Geopolitical Risk
and
Stock Market Volatility

United International University
QUEST FOR EXCELLENCE

Geopolitical Risk & Stock Market Volatility

Submitted To

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Dear Sir,

I respectfully submit my project report titled "Geopolitical Risk & Stock Market Volatility," prepared to meet the requirements of the Bachelor of Business Administration (BBA) program with a major in Finance & FinTech at United International University. This report explores how uncertainty factors affect fluctuations in financial markets. The main aim of this study is to understand how Economic Policy Uncertainty (EPU) and Geopolitical Risk (GPR) influence stock market ups and downs. The findings show that both factors increase ups and downs.

In preparing this report, I have tried to present the analysis clearly and systematically while following academic standards. I am deeply thankful for your guidance and support, which has been essential in completing this work.

I would be grateful if you kindly review this report and give feedback.

Sincerely,

Sadia Islam

ID: 111 221 003

Acknowledgement

I would like to thank everyone who helped me complete this project.

First, I am very grateful to Almighty Allah for giving me the strength, patience, and determination to finish this research successfully.

I would like to sincerely thank my supervisor, Md. Mohan Uddin, PhD, Professor at the School of Business & Economics (SoBE), United International University, for his guidance, advice, and support throughout this project. His suggestions and feedback were very helpful in completing this study.

I am also thankful to United International University for providing the resources and environment that made this work possible.

I would like to thank my friends and classmates for their help, advice, and encouragement during this project.

Finally, I am deeply grateful to my family for their love, support, and understanding, which gave me the motivation to complete this work.

Abstract

This study shows how Economic Policy Uncertainty (EPU) and Geopolitical Risk (GPR) affect stock market ups and downs in 17 major countries from January 2012 to December 2025. This study used a Panel Fixed Effects model. This study also uses three types of market changes: absolute volatility, squared volatility, and 12 month rolling volatility. It uses last month's values to show how markets react with a delay.

The results shows that both EPU and GPR make the market unstable. But their impacts are different from each other. That means they did not affect the market in the same way. EPU has a strong and most steady effect. From This we can see investors care a lot about to changes. Markets react quickly to global events. Then they adjust soon. The effect does not last long.

The study also shows that GDP growth. The market becomes more stable when there was a GDP growth. This means a strong economy helps to keep financial markets stable.

So, these findings show that stable economic policies are more important mainly for long-term market stability. This can help policymakers reduce uncertainty. And it will also help investors to make better decision.

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1.0 Introduction

In recent years, geopolitical events have become an important factor for global financial markets. Geopolitical events like political problems, trade restrictions and bad relation between countries. All these events create uncertainty in the global economy. When uncertainty increases, investors become more careful. This makes stock prices go up and down. This means financial markets are closely connected.

Information from the International Monetary Fund (IMF, 2025) shows that high geopolitical risk can affect financial markets negatively. During this times, global stock prices fall by about 1 percent. In emerging markets, the decline can be larger than developed markets. It go down nearly 2.5 percent in emerging markets. So emerging markets are more sensitive to global events. So finally, we can say that high geopolitical risk reduces investor's confidence. And their low confidence makes the financial markets unstable.

That's why, it has become more important for investors, policy makers and researchers to understand how geopolitical risk affects the stock market ups and downs. This study tries to understand the relationship between geopolitical risk and stock market volatility. And it also tries to find out how political uncertainty can affect financial markets in both developed and emerging economies(*Global Financial Stability Report, April 2025: Enhancing Resilience amid Uncertainty*, n.d.).

1.1 Research Background

1.1.1 Global Context

Nowadays financial markets are highly connected. This means that a conflict can affect global markets within a few hours. Political problems, trade issues like restrictions create uncertainty for investors. When uncertainty increases, investors become more careful. That makes the market unstable. Investors sell their risky assets like stocks. And they try to move safe options like gold, government bonds or cash(Stevens, 2024).

For example, the U.S. and China trade tensions from 2018 to 2020. During this time, the United States imposed extra taxes that is called tariffs. That was more than $200 billion worth of goods from China. For this reason, investors became upset about global supply chains. The S&P 500 stock index fell by 13.2%. It dropped from 2,930.75 on September 20, 2018 to 2,546.16 on December 18, 2018. After that, tensions became less and some agreements were made. So, the stock market again recovered to 3,037.60 by October 31, 2019. In this example we can see how trade problems between two countries can affect stock markets around the world. It also create problem for businesses and investors(*CBOE Volatility Index Historical Rates (VIX) - Investing.Com*, n.d.).

Also, OPEC+ is a group of major oil producing countries. So, they decide how much oil to be produce. And this can change the oil price around the world. In December 2025, OPEC+ increased the oil production by 137,000 barrels per day. Next month, they produced 439,900 less barrels each day. So, the price of the oil around $65 for per barrel. These changes create inflation. Companies may have to pay more and investors become upset (*StreetInsider.Com - OPEC+ Navigates Volatile Waters: Modest Output Hike Followed by Q1 2026 Pause Aims for Oil Market Stability*, n.d.). So, we can say that geopolitical risks are not about one country. It

can affect the whole world. Any kind of political problem, trade issue can reach to global financial markets. That makes investors and policymakers worried everywhere.

