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Exploring the Influence of Economic Policy Uncertainty on the Volatility of Exchange Rates

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Abstract: **The extent to which Economic Policy Uncertainty (EPU) influences exchange rate volatility has progressively become one of the popular issues that economists have devoted their efforts to studying in recent years. In this study, daily and monthly exchange rate data for USD/GBP are selected, and regression analysis using the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) estimation model is employed to explore the difference between the impact of EPU and non-economic policies on exchange rate fluctuations. The experimental results indicate that using daily data is more appropriate than monthly data for estimating EPU, and non-policy uncertainty outweighs the impact of EPU on exchange rate volatility. This finding provides important insights into the factors driving exchange rate fluctuations, offering substantial implications for formulating effective economic policies and risk management strategies. These research findings contribute not only to the academic understanding of international financial markets but also serve as a valuable reference for policymakers in better addressing the challenges posed by economic uncertainty on exchange rate stability.**

Keyword: **EPU; Exchange Rate Volatility; Non-Policy Uncertainty; GARCH Model.**

I. INTRODUCTION

Exchange rate fluctuations would not only affect the economic situation of a country, but also have a certain impact on foreign-related companies and individuals. Therefore, many individuals or institutions lay themself out to obtain benefits or avoid the risks caused by exchange rate fluctuations by purchasing forward contracts. Modeling exchange rate fluctuations can help companies better predict forward contract prices and boost company profits. From a macroeconomic perspective, exchange rate fluctuations can change the relative production costs of industries and may even affect the unemployment rate in some countries. Therefore, the predictive modeling of exchange rate volatility is of great significance.

From a long-term perspective, fundamentally driven long-term exchange rate models (e.g., the Purchasing Power Parity Model) have achieved some success in forecasting exchange rates (Jiang, et al. 2016; Al-Gasaymeh et al. 2019; Nagayasu, 2021), but in the short run, the accuracy of exchange rate forecasts has declined considerably. Many unknown variables in the short term: the uncertainty of policy expectations, the uncertainty of the implementation of economic policies, the possibility of economic policymakers changing their policy stances, etc., may have an impact on the exchange rate.

Although theoretically there is divarication on whether Economic Policy Uncertainty (EPU) affects exchange rate volatility, past empirical studies tend to confirm that EPU has an impact on exchange rate volatility (Krol, 2014; Chen, et al. 2020; Phan, et al. 2021). Scholars such as Baker, et al. (2016) used text mining to predict monthly exchange rate fluctuations to construct a monthly EPU index. through research, it is found that the uncertainty of economic policy has a substantial impact

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on the exchange rate fluctuation in the current month or one-month lag. However, most studies in the past have been based on monthly data, and it is unachievable to distinguish whether current exchange rate fluctuations are caused by EPU on the same day or a month ago. Thus, to some extent, the results obtained from higher frequency data can better reflect the causal relationship between EPU and exchange rate volatility only when persistent EPU is detected.

In addition, since the Generalized Autoregressive Conditional Heteroskedasticity (GRACH) model can better model time series, it can effectively fit heteroskedasticity functions with long-term memory. Favored by academia, scholars such as Bollerslev introduced GARCH models to analyze the effects of economic uncertainty. Therefore, we also use the GARCH model to test the daily exchange rate volatility because (1) by employing the GRACH model, the effect of daily EPU on exchange rate volatility could be detected more quickly; and (2) the results obtained from the analysis using the GRACH model are compared with the findings of previous studies to enhance the credibility of this study findings.

This paper focuses on the use of GARCH models and daily data to examine the impact of EPU in the US and the UK on the fluctuation of the USD/GBP exchange rate. It is organized as follows: Section 2 reviews the current state of research, Section 3 introduces the model used in this paper, Section 4 describes the data collection and empirical results, and Section 6 lays out the conclusions of this paper.

