VOLATILITY OF THE USD: EFFECTS FROM ECONOMIC POLICY UNCERTAINTY, MONETARY POLICY UNCERTAINTY AND GEOPOLITICAL RISK

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MAY 2023

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BY

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A research project submitted in partial fulfillment of the requirement for the degree of

BACHELOR OF ECONOMICS (HONOURS)
GLOBAL ECONOMICS

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF ACCOUNTANCY AND MANAGEMENT
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MAY 2023

Declaration

I hereby declare that:

(1) This undergraduate research project is the end result of my own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

(2) No portion of this research project has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) The word count of this research report is 22278.

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Acknowledgement

I would like to express my sincere gratitude and appreciation to Dr Liew Ping Xin, my supervisor, for her invaluable guidance, encouragement, and support throughout my FYP journey. Her expert advice, critical feedback, and unwavering dedication have been instrumental in shaping my research and helping me to achieve my goals.

Furthermore, I would like to express my profound gratitude to Dr Lee Hui Shan, who served as the second examiner of my Final Year Project, for her valuable contributions and recommendations to enhance the quality of my research during the VIVA. Additionally, I would like to acknowledge Dr Tey Sheik Kyin, the coordinators of the Final Year Project, for providing the necessary guidance and instructions for the successful completion of the project.

I am also grateful to the faculty and staff at UTAR for providing me with access to the resources and facilities necessary to complete my research. Their support and assistance have been indispensable in helping me to overcome the various challenges that I have encountered along the way.

Finally, I would like to thank my family and friends for their love, encouragement, and unwavering support. Their patience, understanding, and unwavering faith in me have been a source of strength and motivation, and I am truly grateful for their unwavering support.

Dedication

I would like to express my sincere dedication of this research paper to Universiti Tunku Abdul Rahman (UTAR) for providing me with the opportunity to utilize the knowledge I acquired in this study. I am also deeply grateful to Dr. Liew Ping Xin, my Final Year Project (FYP) supervisor, for generously sharing her expertise and offering prompt responses to my inquiries, even beyond normal office hours. Without her invaluable guidance, support, and patience, this research would not have been possible. Furthermore, I extend my heartfelt dedication of this paper to Dr. Lee Hui Shan, the second examiner of my FYP, whose valuable suggestions greatly enhanced the research.

Finally, I would like to express my sincere appreciation to my family and friends who provided me with the motivation and assistance required to overcome the challenges I encountered during the research period.

TABLE OF CONTENTS

List Of Table

List Of Figures

List Of Abbreviations

ADF - Augmented Dickey-Fuller test

AFC - Asian Financial Crisis

AIC - Akaike Information Criterion

BIS - Bank for International Settlements

CAD - Canadian Dollar

CNY - Chinese Yuan Renminbi

CPU - Climate Policy Uncertainty Index

DCC-GARCH - Dynamic Conditional Correlation Generalized Autoregressive Conditional Heteroskedasticity

EMV - Equity Market Volatility

EPU - Economic Policy Uncertainty Index

FED - Federal Funds Effective Rate

FPU - Fiscal Policy Uncertainty Index

GARCH - Generalized Autoregressive Conditional Heteroskedasticity

GBP - Great British Pound

GFC - Global Financial Crisis

GPR - Geopolitical Risk Index

GPRA - Geopolitical Acts Index

GPRT - Geopolitical Threats Index

INF - Inflation Rate

JPY - Japanese Yen

KRW - South Korean Won

MPU - Monetary Policy Uncertainty Index

REER - Real Broad Effective Exchange Rate

SAR - Hong Kong Special Administrative Region

SIC - Schwarz Information Criterion

TBILL - US Treasury Bill Rate

TOT - Terms of Trade

TPU - Trade Policy Uncertainty Index

WSJ - Wall Street Journal

Preface

It is my pleasure to present this report on the Volatility of the USD: Effects from Economic Policy Uncertainty, Monetary Policy Uncertainty and Geopolitical Risk. The purpose of this report is to shed light on the factors that influence the volatility of the USD, and to provide insights that can be helpful to policymakers, businesses, and investors in managing their risks.

The report is based on months of research and analysis, using data from 342 months from January 1994 to June 2022 in the United States. I have employed the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model to analyze the data, and have identified the significant factors that impact the volatility of the USD.

I hope that this report will be useful to readers interested in the dynamics of the USD volatility, and that it will contribute to the ongoing discourse on the stability of the global financial system. I welcome feedback and suggestions for future research, and I look forward to continuing my work in this field.

Abstract

In recent years, there has been an increase in economic uncertainties, with uneven growth seen in various economies leading to a divergence of monetary policies of major economies. Furthermore, geopolitical events like instability in politics, wars, and natural disasters can affect the value of the US currency, leading to volatility in the USD. This uncertainty can affect trade and consumption patterns due to the unpredictable nature of the exchange rate movements. Thus, this study aims to examine the relationship between economic policy uncertainty index (EPU), monetary policy uncertainty index (MPU), and geopolitical risk index (GPR) on the volatility of the USD. Using data from 342 months from January 1994 to June 2022 in the United States, this study employs the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) to analyze the data. The main findings indicate that only EPU and MPU are significant in affecting the volatility of the USD. EPU has a positive and significant impact, while MPU has a negative and significant impact on the volatility of USD. The finding that the GPR is not significant in explaining the volatility of USD suggests that geopolitical events and risks do not play a major role in driving US exchange rate volatility. The results of this study suggest that the US government can take various steps to reduce EPU, including increasing the transparency and predictability of economic policy. Additionally, the study indicates that monetary policy uncertainties are less concerning for businesses, consumers, investors, and policymakers. However, companies involved in international trade and investment face currency risks, which arise from the fluctuation in exchange rates. Therefore, they should consider using hedging strategies to manage their currency risks effectively. Overall, this study contributes to the understanding of the complex and uncertain dynamics of the volatility of USD, which can help policymakers and businesses make better decisions to manage their risks and improve the stability of global financial system.

Keywords: Volatility Of USD, Economic Policy Uncertainty Index, Monetary Policy Uncertainty Index, Geopolitical Risk Index, Generalized Autoregressive Conditional Heteroskedasticity.

CHAPTER 1: INTRODUCTION

1.0 Introduction

This section describes the history and factors that determine the exchange rate in the United States (US). The importance of the exchange rate in an economy, the type of exchange rate system in the US and the dominant of the United States Dollar (USD) are also explained. Also presented in this chapter are the objectives of the study, the problems to be addressed, and the hypotheses to be examined.

1.1 Research Background

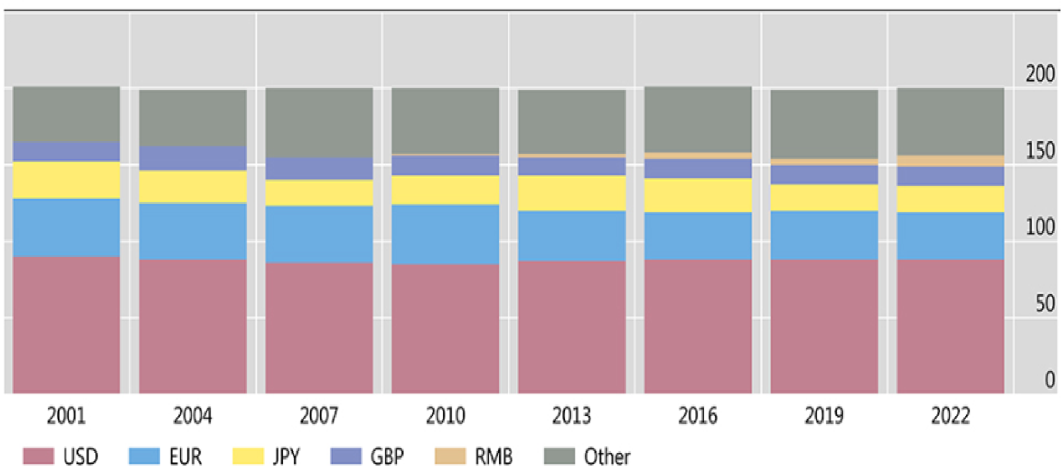
An exchange rate is the value of a country's currency with respect to the currencies of other nations or economic zones. Therefore, an increase in the exchange rate indicates that the price of foreign currency is higher, and the domestic currency is relatively cheaper or depreciated. In contrast, if the unit of domestic currency needed to purchase one unit of foreign currency falls, there is an appreciation in the domestic currency's value. If a country's currency appreciates, all its imports become less expensive. If a country buys significantly more than it exports, an appreciating currency may be desirable and profitable. As opposed to that, if a country's economy is strongly reliant on exports, an appreciating currency may not even be good. As a result, as a currency's value rises, countries that use it will lower their exports considering these goods are more expensive in nations with different currencies. Exchange rate volatility is defined as the risk related to unexpected fluctuations in the exchange rate (Ilhan, 2008). Exchange rate volatility largely affects capital flow (Chen et al., 2019), employment growth (Erkan, 2020), stock exchange (Eyyüp & Halil, 2020), inflation (Robert, 2014), investment (Osinubi & Amaghionyeodiwe, 2009), and real exchange rate (Robert, 2014). Numerous studies back up the idea that slower international trade flows and economic development are caused by higher exchange rate volatility (Erkan, 2020).

Due to its potential utility as a tool for analysing a nation's economic climate, the exchange rate becomes crucial. Currency fluctuations affect businesses by altering the price of goods imported from other countries as well as the demand for their goods among international consumers (James, 2021). For example, the devaluations of currencies were responsible for triggering the Asian Financial Crisis. It started in Thailand in July 1997 and affected other East countries and Southeast Asia. At the time, it was a very serious event that affected the economies of many countries. In some East and Southeast Asian nations, the financial crisis significantly affected the value of currencies, stock markets, and other resources. However, Asian crisis had a minimal and limited effect on the US industrial sector. In most industries, the trend output did not significantly change because of the drop in US exports. Overall, following the Asian crisis, the US had a "nearly free lunch" (James, 2000) as consumers gain from cheaper imports with relatively stable domestic manufacturing and jobs.

Almost all governments or central banks make decisions to influence exchange rates by intervening in currency markets. The foreign exchange market determines the value of a nation's currency based on the supply and demand of other currencies (Corporate Finance Institute, 2022). It is not governed by political authorities or trade regulations. The system has benefited the US by improving market efficiency (Cheung & Menzie, 2001). The US government and banks do not need to use an ongoing regulatory procedure since trading in floating-rate currencies is not limited in any way. However, USD that is floating is very volatile and subject to fluctuation. The value of a currency relative to another can only decrease within a single day of trading. Additionally, the macroeconomic foundations of an economy cannot adjust for short-term variations in floating exchange rates. Unfavourable changes in the currency exchange rate might have major consequences.

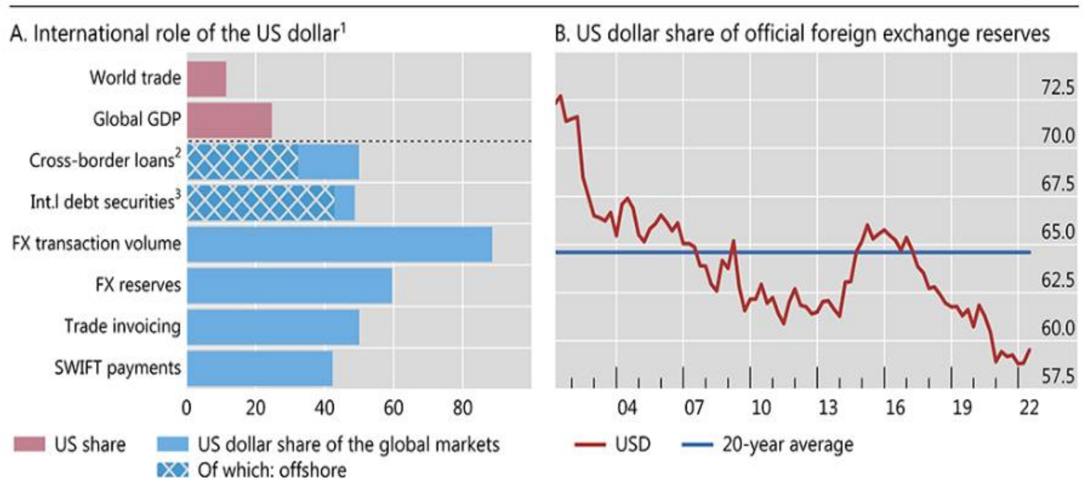
Since USD is the world's dominant reserve currency among other currencies, increased USD volatility makes international trade and investment decisions more challenging due to increased exchange rate risk. According to the IMF, USD accounted for approximately 62% of global foreign exchange reserves in 2021, though dropped slightly to less than 60% in 2022 (Maronoti, 2022). The USD is also widely used in international trade and investment. In 2022, the USD was involved in nearly 85% of all foreign exchange trades. At the same time, an appreciation of the USD would significantly increase the government debt of most other countries, which could lead to financial distress. People are heavily engaged in transactions in foreign markets, so in-depth research and analysis of currency exchange rates are required to reduce losses due to exchange rates.

Figure 1.1: Foreign Exchange Turnover by Currency in %



Source: BIS Triennial Central Bank Survey (2022)

Figure 1.2: The International role of the USD in %



Source: BIS Triennial Central Bank Survey (2022)

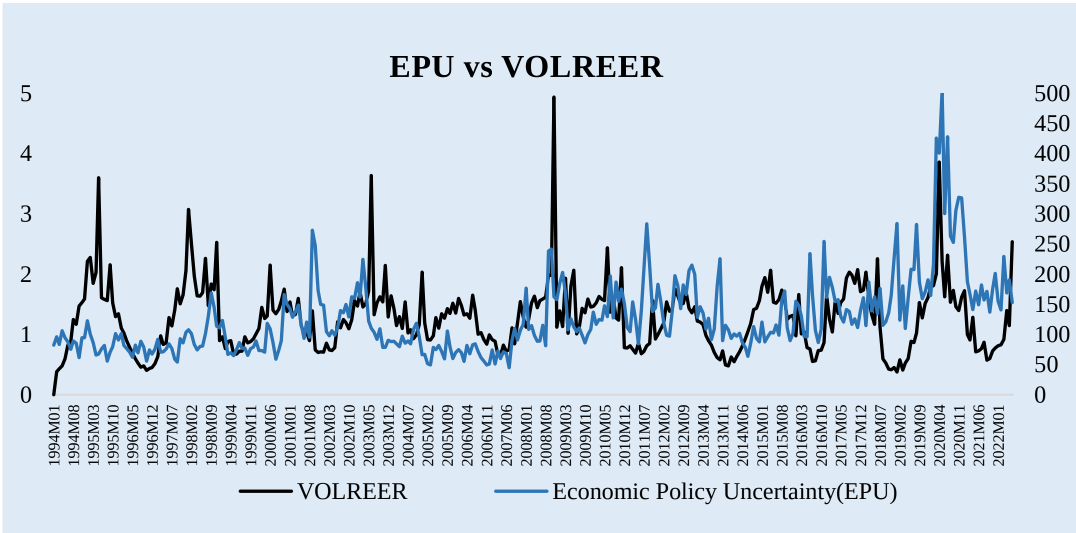
Currency exchanges are sensitive to uncertainties as their values are generally derived from the strength of the respective economies as well as relationships between countries. Firstly, economic policy uncertainty index (*EPU*) for each nation measures how frequently theses three phrases linked to the economy (E), policy (P), and uncertainty (U) appear in newspaper stories. In other words, the value of the national *EPU* index varies from month to month according to the proportion of national media stories that cover the topic of *EPU*. Secondly, according to economic theory, the monetary policy uncertainty index (*MPU*) may have an impact on the economy by encouraging businesses to put off investments and increasing the costs of financing results in reduced investment and production (Lucas et al., 2018). Primary dealers and other investors will modify their interest rate positions more whenever *MPU* is low. Thirdly, according to Dario and Matteo (2022), the geopolitical risk index (*GPR*) is the danger, realisation, and intensification of unfavourable events such as war, terrorism, and any conflict between nations and political actors that affects the peace process in international relations. A larger *GPR* indicates reduced employment and investment, as well as a higher likelihood of disasters and greater negative risk. The GPR index's unfavourable effects are a result of both the potential for and actual incidence of unfavourable geopolitical events.