1.1.3 Geopolitical Risk (GPR)

Geopolitical Risk means uncertainty. It happens because of wars, punishment and political tensions between countries. Normal economic changes happen slowly. But geopolitical risks happen suddenly. They are unpredictable. That makes difficult for investors and policymakers.

Caldara and Iacoviello (2022) developed the GPR Index to measure the risk. It looks at news to see which countries have political problems. They read news about wars and political problem between countries. This tool shows us how political problem can affect financial market around the whole world.

1.1.4 GPR Affects Stock Markets

Geopolitical risk affects stock markets in two main ways. They are given below:

1. Direct Effects: Wars, punishment between countries and trade rules can stop supply chains. They can make goods more expensive and slow down business. This can make companies earn less money. According to the IMF (2025), big geopolitical events make global stock prices fall by about 1% on average. In developing countries, the drop can be around 2.5%. For example, during the U.S. and China trade tensions, some S&P 500 companies lost an extra 3–5% because of trade uncertainty(*The Economic Costs of the 2018 US-China 'Trade War,'* 2018) ; (*How Rising Geopolitical Risks Weigh on Asset Prices*, 2025).

2. Investor Sentiment Effects: As we know fear and uncertainty can also change investors behavior. Investors move their money from risky assets like stocks to safe option like gold or government bonds. This makes the market more unstable. The VIX, which measures market ups and downs. And can go up 20–50% during major geopolitical events. For example, on

December 18, 2018, fear from the U.S. and China trade war made the S&P 500 fall by 13.2%. It dropped from 2,930.75 in September to 2,546.16.

So, we can say, geopolitical risk affects markets in two ways. First one real economic problem. Second one investors behavior. Both ways can make markets more volatile around the world.

1.1.5 Regional Differences

Geopolitical risks affect countries in different ways. If we look down, we can see their financial markets performance.

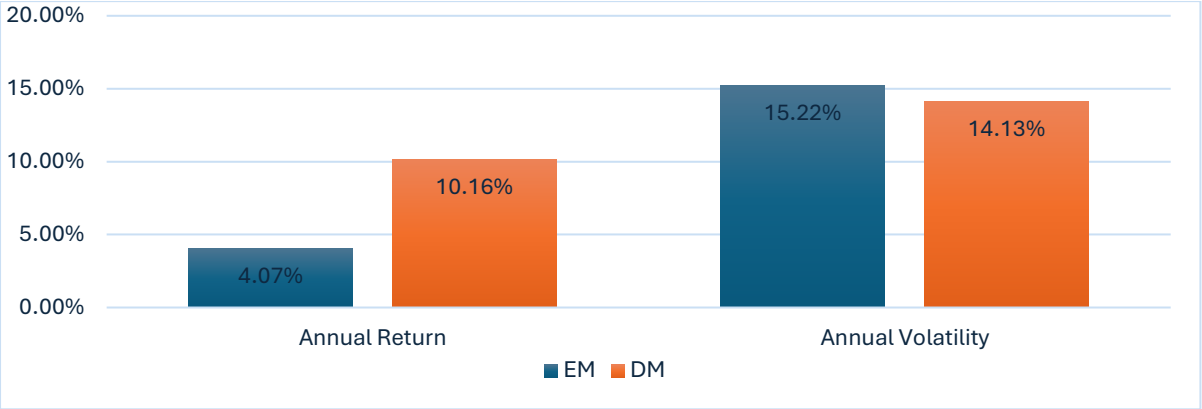

Figure 1: Developed & Emerging Market's Annual Return Vs Annual volatility.

If we look at Figure 1, we can see the MSCI World (Developed Markets, DM) and MSCI Emerging Markets (EM) indices. They show the differences clearly. Developed markets give higher yearly returns that is 10.16%. They also have lower ups and downs that is 14.13%. This means they grow more steadily and have lower risk for investors. In Emerging markets give lower returns 4.07%. But their ups and downs are higher 15.22%. This means their prices change more and they are more affected by political and economic problems. Overall,

developed markets are safe and more profitable but Emerging markets have higher risk.