II. LITERATURE REVIEW

An overwhelming number of scholars have conducted numerous studies on the possible effects of EPU on various aspects of macroeconomics and microeconomics. Bloom (2014) argues that policymakers' formulation of policies is affected by the degree of EPU. When the degree of EPU is high, economic growth becomes slower and policymakers act more aggressively to stimulate the economy to achieve a given rate of economic growth. Carrière and Céspedes (2013) show that sudden changes in EPU could have an impact on macroeconomic cycles, which is more pronounced in emerging markets than in developed countries.

Kim et al. (2013) argue that policy uncertainty can hurt the real economy, specifically, leading to a reduction in investment, exports, consumption, etc.; and on the prices of stocks, futures, exchange rates, etc., in the long run. Julio and Yook (2012) argue that when there is political uncertainty, firms reduce investment spending until this uncertainty is resolved, which is an important channel through which the political process affects real economic outcomes. Huang et al. (2015) point out that EPU increases firms' financing costs, and when there is potential political uncertainty, firms that have paid dividends in the past tend to stop paying dividends and those that have not yet paid dividends will not pay dividends to hedge their risk. Li and Yang (2015) argue that deepening EPU has a dampening effect on the behavior of firms to invest more. Brogaard and Detzel (2015) point out that increased EPU leads to increased volatility in the stock market and affects stock market returns. Liu and Zhang (2015) propose that increased EPU leads to increased volatility in the stock market, and an index of EPU can be added to the stock market price forecasting model to improve the accuracy of model predictions. Cui et al. (2018) combine EPU with the Fama-French five-factor model and use a rolling estimation method to show a significant positive association between exposure to "EPU" and stock price crash risk. Kelly et al. (2016) explored the relationship between EPU and option prices, pointing out that when the economy is weak and political uncertainty is higher, option prices are also more expensive, and options provide greater protection for stocks. Caglayan and Xu (2019) provide significant evidence that EPU reduces the availability of credit while leading to increases in banks' non-performing loans and loan loss provisions, distorting sectoral stability.

Overall, the literature examining the relationship between EPU indices and foreign exchange markets is relatively inadequate. Using monthly data from the EPU Index compiled by Baker, Krol (2014) examines the impact of the EPU index on exchange rate volatility between multiple countries and the U.S. dollar. It concludes that EPU in both home countries and the United States can exacerbate exchange rate volatility when there is an economic downturn. However, for emerging economies with less integrated economies, only EPU in the home country exacerbates exchange rate volatility. Balcilar, et al. (2016) explored the relationship between EPU indices on exchange rate volatility with the U.S. dollar for 16 countries using a VAR model using the monthly EPU index proposed by Baker. The paper notes that the EPU index has a one-month lagged effect on exchange rate volatility. Zhu and Yan (2015) study the dynamic spillover relationship between RMB exchange rate and EPU, and point out that there is a spillover effect between EPU and RMB exchange rate in four countries and regions, namely China, the United States, the Euro area and Japan, and it is reflected as a net spillover of RMB exchange rate to EPU. Chen, et al. (2020) show that the impact of EPU on exchange rate volatility in China exhibits asymmetry and heterogeneity with significant market variability. The impact on exchange rate volatility is significant for the US, Europe and Japan, while the correlation is insignificant for Hong Kong. Phan, et al. (2021) argue that EPU has a negative and statistically significant impact on financial stability, and that the negative impact of EPU on financial stability is greater for countries with higher competition, lower regulatory capital, and smaller financial systems, as well as greater exchange rate volatility.

In the past literature, there exist a large number of studies related to EPU and economic development, but very few scholars have explored the impact of economic uncertainty on exchange rates, and even if some studies exist, they usually use monthly uncertainty index data to study the impact of EPU on exchange rate fluctuations. Based on previous studies, we use daily data while combining GARCH models to try to estimate the impact of EPU on exchange rate fluctuations more efficiently and accurately, and to optimize the speed and accuracy of model detection.