During the sample period from January 1994 to June 2022 examined, the USD's trend and movement were closely associated with significant economic events that caused uncertainties in the global financial market. The USD's real broad effective exchange rate (*REER*) showed an increasing trend from February 1995 until February 2002, which was due to the capital inflows that arose from the Asian Financial Crisis (AFC). However, from 2002 to 2008, the *REER* started to drop, especially during the early stages of the Global Financial Crisis (GFC). During this period, other economies in Asia, such as China and other emerging markets, experienced significant growth and development. For instance, China's economy grew rapidly over the past two decades. After the GFC, the US REER showed an upward trend, reflects the comparative vigor of the US economy in relation to other nations. Overall, the USD's trend and movement during the sample period examined were influenced by several economic uncertainties, including the AFC and the GFC.

1.2 Problem Statement

In recent years, it is observed that there has been an increase in economic uncertainties. A case in point is the US-China trade war that began on July 2018, which has caused many nations to increase their tariff-targeted exports to other nations while reallocating their tariff-targeted exports away from the US and China (Amit, 2022). The trade war has been characterized by steep tariffs on China and the US and has caused the yuan and China's major trading partners' currencies to depreciate against the USD (Yingying & Donald, 2020). Also contributing to increased uncertainties is the Covid-19 pandemic which led to the closing of borders and consumption patterns. Some countries with perceptive international economic management keep their currencies stable against the USD, such as the Swiss franc, euro and Singapore dollar. Figure 1.3 shows a graphical representation of the correlation between *EPU* and USD volatility, highlighting that *EPU* appears to have a closer relationship with USD volatility. On January 2021, *VOLREER* reached its second highest peak of 1.7259, while the *EPU* index reached its highest peak of 261.3062, amidst the high uncertainty caused by the COVID-19 pandemic period.

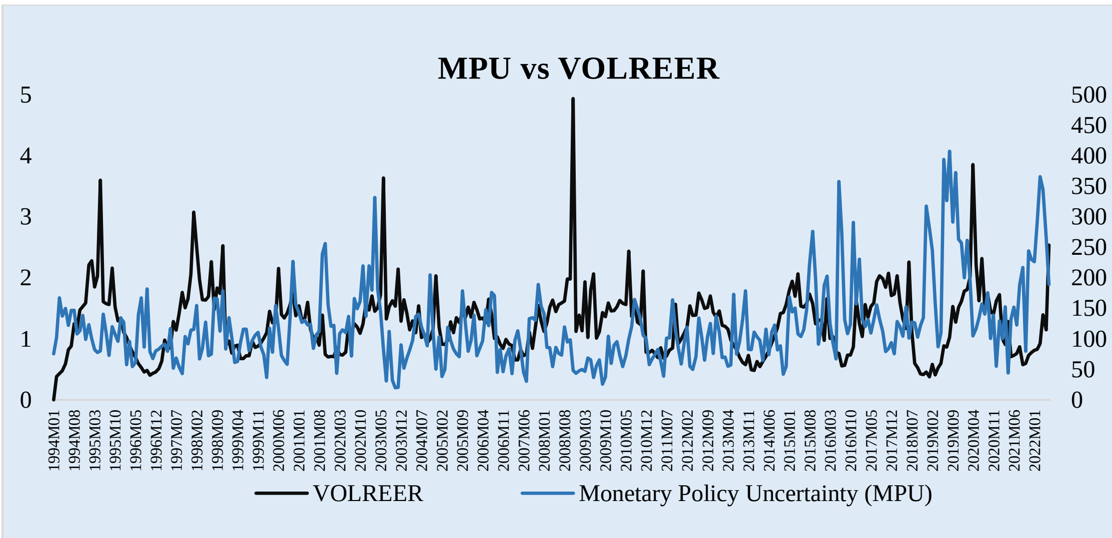
Figure 1.3: Economic Policy Uncertainty (EPU) and volatility of the USD



Source: Authors' Estimation

Figure 1.4 shows a graphical representation of the correlation between *MPU* and USD volatility, highlighting that *MPU* appears to have a closer relationship with USD volatility. In terms of monetary policy, uneven growth seen in various economies has led to a divergence of monetary policies of major economies. According to Philippe, Alireza, and Andrea's (2017) study, the currencies with higher US spreads have higher increases in excess returns because of *MPU*. Investors are more cautious about buying dollar-denominated assets when there is greater uncertainty about future monetary policy decisions. This could lead to less demand for these assets, which in turn leads to more volatility in the USD exchange rate. The Fed faces difficulties in managing monetary policy during times of increased *MPU* as it attempts to achieve an equilibrium between its objectives of promoting economic development and stabilising financial markets. While reduced interest rates can encourage buying and financing, they can also increase market volatility during uncertain periods. Nevertheless, the decision to reduce interest rates during high *MPU* events helped to sustain the economy during the outbreak of COVID-19 and the global financial crisis of 2008–2009. The Federal Reserve reduced interest rates almost to zero during the global financial crisis, which increased demand for assets based on dollars.

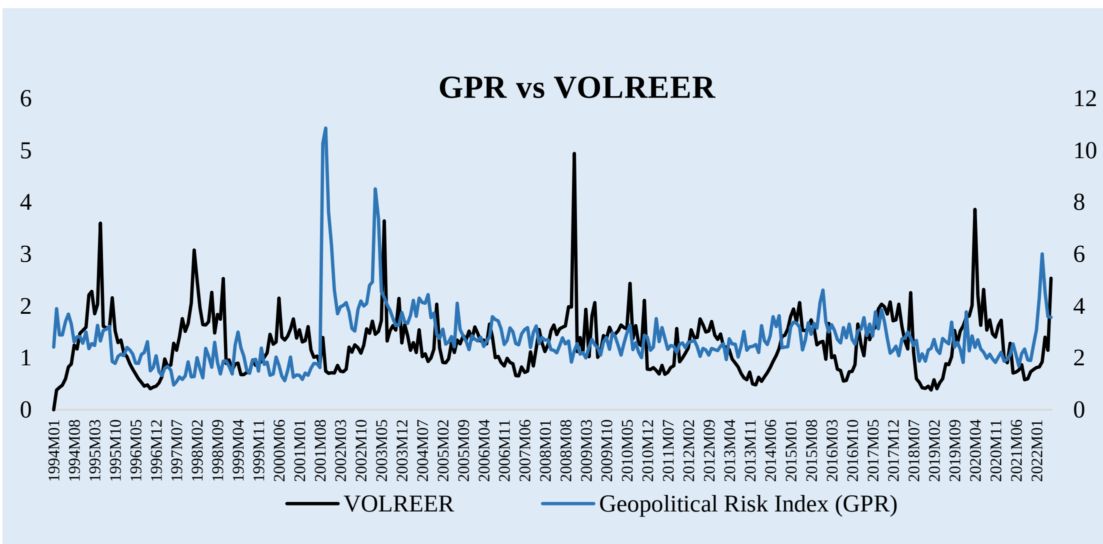
Figure 1.4: Monetary Policy Uncertainty (MPU) and volatility of the USD



Source: Authors' Estimation

Moreover, geopolitical events like instability in politics, wars, and natural disasters can affect the value of the US currency. The current COVID-19 pandemic, Brexit, and trade tensions between the United States and China have all had an impact on the USD. As investors became more risk-averse during the early phases of the US-China trade tension, the dollar declined. Due to this, the fluctuation of the US *REER* significantly increased, rising from 99.47 in April 2018 to 106.34 in September 2019. The 18-month period during which the dollars' worth versus the currencies of its main trading partners has changed by more than 6% is a sign of the effect of the trade war on the currency. Next, the volatility of the USD exchange rate has also been worsened by the uncertainty surrounding the Brexit negotiations. Investors worried about the possible effects of Brexit on the economy which caused some volatility in the US *REER*. However, the level of volatility during this period has not been as pronounced as it has been during other major geopolitical events, such as U.S.-China trade tensions. US *REER* values have fluctuated around 9.7% over 7 months, from a low of 109.49 in June 2016 at the time of the Brexit referendum to a high of 120.17 in January 2017. US *REER* did continue to experience some volatility in the ensuing Brexit negotiations, but the volatility was generally small. Figure 1.5 shows that *GPR* tracks the volatility of the USD less closely compared to other factors, indicating a weaker relationship. While there are some spikes in the *GPR*, they are not significant enough to establish a clear relationship with USD volatility. Despite the lack of clear tracking between *GPR* and USD volatility in the graph, some authors have found a significant relationship between the two factors (Javed et al., 2022; Khalid & Mohammad, 2021), warranting further study. Although the graph suggests a weaker correlation between *GPR* and USD volatility, it is still important to test for significance using statistical models to ensure accurate conclusions.

Figure 1.5: Geopolitical Risk Index (GPR) and volatility of the USD



Source: Authors' Estimation

Previous studies have separately investigated the impact of *EPU*, *MPU*, and *GPR* on exchange rates. However, there is a gap in the literature in terms of studies that simultaneously consider the effects of all three factors on exchange rates. Some studies have found that *EPU* can lead to a depreciation of the Russian currency during the floating period (Kazi et al., 2021), while *MPU* tends to increase the variance of exchange rates rather than affecting their level (Donghyun et al., 2020). On the other hand, a study on *GPR* and *EPU* showed that the global geopolitical risk index has symmetric long-run effects on all five currencies (Khalid & Mohammad, 2021).

The volatility in the USD observed during this period may not benefit businesses, consumers, and investors as it can affect trade and consumption patterns due to the uncertain and unpredictable nature of the exchange rate movements. The impact of uncertainties, such as geopolitical tensions or monetary policy changes, on the volatility of the USD is uncertain and complex, and therefore requires further analysis and research to better understand the dynamics and effects of these factors on exchange rate movements. The exchange rate market of the US is impacted by those uncertainties including *EPU*, *MPU* and *GPR* due to economic globalization. Therefore, how significant *EPU*, *MPU* and *GPR* measures affect USD volatility in the US from January 1994 until June 2022 is investigated in this study.

1.3 Research Questions

Motivated by the increased uncertainties and geopolitical events as well as the lack of studies examining the collective impact of *EPU*, *MPU* and *GPR* on the volatility of the USD, this study formulated the following research questions:

i. Is there a relationship between economic policy uncertainty index (*EPU*) and volatility of USD?
ii. Is there a relationship between monetary policy uncertainty index (*MPU*) and volatility of USD?
iii. Is there a relationship between geopolitical risk index (*GPR*) and volatility of USD?

1.4 Research Objectives

Given the research questions outlined in the previous section, the research objectives of this study are as follows:

i. To examine the relationship between economic policy uncertainty index (*EPU*) and volatility of USD.

ii. To examine the relationship between monetary policy uncertainty index (*MPU*) and volatility of USD.

iii. To examine the relationship between geopolitical risk index (*GPR*) and volatility of USD.

1.5 Hypotheses of the Study

The following hypotheses are formulated in the attempt to examine the relationship between *EPU* and volatility of the USD.

Ho_1: There is no significant relationship between *EPU* and volatility of USD.

HA_1: There is a significant relationship between *EPU* and volatility of USD.

The following hypotheses are formulated in the attempt to examine the relationship between *MPU* and volatility of the USD.

Ho_2: There is no significant relationship between *MPU* and volatility of USD.

HA_2: There is a significant relationship between *MPU* and volatility of USD.

The following hypotheses are formulated in the attempt to examine the relationship between *GPR* and volatility of the USD.

Ho_3: There is no significant relationship between *GPR* and volatility of USD.

HA_3: There is a significant relationship between *GPR* and volatility of USD.

1.6 Significance of the Study

While there have been individual studies on the impact of each uncertainty on exchange rates including *EPU* (Kazi et al., 2021; Kido, 2016; Li et al., 2020; Zhou et al., 2019), *MPU* (Gianluca et al., 2012; Philippe et al., 2017; Alexander & Raluca, 2017; Donghyun et al., 2020) and *GPR* (Eyyüp & Halil, 2020), but few studies have investigated the combined effect of all three uncertainties. As a result, this study aims to address the research gap by examining individual and combined effect of these three uncertainties on exchange rate volatility. *EPU*, *MPU*, and *GPR* are three different economic indicators that can provide valuable insights into the factors affecting the US *REER*. These three uncertainties are related and can influence each other. During China trade war in 2018, geopolitical risk occurs due to the tensions and disagreements between the two largest economies in the world. As the US and China imposed tariffs on each other's goods, this led to an increase in *GPR*, which created uncertainty and volatility in the market. The increase in *GPR* also led to a decline in economic performance globally, affecting businesses and investments. Due to the escalation of the GPR and the trade war, *EPU* also increased, creating uncertainty among investors, businesses, and consumers. This uncertainty can cause a delay in spending and investment decisions, leading to market volatility. In response to this, the US Federal Reserve (Fed) may take action to reduce uncertainty and market tension by implementing monetary policy. However, this action can also increase *MPU* among investors as they become uncertain about the direction of monetary policy, leading to further hesitation in spending and investment decisions. Examining EPU, MPU, and GPR collectively can yield a more thorough comprehension of the factors that impact the US REER.

Next, this research is significant because it analyses the relationship between uncertainty and volatility in the USD over an extended time by using the 342 monthly date from January 1994 to June 2022. While earlier studies have investigated this connection, few have examined such a big sample over such a long period. For instance, Alexander and Raluca (2017) analyzed daily data from January 26, 2012, to December 15, 2015, which covers approximately 3 years and 11 months. Li et al. (2020) used monthly data from January 2012 to December 2018, covering approximately 6 years. Meanwhile, Maria et al. (2022) analysed a sample period of about 10 years and 5 months from August 2010 to December 2020. This research aims to obtain a more comprehensive knowledge of the factors that cause USD volatility by examining this relationship over an extended period using a longer sample period.

The aim of this study is to investigate more accurately and comprehensively between exchange rate volatility and *EPU, MPU, GPR*. The results of this study enhance comprehension of the elements that affect exchange rate volatility and may have implications for policymakers and investors. Given the literature's inconsistent results, a study found that the *MPU* had a significant effect on the exchange rate volatility of some Asian economies while exchange rate volatility of HKD, INR, and JPY remained unaffected by the increase in *MPU* within the same model (Donghyun et al., 2020).

The study's findings and analyses may offer valuable contributions to the practice of business and finance, particularly in informing strategies related to managing risks associated with USD volatility and making informed decisions in uncertain market conditions. By monitoring these indicators, businesses can gain insights into the overall economic conditions that affect exchange rates, such as changes in monetary policy, political uncertainty, and global economic trends. With this knowledge, businesses can make more informed decisions about their investments, production processes, and pricing strategies, considering the potential risks and opportunities arising from exchange rate volatility. As an illustration, if a company conducts operations in various nations and generates income in diverse currencies, it may choose to hedge its currency risk by employing financial instruments, like forward contracts or currency options, to secure exchange rates and reduce uncertainty. Similarly, businesses may adjust their pricing strategies in response to changes in exchange rates to remain competitive and maintain profitability.

Next, consumers can benefit from a better understanding of how changes in global risk perceptions and policy uncertainty can affect the cost of goods and services. Consumers can use this information to plan their purchases and make better-informed decisions about when to buy these goods to take advantage of favorable exchange rates. If the exchange rate of USD expected to strengthen against a foreign currency, consumers may choose to delay their purchases of foreign goods until the exchange rate becomes more favorable, allowing them to save money on their purchases.

Moreover, investors can anticipate potential changes in exchange rates and adjust their investment portfolios accordingly. If there is high policy uncertainty and global risk perceptions, investors may choose to invest in safe-haven assets, such as US Treasuries, which can increase demand for the US dollar and strengthen its value. If the global risk perceptions are low, investors may choose to invest in higher-yielding assets in other countries, which can reduce demand for the US dollar and weaken its value. This can help investors can make informed decisions about where to allocate their resources, which can help them manage risks and potentially generate higher returns.

For policymakers and governments need to understand the relationships between *EPU*, *MPU*, *GPR*, and exchange rate volatility in developing effective economic policy. If policymakers observe a high level of geopolitical risk, they may implement measures to reduce political tensions and prevent economic shocks that would affect the exchange rate adversely. Additionally, policymakers can use this knowledge to design policies that promote economic growth and stability while minimizing the risks of exchange rate volatility.