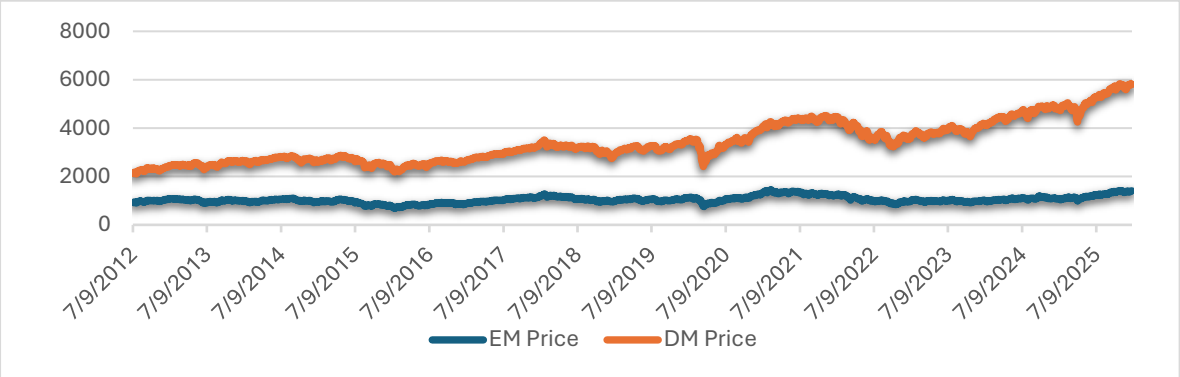

Figure 2: Developed & Emerging Markets price.

(*MSCI World Historical Data (MIWO00000PUS)*, 2026) ; (*MSCI Emerging Markets Historical Data (MSCIEF)*, 2026)

In Figure 2, we can see that developed markets, like the U.S., Germany, and Japan. They are developed country. They have strong economy and their strong economy help them recover very fast from the sudden come big event. So better economy country can recover fast because their economy help them. In the above figure 2 we can see developed market grow day by day from 2012 to 2025. Their economy help them recover quickly from any kind of problem. We can see they recover from 2020 covid and 2022 market fall because of war. They recover quickly after problems like the 2020 pandemic and the 2022 market drop. They have strong economy that's why big tech company and strong currency helped them. On the other hand, emerging markets like India, Brazil and many countries in Africa or Southeast Asia. Their economy was not strong. They grow more very slowly. They don't have economy backup that's why they have more ups and downs. The same political pr global events also affect them but they could not recover fast like developed country economy. They took more time to recover because of economy. So we can say, developed markets are safe for investors. They have growth opportunity that make investor feel safe. And emerging markets are risky for investors.

1.2 Research Problem

There are many studies who have studied have on Geopolitical Risk and Economic Policy Uncertainty to understand stock market return and risk. Their main focus on how they affect stock market ups and downs. As we know a study can't cover all the factors so there was gap. Firstly, we can see most of the studies focus only developed markets or emerging markets. They did not focus both. There was a difference of their economy that react differently. That's why we have uses data of 17 countries. From them 8 developed and 9 emerging economic country. It's main focus to see if GPR and EPU both affect developed and emerging markets in the same way. Secondly In some previous research finds a strong relationship between GPR and market ups and downs. Many studies do not check the across countries effect and also do not check long term patterns. So, we use Driscoll-Kraay standard errors that helps us to see GPR's effect that is weak or strong. Thirdly most of the studies use absolute return method. Absolute return method gives a small view. So, to understand better we use 3 measuring method. Those methods are absolute returns, squared returns, and rolling standard deviations. These methods helps us to get a better view. So that we understand the impact of uncertainty on financial stock markets. Here we don't have enough recent data after the pandemic. In this study we include data up to September 2025. It looks at how GDP growth can help reduce market ups and downs during uncertain times. Overall, this study fills these gaps. It compares developed and emerging markets. It uses multiple ways to measure market risk and recent data. This gives a complete and updated picture of how markets behave during uncertain times.

1.3 Research Question

This study looks at the following questions:

1. How do Geopolitical Risk (GPR) and Economic Policy Uncertainty (EPU) affect stock market ups and downs?

2. Do GPR and EPU affect Developed and Emerging markets in different ways?
3. Can real GDP growth help reduce market ups and downs?

To answer these questions, the following alternative hypotheses were tested

1. H1: Economic Policy Uncertainty makes stock market ups and downs.
1. H2: Geopolitical Risk (GPR) has a weak and less clear effect on market ups and downs than EPU.
2. H3: Real GDP growth can reduce stock market ups and downs in both Developed and Emerging markets.

1.4 Significance of the Research

This study is important for many reasons. Because it shows that Economic Policy Uncertainty is a main reason of stock market ups and downs. So, Stable and clear policies are needed to keep markets stable. For investors and portfolio managers, this study is very much useful. It shows that Geopolitical Risk has a weak and less clear effect than EPU. GPR have weak effect that is very important information for investor. So this information help investor make better decision and invest their money in safe option. So that they keep their money safe. In this study we have use 3 method that helps us to understand the effect of developed and emerging countries. Here we can see strong GDP growth helps the market recover very fastly from any problem. And this information is also useful for banks or any kind of financial institutions if they plan for future. Finally, this study we have 17 countries data from 2012 to 2025. Here we fills a gap that we see the effect of after the pandemic and tries to give update information for financial professionals. So that they could use it in future.