III. MODEL DESIGN

This study employs a classical GARCH model to investigate the connection between the index of EPU and the volatility of the USD/GBP exchange rate. The exchange rate returns are shown in equation (1).

$$r_t = \ln(e_t) - \ln(e_{t-1}) \qquad (1)$$

where e_t represents the current period rate and e_{t-1} is the previous period rate.

When empirically analyzing the impact of the EPU index on the fluctuation of the USD/GBP exchange rate, the GARCH model can be operated to construct equations as shown in Equation (2) and Equation (3).

$$r_t = \alpha_0 + \beta_0 r_{t-1} + \varepsilon_t h_t^{1/2} \qquad (2)$$

$$h_t = \alpha_1 + \sum_{i=1}^{p} \delta_i h_{t-i} + \sum_{i=1}^{p} \varphi_i \varepsilon_{t-i}^2 \qquad (3)$$

When we choose the standard GARCH (1,1) for modeling and the average daily return is 0, and the autoregressive coefficient is not significant, equation (2) and equation (3) become

$$r_t = \varepsilon_t h_t^{1/2} \qquad (4)$$

$$h_t = \alpha_1 + \delta_1 h_{t-1} + \varphi_1 \varepsilon_{t-1}^2 \qquad (5)$$

Considering the impact of EPU and non-EPU on exchange rate fluctuations, we add EPU and non-EPU and their respective first-order lag terms to the model, which becomes.

$$r_t = \varepsilon_t h_t^{1/2} \qquad (6)$$

$$h_t = \delta_1 h_{t-1} + \varphi_1 \varepsilon_{t-1}^2 + e^{\alpha_2} * e^{\left(\sum \beta_i x_{i,t}\right)} \qquad (7)$$

$$\sum \beta_i x_{i,t} = \beta_1 (Non - EPU)_{t-1} + \beta_2 (Non - EPU)_{t-2} + \beta_0 EPU_t + \beta_1 EPU_{t-1} \qquad (8)$$

In this model, we select the current value as the EPU index, because the EPU index is calculated based on the relevant data of the newspaper of the day, which is usually published in the morning. The exchange rate value we adopt is the spot exchange rate value at noon, so it can be considered that the current exchange rate can reflect the EPU of the day. Therefore, for non-EPU, we select its first-order lag term to reflect the changes in the exchange rate on the day. To fully reflect the non-timely adjustment behavior of the market, we have added a first-order lag term to both the EPU index and the non-EPU index. The EPU index in this study consists of indices from the US and the UK.

To define non-policy uncertainty, we introduce the VIX index, as shown in Equation (9):

$$VIX_t = \alpha + \beta_0 EPU_{US,t} + \beta_1 EPU_{UK,t} + \mu_t \qquad (9)$$

Among them, μ_t is the part of the market that cannot be explained by EPU, and is the part caused by non-EPU, which is called non-policy uncertainty.

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IV. DATA SELECTION AND EMPIRICAL ANALYSIS

4.1. Data Selection

On June 23, 2016, the U.K. held a referendum, marking one of the most significant decisions made by the British people in nearly half a century. Over the subsequent three years, in 2019, the UK was further confronted with the once-in-a-century COVID-19 pandemic. Given the paramount importance of both Brexit and COVID-19 on the UK's economy and exchange rates, our research covers data spanning from July 2016 to June 2021. For the EPU index, this study adopts daily EPU index values from both the United Kingdom and the United States. The EPU index values in this paper were obtained, following the methodology of Baker et al. (2016), from articles related to EPU in prominent local newspapers or authoritative media sources (including 32 media outlets such as The Times, The Guardian, The Independent, Financial Times, The Economist, etc.). Subsequently, the search volumes for specified keywords are statistically standardized to derive the EPU index values.

The exchange rate and VIX index are derived from the Federal Reserve Economic Data (FRED), where the exchange rate is the spot exchange rate value. Since no corresponding exchange rate data exists for weekends and holidays, there are 3766 observations. The UK and US EPU index have 5478 observations and the VIX Index has 3773 observations.