1.7 Chapter Layout

Chapter 2 of research paper focuses on the literature review, providing a comprehensive outline of the existing research on foreign exchange and economic policy uncertainty, foreign exchange volatility and uncertainty, uncertainty as independent variables, and foreign exchange as a dependent variable. This chapter will examine and synthesize the findings of previous studies in these areas, identifying the gaps in the literature that the current study aims to address.

Chapter 3 details data and methodology used in the research. The chapter will describe the sources of the data, which include real effective exchange rate (*REER*) and several independent variables, including Economic Policy Uncertainty Index (*EPU*), Monetary Policy Uncertainty Index (*MPU*), and Geopolitical Risk Index (*GPR*). The chapter also outline control variables such as terms of trade (*TOT*), federal funds effective rate (*FED*), inflation rate (*INF*), and US Treasury bill rate (*TBILL*). Additionally, the chapter will explain how the exchange rate volatility will be computed and will discuss the stationarity of variables. Finally, the chapter will detail the model specifications that will be used in the study.

Chapter 4 presents the study's findings and offers a comprehensive analysis and discussion of these outcomes. The chapter will begin by presenting graphical plots of the *REER* and *VOLREER*. Then, it will provide descriptive statistics and correlations of variables. Finally, the chapter will present the output estimation of the model specifications outlined in chapter 3.

Chapter 5 concludes the research paper by summarizing the main findings of the study and discussing their implications. The chapter will also provide limitations based on the study's results.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

Chapter 2 presents the previous studies with some examination of those earlier studies that explain empirical investigations in the past as demonstrated. Section 2.1 discusses the literature on foreign exchange and uncertainty. The next section 2.2 explains an overview of the literature on foreign exchange volatility and uncertainty. The literature on uncertainty as independent variables will be analysed in section 2.3. Lastly, an outline of the literature on foreign exchange as a dependent variable is presented in section 2.4.

2.1 Foreign Exchange and Uncertainty

2.1.1 Foreign Exchange and Economic Policy Uncertainty (*EPU*)

Kazi et al. (2021) use quantile-based time-series approaches to analyse the exchange rate reaction to domestic EPU, considering oil prices and trade volume in dissimilar economic conditions. They analyse Russian *EPU* and exchange rates from 1 January 1998 until 30 September 2020. Their finding shows the local currency increases at various quantiles of the managed float due to the country's increasing *EPU*, but it depreciates at most quantiles during the float period because Russia is an oil exporter. Meanwhile, in Kido's (2016) research, a dynamic conditional correlation GARCH (DCC-GARCH) model is utilized to examine the spillover effects of US *EPU* on real effective exchange rates (*REER*) across various countries. The study examines the exchange rates of Australia, Brazil, South Korea, Mexico, United States, Euro, and Japan from January 2000 to December 2014. The findings reveal that there is a consistent negative correlation between US *EPU* and returns on high-yielding currencies, and a positive correlation is consistently observed between US *EPU* and JPY returns. Additionally, the study demonstrates that the correlation between the US *EPU* and certain *REER* strengthens during US recessions.

Using a nonlinear ARDL model, Li et al. (2020) investigates the asymmetric impacts of EPU and other potential factors on the CNY-CNH spreads for China and G7 nations. The research examines the difference between the CNY and CNH exchange rates (CNY–CNH spread) as dependent variable, *EPU* as independent variable, and the CNY and CNH exchange rates as control variables. The study's time frame is from January 2012 to December 2018. The study's results show that the relevant factors have significant asymmetric impacts on spreads. Additionally, favourable shocks to the composite *EPU* cause the CNY-CNH spreads to expand, having a substantial impact on the spreads.

The three articles emphasis on investigating the impact of *EPU* on exchange rates, but each takes a different approach to the analysis. Kazi et al. (2021) use quantile-based time-series approaches to analyse the exchange rate reaction to domestic *EPU*, considering oil prices and trade volume in dissimilar economic conditions. Kido (2016) employs a dynamic conditional correlation GARCH (DCC-GARCH) model to explore the spillover effects of US *EPU* on real effective exchange rates (REER) across multiple countries. Li et al. (2020) use a nonlinear ARDL model to investigate the asymmetric impacts of *EPU* and other potential factors on the CNY-CNH spreads for China and G7 nations.

2.1.2 Foreign Exchange and Monetary Policy Uncertainty (*MPU*)

Gianluca et al. (2012) use G7 countries consisting of Canada, Germany, France, Italy, United Kingdom Japan and US to examine how nominal and real stochastic volatilities affect exchange rate behaviour. They analyse the relationship between the inflation target shock, monetary- policy shock, productivity shock and real exchange rate (USD). Control variables included US nominal Federal Funds Rate, CPI Index, and treasury bill rate. According to their VAR analysis, the result shows more nominal shock volatility would cause the dollar to appreciate, especially over the medium term. Increased actual shock volatility also would have the opposite impact.

Next, Philippe et al. (2017) use spot exchange rate data from the year 1994 to 2013 for G10 currencies Euro, Canada, Norway, Australia, New Zealand, Japan, Switzerland, United Kingdom and Sweden and to examine if Federal Reserve releases have a unique impact on exchange rates or if similar trends are found in other central bank announcements. FOMC announcements and monetary policy indicators are used as independent variables. The results indicate that currencies with higher interest rate differentials from the USD tend to have higher excess returns, which increase with *MPU* and rise even further when the Federal Reserve implements a monetary easing policy.

Using data for the US economy from 26 January 2012 to 15 December 2015, Alexander and Raluca (2017) estimate intraday futures data to examine whether the impact of *MPU* on the reactions of various markets, such as equities, foreign exchange treasury securities, crude oil, and medium-term interest rates, to US macroeconomic news is explored in this study. The primary finding reveals that macroeconomic announcements have a significant influence on the financial and crude oil markets via anticipations of future monetary policy during periods of high *MPU*. Conversely, the response to macroeconomic news decreases in the stock and crude oil markets but increases in the interest rate, treasury, and foreign exchange markets when policy uncertainty is heightened.

Donghyun et al. (2020) estimate an EGARCH model using February 2006 and January 2019 monthly data to investigate the influence of US *MPU* on USD of 10 Asian economies which include Indonesia, Malaysia, Japan, China, India, Republic of Korea, Philippines, China, Taipei, Thailand and Singapore. The main results show that instead of impacting the level of exchange rates, *MPU* also enhances exchange rate changes. The outcomes might have a big impact on how the 10 economies conduct their monetary policy.

These studies investigate the impact of *MPU* on currency rates, but they differ in their approaches and findings. Gianluca et al. (2012) show that more nominal shock volatility leads to dollar appreciation in the medium term, while real shock volatility has the opposite effect. Philippe et al. (2017) find that currencies with larger interest rate differentials to the US dollar observe higher excess returns when the Fed engages in monetary easing during periods of high *MPU*. Alexander and Raluca (2017) show that macroeconomic announcements have a significant impact on financial and crude oil markets during periods of high *MPU*. Donghyun et al. (2020) find that the *MPU* enhances exchange rate changes for 10 Asian economies.

2.1.3 Foreign Exchange, Economic Policy Uncertainty (*EPU*), Monetary Policy Uncertainty (*MPU*) and Fiscal Policy Uncertainty (*FPU*)

Some authors apply vector autoregression model (VAR) to examine the dynamic relationships that exist between variables that interact with one another. Firstly, Beckmann and Czudaj (2016) give a fresh perspective on how political decisions affect exchange rates. They obtain exchange rate expectations from Financial Times Currency

Forecaster from August 1986 until December 2014 in the US. The majority is computed as a geometric mean based on 48 individual replies to minimise distortion brought on by extreme outliers. Independent variables used include *MPU*, *EPU* and *FPU*. They also include control variables such as interest rate, money supply and money market rate to study the effect on the exchange rate. The main data on *EPU* is based on 10 largest US newspapers: Miami Herald, USA Today and more. According to their findings, expectations regarding future economic policy are not only influenced by official announcements, but also by the level of ambiguity surrounding such policies. The study suggests that forecast inaccuracies are significantly influenced by policy uncertainty, as compared to expectations, which suggests market expectations may not adequately account for the effects of uncertainty.

Moreover, Elif et al. (2017) find that the total *EPU* index commonly changes favourably with predicted volatilities for Japanese stocks, currency rates and interest rates and with a survey-based indicator of political uncertainty. Their uncertainty indices for fiscal, monetary, trade and exchange rate policy co-vary favourably yet also reveal unique patterns. Different from Beckmann and Czudaj (2016), Elif et al. (2017) develop new *EPU* indices from January 1987 onwards for quarterly data and January 1994 to December 2016 for monthly data. Other than *EPU*, *MPU* and *FPU*, they also investigate how exchange rate policy and trade policy impact Japanese equities, interest rates and exchange rates.

Jiang et al. (2019) utilize a TVP-VAR methodology and real exchange rate as the dependent variable to examine the potential underlying determinants of spillovers within and between China and the US. They consider trade policy uncertainty (*TPU*), *MPU*, and *FPU* as independent variables and analyze data from January 2000 to February 2019. The results of the study suggest a significant correlation between the policy uncertainties of the world's two largest economies, with relatively high levels of total and directional spillovers across the variables. The dominant role in the system is played by China's fiscal policy uncertainty, which transmits 38.613% of its shock to other variables. Moreover, *TPU* is mostly driven by domestic *MPU* and *FPU* in China, while US *TPU* is primarily affected by domestic *MPU* and *FPU*.

2.1.4 Foreign Exchange, Economic Policy Uncertainty (*EPU*) and Geopolitical Risk Index (*GPR*)

Javed et al. (2022) employ not only quantile regression but also the quantile connectedness approach and OLS regression to analyze the hedging and safe-haven properties of gold, oil, stocks, and foreign currency rates in relation to US *EPU* and *GPR*. The study uses pre-Covid data from 1 October 2013 until 10 March 2020 and post-Covid data from 11 March 2020 until 27 August 2021. The financial assets studied include S&P 500, Japanese Yen, Great Britain Pound, Euro, and Yuan exchange rates, as well as gold and WTI oil price. Based on the quantile regression analysis for the pre-Covid period, the study finds that the asset returns do not serve as a hedge against unfavorable market conditions. Additionally, the OLS data suggests that only the stock market exhibits a positive risk premium for both uncertainty metrics.

Other than that, Philippe et al. (2017) and Khalid and Mohammad (2021) both focus on US dollar-based exchange rates across multiple countries. Philippe et al. (2017) examine spot exchange rate data for G10 currencies, including Euro, Canada, Norway, Australia, New Zealand, Japan, Switzerland, United Kingdom, and Sweden, from 1994 to 2013. In contrast, Khalid and Mohammad (2021) estimate monthly USD exchange rates for Republic of Korea, China, Japan, UK, and Canada, starting from different years ranging from 1986 to 1997 and ending in May 2020. Despite differences in the specific currencies studied and periods analyzed, both studies contribute to our understanding of US dollar-based exchange rates and their determinants across multiple countries. Khalid and Mohammad (2021) examined the asymmetric impacts of changes in oil prices and two metrics of uncertainty which included world geopolitical uncertainty and *EPU* on currency rate volatility. The authors use West Texas Intermediate oil price (*WTI*), *EPU*, and the global *GPR* index. However, their results explain *EPU* has a long-run asymmetric effect on Japan's yen and UK's pound, and it has a symmetric effect on China's renminbi, Canadian dollar and pound. The log-run effect of the *WTI* oil price is asymmetric for the Canadian dollar and the Chinese renminbi but symmetric for the Japanese yen, Korea's won, and the British pound. The long-term impacts of the global *GPR* index tend to be similar for all five currencies.

2.2 Foreign Exchange Volatility and Uncertainty

2.2.1 Foreign Exchange Volatility and Economic Policy Uncertainty (*EPU*)

Zhou et al. (2019) investigate how *EPU* affects China's exchange rate volatility. By using data from January 2003 to September 2018, Sino-US *EPU* ratio as the explanatory variable. This is because the two nations influence exchange rate volatility, and as the Sino-US *EPU* ratio captures the degree of political unpredictability of the two nations, it is taken into account when analysing the impact of *EPU* on the exchange rate. The study utilized the GARCH-MIDAS model and found that the Sino-US EPU ratio had a significant positive effect on the exchange rate's long-term volatility. Moreover, the GARCH-MIDAS model outperformed the standard GARCH-type models in terms of accuracy and predictability.

Other than that, Bush and Noria (2021) investigate the effects of various types of uncertainty on exchange rate volatility and find that Knightian uncertainty has a distinct impact. The study uses monthly log returns of the MXN/USD exchange rate and measures of domestic economic and political uncertainty, international financial and political instability, from 1999 to 2018. The authors also incorporate a survey of professional forecasters from Banco de México. The study's results indicate that a rise in Knightian uncertainty contributes to a rise in exchange rate volatility, and during economic downturns, it magnifies the impact of domestic economic uncertainty on exchange rate fluctuations.

Next, Robert (2014) examines the effect of general EPU and *EPU* on exchange rate volatility in ten industrial and developing nations from 1990 to February 2012 which is more sample countries taken compared to Bush and Noria’s (2021) research. The ten economies consist of Canada, Brazil, India, Japan, the Euro area, South Africa, South Korea, Sweden, Mexico and United Kingdom. There is significant proof that both the home country and US *EPU* exacerbate currency volatility during complicated economic times for more linked industrial economies. The key findings show that only home-country *EPU* enhances exchange rate volatility during weak economic times for less connected developing nations. The overall *EPU* also raises currency rate volatility, however, its influence is often lower than that of *EPU*.

2.2.2 Foreign Exchange Volatility, Economic Policy Uncertainty (*EPU*), Monetary Policy Uncertainty (*MPU*)

Both Zhou et al. (2019) and Chen et al. (2019) use the USD/RMB exchange rate in their studies. Zhou et al. (2019) utilize the GARCH-MIDAS model to examine the relationship between EPU and China's exchange rate volatility, covering the period from January 2003 to September 2018. Chen et al. (2019) utilized quantile regression to examine the influence of general economic and economic policy uncertainty on exchange rate volatility across ten industrial and emerging economies since 1990, analyzing data from December 2001 to November 2018. The independent variable includes *EPU* and monetary policy mean while capital flow, foreign exchange reserves (*RES*), terms of trade (*TOT*), repurchase rate (*INR*) of the People's Bank of China, and producer price index (*PPI*) are the control variables. Based on the quantile regression, the effect of *EPU* on exchange rate volatility in China shows heterogeneity and asymmetries in various markets. The *EPU* for China has a positive and large influence on all quantiles of exchange rate volatility.

Thiem (2020) analyzes the transmission of financial market volatility between the US and Japan across different categories and countries, using data from 1987 to 2017. Exchange rate fluctuation is the dependent variable, and *EPU*, *MPU*, *FPU*, and *TPU* are the independent variable. To represent the connection between the variables, he used vector autoregression with a generalised variance decomposition. The results demonstrate that various *EPU* categories were significant and direction of net *EPU* spillovers between the US and Japan varied based on the category and time.

2.2.3 Foreign Exchange Volatility and Geopolitical Risk Index (*GPR*)

There are two papers which examine how *GPR* affects the *REER*. Afees et al. (2021) focus on the BRICS nations, they use the ARCH-MIDAS-X model to examine how *GPR* and exchange rate fluctuations are related from January 1985 until August 2020. They discover that more recent *GPR* data than older data have a greater impact on exchange rate fluctuation. On the other hand, Eyyüp and Halil (2020) conducted a nonparametric causality-in-quantiles test approach to investigate the impact of *GPR* on market and exchange rate returns and volatility in 18 emerging nations, including Malaysia, South Africa, Philippines, Ukraine, Argentina, Korea. They discover that *GPR* has a substantial impact on the stock market and exchange rate volatility, but only considerably on stock and exchange rate returns in some of the nations examined, using a nonparametric quantile causation test method.