2.0 Literature Review

2.1 Impact of Geopolitical Risk on Stock Market

2.1.1 Geopolitical Risk and Financial Market Uncertainty

The existing studies show that geopolitical risk makes financial markets more risky and causes stock prices to change a lot. But this does not happen the same way in every country. For example, (Hachicha, 2023) explains that geopolitical risk affects how investors feel, exchange rates, and stock markets in developing countries. During the Russia–Ukraine war, both stock markets and currency markets became more risky. This shows that conflicts in one place can create uncertainty in many parts of the financial system at the same time. Similarly, (Ahmed, 2023) finds that not all markets react the same way. The reaction is different in E7 countries (emerging economies) and G7 countries (developed economies). Some markets face more ups and downs depending on their economic strength and financial setup.

2.1.2 Market Vulnerability and Firm-Level Effects

At a bigger level, studies show that geopolitical shocks affect many financial markets. (Alsadan et al., 2025) find that these shocks have long-term negative effects on housing, bond, and stock markets. Emerging markets are more weak. They face stronger ups and downs than developed countries. In another study, (Darsono et al., 2024) show that geopolitical risk affects Indonesia's sustainable stock market. This happens in both the short run and the long run. It means that geopolitical problems can change how market risk works over time.

At the company level, (Golden et al., 2024) find that geopolitical risk in a firm's home country reduces its value. This shows that companies face more risk during uncertain times. But the study also shows something positive. Strong management and clear information can reduce these negative effects.

2.1.3 Cross-Market and Sectoral Volatility Transmission

In developed countries, (Salisu et al., 2022) find that geopolitical risk strongly affects stock markets. They show that markets react more to threats than to real events. This means fear and expectations play a big role in market changes. In emerging markets, (Hoque & Zaidi, 2020) find that the effect is not always the same. It depends on the market condition.

When markets are already unstable, geopolitical risk increases volatility more. But when markets are stable, the effect is smaller. (Zhou & Liang, 2025) find a strong link between geopolitical risk and gold price bubbles. This shows that political problems can increase gamble even in safe assets like gold.

(Yang et al., 2025) show that geopolitical risk affects the US dollar, oil, and gold markets together. During big conflicts, risk increases financial instability. It also changes how information moves across markets.

At the sector level, (S, 2025) finds that geopolitical risk increases volatility in different sectors of the Indian stock market. They also find that threats create stronger and longer effects than actual events.

Overall, studies show that geopolitical risk is a major reason for financial risk and market volatility around the world. But its effect is not the same in every country. It is stronger in emerging and weaker economies. It also changes across different sectors. The impact becomes bigger when there is more uncertainty, strong market connections, and sudden changes.

2.2 Future Directions

2.2.1 Expanding Country and Event-Based Research

The studies give some ideas for future research on geopolitical risk and market volatility. (Hachicha, 2023) suggests studying more developing countries, longer time periods, and different crisis events. This will help us understand how risk changes over time.

(Ahmed, 2023) suggests looking at more types of geopolitical events. He also says we should include different types of assets. This will show how volatility affects them in different ways.

(Alsadan et al., 2025) suggest studying how global uncertainty increases volatility in different markets and assets.

2.2.2 Firm-Level, Sectoral, and Policy Analysis

(Darsono et al., 2024) suggest studying sustainable markets in more emerging countries. This will help us understand the topic better.

(Golden et al., 2024) suggests looking at differences between sectors. He also says companies should improve how they share information to reduce risk.

(Salisu et al., 2022) suggests using different ways to measure geopolitical risk and recommends improving prediction models to forecast risk better. (Hoque & Zaidi, 2020) suggest using more detailed risk measures. They also say we should study how policies work together under different market conditions.

2.2.3 Multi-Asset and High-Frequency Data Approaches

(Zhou & Liang, 2025) suggest studying more commodities. They also say we should use faster data to better find price bubbles caused by risk. (Yang et al., 2025) suggests adding more types of assets and recommends comparing different conflicts. This will help us understand how risk spreads across markets.

(S, 2025) suggests using high-frequency data, like intraday data. This helps to study short-term changes more clearly. He also says we should study how global risk and local policies work together.

Overall, these ideas show that future research should be wider and more detailed. It should include more countries, sectors, and asset types. It should also use better models and faster data. This will help us understand how geopolitical risk affects financial risk and stock market volatility.

3.0 Research Methodology

3.1 Data and Sample

For this study we have collected monthly data of 17 countries. This data covers April 2012 to September 2025 with 2,689 observations in total. So the include period is important because this includes big global events like covid 19 and recent political problem. And all these geopolitical events already had impact on financial stock markets that create market ups and downs. There are 17 countries divided into two groups Developed and emerging. So there are 8 Developed Markets. They have strong economy. They are Australia, Canada, France, Germany, Italy, Japan, UK, and USA. There are 9 Emerging Markets. They have weak economy and they are Brazil, China, India, Indonesia, Mexico, Russia, Saudi Arabia, South Korea, and Turkey. From this we can see how different market react differently. How their economy have been affected and how much time they need to recover.

