risk and management methods is a very important factor in asset and portfolio management. The exchange rate of ALL to EUR is a key factor for Albania's economy, as it affects trade, foreign investment, and monetary policy. Through this analysis, interest groups can use the information to make informed financial decisions. Using the historical exchange rate from January 2012 to October 2024, involving the GARCH (1.1) model to estimate the variability in the returns and calculate the Value at Risk at confidence levels of 95% and 99% confidence levels. The econometric techniques used in this study capture time-varying volatility and provide risk-specific insights for the Albanian currency market.

This study addresses a specific question: How can the VaR for the exchange rate between the Albanian Lek and the Euro be effectively estimated using GARCH modeling? VaR is a critical metric for the maximum potential loss that might occur over a given time period at a given confidence level under normal market conditions. Exchange rate volatility directly and indirectly impacts firms, investors, the government, policymakers, and overall international trade and investment.

The paper is organized as follows. Section 2 provides the literature review. The methodology and data preparation are described in Section 3. Section 4 presents and discusses the results of the empirical analysis. Section 5 concludes the article.

2. Literature Review

Maintaining stable exchange rates is crucial, especially in volatile markets where fluctuations can greatly affect economic stability. Exchange rates influence trade, investment, and policy decisions, making them vital for balancing a country's external position. Krugman and Obstfeld (2011) emphasize the importance of exchange rates in maintaining global economic equilibrium, as they directly affect import and export costs. Similarly, Friedman (1953) supports flexible exchange rates as a catalyst for external economic crises, thereby promoting economic resilience. Albania's economic transition, characterized by shifting towards market-based policies and global integration, has exposed the Albanian Lek to considerable foreign exchange volatility.

Remittances from European countries help stabilize the Albanian Lek within the national economy (Vika & Luçi, 2011). They function as a buffer during periods of uncertainty, but fluctuations in these payments can also lead to currency volatility. According to Çera et al. (2013), the relationship between conditions and Albania's dependence on the Eurozone market exposes the Lek to wider European economic shifts. Value at Risk (VaR) is commonly used to assess risk by quantifying the maximum possible loss within a specified timeframe. Issues arise regarding the effectiveness of VaR estimation methods, such as Historical Simulation and Monte Carlo Simulation, due to limitations identified by Jorion (2007). As highlighted by Christoffersen (2012), the assumptions underlying these methods regarding the normality of returns may not hold under market conditions. According to Mandelbrot and Hudson (2004), relying on the assumption of normality when considering returns can downplay losses during crises.

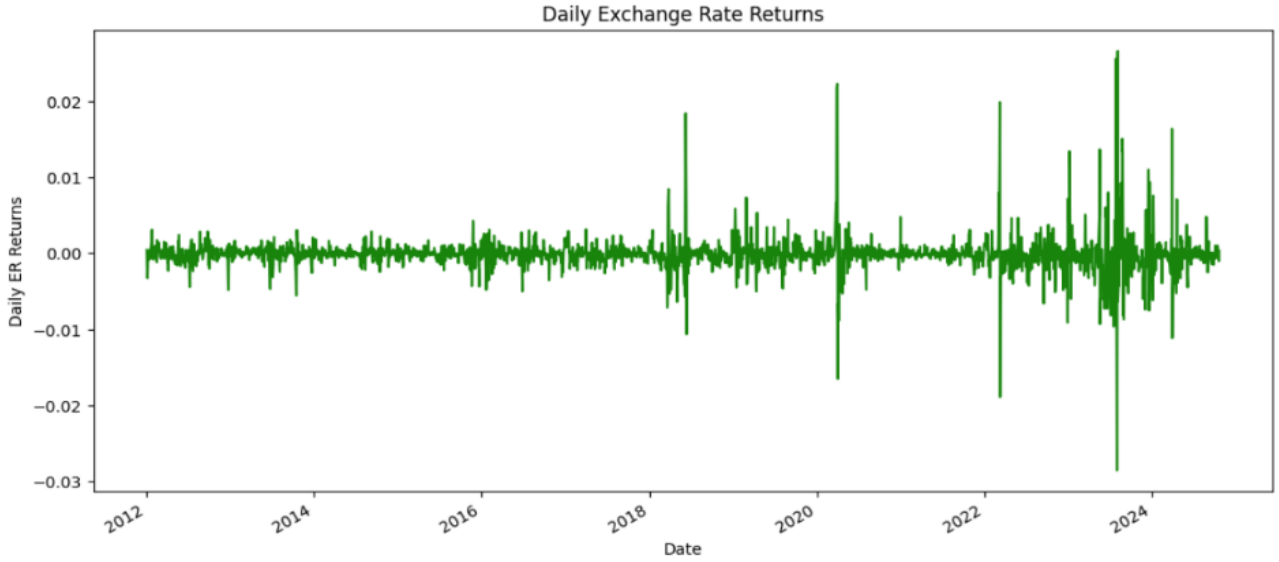
In emerging markets, GARCH models improve the accuracy of risk forecasts by adjusting to market conditions. changing volatility over time. Nelson (1991) provides evidence that VaR estimation can benefit from using GARCH models. This is because they provide a better fit when the returns are modeled as conditionally heteroskedastic, which they tend to be in unstable markets. Engle and Ng (1993) emphasize that the GARCH model's dynamic approach provides better (and more consistent) "fits" over time. This is particularly important for financial institutions that use such models for risk management. Çera et al. (2013) employed the GARCH model and a GARCH-based VaR approach to estimate the volatility of the Albanian Lek against major currencies. They find that the GARCH model offers a relevant method that outperforms the traditional VaR models in providing timely estimates of the Lek's volatility. Krugman and Obstfeld (2011) maintained that exchange rates are important for maintaining balance in the international monetary system, as they directly influence the costs of imports and exports. Bekaert and Harvey (2003) found that, in rising markets, currency volatility can be driven by a range of external factors. These factors can be attributed to fluctuations in product prices, foreign direct investment flows, and global investor opinion. GARCH models have been found to give more accurate risk assessments than traditional methods. Nelson (1991) emphasized that GARCH models enhance volatility estimation compared to simple moving averages. Christoffersen and Diebold (2000) also demonstrated that GARCH-based VaR models outperform traditional VaR estimation techniques by accounting for the dynamic nature of financial market volatility.