2.3 Uncertainty as Independent Variables

2.3.1 Uncertainty and Stock Market Returns

These three articles focus on the impact of various factors on stock returns in different contexts. Mengxi and Yaojie (2022) use Climate Policy Uncertainty (*CPU*) to forecast future stock returns within the crude oil sector and compare its predictive power with other uncertainty indicators. Adam et al. (2021) use a news-based gauge of *GPR* to examine its role in asset pricing in 19 global emerging markets including China, Colombia, Hong Kong, India, Indonesia, and more countries. Tomiwa et al. (2022) assess the influence of *GPR*, exchange rate, and *EPU* on the South Korean stock market using causality-in-quantile analysis. In terms of the variables studied, Mengxi and Yaojie (2022) consider *CPU*, *EPU*, *VIX*, equity market volatility (*EMV)*, *MPU*, and *GPR*, while Adam et al. (2021) focus solely on GPR. Tomiwa et al. (2022) analyze the impact of *GPR* and *EPU* on exchange rate and stock market returns in South Korea. The methodology used also varies across the studies. Mengxi and Yaojie (2022) employ predictive regression, Adam et al. (2021) use a news-based gauge of *GPR*, and Tomiwa et al. (2022) use causality-in-quantile analysis. The findings of these studies also differ. Mengxi and Yaojie (2022) find that future stock returns in the oil industry can be predicted strongly by CPU, and its predictive power is greater than that of other uncertainty indicators. Adam et al. (2021) find that changes in *GPR* positively predict future stock returns in emerging markets. Tomiwa et al. (2022) report that the impact of macroeconomic shocks on the South Korean stock market is diverse.

2.3.2 Uncertainty and Stock Market Volatility

Maria et al. (2022) and Balcilar et al. (2019) both investigate the predictability of stock market volatility using *EPU* measures. While Maria et al. (2022) focus on the Pakistani stock market and use a mixed data sampling (MIDAS) model from August 2010 to December 2020, Balcilar et al. (2019) examine stock prices and exchange rate volatility in Hong Kong, Malaysia, and South Korea through a nonparametric causality-in-quantiles test from January 1997 to March 2012. Both studies incorporate control variables such as inflation, interest rates, and foreign direct investment to better understand the relationship between *EPU* and stock market volatility.

In terms of control variables and independent variables, there are some differences between the studies conducted by Maria et al. (2022) and Balcilar et al. (2019). Maria et al. (2022) include control variables such as exchange rate, money supply, industrial production, foreign direct investment, oil prices, and gold price in their model. These variables are likely to affect the stock market volatility in Pakistan and need to be controlled to more accurately assess the impact of *EPU* on the Pakistani stock market. In contrast, Balcilar et al. (2019) do not include as many control variables in their model. They focus primarily on the *EPU* measures from different countries, including China, European Area, Japan, and US, and how these measures affect stock prices and exchange rate volatility in Hong Kong, Malaysia, and South Korea. This approach allows them to assess the international impact of *EPU* on the selected markets.

Maria et al. (2022) find that the *EPU* index can forecast Pakistani stock market volatility and that oil prices are the best predictor of volatility. On the other hand, Balcilar et al. (2019) report that *EPU* measures from different countries can affect Malaysian stock return volatility and Korean conditional distribution returns and volatility, but there is no evidence of predictability for Hong Kong market returns and volatility.

2.3.3 Uncertainty and Tourism

Uju et al. (2018) and Jiang et al. (2022) both investigate the impact of different sources of uncertainty on the tourism industry, but they differ in their approach, independent variables, and control variables. The study by Uju et al. (2018) focuses on the impacts of tourist revenue spillovers and associated causes of uncertainty in Turkish commerce and political variables. The dependent variable is international tourist revenue, and they use a "better give than take" method to quantify the forecast direction of volatility spillovers. The political risk indicator (*GPR*), commerce with high-income nations, and real exchange prices for metal exports are examples of independent factors. According to their research, the country's tourism sector has been significantly impacted, with a net spillover rate of 4.1% in tourist revenue.

In comparison, Jiang et al. (2022) investigate how global and *EPU* affect the returns on Chinese tourist stock. With China tourist stock returns serving as the dependent variable and *GPR* and *EPU* are independent variables, they employ the quantile-by-quantile method and the quantile causality approach. In addition, they take into account China's *TPU*, *MPU*, *FPU* and *ERPU* as control factors. Their findings demonstrate that while disaggregated *EPU* has both negative and positive impacts on stock returns at various distribution levels, *GPR* has a persistently negative effect on travel stock returns, particularly at the low quantiles.

2.4 Foreign Exchange as dependent variable

2.4.1 Foreign Exchange and Quantitative Easing (QE)

These studies investigate the impact of quantitative easing (QE) on exchange rates, but they differ in terms of the central banks studied and the periods analysed. Serag et al.

(2019) focus on the influence of US unconventional monetary policies on exchange rate movements and volatility in leading emerging and developing economies (EAGLEs) by analyzing data from Brazil, India, Indonesia, Mexico, the Philippines, and Turkey. The *EER* covers from January 1990 to April 2018 and *AER* spans from January 1980 to April 2018. Using ARIMA and ARCH models, they find that only India was affected by the US monetary policy. In contrast, Dimitris et al. (2015) investigated the impact of quantitative easing (QE) announcements on three major exchange rates, namely EUR/USD, GBP/USD, and JPY/USD from 3 February 2009, until 31 December 2012. They used the APARCH model and observed a direct negative impact on GBP and JPY exchange rates, with no effect on their volatility. Meanwhile, Luca et al. (2020) conducted an analysis on the impact of QE measures on the US dollar-euro exchange rate by the ECB and the Federal Reserve. They used two-stage least squares regressions to study the effects of QE measures and found that these measures had significant and long-lasting impacts on the exchange rate, resulting in a depreciation of approximately 7% after a typical expansionary QE announcement.

2.5 Theories

Rational Expectations Model is an economic theory that suggests that individuals form their expectations about future economic variables based on all available information, including their expectations about future government policies (Muth, 1961). This model is a widely used economic model that was first introduced by John F. Muth in 1961. If government policies are uncertain, this can affect individuals' expectations about future economic variables and can lead to greater uncertainty about the future. When investors expect higher interest rates in the US, they may demand more USD to invest in US assets such as bonds, stocks, and other financial instruments. This increased demand for dollars can boost its exchange rate relative to other currencies, making it more expensive to buy USD. The equation presented below establishes the rationality of price expectations, implying that the general price level is expected based on all the information available in the previous time period, It-1. $E[P_t \mid I_{t-1}]$, represents the expected value of the variable at time t based on all available information up to time t-1 (represented by I_{t-1}).

$$E[P_t] = E[P_t \mid I_{t-1}] \quad (1)$$

Since rational expectations models form the basis of investors' decisions to buy or sell assets, this behavior is captured by Asset Market Models that affect USD price movements.

The Asset Market Model is a theoretical framework used to explain the behavior of asset prices based on the supply and demand of financial assets (Sosvilla-Rivero, 1991). In this case, the price movement of the USD captured by supply and demand for financial assets denominated in different currencies. This model is a widely used economic theory that has been developed and refined by several economists over time. Some of the most influential contributors to the theory include Robert Mundell and Simón Sosvilla-Rivero. According to this model, exchange rates are primarily determined by the supply and demand for financial assets, rather than traditional factors such as trade flows or relative price levels. The demand for an asset is based on the expected return that the asset will generate in the future, and the risk associated with the asset. If investors expect higher interest rates in the US compared to other countries, they may demand more USS to invest in US assets, which increases the demand for USD and tends to appreciate the value of the USD. Changes in expectations about the US economy, inflation rates, and political stability can also affect the supply and demand of dollars and hence their exchange rate.

CHAPTER 3: DATA AND METHODOLOGY

3.0 Introduction

This chapter outlines the findings and discussions derived from the analysis of monthly time-series data for the US, spanning from January 1994 to June 2022. The included variables and sources are described in Section 3.1, along with the rationale behind the selection for the study. In addition, Section 3.2 outlines the process for computing exchange rate volatility and establishes the stationarity of the variables. The GARCH model is utilized for calculating exchange rate volatility. Stationarity tests are conducted to evaluate the variables, and the results are presented in Section 3.3. Finally, Section 3.4 presents the GARCH model specifications.

3.1 Data and Sources

The research sample period is from January 1994 to June 2022, including 342 months of data. The data are in the form of US monthly time series data. This study examines the relationship between the dependent variable, the volatility of the real effective exchange rate (*REER*) of USD, and several key independent variables, including the Economic Policy Uncertainty Index (*EPU*), Monetary Policy Uncertainty Index (*MPU*), and Geopolitical Risk Index (*GPR*). In addition, several control variables are included in the analysis, such as terms of trade (*TOT*), federal funds effective rate (*FED*), inflation rate (*INF*), and US Treasury bill rate (*TBILL*).

This sample period is chosen due to the occurrence of a series of major economic and geopolitical events that may have affected the volatility and uncertainty of the US dollar. First, the Asian financial crisis of 1997-1998 led to currency devaluation and economic downturn in many Asian countries. Additionally, the dot-com bubble of the late 1990s and early 2000s, characterized by rapid growth and decline in numerous technology-related businesses, impacted global stock markets. The 9/11 terrorist attacks in 2001 severely affected global security and heightened geopolitical tensions. The 2008 financial crisis stemmed from subprime mortgage market crash, which eventually led to a global recession. Finally, the COVID-19 pandemic in 2020 had a considerable impact on the global economy, financial markets, and geopolitical relations. By choosing this specific time frame, this study analyzes how these events affect USD volatility and USD uncertainty.

3.1.1 Real Broad Effective Exchange Rate (*REER*)

The real effective exchange rate (*REER*) is the nominal effective exchange rate divided by a price deflator or index of costs. The nominal effective exchange rate is a measure of the value of a currency against a weighted average of several foreign currencies (The World Bank Group, 2023). When determining a currency's overall coherence, economists and policymakers typically use the *REER*. *REER* is weighted by each partner's portion of the deal. As it is an average value, a country's currency may be in "equilibrium" if it is overvalued relative to the currencies of one or more trading partners, as long as it is undervalued relative to other nations (Luis, 2007). The narrow BIS effective exchange rate only includes 27 countries Australia, Austria, Belgium, Canada, Chinese, Taipei, Denmark, Euro area, Finland, France, Germany, Greece, Hong Kong (SAR), Italy, Ireland, Japan, Korea, Netherlands, Mexico, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom and United States. The term “broad’ means the *REER* is covering more partner nations which is a total of 64 counties including Bosnia and Herzegovina, Morocco, North Macedonia and Serbia. The indices' base year is updated to 2020 (Bank for International Settlements, 2023). *REER* is expressed as an index number.

The monthly data on *REER* which is the USD exchange rate from January 1994 to June 2022 is collected from Bank for International Settlements (BIS). *REER* is used to compute the volatility of the US exchange rate as the dependent variable in this study to investigate the impact of Economic Policy Uncertainty (*EPU*), Monetary Policy Uncertainty Index (*MPU*) and Geopolitical Risk Index (*GPR*) on USD exchange rate volatility, similar to Alexander and Raluca (2017) and Robert (2014). Meanwhile, others have explored similar research questions using implied real USD exchange rate (Gianluca et al., 2012), Russian exchange rate (Kazi et al., 2021), US exchange rate expectations (Beckmann & Czudaj, 2016) and Japanese exchange rate against USD (Elif et al., 2017).

3.1.2 Economic Policy Uncertainty Index (*EPU*)

The EPU index measures the level of economic policy uncertainty in a country by tracking the frequency of newspaper articles containing the terms "economy" (E), "policy" (P), and "uncertainty" (U) (Baker, Bloom & Davis, 2016). According to Baker et al. (2016), their first component is an index of search results from 10 large newspapers which include USA Today, Miami Herald, Chicago Tribune, Washington Post, Los Angeles Times, Boston Globe, San Francisco Chronicle, Dallas Morning News, Houston Chronicle, and Wall Street Journal (WSJ). The index reflects the frequency of articles in 10 leading US newspapers that contain "economic" or "economy"; "uncertain" or "uncertainty"; and "congress", "deficit", "Federal Reserve", "legislation", "regulation" or "White House". They also involved analyzing a wide range of newspapers in the United States, with NewsBank providing access to over 1,000 newspapers of various sizes, from national publications like USA Today to local papers across the country. The EPU index is primarily measured by counting the number of newspaper articles that contain at least one phrase from each of the three categories: economy (E), policy (P), and uncertainty (U). These sets include terms related to the economy or economic matters, terms related to uncertainty or being uncertain, and terms related to legislation, deficits, regulations, Congress, the Federal Reserve, or the White House.

Based on the studies of Beckmann and Czudaj (2016), Chen et al. (2019), Elif et al. (2017), Javed et al. (2022), Kazi et al. (2021), Khalid and Mohammad (2021), Robert (2014), Maria et al. (2022), Tomiwa et al. (2022) and Zhou et al. (2019), the *EPU* index is a key part of the empirical approach to measure exchange rate volatility. Chen et al. (2019), Elif et al. (2017), Kazi et al. (2021), Robert (2014) and Maria et al. (2022) show *EPU* increases the volatilities of exchange rates and local currency appreciation which is a positive relationship. Khalid and Mohammad (2021) also indicate that the *EPU* index has a long-run asymmetric effect on the Japanese yen and the great British pound while the Sino-US *EPU* ratio has a positive impact on the long-term volatility of the Chinese exchange rate according to Zhou et al. (2019). Therefore, the data of the US monthly *EPU* index calculated by Baker et al. (2016) that collected from the Economic Policy Uncertainty webpage and is one of the three key independent variables in this study.

3.1.3 Monetary Policy Uncertainty Index (*MPU*)

The Husted-Rogers-Sun *MPU* Index for the United States is calculated by Husted, Rogers and Sun (2017) in a similar approach to the *EPU* by Baker et al. (2016). They search the New York Times, Wall Street Journal, and Washington Post for keywords related to monetary policy uncertainty. They qualify articles containing the triple of (i) "uncertainty" or "uncertain," (ii) "monetary policy(ies)" or "interest rate(s)" or "Federal fund(s) rate" or "Fed fund(s) rate," and (iii) "Federal Reserve" or "the Fed" or "Federal Open Market Committee" or "FOMC”.

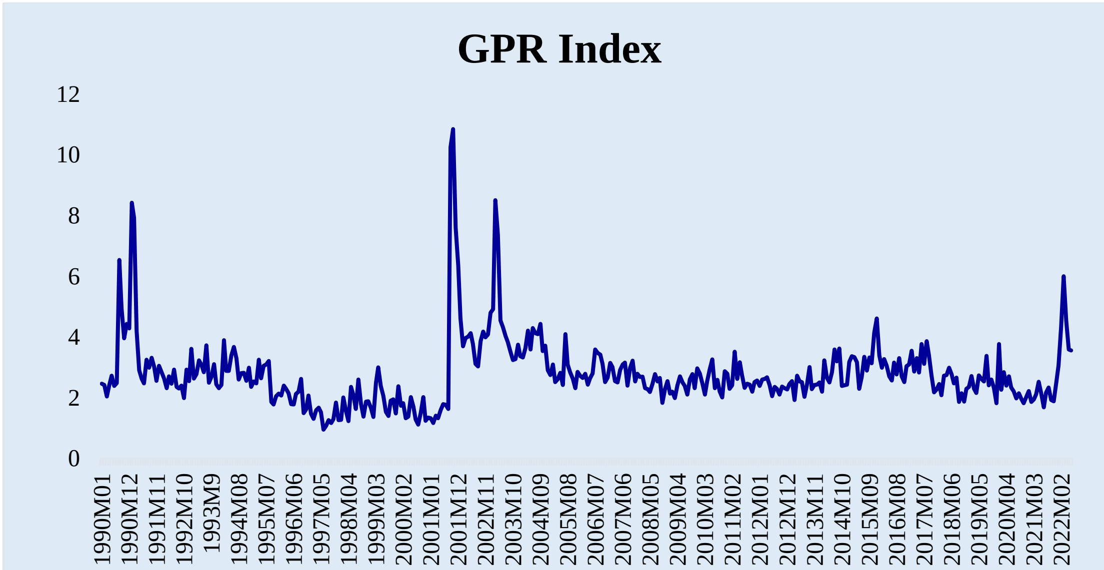
MPU influences how monetary policy shocks are transmitted to long-run nominal and real rates (Pooter et al., 2020). When the level of *MPU* is low, yields are more sensitive to a particular monetary policy shock. *MPU* is also a major determinant in analyzing the US exchange rate. This variable is also utilized by Alexander and Raluca (2017), Beckmann and Czudaj (2016), Chen et al. (2019), Donghyun et al. (2020) and Elif et al. (2017). Alexander and Raluca (2017) show the presence of higher *MPU* strengthens the foreign exchange markets and Donghyun et al. (2020) suggest that MPU index has a tendency to increase exchange rate volatility rather than having a direct impact on the level of exchange rates. Elif et al. (2017) imply monetary policy co-vary positively with the exchange rate but also displays distinct dynamics in their study. Therefore, the *MPU* index is collected from Economic Policy Uncertainty website and utilized in this study, covering the period from January 1994 to June 2022.