Here, the independent variables are Geopolitical Risk (GPR) and Economic Policy Uncertainty (EPU). These are the main variable. Independent variable come from the Economic Policy Uncertainty database. This database is based on work by Caldara and Iacoviello (2022) and Baker, Bloom, and Davis (2016). Here we have one control variable that is GDP growth. We have collected this from IMF (International Monetary Fund). The dataset we have prepared for this analysis is complete about 97.6% of data available. And this helps to makes the results accurate.

3.2 Variable Construction and Transformation

Here we have 2 independent variable, 1 control variable and 1 dependent variable.

Table 1: Data Source and Variable Details

Variable	Description	Frequency	Unit	Source	Link
Geopolitical risk	Measures geopolitical tensions	monthly	index(100=baseline)	EPU	Economic Policy Uncertainty Index
Economic Policy Uncertainty	Policy uncertainty index country by country	monthly	index	EPU	Economic Policy Uncertainty Index
Stock Index Prices	Major national stock index	monthly	index	Investing.com	Investing.com - Stock Market Quotes & Financial News
GDP Growth	Quarterly GDP growth rate	Quarterly	%	IMF	World Economic Outlook - All Issues

In table1 we can see all the variable that we have used in this study. We have 2 independent variable and we have monthly data and 1 control variable that have quarterly data. We have used these 3 variables to understand markets ups and downs. Here stock market volatility is a dependent variable. We have used 3 types of measurement way those are absolute return. Squared return and rolling 12-month standard deviation. These 3 ways helps us to understand the effect of short term and long term.

We have used GDP growth as a control variable. It helps us to understand how it react in different economy. that's why in 17 countries we have taken 8 developed markets and 9 emerging market. So that we can understand the situation of strong and weak economies. For

GDP growth we have quarterly data. So to convert it monthly we have use same data within that month. For this analysis we have also convert GPR and EPU data into natural logs (LN).

The independent variable move back by one month like (t-1) so that we understand the delay market reactions.

3.3 Econometric Specification and Robustness

In this study we have use a Panel Fixed Effects (FE) model. And this panel fixed effects use to control thikng. It controls things that does not change over the time and it also helps us to reduce biasness. So here we use control variable to control things that does not change over time for each country and also for events. Using this panel fixed effect method we will get accurate result why market go ups and downs. So the main model was given below:

$$Vol_{i,t} = \alpha + \beta_1 \ln (GPR)_{i,t-1} + \beta_2 \ln (EPU)_{i,t-1} + \beta_3 GDP\_Growth_{i,t} + \eta_i + \gamma_t + \epsilon_{i,t}$$

Here we can see Volatility_i,t that help us to see how stock market ups and downs for country.i at time t. α and delta t show country-specific and time-specific fixed effects. For better results we have selected a the best method. That's why, this study uses a Hausman test and an F-test. These tests helps us to see the Fixed Effects model is better than Random Effects or Pooled OLS models. It proves that each country had some own hidden differences that are different from others. In this study we have also uses Driscoll Kraay standard errors to correct problems. Those problems are cross country problem, variance differences and the repeated patterns in the data. Abd this helps us to get better and more accurate and results. In this study we have uses three ways to measure volatility. They are Absolute return, Squared return and Rolling 12 month standard deviations.

4.0 Findings

4.1 Descriptive Statistics

Here in Table 2 we can see a summary of 2 independent variable and 1 control variables we have used in this study and also the absolute, squared and rolling 12-month volatility. We can see we have 2689 monthly observations from April 2012 to September 2025. This data includes 17 countries. 8 developed and 9 emerging markets. And provide a clear view for the analysis what we have to do.

Table 2: Summary Statistics of Variables

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Abs. monthly return volatility	2,689	0.0358	0.0281	0.0319	0	0.3002
Sq. monthly return volatility	2,689	0.0023	0.0007	0.0051	0	0.0901
Rolling 12-month volatility	2,689	0.0451	0.0413	0.0177	0.0097	0.123
Lagged log GPR	2,689	0.3301	0.1906	0.3476	0	2.2823
Lagged log EPU	2,689	5.0891	5.0295	0.6458	2.4924	7.3996
GDP growth	2,689	0.0126	0.0122	0.0211	-0.131	0.1265

Here we can see the mean, median, std dev, min and max of all 3 variable and it helps us to see how the markets are reacting. Here we can see 3 ways that helps us to measure volatility. Here we can see the mean of absolute monthly return volatility is 0.0358. This means in average stock prices could be change about 3.59% on each month. The maximum value is 0.3002. Maximum value means sometimes the market have very big changes and it makes the market

unstable. This shows that sometimes the market had very big changes. Then Squared monthly return volatility shows high changes. Any big high changes come in it highlight that. Squared monthly volatility is sensitive to high changes. Rolling 12-month volatility measure one year volatility. Here we can see a higher mean value 0.0451 and a lower standard deviation of 0.0177. This means long-term volatility is more stable than short term. This does not go ups and downs like short-term volatility. Now we focus on the main variables. Those are lagged log GPR, lagged log EPU and GDP growth. The mean of Lagged log GPR is 0.3301 and standard deviation is 0.3476. here the standard deviation is little high than the mean. So we can say geopolitical risk is low but suddenly it can go up when any global events happened. Its maximum value is 2.2823 that supports that when war come it go up.