3. Data, Methodology, and Preparation

The exchange rate data is sourced from the official records of the Bank of Albania. The daily exchange rate returns were calculated from 4th January 2012 to 18th October 2024. The daily logarithmic returns focus on percentage changes rather than on absolute return values. The calculated daily return was plotted (Graph 1), demonstrating volatility patterns over the timeline.

3.1 Observation of the Returns Graph

The graph of the period from 2012 to 2018 shows minimal daily percentage change, indicating a stable exchange rate trend. From 2018 to 2020, there was noticeable volatility, peaking in 2020 at the onset of the COVID-19 pandemic. From the middle of 2020 to the end of 2021, the exchange rate stabilized. Since 2022, there has been significant volatility due to high economic uncertainty, high borrowing costs, the risk of a recession, wars around the world, and political instability, among other factors.



Graph 1. Daily Exchange Rate Return

3.2 Cumulative Daily Exchange Rate Returns

The cumulative return remains relatively flat during the 2012-2018 period. The market appears stable, with no significant upward or downward trends. From 2018 to 2020, cumulative returns declined, suggesting a sustained depreciation of the EUR against the ALL. After this period, the graph has sharp spikes due to uncertainty, increased volatility, and significant short-term risk.

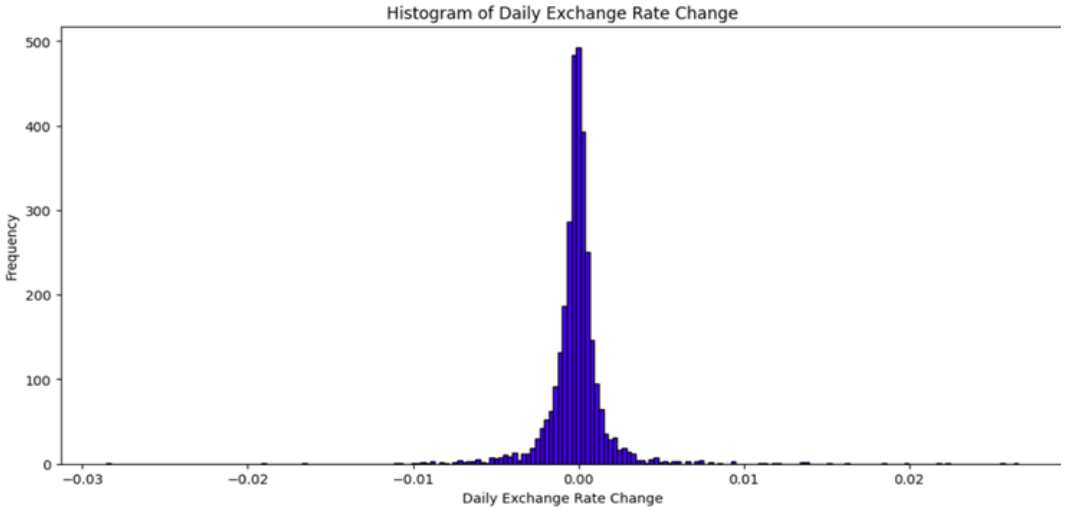
Daily exchange rate returns have been declining rapidly from 2022 to 2024, reflecting a strong depreciation of the Euro due to external shocks. Mostly affected by huge changes in monetary policies by the European Institutions, political factors, and macroeconomic instability.