3.1.4 Geopolitical Risk Index (*GPR*)

GPR is compiled by Fed economists Caldara and Iacoviello (2021). The authors constructed a new measure of adverse geopolitical events based on statistics from newspaper articles covering geopolitical tensions and studied their evolution and economic impact since 1900. Based on Figure 3.1, the *GPR* index increased around World War I (1914 - 1918), World War II (1939 - 1945), at the beginning of the Korean War (1950 - 1953), during the Cuban Missile Crisis (October 1962), and after 9/11 (2001). *GPR* index is the automated text-search results of the electronic archives of 10 newspapers which include the Chicago Tribune, Daily Telegraph, Financial Times, Globe and Mail, Guardian, Los Angeles Times, New York Times, USA Today, Wall Street Journal, and Washington Post. The authors constructed the index by measuring the number of pieces about negative geopolitical events that appeared in each publication each month. The search categories are classified into eight categories, namely War Threats, Peace Threats, Military Buildups, Nuclear Threats, Terror Threats, Beginning of War, Escalation of War, and Terror Acts. Additionally, two subindexes are constructed based on the search groups above, namely the Geopolitical Threats (GPRT) and Geopolitical Acts (GPRA) indexes.

These geopolitical risks are key factors affecting the economy, financial markets and currency markets. According to Khalid and Mohammad (2021), the global *GPR* index tends to have symmetric long-run effects on all five currencies, namely Canadian Dollar (CAD), Chinese Yuan Renminbi (CNY), Japanese Yen (JPY), South Korean Won (KRW) and Great British Pound (GBP), in their study. Unexpected geopolitical risks can move in the opposite direction and thus can harm the currency, devaluing the exchange rate which has a negative relationship. This geopolitical event will not only affect the country in which it takes place it will also affect the whole world. The *GPR* data is collected from Economic Policy Uncertainty website to analyse the asymmetric effects of *GPR* on exchange rate volatility. The *GPR* was also utilized by Javed et al. (2022), Khalid and Mohammad (2021), Tomiwa et al. (2022) and Uju et al. (2018) to examine the protective and risk-averting qualities of gold, oil, equities, and foreign exchange rates against US *EPU* and *GPR*, imbalanced effects of oil price fluctuations and two forms of uncertainty measures *EPU* and *GPR* on exchange rate instability, the influence of *GPR*, exchange rate, and *EPU* on the stock market of South Korea, as well as the spillover effects of tourism receipts and various sources of uncertainty related to trade and politics.

Figure 3.1: Graphical plot of GPR index from January 1900 to June 2022



Source: Economic Policy Uncertainty (2012)

3.1.5 Terms of Trade (*TOT*)

The ratio of the export price index to the import price index is known as *TOT*. Positive terms of trade occur when a country can purchase more imports with the same quantity of exports, as its export prices have increased more than its import prices. If export prices rise relative to import prices, it is a positive or improvement in the terms of trade. This also shows that with the same amount of exports, residents can buy relatively more imported goods. The result of this would be an improvement in the standard of living, as consumers would be able to purchase more imported goods at a lower cost. However, if the terms of trade deteriorate, residents will buy fewer imported goods, leading to a decline in living standards.

The *TOT* data is gathered from International Monetary Fund. The data is Commodity Net Export Price Index with the indicator of Individual Commodities Weighted by Ratio of Net Exports to GDP in Recent, Fixed Weights. The index is June 2012=100. As mentioned by Raza and Afshan (2017), the long-run estimates show a considerable negative relationship between exchange rates and *TOT*. The *TOT* data is used as one of the control variables in this study, consistent with the studies of Chen et al. (2019) and Kazi et al. (2021) conducted a study that analyzed the effect of EPU on China's exchange rate volatility. They also examined how the exchange rate responds to domestic EPU by taking into account oil prices and trade volume in various economic scenarios.

$$\text{Terms of Trade (TOT)} = \frac{\text{Index of Average Export Prices}}{\text{Index of Average Import Prices}} \times 100 \qquad (2)$$

3.1.6 Federal Funds Effective Rate (*FED*)

The federal funds rate (*FED*) is an interest rate that facilitates the trading of federal funds between depository institutions. These funds represent overnight balances held by these institutions at Federal Reserve Banks, and are exchanged among themselves. When a depository institution has surplus balances in their reserve accounts, they will lend those excess balances to other banks. This excess cash will be called liquidity and they will lend this liquidity to other banks as loans. The two banks will negotiate the interest rate paid by the borrower to the lender, and the weighted average of all these sorts of agreements is known as the effective federal funds rate. The Federal Reserve System (Fed) can control the fund rate through open market operations (OMO). When the Fed wishes to change interest rates, it pushes them up or down the ranges established by the IORB (interest on reserve balances) and ON RRP (overnight reverse repurchase agreement rate) (Kimberly, 2022). As a result, banks adjust their interest rates accordingly. These interest rates, in turn, influence all other interest rates in the economy.

Raising interest rates by the Fed can make the USD more attractive to investors, leading to an increase in demand for the currency and resulting in an appreciation of its value. Lower interest rates, on the other hand, can contribute to higher exchange rate volatility because buyers are more likely to participate in speculation to benefit from market movements. Being one of the control variables following the study by Chen et al. (2019), the *FED* data is collected from the Federal Reserve Bank of St. Louis in percentage.

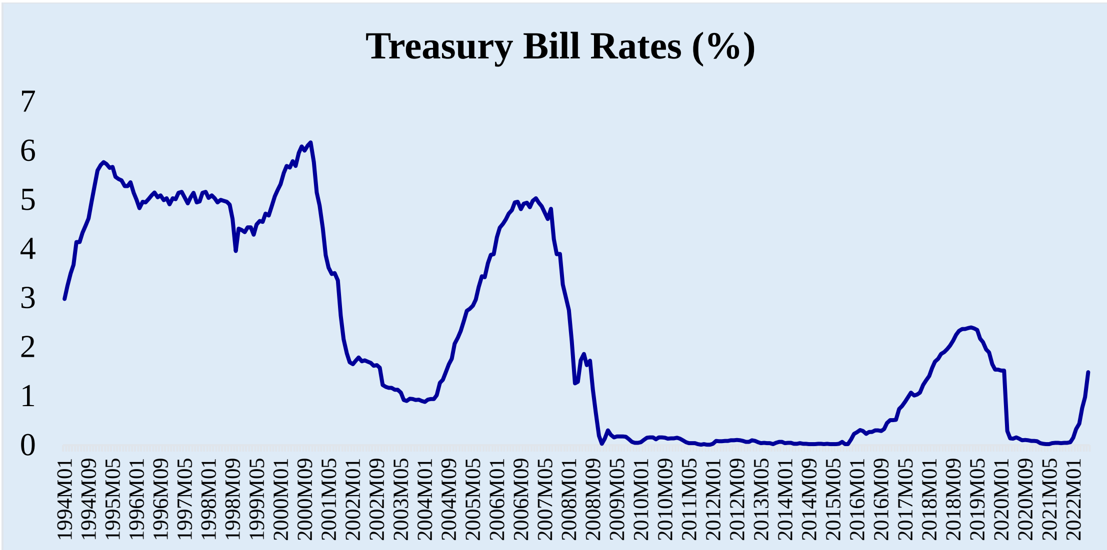
3.1.7 Inflation Rate (*INF*)

The inflation rate (*INF*) refers to the percentage change in the general level of prices for goods and services over a specified time period, typically a year. *INF* is typically defined as a broad measurement, such as an increase in general prices or the cost of living in a country. To control *INF*, several central banks maintain monetary discipline by setting exchange rates. This ties its currency's value to the value of another currency, and hence its monetary policy to the policy of another nation. The Fed tries to control *INF* by influencing interest rates. When *INF* gets too high, the Fed typically raises interest rates to slow the economy and lower *INF*. When interest rates are high, customers will choose to eventually start spending less or reduce investment, so that the demand for goods and services will then drop, which will cause *INF* to fall. When *INF* is high, this tends to negatively affect the value of a country's currency and a negative relationship is expected to show. This is because higher *INF* reduces the purchasing power of a currency, which weakens that currency against other currencies. However, higher home country *INF* will increase exchange rate volatility, especially for emerging economies (Robert, 2014). Given this relationship, *INF* is also adopted as the control variable to study how *INF* will affect the volatility of *REER* and it is from the source of U.S. Bureau of Labor Statistics.

3.1.8 United States Treasury Bill Rate (*TBILL*)

The 3-Month Treasury Bill Rate is the rate of return on government-issued 3-month Treasury notes. The 3-month Treasury yield is featured on the shorter end of the yield curve and is significant when looking at the overall economy of the US. Looking at the graphical plot of the *TBILL* in Figure 3.2, from 2009 to 2015, the 3-month Treasury yield was close to zero as the Federal Reserve held its benchmark rate at zero following the Great Recession. The *TBILL* data was employed by Gianluca et al. (2012) in their exploration of the relationship between the role of nominal and real stochastic volatilities for the behaviour of exchange rates. *TBILL* is selected as one of the control variables in this study. The data is collected from the Federal Reserve Bank of St. Louis at a monthly frequency.

Figure 3.2: Graphical plot of TBILL from January 1994 to June 2022



Source: Federal Reserve Bank of St. Louis (1954)

3.1.9 Summary of Data and Sources

The table below summarizes the data employed in this study as well as the sources at which they are collected.

Table 3.1: Summary of Data and Sources

Variable	Units	Type	Sources	Sources and Link
Real Broad Effective Exchange Rate (*REER*)	Index	Input for DV	Bank for International Settlements	https://www.bis.org/statistics/eer.htm
Economic Policy Uncertainty Index (*EPU*)	Index	IV	Economic Policy Uncertainty	https://www.policyuncertainty.com/us_monthly.html
Monetary Policy Uncertainty Index (*MPU*)	Index	IV	Economic Policy Uncertainty	https://sites.google.com/site/lucasfhusted/data
Geopolitical Risk Index (*GPR*)	Index	IV	Economic Policy Uncertainty	https://www.policyuncertainty.com/gpr.html

Terms of trade (*TOT*)	Index	Control Variable	International Monetary Fund	https://data.imf.org/?sk=2CDDCCB8-0B59-43E9-B6A0-59210D5605D2
Federal Funds Effective Rate (*FED*)	%	Control Variable	Federal Reserve Bank of St. Louis	https://fred.stlouisfed.org/series/FEDFUNDS
Inflation Rate (*INF*)	Index	Control Variable	U.S. Bureau of Labor Statistics	https://fred.stlouisfed.org/series/CPIAUCSL
United States Treasury Bill Rate (*TBILL*)	%	Control Variable	Federal Reserve Bank of St. Louis	https://fred.stlouisfed.org/series/TB3MS

3.2 Computation of Exchange Rate Volatility

This study adopts the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) to compute the conditional volatility of the USD exchange rate as used by Serag et al. (2019) and Zhou et al. (2019). Instead of using arithmetic way of counting volatility, which is standard deviation, this study use GARCH model which can account for volatility clustering often observed in financial time series. The Real Broad Effective Exchange Rate (*REER*) data used for this study covered January 1994 to June 2022.

The conditional volatility of the US *REER* is given by the following equation:

$$VOLREER_t = a_0 + \sum_{i=1}^{q} \beta_i u^2{}_{t-1} + \sum_{j=1}^{p} \theta j VOLREER_{t-j} \quad (3)$$

where $VOLREER_t$ is the conditional variance of US *REER*, u^2 is the residuals and $VOLREER_{t-j}$ is the lagged conditional variance that differentiates the GARCH from the ARCH model. This study determines the ideal order of the GARCH and ARCH terms for Equation (3) by performing trial and error up to maximum lag order of six for both the ARCH and GARCH terms. Hence, there are 36 possible models within the GARCH family arising from testing both the ARCH and GARCH order from one to six. The lag order of 6 is due to how far back in time the model looks to capture the dynamics of the time-varying volatility of the series which is 6 months in a year. These estimations are performed with Normal distribution as the chosen distribution for the error terms. In this process, the Akaike Info Criterion (AIC) and Schwarz Criterion (SIC) values are recorded. By comparing the AIC and SIC values among the 36 GARCH models, the lowest AIC value which is 3.0180 from the GARCH (3, 2) model is selected to generate the conditional volatility series for the US exchange rate – *VOLREER*.

3.3 Stationarity of Variables

To prevent spurious regression, it is important to verify the stationarity of all variables in this study before specifying the model. The Augmented Dickey-Fuller (ADF) unit root test is utilized for this purpose, with both intercept and intercept with trend options being considered. According to Dickey and Fuller's (1979) findings, when the null hypothesis assumes a unit root, the resulting statistic does not adhere to the conventional Student's t-distribution. Beside, they establish asymptotic results and simulate critical values for different tests and sample sizes.

To ensure the reliability of the regression model, two measures are taken. First, exogenous variables are excluded from the test regression. Second, up to 16 lagged difference terms are included in the regression model using the automatic selection method based on the Akaike Information Criterion. While the assumption of an autoregressive process may seem restrictive, Said and Dickey (1984) showed that the ADF test is asymptotically valid even in the presence of a moving average component as long as enough lag differences are included. Compared to the Dickey-Fuller test, the ADF test is more powerful and can handle more complex models (Stephanie, 2016).

ADF is an extended version of the simple Dickey Fuller test because the error term is unlikely to be white noise (Rizwan, 2011). ADF include an additional lag on the dependent variable to remove the autocorrelation problem. A p-value less than 0.05 indicates that the variable's data is stationary.

Based on the results of the Augmented Dickey-Fuller (ADF) unit root test presented in Table 3.2, it is gathered that the *VOLREER*, *EPU*, *MPU*, *GPR*, *FED* and *TBILL* series is stationary at the level, I(0) since the p-value is smaller than 0.05, so the null hypothesis of unit root is rejected. On the other hand, *TOT* and *INF* series are not stationary at level, I(0) since the p-value is greater than 0.05, but are stationary at the first difference, I(1). Given the results of the unit root test, *VOLREER*, *EPU*, *MPU*, *GPR*, *FED* and *TBILL* enter the model at a level whereas *TOT* and *INF* enter the model in the first difference.

Table 3.2: Augmented Dickey-Fuller (ADF) Test (Intercept, Intercept and Trend)

Variables	At Level (Intercept)	At Level (Intercept + Trend)	At First Difference (Intercept)	At First Difference (Intercept + Trend)	Order of Integration
VOLREER	-8.4835***	-8.4595***	-7.9491***	-7.9313***	I(0)
EPU	-2.2309	-5.0228***	-6.0532***	-6.0431***	I(0)
MPU	-3.9645***	-4.6041***	-12.3243***	-12.3312***	I(0)
GPR	-6.6572***	-6.6622***	-7.7008***	-7.6931***	I(0)
TOT	-2.1996	-2.8927	-10.8326***	-10.8202***	I(1)
FED	-2.6425*	-3.5545**	-3.7991***	-3.7687**	I(0)
INF	-2.0330	-1.5935	-4.1329***	-4.3700***	I(1)
TBILL	-2.8174*	-3.4843**	-4.3531***	-4.3386***	I(0)

Source: Authors' Estimation

3.4 Model Specifications

This research employs Generalized Autoregressive Conditional Heteroskedasticity (GARCH), introduced by Bollerslev (1986), to measure the relationship between various uncertainties and volatility of USD from January 1994 to June 2022, following the model used in Serag et al. (2019) and Zhou et al. (2019). GARCH is implemented to enable a more flexible lag structure compared to ARCH. The process of extending the ARCH model to the GARCH model is similar to extending the standard AR time series process to the ARMA process (Bollerslev, 1986). GARCH models are considered a more sophisticated and effective tool for modelling the volatility of financial time series data compared to ARCH models. This is because GARCH provide a better fit to financial time series data than ARCH models and it can capture the time-varying volatility that is often present in financial time series data. It also allows for a more flexible and nuanced representation of volatility than ARCH models.