Then the lagged log of EPU has a high mean that is 5.0891 and standard deviation is lower that is 0.6458. This means that policy uncertainty is more stable, it does not easily go ups and downs. And then GDP growth, the mean is 0.0126 and the median is 0.0122. which means are same almost. So, here the data is well balanced and this GDP growth is not affected by high values. Here we have both positive and negative growth.

Finally we can say the mean and median of above mentioned variables are similar. That means the data is not heavily skewed. We use lagged values of GPR and EPU to see how today's events affect later and also to get correct result.

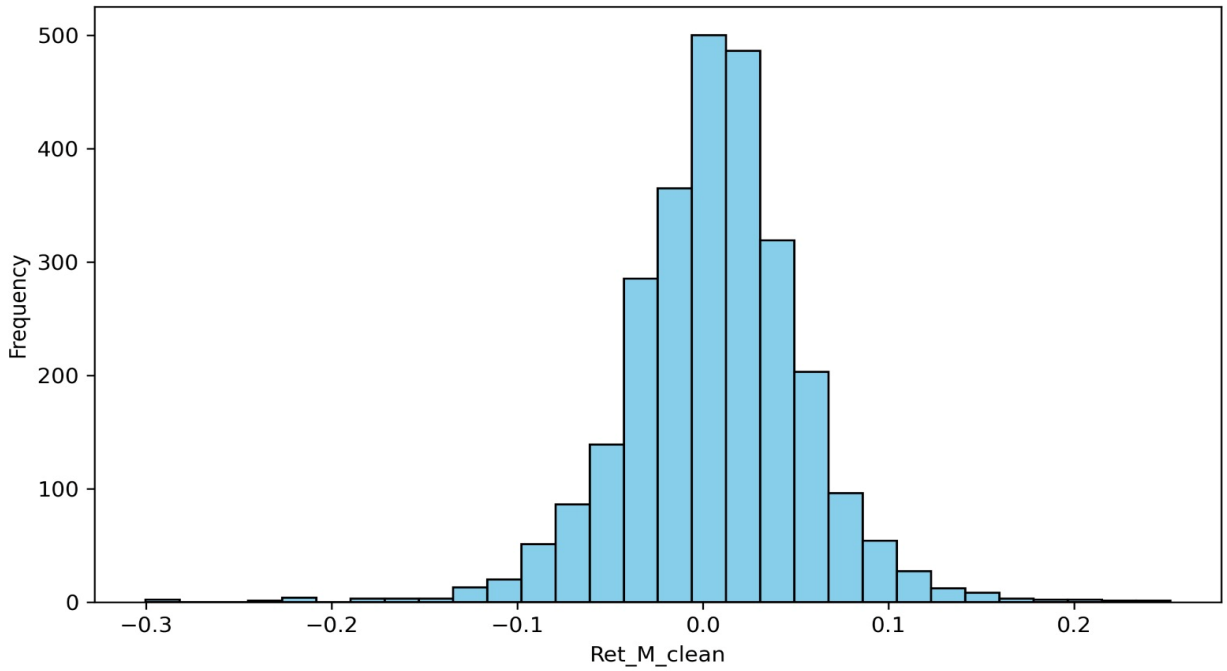

Figure 3: Monthly Returns

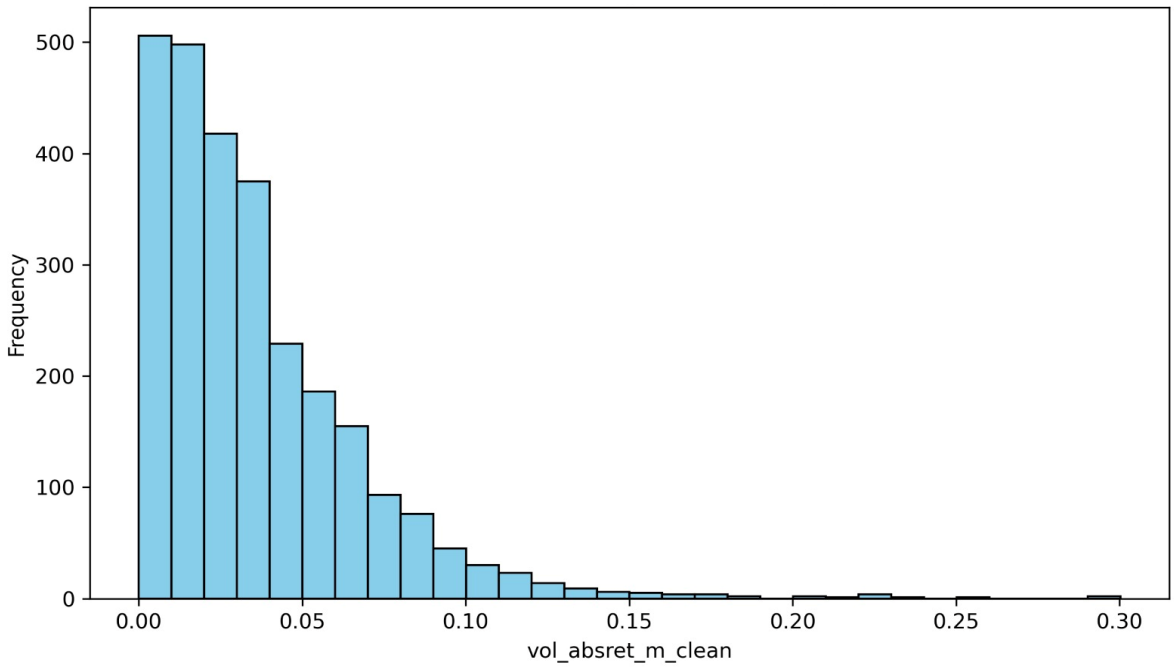

Figure 4: Absolute Monthly Return Volatility

In Figures 3 and 4 we can see monthly returns and absolute return volatility histogram chart. In Figure 3 we can see returns are close to zero that means the market was stable. There is a small left tail that negative returns can be a little bigger than positive ones. So, here most values

are between -0.1 and 0.1. This means no big profit of loss happened here. If that happened that is rare. In Figure 4 we can the absolute returns volatility. Here the distribution is right-skewed. That means most volatility is low or medium between 0.00 and 0.05 most of the time. But sometimes here happened high volatility that create a long tail in right side.