4.2. Empirical Analysis

Table 1 displays the descriptive statistics of the daily exchange rate returns, the daily US EPU index (EPU_{US}), the UK EPU index (EPU_{UK}) and the market uncertainty index (Market Uncertainty).

Table 1: Descriptive statistics of variables

Daily Exchange Rate Returns		EPU_{US}	EPU_{UK}	Market Uncertainty
Average Value	0.0089	107.4	261.7	0.0
Standard Deviation	0.0059	72.0	160.9	7.7
Maximum Value	0.0443	719	1645	53.5
Minimum	-0.0497	3.3	0.0	-26.1
Skewness	-0.3207	1.9	1.3	1.8
Kurtosis	8.55	9.2	6.2	9.2

Table 2 presents the results of ADF and PP tests for daily exchange rate returns, daily EPU_{US}, and daily EPU_{UK} market uncertainty indices, which are all smooth series from the test results.

Table 2: The results of the smoothness test of the sequences

Variable	ADF（Lagging 60 steps）	PP（Lagging 60 steps）
Daily Exchange Rate Gains	0.0241	0.0000
EPU_{US}	0.0002	0.0000
EPU_{UK}	0.0102	0.0000
Market Uncertainty	0.0083	0.0000

The results of the Box-Jenkins method are given in Table 3. According to the AIC and BIC criteria, the order of the GARCH model can be optimally modeled by selecting p=1, q=1, that is, we employ GARCH (1,1) to model the time series data.

Table 3: Model order determination

Variable	Order Selection
Daily Exchange Rate Gains	(1,1)
EPU_{US}	(1,1)
EPU_{UK}	(1,1)
Market Uncertainty	(1,1)

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The first column of Table 4 presents the estimated results of the coefficients in Equation (5), and the second to fourth columns present the estimated results of the coefficients in Equations (7)-(8). The second column shows the estimated results of the coefficients of EPU_{US} and EPU_{UK} on the same day, the third column shows the estimated results of the coefficients after adding the market uncertainty index, and the fourth column reveals the estimated results of adding the first-order lag term of each item.

Table 4: GARCH (1,1) Model estimation results

Variable	(1)	(2)	(3)	(4)
constant	0.005^{***}	-5.117^{***}	-4.851^{***}	-5.086^{***}
δ_1	0.040^{***}	0.039^{***}	0.038^{***}	0.037^{***}
φ_1	0.955^{***}	0.954^{***}	0.952^{***}	0.953^{***}
EPU_{US}		-0.036^{***}	0.034^{***}	-0.174^{***}
$L.EPU_{US}$				-0.065^{***}
EPU_{UK}		0.412^{***}	0.338^{***}	-0.367^{***}
$L.EPU_{UK}$				0.673^{***}
$L.$ Market Uncertainty			0.371^{***}	1.423^{***}
$L2.$ Market Uncertainty				-1.608^{***}

Note: $L.EPU_{US}$ represents the first-order lag term of the US EPU index, $L.EPU_{UK}$ represents the first-order lag term of the UK EPU index, $L.$ Market Uncertainty designates the first-order lag term of the market uncertainty index, $L2.$ Market Uncertainty stands for the second-order lag term of the market uncertainty index

Based on the coefficients of the variables presented in Table 4, EPU_{UK} is relatively more robust. The fourth column contains the EPU index and the market uncertainty index for that day and the day after. In terms of coefficients, the effect of either same-day EPU_{US}, or one-day lagged EPU_{US}, on the volatility of exchange rate returns is not significant.

The impact of the current day on the volatility of exchange rate returns is not significant, but the impact of EPU_{UK} with a one-day lag on the volatility of exchange rate returns is more significant and of a larger magnitude. The results in the third and fourth columns show that the market uncertainty index has a greater impact on exchange rate return volatility than the UK EPU index, and the US EPU index has essentially no significant impact on the variance of exchange rate volatility.