One of the key assumptions of ordinary least squares (OLS) regression is that the error term has a constant variance. When the error term has high volatility, it violates this assumption and is referred to as heteroscedasticity. In this study, the *VOLREER* series has high volatility which can lead to incorrect standard errors and incorrect inferences about the parameters in the regression model. Since the error term has high volatility, GARCH can be used to model the volatility in the error term and account for the heteroscedasticity in the data.

There are three models to test the significance of the individual uncertainty index, which is *EPU* in Equation (4), *MPU* in Equation (5) and *GPR* in Equation (6), respectively. The last model is a model with all uncertainty indices namely *EPU*, *MPU* and *GPR*, as specified in Equation (7). The most suitable model, either the individual model or the full model, will be selected by comparing their AIC value and adjusted R-squared. The *TOT* and *INF* variable are stationary at the first difference, I(1). So, *TOT* and *INF* were analyzed using the first difference in the model specifications with a symbol of Δ, the differencing operator. Thus, the empirical model is as follows:

i) Model with Economic Policy Uncertainty Index (*EPU*)

$$VOLREER_t = \beta_0 + \beta_1 EPU_t + \beta_2 \Delta TOT_t + \beta_3 FED_t + \beta_4 \Delta INF_t + \beta_5 TBILL_t + \varepsilon_t \quad (4)$$

ii) Model with Monetary Policy Uncertainty Index (*MPU*)

$$VOLREER_t = \theta_0 + \theta_1 MPU_t + \theta_2 \Delta TOT_t + \theta_3 FED_t + \theta_4 \Delta INF_t + \theta_5 TBILL_t + u_t \quad (5)$$

iii) Model with Geopolitical Risk Index (*GPR*)

$$VOLREER_t = \omega_0 + \omega_1 GPR_t + \omega_2 \Delta TOT_t + \omega_3 FED_t + \omega_4 \Delta INF_t + \omega_5 TBILL_t + v_t \quad (6)$$

iv) Model with all uncertainty indices (*EPU*, *MPU* and *GPR*)

$$VOLREER_t = a_0 + a_1 EPU_t + a_2 MPU_t + a_3 GPR_t + a_4 \Delta TOT_t + a_5 FED_t + a_6 \Delta INF_t + a_7 TBILL_t + e_t \quad (7)$$

The variance equation for all the models above is specified as follows:

$$h_t = a_0 + \sum_{i=1}^{q} a_i \upsilon^2{}_{t-1} + \sum_{j=1}^{p} \delta_j h_{t-j} \quad (8)$$

where υ_t represents the error terms e_t, ε_t, u_t and v_t for the respective equation. The variable h_t represents the conditional variance of the error process.

In all four models, the dependent variable is the conditional volatility of the Real Broad Effective Exchange Rate (*VOLREER*), and the independent variables are the Economic

Policy Uncertainty Index (*EPU*), Monetary Policy Uncertainty Index (*MPU*), and Geopolitical Risk Index (*GPR*). The control variables selected for this study are supported by the studies from Chen et al. (2019) and Kazi et al. (2021) for Terms of Trade (*TOT*), Chen et al. (2019) for Federal Funds Effective Rate (*FED*), Robert (2014) for Inflation Rate (*INR*), and Gianluca et al. (2012) and Maria et al. (2022) for Treasury Bill Rates (*TBILL*). The purpose of including these control variables is to control for other factors that may affect the dependent variable, *VOLREER* and to isolate the effect of the independent variables, *EPU*, *MPU*, and *GPR* on the volatility of USD exchange rate. By including these control variables, the changes in the *EPU*, *MPU*, and *GPR* related to changes in the dependent variable *VOLREER* can be observed while controlling for the effects of the other factors.

In deciding on the ARCH and GARCH orders of Equation (4) to Equation (7), this study estimates different combinations of ARCH and GARCH terms, ranging from ARCH (1 to 6) and GARCH (1 to 6), resulting in 36 different models. The models are then compared based on Akaike Information Criterion (AIC) and Schwarz Criterion (SIC) values. The lower AIC or SIC indicates a better fit. Among the individual model, GARCH (6,2) is the best fit for Equation (4), GARCH (5,1) is the best fit for Equation (5) and GARCH (2,5) for Equation (6). Once the AIC and SIC values for all 36 models were calculated, the GARCH (2, 2) model was selected, which has an AIC value of 1.5897 for Equation (7). Equation (7) model is the best-fitting model among the 36 models based on its lowest AIC value.

CHAPTER 4: RESULTS AND DISCUSSIONS

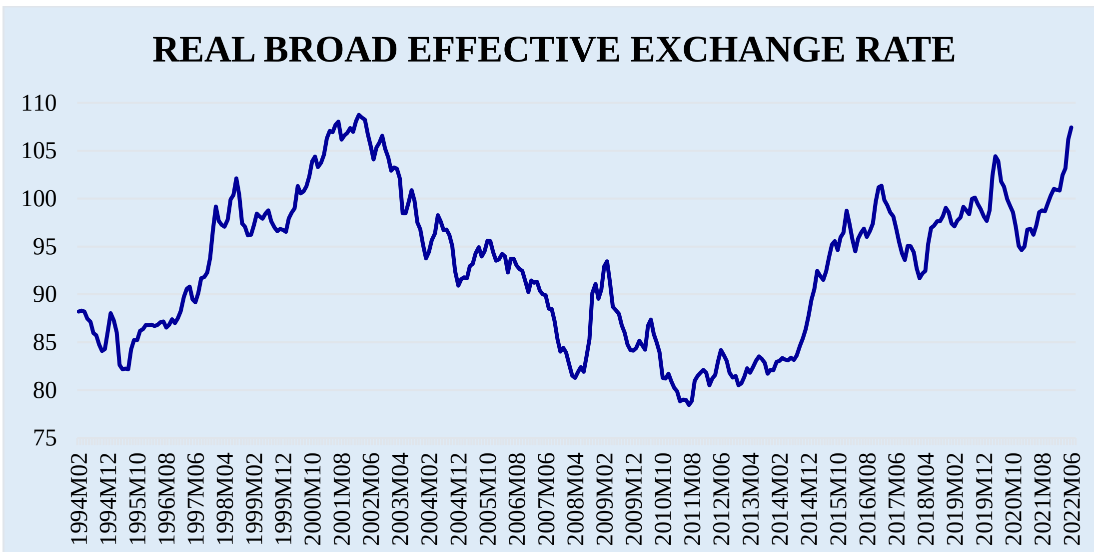
4.0 Introduction

This chapter presents and discusses the results of the analysis in detail, providing insights and interpretation of the findings. Section 4.1 includes a graphical representation of the Real Board Effective Exchange Rate (*REER*) and the Volatility of Real Broad Effective Exchange Rate (*VOLREER*) to visualize the trends and patterns in the data. This section aims to aid in understanding the volatility of *REER* over time. In Section 4.2, the descriptive statistics are presented to summarize the key characteristics of the data, including measures such as mean, standard deviation, minimum, and maximum. The results of the correlations test are presented and discussed in Section 4.3. Section 4.4 presents and discusses the results of the GARCH model estimation, which is performed on four different models: the model with only the Economic Policy Uncertainty Index (*EPU*), the model with only the Monetary Policy Uncertainty Index (*MPU*), the model with only the Geopolitical Risk Index (*GPR*), and the model with all uncertainty indices (*EPU*, *MPU*, and *GPR*). The main goal of this chapter is to present and discuss the results of the analysis in a clear and concise manner while providing insights and interpretation of the findings.

4.1 Graphical Plots of *REER* and *VOLREER*

Figure 4.1 presents the graphical plot of the REER over the sample period. It shows an increasing trend in *REER* from February 1995 until February 2002. This is likely due to the capital inflows arising from the Asian Financial Crisis (AFC) which generated a positive effect on the US GDP, leading to strong US growth performance in 1998 (Eric & Yi, 2000). There are several Southeast Asian countries suffered significant recessions during the AFC of 1997-1998, resulting in currency depreciation, stock market collapses, and high levels of corporate and bank debt. The crisis had increased global financial market unpredictability and turbulence, and many investors were concerned about the safety of developing market economies. As a result, investors wanted a safe haven for their money, and many selected the USD as a comparatively stable and safe currency. This increased demand for the USD, which strengthened its worth during the period observed.

Figure 4.1: Time Series Plot of REER



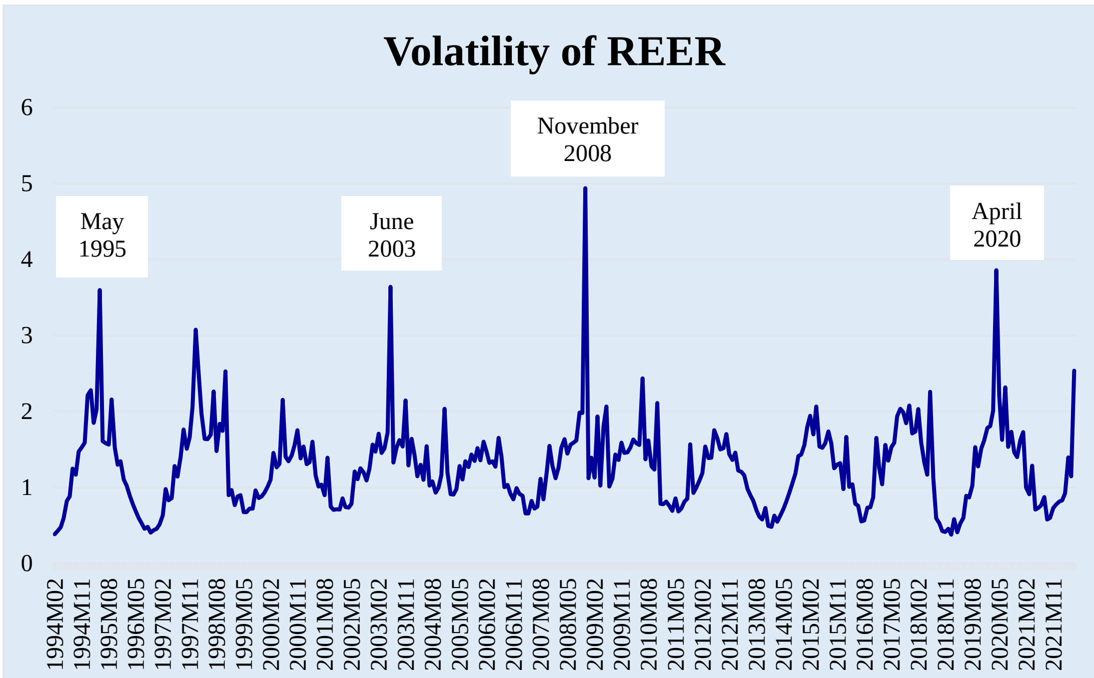
Source: Bank for International Settlements (2023)

Next, the *REER* started to drop from 2002 until 2008. Several factors contributed to the decline of *REER*. In the early stages of the Global Financial Crisis (GFC), the USD strengthened as investors sought the safe haven of US assets. However, the dollar weakened as the crisis deepened and spread globally. The US housing market crash during the 2007-2008 GFC served as a trigger for a financial catastrophe that swiftly spread from the US to other parts of the globe via interconnections in the worldwide financial network (Reserve Bank of Australia, 2018). This crisis led to major losses for numerous banks worldwide, forcing them to seek government assistance to avoid collapse. The US government's approach to the crisis was one of the primary causes of the USD's decline during the GFC. To help the struggling US economy, the Federal

Reserve lowered interest rates to near-zero levels and adopted a quantitative easing (QE) strategy that involved purchasing large amounts of US government bonds and other assets (Reserve Bank of Australia, 2018). This increased the quantity of USD in circulation while depreciating its worth against other currencies. The effect of the crisis on global trade and investment flows was another reason that added to the decline in the USD. The amount of international trade fell as worldwide demand for products and services fell. This is decreasing the demand for USD to complete cross-border transactions. Furthermore, many investors became more risk-averse and shifted their funds out of USD-denominated assets, lowering demand for the currency in the end.
At the same time, other economies in Asia such as China and other emerging markets have experienced significant growth and development during that period. For example, China's economy has grown rapidly over the past 20 years, with its GDP increasing from USD1.21 trillion in 2000 to USD17.73 trillion in 2021 (The World Bank Group, 2023). Other emerging market economies, such as Brazil, Russia, India, and South Africa (BRICS), have also experienced significant growth and leading emerging economies of the early 2000s. The rise of the BRICS has led to greater competition for financial flows. As these countries' economies developed and opened up, they became appealing locations for international investment. This lowers the relative appeal of the United States as an investment destination and places downward pressure on the value of the dollar.

After the GFC, US *REER* showed an upward trend, reflecting the relative strength of the US economy compared to other countries, as well as the US dollar's status as a safe-haven currency and a global reserve currency. Over the past few years, the US economy has strengthened significantly, with low unemployment rates, robust GDP growth, and strong consumer spending. This has led to increased demand for the US dollar, which has in turn caused its value to rise against other currencies. Furthermore, when the US Fed actively pursues a contractionary monetary policy, reducing the domestic money supply will increase interest rates and, all else being equal, capital inflows will occur (Dilmaghani & Tehranchian, 2015). This makes US assets more appealing to investors, who can receive greater returns in the US than in other nations. As a result, demand for the currency increases, which can lead to an appreciation of the currency's value relative to other currencies. This is particularly true for developing market countries, which have seen capital withdrawals as investors seek secure and more reliable assets in the US.

Figure 4.2: Time Series Plot of VOLREER



Source: Authors' Estimation

Looking at the graphical plot of the volatility series illustrated in Figure 4.2, it is observed that there were periods of heightened volatility of the USD almost every two to three years. Zooming into the peaks of the USD volatility, the first peak took place in May 1995, mainly attributable to the Mexican peso crisis which began in late 1994 and continued into early 1995. The Mexican peso was devalued by 40% in December 1994, resulting in capital flight, a stock market crash, the loss of 2 million employment, and a drop in real wages. As the Mexican economy suffers, investors are withdrawing funds from Mexican assets and pursuing safer investments. This resulted in a "flight to safety" as buyers shifted funds into US assets such as Treasuries and the US currency. This increases demand for the USD and contributes to its strengthening. Meanwhile in

the US, to slow economic development and protect against inflation attacks, the Fed increased its benchmark short-term interest rate by three percentage points between February 1994 and February 1995 (Klein, 2019). The rate reduction also raised dollar volatility as investors attempted to forecast the future path of US monetary policy.
Subsequently, the USD experienced another period of increased volatility in June 2003. The Fed lowered interest rates to 1% which is their lowest level in 45 years on 25 June 2003, potentially resulting in increased volatility of the US currency (Taylor, 2023). This was to stimulate economic growth and combat the effects of a dot-com recession of the early 2000s. The US tried to encourage borrowing and spending, which in turn would stimulate demand for goods and services and boost economic activity. However, when the central bank lowers interest rates, the currency becomes less attractive to investors who may be more inclined to move their money to other countries with higher interest rates, which may contribute to a decrease in demand for USD and its value.

In November 2008, the USD experienced its highest level of volatility, caused by the breakdown of the US housing market in the wake of the GFC. Investors around the world have become increasingly risk-averse and seek security assets such as US Treasury bonds, resulting in a sharp rise in the value of the USD to fight other currencies. However, as the crisis worsens, the value of the US dollar becomes more unpredictable, and investors were starting to fear that the US government's large-scale intervention in the financial system would lead to inflation and a weakening of the US dollar. As buyers tried to forecast the path of currency, these worries had increased volatility in the US dollar.

Lastly, in April 2020, there was another heightened volatility observed in the USD. The global COVID-19 pandemic had led to widespread uncertainty and panic in financial markets around the world. The US started implementing shutdowns on March 15, 2020, as a measure to prevent the spread of COVID-19 (Centers for Disease Control and Prevention, 2022). Investors grew increasingly concerned about the potential impact of the outbreak on the global economy as countries go into lockdown and businesses are forced to close. This uncertainty and fear caused sharp swings in the value of the USD against other currencies.