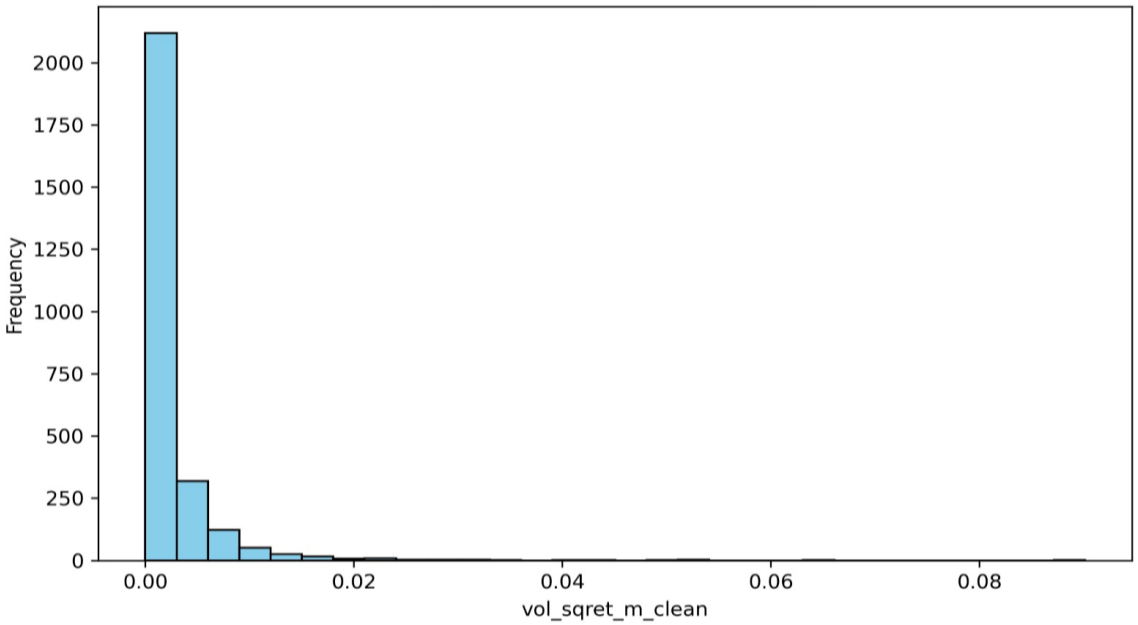

Figure 5: Squared Monthly Return Volatility

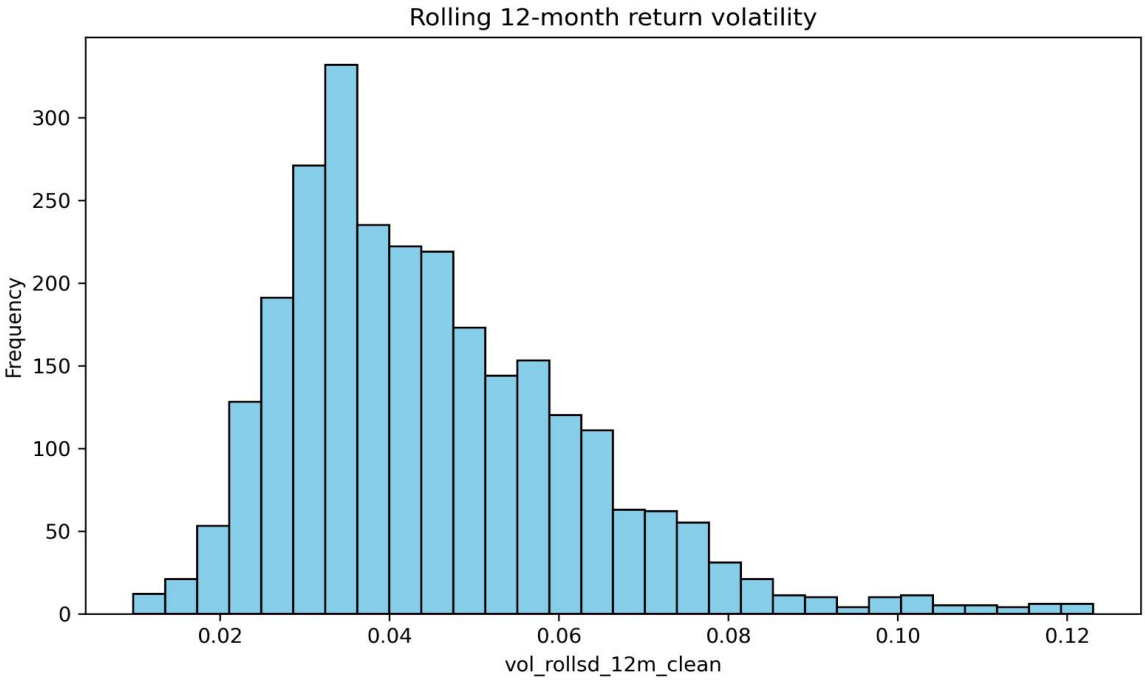

Figure 6: Rolling 12 Month Return Volatility

In Figures 5 and 6 we can see the behavior of market volatility. In Figure 5 we can change of return in each month. Here we can see the value are very close 0 that means monthly return are small. And we can see a long tail that is 0.08 that show rare months when the market moves a lot. These are called volatility spikes.

Figure 6 12-month rolling volatility that see change of return over the year. It measure the volatility of one year and this helps smooth short-term ups and downs. Here we can say Most of the values are between 0.03 and 0.04. that there was a medium risk in the long run. Sometimes the values go up to 0.12 that means some periods have high risk in the long time, not just one month. So we can say in long term ups and downs are stable and medium but sometimes the market face high risk.

4.2 Correlation Analysis

Here we can see how the variables are related to each other. Here we have use a Pearson correlation matrix that tells us how variables are connected to each other positively or negatively. Also helps find problems when the variables are too similar. In Table 3 we can see the correlations between volatility, uncertainty indices, and GDP growth.

Table 3: Correlation Matrix

Variable	Abs. monthly vol.	Squared monthly vol.	Rolling 12m vol.	Lagged log GPR	Lagged log EPU	GDP growth
Abs. monthly vol.	1	0.876794	0.366568	-0.018305	0.075165	-0.076423
Squared monthly vol.	0.876794	1	0.342522	-0.010973	0.056311	-0.066106
Rolling 12m vol.	0.366568	0.342522	1	-0.0849	0.117134	0.028545