To illustrate the magnitude differences of the coefficients. We normalize all series data to a series with mean 0 and standard deviation 1, using the coefficients in column 3 of Table 4. When using only constants to describe the unit standard deviation of daily exchange rate returns, the unit standard deviation is 9% ($\sqrt{h}=\sqrt{e^{-4.851}}$ =9%), which becomes 11%($\sqrt{h}=\sqrt{e^{-4.851+0.371}}$ =11%)， when the market uncertainty index is added, and 13% ($\sqrt{h}=\sqrt{e^{-4.851+0.371+0.338}}$ =13%) when the UK EPU index is added. This indicates that about 5% of the unit standard deviation is caused by the EPU index and the market uncertainty index.

To evaluate the effect of the frequency of sampled data on the model, we employed monthly data and fitted it using a GARCH model. For the monthly exchange rate data, we sampled the exchange rate values once a month instead of taking the monthly average. The monthly EPU index can be obtained from the index data compiled by Baker et al. Both the monthly exchange rate and VIX index are taken from the value of the last trading day of the month.

Table 5: Model order determination

Variable	Order selection
Daily exchange rate gain	(2,2)
EPU_{US}	(1,1)
EPU_{UK}	(1,1)
Market Uncertainty	(1,1)

The results of the selection of the Box-Jenkins method are given in Table 5, and from the results in Table 5, the GARCH (2,2) model should be used for modeling. The results of fitting the GARCH (2,2) model and the sample data are given in Table 6.

Table 6: Fitting results of GARCH (2,2) model for monthly data

Variable	(1)	(2)	(3)	(4)
Constant	1.000***	0.012***	-0.036***	-0.756***
δ_1	0.036***	-0.018***	-0.064***	-0.107***
δ_2	0.055***	0.091***	0.177***	-0.041***
φ_1	0.85***	0.669***	0.703***	0.54***
φ_2	-1.002***	-0.799***	-0.863***	0.039***
EPU_{US}		-0.169***	-0.032***	0.198***
$L.EPU_{US}$				-0.285***
EPU_{UK}		0.323***	0.127***	-0.237***
$L.EPU_{UK}$				0.324***
Market Uncertainty			0.174***	0.76***
L. Market Uncertainty				-0.289***

From the results in Table 6, the magnitude of the coefficients of the variables is weaker than the results obtained from the daily data, however, we could still conclude that the market uncertainty index has a greater impact on the volatility of exchange rate returns than the UK EPU index, and the US EPU index has no significant impact on the variance of exchange rate volatility.

Table 7: Daily data spectral density analysis results

Variable	Bartlett's test	annual cycle	quarterly cycle	monthly cycle
Daily exchange rate gain	0.0000	0.260	0.187	0.164
Daily EPU_{US}	0.0000	0.626	0.516	0.432
Daily EPU_{UK}	0.0000	0.566	0.464	0.415
Daily market uncertainty index	0.0000	0.848	0.784	0.678

The results of spectral density analysis for daily and monthly data are given in Tables 7 and 8, and the results indicate that the assumption of white noise series does not hold. Since the daily data can accurately express the dynamic characteristics of the time series, we employ the daily data as a benchmark for the comparison of the monthly data. In general, when sampling at low frequencies, the proportion of sinusoidal periods at high frequencies is lower, and this misrepresentation of high frequency periods is related to the decrease in the concavity of the cumulative spectral density function as the sampling frequency decreases. The increase in concavity with increasing sampling frequency implies that (1) when using data at lower frequencies, the impact of EPU is allowed to be viewed over a longer time period, which would misestimate the importance of the impact of EPU, and (2) previous work using monthly data for research largely ignores the dynamic nature of the time series itself.