4.2 Descriptive Statistics

Table 4.1 shows the descriptive statistics of the eight variables with data consisting of 341 *VOLREER* and 342 other variables monthly observations for the period from January 1994 to June 2022. The mean for *VOLREER* is 1.2738 and its median value is 1.2625. *VOLREER* recorded the highest value of 4.9372 on November 2008 and the lowest value is 0.3775 on January 2019. The largest *VOLREER* was recorded in 2008, most likely because of the collapse of trade and financial flows, which caused a huge balance of payments gap created by the 2008 financial crisis, which also caused the fast devaluation at the time (Stella et al., 2009). The standard deviation of *VOLREER* is 0.5635 and the skewness is 1.6472 which is greater than 1, *VOLREER* distribution is highly skewed.

Table 4.1: Descriptive Statistics

	VOLREER	EPU	MPU	GPR	TOT	FED	INF	TBILL
Mean	1.2738	126.8633	120.5326	2.7267	100.6382	2.3678	0.0238	2.1955
Median	1.2625	109.2910	108.6192	2.5464	100.5011	1.7150	0.0224	1.6000
Max	4.9372	503.9633	407.3653	10.8536	102.2791	6.5400	0.0906	6.1700
Min	0.3775	44.7828	19.7490	0.9528	99.4174	0.0500	0.0210	0.0100
Std. Dev.	0.5635	63.0679	65.4212	1.1140	0.7174	2.2311	0.0147	2.0830
Skewness	1.6472	2.1175	1.6813	3.0914	0.4661	0.4483	1.1087	0.4383
Obs	341	342	342	342	342	342	342	342

Note: *VOLREER* represents Volatility of Real Broad Effective Exchange Rate, *EPU* represents the Economic Policy Uncertainty Index, *MPU* denotes Monetary Policy Uncertainty Index, *GPR* denotes Geopolitical Risk Index, *TOT* denotes Terms of Trade, *FED* denotes Federal Funds Effective Rate, *INF* denotes Inflation Rate, *TBILL* denotes United States Treasury Bill Rate.

Next, the average value of *EPU* is 126.8633, and its median value is 109.2910. On January 21, 2020, the first US case of the 2019 coronavirus was confirmed in a man from Washington state (A&E Television Networks, 2023). This pandemic started to create uncertainty for US residents. The highest *EPU* value of 503.9633 collected on May 2020 reflects the level of uncertainty in the US economic policy leading to rising unemployment and impacting investment decisions, with consumers focusing only on necessities during times of high uncertainty. The lowest *EPU* is 44.7828 in July 2007. The standard deviation of *EPU* is 63.0679, and the *EPU* distribution is highly skewed since its skewness is 2.1175.

Other than that, *MPU* has a mean and median of 120.5326 and 108.6192 respectively. The highest *MPU* is occur on August 2019 with a value of 407.3653, it may be due to US monetary policy being likely to ease in 2019 but would be subject to a lot of uncertainties (Park et al., 2022). Monetary policy uncertainties were at the lowest level in October 2003, possibly due to the limited room available to the Fed to lower the nominal federal funds rate during the period. The standard deviation for *MPU* is 65.4212 and its skewness is 1.6813 which means *MPU* is not evenly distributed.

Looking at *GPR*, the results show that the *GPR* has an average value of 2.7267, with a median value of 2.5464. The largest value of the *GPR* was recorded in October 2001, with a value of 10.8536. This was during the period when the US economy entered a recession after the September 11 Attacks. On September 11, 2001, 19 militants involved with the Islamic extremist organization al Qaeda hijacked four planes and carried out suicide attacks against US targets (A&E Television Networks, 2022). On the other hand, the lowest value of *GPR* was recorded at 0.9528 in June 1997, before the Thai baht crisis in July 1997. The GPR index is considered to have lower volatility and greater stability due to its lower standard deviation of 1.114 compared to the EPU and MPU. The distribution of *GPR* is highly skewed, with skewness of 3.0914.

The mean of *TOT*, *FED*, *INF* and *TBILL* is 100.6382, 2.3678, 0.0238 and 2.1955 respectively. The median value which are the middle values of variables for *TOT*, *FED*, *INF* and *TBILL* is 100.5011, 1.7150, 0.0224 and 1.6000 respectively. *TOT* recorded the highest value of 102.2791 on December 1998 and the lowest value is 99.4174 in

July 2008. The highest value of *FED* is 6.5400 on June 2022 and its lowest value is 0.0500 in April and May 2020. *INF* measured the highest value of 0.0906 on October 2001 and the lowest value is 0.0210 on February 2011. *TBILL* reached its highest value of 6.1700 on November 2000 while its lowest of 0.0100 in September, November and December 2011. Other than that, the standard deviation for *TOT*, *FED*, *INF* and *TBILL* is 0.7174, 2.2311, 0.0147 and 2.0830 respectively. *INF*'s skewness is greater than 1, the distribution is highly skewed. *TOT*, *FED* and *TBILL*'s skewness is 0.4661, 0.4483 and 0.4383 and the distribution is approximately symmetric. Jarque-Bera's probability is below 0.05, so reject the null hypotheses and the variables are not normally distributed.

4.3 Correlations Test

In Table 4.2, only *TBILL* and *FED* are high positive correlation with a correlation coefficient of 0.9950. This means that when *TBILL* increases, *FED* tends to increase as well. Despite the high correlation between these control variables, this study opines that it should not be a cause of concern given that the correlation is not between the key independent variables in this study, namely *EPU*, *MPU* and *GPR*. Meanwhile, *EPU* and *MPU* have a correlation coefficient of 0.4450 show a low positive correlation. The correlation between *FED* and *EPU*, *TBILL* and *EPU*, ΔINF and ΔTOT with a correlation coefficient of -0.4722, -0.4795 and -0.4424 respectively and show a low negative correlation between the variables. All other variables have negligible correlation and the correlation coefficient is positive or negative values between 0.00 to 0.30.

Table 4.2: Correlations between Independent Variables

	EPU	*MPU*	*GPR*	Δ*TOT*	*FED*	Δ*INF*	*TBILL*
EPU	1						
MPU	0.4450	1					
GPR	0.1282	0.2825	1				
Δ*TOT*	0.1361	0.0914	0.0639	1			
FED	-0.4722	-0.1084	-0.2697	-0.0166	1		
Δ*INF*	-0.0814	0.0839	-0.0195	-0.4424	-0.0345	1	
TBILL	-0.4795	-0.1032	-0.2606	-0.0240	0.9950	-0.0327	1

Note: *EPU* represents the Economic Policy Uncertainty Index, *MPU* denotes Monetary Policy Uncertainty Index, *GPR* denotes Geopolitical Risk Index, *TOT* denotes Terms of Trade, *FED* denotes Federal Funds Effective Rate, *INF* denotes Inflation Rate, *TBILL* denotes United States Treasury Bill Rate.

4.4 Output Estimation

4.4.1 Model with Economic Policy Uncertainty Index (*EPU*)

From the results presented in Table 4.3 above, the resulting estimated model for Equation (4) is as follows:

Mean Equation:

$$\widehat{\text{VOLREER}}_t = 0.0017EPU_t + 0.4070\Delta TOT_t + 0.3037FED_t - 22.2104\Delta INF_t - 0.3235TBILL_t + 1.0774$$

Variance Equation:

$$h_t = 0.1954 + 0.0788u^2{}_{t-1} - 0.0653u^2{}_{t-2} - 0.0062u^2{}_{t-3} + 0.1013u^2{}_{t-4} - 0.0315u^2{}_{t-5} - 0.0254u^2{}_{t-6} + 0.3190h_{t-1} - 0.0021h_{t-2}$$

Table 4.3:GARCH (6,2) of Equation (4)

Mean Equation								
C	EPU	ΔTOT	FED	ΔINF	TBILL			
1.0774***	0.0017***	0.4070	0.3037*	-22.2104***	-0.3235*			
(0.1109)	(0.0006)	(0.3554)	(0.1676)	(6.8878)	(0.1781)			
Variance Equation								
C	u_{t-1}^2	u_{t-2}^2	u_{t-3}^2	u_{t-4}^2	u_{t-5}^2	u_{t-6}^2	h_{t-1}	h_{t-2}
0.1954	0.0788	-0.0653	-0.0062	0.1013	-0.0315	-0.0254	0.3190	-0.0021
(0.2558)	(0.0836)	(0.0846)	(0.0652)	(0.0873)	(0.1004)	(0.0201)	(0.9134)	(0.0098)

Note: () is the standard errors. Number of observations is 341 after adjustment. *EPU* represents the Economic Policy Uncertainty Index, *TOT* denotes Terms of Trade, *FED* denotes Federal Funds Effective Rate, *INF* denotes Inflation Rate, *TBILL* denotes United States Treasury Bill Rate. ∗∗∗, ∗∗ and ∗ denote significance at the 1%, 5% and 10% levels, respectively.

The results shown in Table 4.3, *EPU* is significant in affecting the volatility of the USD (*VOLREER*). For an additional unit increase in the *EPU* Index, the volatility of the USD is estimated to increase by 0.0017 unit. This finding is consistent with the result in the model with all uncertainty indices (*EPU*, *MPU* and *GPR*) which indicate a positive relationship between *EPU* and *VOLREER*. High *EPU* can lead to increased protectionist policies, such as tariffs and trade barriers, as policymakers seek to protect domestic industries from the uncertainty and risks of international trade. In 2018, the US initiated a trade war with China by imposing a 25 percent tariff on imported steel and a 10 percent tariff on imported aluminum, among other measures, which led to a series of retaliatory actions from both sides and created uncertainty in global markets. The rationale for this action is that the government perceives the trade policies of foreign nations as a threat to American national security, as they are believed to be negatively impacting domestic production. These protectionist policies can further reduce international trade flows and increase exchange rate volatility, as they create uncertainty about the prospects of a country's economy and its currency (Salotti et al., 2019). If a country's economy is experiencing high levels of *EPU*, it may lead to a reduction in foreign investment and a decrease in the demand for the country's exports, as foreign buyers become more risk-averse. This positive relationship between *EPU* and *VOLREER* agrees with the research by Robert (2014), which suggests that currency volatility during challenging economic times is influenced by both home-country and US economic policy uncertainty. This finding is in line with Zhou et al.'s (2019) discovery that the Sino-US *EPU* ratio has a favorable effect on the long-term volatility of the Chinese exchange rate.

Among the control variables, only Δ*INF* is significant in affecting the volatility of the USD (*VOLREER*) at the 1% significance because its p-value is smaller than 0.01. For an additional unit increase in the Δ*INF*, *VOLREER* is estimated to decrease by 22.2104 unit. This negative relationship is also consistent with the result in the model with all uncertainty indices. If the Federal Reserve increases interest rates to control inflation, this can increase demand for the currency, helping to maintain its value and reduce volatility. Higher interest rates make the currency more appealing to buyers seeking higher yields, which can lead to increased demand for the currency and thus help to maintain its value. Besides that, the control variables *FED* and *TBILL* are only weakly significant at the 10% significance level.

4.4.2 Model with Monetary Policy Uncertainty Index (*MPU*)

From the results presented in Table 4.4 above, the resulting estimated model for Equation (5) is as follows:

Mean Equation:

$$\widehat{\text{VOLREER}}_t = -0.0005MPU_t + 0.5391\Delta TOT_t + 0.3052FED_t - 20.9638\Delta INF_t - 0.3585TBILL_t + 1.4390$$

Variance Equation:

$$h_t = 0.1558 + 0.1092u^2{}_{t-1} - 0.0808u^2{}_{t-2} + 0.0562u^2{}_{t-3} + 0.0923u^2{}_{t-4} - 0.0604u^2{}_{t-5} + 0.3613h_{t-1}$$

Table 4.4: GARCH (5,1) of Equation (5)

Mean Equation						
C	MPU	ΔTOT	FED	ΔINF	TBILL	
1.4390***	-0.0005	0.5391*	0.3052**	-20.9638***	-0.3585**	
(0.0890)	(0.0006)	(0.3079)	(0.1528)	(6.8115)	(0.1630)	
Variance Equation						
C	u_{t-1}^2	u_{t-2}^2	u_{t-3}^2	u_{t-4}^2	u_{t-5}^2	h_{t-1}
0.1558 (0.3099)	0.1092 (0.0859)	-0.0808 (0.1266)	0.0562 (0.0687)	0.0923 (0.0998)	-0.0604 (0.1378)	0.3613 (1.2829)

Note: () is the standard errors. Number of observations is 341 after adjustment. *MPU* denotes Monetary Policy Uncertainty Index, *GPR* denotes Geopolitical Risk Index, *TOT* denotes Terms of Trade, *FED* denotes Federal Funds Effective Rate, *INF* denotes Inflation Rate, *TBILL* denotes United States Treasury Bill Rate. ∗∗∗, ∗∗ and ∗ denote significance at the 1%, 5% and 10% levels, respectively.

The results as shown in Table 4.4, *MPU* is not significant in affecting the volatility of the USD (*VOLREER*). For an additional unit increase in the *MPU* Index, the volatility of the USD is estimated to decrease by 0.0005 unit. This finding is not consistent with the model with all uncertainty indices (*EPU*, *MPU* and *GPR*) estimation which shows a significant negative relationship between *MPU* and *VOLREER*. This inconsistency may be due to misspecification of the model, with more accurate and comprehensive models providing different results. In this case, it is suggested that the model with all uncertainty indices is more correctly specified than the individual *MPU* model. This is supported by the fact that the model with all uncertainty indices has a lower AIC value (1.5897) than the individual *MPU* model (1.6033), indicating that the model with all uncertainty indices is a better fit for the data. Additionally, the model with all uncertainty indices has a higher adjusted R^2 value (0.1036) than the individual *MPU* model (0.0725), indicating that it explains a larger proportion of the variance in the dependent variable.

Among the control variables, *FED*, Δ*INF* and *TBILL* are significant in affecting the volatility of the USD (*VOLREER*) at the 5% significance. For an additional unit increase in the *FED*, *VOLREER* is estimated to increase by 0.3052 unit. A higher *FED* rate can also make a USD more attractive to international investors looking for bigger returns. This can result in an inflow of capital into the US, increasing demand for the USD and increasing its worth. Next, for an additional unit increase in the ΔINF, *VOLREER* is estimated to decrease by 20.9638 unit. This is because inflation is often associated with a stronger economy, which can attract foreign investment and increase demand for the USD. This increased demand can help to stabilize the value of the currency and reduce its volatility. Moreover, an additional unit increase in the *TBILL* is expected to decrease the volatility of the USD by 0.3585 unit. As the T-Bill rate increases, it becomes more expensive for the government to borrow money, which can lead to a reduction in government spending and a slowdown in the economy. Then, a higher T-Bill rate can also make US debt more attractive to foreign investors, which can increase demand for the USD and help to stabilize its value. At the same time, the control variable ΔTOT is only weakly significant at the 10% significance level.

4.4.3 Model with Geopolitical Risk Index (*GPR*)

From the results presented in Table 4.5 above, the resulting estimated model for Equation (6) is as follows:

Mean Equation:

$$\widehat{\mathrm{VOLREER}}_t = -0.0234GPR_t + 0.0502\Delta TOT_t + 0.2974FED_t - 25.1645\Delta INF_t - 0.3499TBILL_t + 1.4256$$

Variance Equation:

$$h_t = 0.1416 + 0.1657{u^2}_{t-1} - 0.0979{u^2}_{t-2} + 0.3670h_{t-1} + 0.2348h_{t-2} + 0.1727\, h_{t-3} - 0.0939\, h_{t-4} - 0.2487h_{t-5}$$

Table 4.5: GARCH (2, 5) of Equation (6)

Mean Equation							
C	GPR	ΔTOT	FED	ΔINF	TBILL		
1.4256***	-0.0234	0.0502	0.2974**	-25.1645***	-0.3499**		
(0.1058)	(0.0317)	(0.3358)	(0.1484)	(6.5489)	(0.1592)		
Variance Equation							
C	u_{t-1}^2	u_{t-2}^2	h_{t-1}	h_{t-2}	h_{t-3}	h_{t-4}	h_{t-5}
0.1416	0.1657	-0.0979	0.3670	0.2348	0.1727	-0.0939	-0.2487
(0.1022)	(0.0847)	(0.0934)	(0.4794)	(0.2421)	(0.2450)	(0.0597)	(0.2055)

Note: () is the standard errors. Number of observations is 341 after adjustment. *GPR* denotes Geopolitical Risk Index, *TOT* denotes Terms of Trade, *FED* denotes Federal Funds Effective Rate, *INF* denotes Inflation Rate, *TBILL* denotes United States Treasury Bill Rate. $***$, $**$ and $*$ denote significance at the 1%, 5% and 10% levels, respectively.