Graph 2. Cumulative Daily Exchange Rate Returns

3.3 Descriptive Statistics

The mean of -0.000107 indicated a marginal depreciation of the EUR against ALL over time due to economic divergence between the Eurozone and the European Central Bank's prolonged periods of monetary easing. This might reflect Albania's greater stability and performance relative to the Eurozone. The standard deviation of daily returns is 0.21%, which shows low variability of returns under normal conditions, with temporary spikes due to extreme events, as stated by skewness and kurtosis. The minimum and maximum values indicate the most extreme day-to-day changes in the ALL/EUR, ranging from -2.86 % to +2.66 %, linked to market shocks during the crisis and geopolitical developments. The distribution of returns is narrow, indicating that many daily returns are close to 0. Skewness of 1.797 indicates that the distribution of returns has a longer tail on the right side.

However, the upward movements in the Euro were not enough to counter the overall depreciation trend we observed, given the negative mean. Kurtosis of 46.775 is much greater than 3, indicating leptokurtic behavior, with a heavy-tailed distribution and a peak around the mean. The ALL/EUR rate has been affected by shocks driven by market stress, inflation, global concerns, and central bank action to counter COVID-19. An important factor is seasonal demand for the Euro in Albania during peak travel periods, driven by tourism, businesses exchanging Euro as they operate mostly in Euro, money from illegal sources, and remittances from a large number of immigrants.



Graph 3. Histogram of Daily Exchange Rate Change

The histogram effectively visualizes the daily exchange rate changes, centered near 0, with a sharp peak and heavy tails, and rare but significant outliers. It shows a stable distribution with occasional extreme fluctuations.

4. Empirical Results

The GARCH model (Table 1) suggests that the ALL/EUR exchange rate has periods of high volatility and low volatility.

a) The Mean of returns: is -0.0473, significant at a 5% level (p-value=0.026), where the average return on the exchange rate is negative, indicating a depreciation of the Euro over time.
b) Volatility Equation:
   - ω (constant): 0.1161 is significant (p-value <0.001), which shows the base level of volatility.
   - α_1 (parameter): 0.4398 is significant (p-value <0.001), which shows that recent economic shocks have a moderate impact on current volatility.
   - β_1 (parameter): 0.5602 is significant (p-value <0.001), which shows that the volatility of the exchange rate is persistent, as GARCH captures the impact of past volatility.
c) $\alpha_1 + \beta_1 = 0.9999$, meaning that shocks have long-lasting effects on the ALL/EUR exchange rate.

Table 1. Empirical results of the GARCH (1:1) model.

GARCH (1.1)		Coefficient	Std. error	Test-statistic	p-value	95% Confidence Interval
Mean Model	μ (mu)	-0.0473	0.02126	-2.224	0.02615	[-0.08896,-0.00561]
Volatility Model	ω (omega)	0.1161	0.03243	3.581	0.00034	[0.05257,0.180]
	α_1 (alpha [1])	0.4398	0.04097	10.733	<0.00001	[0.359, 0.520]
	β_1 (beta [1])	0.5602	0.04758	11.774	<0.00001	[0.467,0.654]

Source: Author's estimation

4.1 GARCH - Based Value at Risk and Historical Value at Risk

GARCH-based VaR (Table 2) adjusts for periods of high and low volatility based on past returns and is more responsive to recent market conditions, which captures the adjusted risk. The VaR results from the GARCH (1.1) model indicate a substantial risk level, particularly at the 99% confidence level. The calculated VaR suggests a manageable risk for small and short- to mid-term investments in Euro, but a large exposure to exchange rate risk, since the VaR calculations might underestimate the true risk and distribution of returns, with fat tails and skewness. On the other hand, the Historical VaR relies on historical data and captures more extreme movements, which are less likely to occur under current market conditions.

Table 2. Empirical findings – GARCH and Historical Value at Risk

VaR Method	Confidence Level	Value at Risk (EUR)	Monetary VaR for 100 (EUR)
GARCH-Based	95%	-0.0014618	-0.146
	99%	-0.0020478	-0.205
Historical VaR	95%	-0.0024109	-0.241
	99%	-0.0060146	-0.601

Source: Author's estimation

5. Conclusions

The GARCH model's volatility forecast provides the standard deviation of returns, combined with the mean of returns, to compute the Value at Risk, up-to-date with adjusted risk. It helps us understand and predict future exchange rate movements. The GARCH-derived VaR indicates that past volatility patterns persist, and the value of EUR investments could decline further in ALL terms. If this trend continues, the EUR-denominated assets will incur losses upon conversion into ALL. Investors, businesses, or financial institutions should use financial instruments such as forwards or options to protect themselves against exchange rate fluctuations. Shifts in monetary policy in the Eurozone, the geopolitical situation, increased inflation during the pandemic, and market uncertainty have increased volatility, raising the potential for losses of the Euro against the Albanian Lek. We should consider that VaR does not account for extreme market events, which could lead to much larger losses than the model predicts. The losses are not ex-

tremely large, but should not be neglected. A prolonged period of depreciation could result in more losses for EUR holders under current market conditions. Over time, the Albanian LEK has been relatively strong against the Euro. Small changes in exchange rates can have a significant impact on investments, tourism, and business transactions when multiplied over large volumes or long periods.

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