Table 8: Monthly data spectrum density analysis results

Variable	Bartlett's test	annual cycle	quarterly cycle	monthly cycle
Monthly exchange rate gain	0.0289	0.212	0.065	
Monthly EPU_{US}	0.0000	0.553	0.341	
Monthly EPU_{UK}	0.0000	0.792	0.622	
Monthly market uncertainty index	0.0000	0.611	0.375	

Note: The first column of Tables 7 and 8 is the Bartlett test of the white noise sequence; The other columns are the proportions of sinusoidal periods.

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V. CONCLUSION AND PRACTICAL IMPLICATIONS

5.1. Conclusion

EPU is difficult to be measured accurately by empirical methods, and uncertainty can be characterized as a knowledge-based problem across time, not necessarily symmetric. Since perfect intertemporal knowledge is impossible to obtain, accurate estimates of future returns should not be compared to full knowledge models. In contrast, the relative accuracy of market beliefs is the result of comparisons across time and markets of interest, and policy uncertainty is only one of many sources that can lead to incorrect beliefs.

In this paper, we use a GARCH model to compare the results of daily and monthly data. We argue that relevant information in newspapers affects market participants' beliefs faster than the rate of this effect was previously perceived.

Comparing and analyzing the EPU indices of the UK and the US, we find that the former is more likely to lead to daily fluctuations in the USD/GBP exchange rate, while the latter has little effect. But this result doesn't hold for models that sample data weekly and monthly. Similar to the findings of Balcilar et al. (2016), we also found no evidence that EPU has a one-month lag effect on exchange rate volatility. Using daily data modeling can fully take into account the dynamic characteristics of the time series itself, and can detect the impact of policy uncertainty on the exchange rate more quickly.

Finally, this comprehensive study not only identifies the impact of Economic Policy Uncertainty (EPU) but also delves into the intricate relationship between EPU and market uncertainty, highlighting their combined effect in exacerbating exchange rate volatility. Interestingly, the findings underscore that while both EPU and market uncertainty contribute to the volatility observed in exchange rates, the latter appears to exert a more pronounced influence. In dissecting the nuanced dynamics at play, it becomes evident that the heightened exchange rate volatility can be attributed to the intricate interplay between policy-related factors and non-policy elements in the day-to-day operations of businesses. The relative significance of these aspects underscores the multifaceted nature of the challenges faced by financial markets. This study, by offering a nuanced understanding of the factors influencing exchange rate volatility, contributes valuable insights to the broader discourse on economic stability and risk management.

5.2. Theoretical and Practical Implications

In this paper, we present both theoretical and practical arguments for the impact of economic policy uncertainty on the exchange rate market. Theoretically, we contend that utilizing daily data is more advantageous than monthly data due to the higher frequency of changes in exchange rates and economic policy uncertainty. Employing daily data allows for more accurate and timely identification of the effects of economic policy uncertainty on exchange rate volatility. Moreover, this paper discovers that economic policy uncertainty in the UK elevates USD/GBP exchange rate volatility, while its counterpart in the US has virtually no influence. After distinguishing economic policy uncertainty from general macroeconomic uncertainty, this paper also endorses the notion that non-policy market uncertainty has a more significant impact on exchange rate volatility compared to economic policy uncertainty.

Practically, this paper offers implications based on the aforementioned conclusions. Investors should actively monitor economic policy changes and exchange rate market development trends, increase awareness of financial risk prevention, and remain vigilant towards exchange rate market risks. When confronted with adverse shocks resulting from economic policy changes, investors ought to evaluate these based on exchange rate market information, optimize asset portfolio management, and devise appropriate strategies to counteract the negative effects of policy changes on the exchange rate market for risk avoidance purposes. Furthermore, to avert and mitigate potential losses caused by cross-country spillover effects of economic policy uncertainties in other nations, one should also actively observe economic trends and policy changes in those countries, as well as the correlation of exchange rate markets among different nations, to prevent possible losses induced by risk contagion in the exchange rate market. Additionally, financial policy-making institutions should heighten their awareness of international uncertainty risks and accurately assess the role of economic policy uncertainty in the exchange rate market.

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