The results as shown in Table 4.5, *GPR* is not significant in affecting the volatility of the USD (VOLREER). For an additional unit increase in the *GPR* Index, the volatility of the USD is estimated to decrease by 0.0234 unit. This finding is consistent with the model with all uncertainty indices (*EPU*, *MPU* and *GPR*) estimation which shows *GPR* are not significant in explaining the volatility of the USD. However, the finding of insignificant effect of geopolitical risks on the volatility of USD contrasts with Eyyüp and Halil's (2020) study which found that geopolitical risks have a significant effect on stock market and exchange rate volatility. The difference in the findings could be due to the difference in the modeling approach used to examine the relationship between geopolitical risk and volatility of USD. Eyyüp and Halil (2020) use a Nonparametric Causality-In-Quantiles Test approach, while this study used a GARCH model. Additionally, the long sample period used in this study may have diluted the effect of geopolitical events that could impact the volatility of USD, while the sample period in the work of Eyyüp and Hail (2020) starting from January 2005 until April 2018 may have captured a period with heightened geopolitical events which were sufficiently concentrated to establish a statistical relationship with stock market and exchange rate volatility. Political risk can be difficult to quantify and evaluate, making it difficult to integrate into financial models. Therefore, its effect on financial markets could be less predictable.

Among the control variables, *FED*, Δ*INF* and *TBILL* are significant in affecting the volatility of the USD (*VOLREER*) at the 5% significance. For an additional unit increase in the *FED*, *VOLREER* is estimated to increase by 0.2974 unit. When *FED* rise, investing in a particular currency becomes more profitable, which can make that currency more attractive to investors. This increased demand for a currency can lead to an appreciation in its value, which can lead to increased volatility as the currency responds to market fluctuations. Next, for an additional unit increase in the Δ*INF*, *VOLREER* is estimated to decrease by 25.1645 unit. High inflation can potentially lead to a decrease in USD volatility if the market expects the Federal Reserve to respond by raising interest rates. This can increase demand for the USD and potentially stabilize its value, resulting in decreased volatility. Moreover, an additional unit increase in the *TBILL* is expected to decrease the volatility of the USD by 0.3499 unit. Raising T-bill rates can reduce market volatility by showing the Federal Reserve's trust in the economy and readiness to take inflation-control measures. As investors and traders obtain better transparency on the market's path and feel more confident in making financial choices, volatility may decrease. However, the control variable Δ*TOT* is not significant at the 10% significance level.

4.4.4 Model with All Uncertainty Indices (*EPU, MPU* and *GPR*)

From the results presented in Table 4.6, the resulting estimated model for Equation (7) is as follows:

Mean Equation:

$$\widehat{\text{VOLREER}}_t = 0.0021EPU_t - 0.0013MPU_t + 0.0130GPR_t + 0.5977\Delta TOT_t + 0.2745FED_t - 17.7156\Delta INF_t - 0.2678TBILL_t + 1.0713$$

Variance Equation:

$$h_t = 0.1320 + 0.1200u^2{}_{t-1} - 0.0968u^2{}_{t-2} + 0.4785h_{t-1} + 0.0174h_{t-2}$$

Table 4.6: GARCH (2, 2) of Equation (7)

Mean Equation							
C	EPU	MPU	GPR	ΔTOT	FED	ΔINF	TBILL
1.0713***	0.0021***	-0.0013**	0.0130	0.5977***	0.2745*	-17.7156***	-0.2678*
(0.1144)	(0.0004)	(0.0006)	(0.0267)	(0.1909)	(0.1504)	(3.2138)	(0.1605)
Variance Equation							
C	u^2_{t-1}	u^2_{t-2}	h_{t-1}	h_{t-2}			
0.1320	0.1200	-0.0968	0.4785	0.0174			
(0.2342)	(0.0803)	(0.0837)	(0.5910)	(0.4382)			

Note: () is the standard errors. Number of observations is 341 after adjustment. *EPU* represents the Economic Policy Uncertainty Index, *MPU* denotes Monetary Policy Uncertainty Index, *GPR* denotes Geopolitical Risk Index, *TOT* denotes Terms of Trade, *FED* denotes Federal Funds Effective Rate, *INF* denotes Inflation Rate, *TBILL* denotes United States Treasury Bill Rate. ∗∗∗, ∗∗ and ∗ denote significance at the 1%, 5% and 10% levels, respectively.

The results as shown in Table 4.6 reveal that out of all the three uncertainty indices, only *EPU* and *MPU* are significant in affecting the volatility of the USD (*VOLREER*). For an additional unit increase in the *EPU* Index, the volatility of the USD is estimated to increase by 0.0021 units. This finding is consistent with the studies of Elif et al. (2017), which employed VAR models that show the overall EPU index co-varies positively with implied volatilities for Japanese equities and exchange rates. The MIDAS (mixed data sampling) model used by Maria et al. (2022) indicates that the *EPU* index has predictive power to forecast Pakistan's stock market volatility. The positive relationship between *EPU* and *VOLREER* is also displayed in the studies of Chen et al. (2019), Kazi et al. (2021), Robert (2014), Khalid and Mohammad (2021) and Zhou et al. (2019). An increased level of *EPU* can have a significant impact on exchange rate volatility, as uncertainty and unpredictability can lead to increased risk aversion among investors, causing them to reduce their investments in the stock market. This lack of confidence can prompt investors to shift their investments to other currencies or assets perceived as less risky. This is related to *EPU* can create uncertainty about future economic conditions, and then the capital flows move away from a particular country, putting downward pressure on the exchange rate (Chen et al., 2020). Next, *EPU* increases cause changes in expectations about future economic situations. For example, investors think that economic strategy will become more accommodating in the future. To promote economic development, the accommodative policy usually includes increasing government expenditure or lowering interest rates. If such policies are adopted, investors may expect inflation to rise consequently. Higher inflation reduces the worth of a currency over time by reducing its purchasing power. Therefore, investors may trade their currency assets, causing their worth to decline in the foreign exchange market. As the value of the USD compared to other currencies becomes more uncertain, devaluation can contribute to increased exchange rate volatility.

Moving on to the *MPU*, an additional unit increase in the *MPU* index is expected to decrease the volatility of the USD by 0.0013 unit. This negative relationship is consistent with some studies in literature such as Alexander and Raluca (2017) and Donghyun et al. (2020). According to Alexander and Raluca (2017), a higher *MPU* strengthens the foreign exchange markets which means that *MPU* can lower the volatility of the USD. According to their research, higher levels of monetary policy uncertainty have a stronger effect on 10 out of the 22 macroeconomic releases analysed concerning the foreign exchange market.

One of the aspects of the *MPU* index, "interest rate(s)" and "Federal fund(s) rate" may capture uncertainty arising from unexpected changes or surprises in monetary policy, such as unexpected interest rate raise or cuts. When the *FED* increases, it is generally expected to strengthen the value of the US dollar, which could potentially lead to a decrease in exchange rate volatility. This is due to when the *FED* increases, it typically leads to an increase in other short-term interest rates as well, as other rates tend to move in tandem with the *FED*. This increase in interest rates can make it more attractive for foreign investors to invest in US financial assets, as they can earn a higher return on their investments. When foreign investors invest in US assets, it increased demand for USD and strengthens the value of USD relative to other currencies, which could lead to lower volatility in the exchange rate. Other than that, when the *MPU* increases, it can create uncertainty in the market and increase the perceived risk of investing in certain assets. The US has a relatively stable political and economic system, and the US dollar is one of the most widely used currencies in international trade. This uncertainty can lead investors to seek safe havens such as the USD and US Treasury bills to reduce risk. The rise in demand for US assets has the potential to reduce exchange rate volatility by boosting the value of the USD. This contributes to a decrease in exchange rate volatility, as the relative stability of the US economy and financial system can make it an attractive destination for investors seeking to reduce risk.

On the other hand, *GPR* is not significant in explaining the volatility of the USD. This result is in contrast with Khalid and Mohammad (2021). It means that the relationship between *GPR* and the *VOLREER* is not statistically significant at the chosen level of significance. Based on previous studies by other researchers, a positive relationship between these two variables was expected. Investors may be willing to take on additional risks associated with geopolitical instability for the potential return of investing in a growing economy. This increases the demand for the currency and leads to appreciation, which reduces its volatility. However, this may occur because high geopolitical risk can lead to a decrease in demand for USD, increased uncertainty and unpredictability in the financial markets, and increased speculation and risk aversion among investors, all of which can increase exchange rate volatility. This could suggest that other factors are having a greater impact on the dependent variable or size of the sample is inadequate. to detect a significant relationship.

Among the control variables, only ΔTOT and ΔINF are significant in affecting the volatility of the USD (*VOLREER*) at the 1% significance because its p-value is smaller than 0.01. For an additional unit increase in the ΔTOT, *VOLREER* is estimated to increase by 0.5977 unit. This means that a positive change in the term of trade is associated with an increase in the volatility of the exchange rate in the US which is consistent with the result of Raza and Afshan (2017). An increase in *TOT* indicates demand for US exports is increasing. This indicates that the US can buy more imports while exporting the same amount. A devaluation of exchange rates may occur when export prices increase and lead to a decline in revenue, particularly in an elastic export demand scenario, given that the US is a significant open economy. Next, for an additional unit increase in the ΔINF, *VOLREER* is estimated to decrease by 17.7156 unit. A decrease in *VOLREER* means a more stable and predictable exchange rate happens in the US. This can be seen as a sign of stability and predictability in the foreign exchange market and can be attractive to investors and businesses that operate internationally. However, this negative relationship is inconsistent with Robert (2014) that proved higher *INF* will increase exchange rate volatility. In this case, higher inflation can achieve a more stable exchange rate if the US central bank implements effective monetary policy measures to control inflation. For example, if the Fed raises interest rates to control inflation, this can increase demand for the currency, which can help to stabilize its value and reduce its volatility. Meanwhile, the control variables *FED* and *TBILL* are only weakly significant at the 10% significance level.

CHAPTER 5: CONCLUSION, POLICY IMPLICATIONS AND LIMITATIONS

5.0 Introduction

In this chapter, the main findings and policy implications of the study are summarized. Section 5.1 outlines the variables and results of the analysis for each of the three uncertainty measures (*EPU*, *MPU*, and *GPR*). Section 5.2 discusses the policy implications of the study for each of these measures, highlighting the potential implications for policymakers, businesses, and individuals. Finally, section 5.3 identifies some limitations of the study and suggests areas for future research.

5.1 Summary

In this study, the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model is employed to investigate the relationships between different types of uncertainty and the volatility of the USD from January 1994 to June 2022. The three types of uncertainties are the Economic Policy Uncertainty Index (*EPU*), Monetary Policy Uncertainty Index (*MPU*), and Geopolitical Risk Index (*GPR*). The examinations of these relationships are controlled by other factors such as terms of trade (*TOT*), federal funds effective rate (*FED*), inflation rate (*INF*), and US Treasury bill rate (*TBILL*) in the analysis. The finding of the analysis suggests that the full model, which includes multiple predictor variables, is the most suitable model for explaining the dependent variable, as it has a lower AIC value and a higher adjusted R^2 value than the individual models, indicating a better fit for the data. Additionally, the positive and significant impact of the *EPU* index on USD volatility in the full model has increased from 0.0017 to 0.0021.

The main findings indicate that only *EPU* and *MPU* are significant in affecting the volatility of the USD (*VOLREER*) out of all the three uncertainty indices. *EPU* has a positive and significant impact, while *MPU* has a negative and significant impact on *VOLREER*. The finding that the Geopolitical Risk Index (*GPR*) is not significant in explaining *VOLREER* suggests that geopolitical events and risks do not play a major role in driving US exchange rate volatility. However, the geopolitical risk may be more important in other countries or regions, and further research is needed to explore this possibility. Additionally, the model with all uncertainty indices has a lower AIC value than the individual *MPU* model, this is suggesting that the full model is more correctly specified. Finally, this study highlights the importance of understanding the relationship between uncertainty and exchange rate volatility and policymakers need to implement appropriate measures to manage exchange rate volatility and promote economic stability.

5.2 Policy Implications

Higher exchange rate volatility is generally considered bad for the economy as it causes instability and confusion and affects the decision-making of financial market participants. The US government can lower the *EPU* by improving the transparency and predictability of economic policy. Policymakers can promote openness by sharing information about their policy choices openly, revising policy decisions and their intended impacts regularly, and working with stakeholders to settle issues and seek input. For example, Federal Open Market Committee (FOMC) which meets eight times a year issues press releases that report the outcomes of its planned sessions. US central bank may consider increasing policy openness by increasing the frequency of FOMC meetings and releasing more information to businesses and customers, such as issuing regular reports on the outcomes of these meetings and seeking input from stakeholders. As a result, investors around the world will be able to concentrate more on the Committee's evaluation of economic and financial circumstances, as well as its monetary policy choices. This includes economic strategy, which is frequently a hot subject at FOMC meetings. Thus, policymakers can create more secure and predictable business and investment environments that can reduce exchange rate volatility and advance economic stability. Additionally, those businesses and investors with high exposure to the USD should give more consideration to the *EPU* in the US, as it can assist them in formulating their business, investment, and adjust their strategies accordingly, such as by implementing appropriate hedging strategies to mitigate risks.

Based on the results of the study, *MPU* has a negative impact on US *REER*, this shows increased uncertainty in monetary policy can reduce the volatility of the USD exchange rate. This finding implies that monetary policy uncertainties are less of a concern for businesses, consumers, investors, and policymakers. Businesses engaged in international trade and investment are exposed to currency risk, which arises from the fluctuation in exchange rates. Such fluctuations can lead to fluctuations in the prices of goods and services, increase in transaction costs, and impact the competitiveness of a business. However, if the volatility of the exchange rate is reduced, businesses can have greater certainty about the prices of goods and services, which can help them plan and make more informed decisions. This can ultimately reduce the risk of unexpected exchange rate movements impacting their operations and profitability. For customer, reduced exchange rate volatility could lead to lower inflation and more stable prices for imported goods, which could benefit consumers by improving their purchasing power and reducing the risk of sudden price increases. From the perspective of investors, a reduction in exchange rate volatility may provide more stable returns for investors engaged in foreign exchange markets, making it easier to plan and manage their investments. It is possible that investor confidence in the US economy and financial markets may increase, which may attract more investment to the country. Understanding the relationship between *MPU* and exchange rate volatility could inform policymakers' decisions on monetary policy and regulatory frameworks to promote greater stability in the economy. This may involve implementing measures to reduce uncertainty and improve transparency in the monetary policy process, which could lead to greater confidence in the US economy and financial markets.

Lastly, periods of high monetary policy uncertainties and geopolitical tensions should not be a concern as these uncertainties either reduces or have no impact on the volatility of the USD. The monetary policy uncertainties and geopolitical tensions can cause significant market disruptions that impact the value of the USD

5.3 Limitation

One of the limitations of this study is to use only *VOLREER* data and not *REER* to analyse exchange rate movements and their impact on the economy because the *REER* data here are not stationarity. While *VOLREER* can provide important insights into the behaviour of exchange rate movements, it may not provide a complete picture of how exchange rates affect the economy. If *REER* is excluded, the results may omit information about the overall level and trends of exchange rates, and how changes in exchange rates affect trade and investment flows between countries. Therefore, it is recommended to include both *VOLREER* and *REER* data in further studies to provide a more comprehensive analysis.

Next, this study covers the long period from January 1994 to June 2022. It is possible that some key factors that could influence the association between uncertainty and exchange rate volatility have not been taken into account. To work around this limitation, it may be useful to investigate a longer period or to perform an independent analysis of recent times. Furthermore, it may be valuable to include other economic factors such as foreign direct investment (*FDI*), gross domestic product (*GDP*), and unemployment in future studies to gain a more complete understanding of the topic.

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