Lagged log GPR	-0.018305	-0.010973	-0.0849	1	0.345077	0.016091
Lagged log EPU	0.075165	0.056311	0.117134	0.345077	1	-0.051815
GDP growth	-0.076423	-0.066106	0.028545	0.016091	-0.051815	1

Here we can see Economic Policy Uncertainty (EPU) affect the market ups and downs. If there was higher market uncertainty so there was a higher chance of market ups and downs. So EPU has a positive with stock market volatility. For example, it has small positive values like 0.075 and 0.117. This means if uncertainty increase then it can make market ups and downs. Then Geopolitical Risk has a very small negative effect. The values are -0.018 and -0.085. This

means it does not have too much effect on short-term market change. And then GDP growth has a negative relation with market ups and downs (-0.076). This means strong economy does not affect too much. It recover quickly than weak economies. When the economy is weak then it is affected. There is no big problem with the variables GPR and EPU. They have a correlation value is 0.345 and This is low that means we can use use both together.

Then Absolute and squared volatility have a high correlation value is 0.877 and the reason of this they both came from same data. And also GPR and EPU have very small effect on GDP growth that means global problems and economic growth are not similar. They are separate from each other. So we can say all 3 variable are okay to use for more analysis.

4.3 Regression Analysis

Now we have to do regression analysis. So before that we have to look at the data. This data help us to understand how uncertainty and market stability affect each other over the times. In Figure 7 we can see the trends of stock market volatility and geopolitical risk from 2012 to 2025.

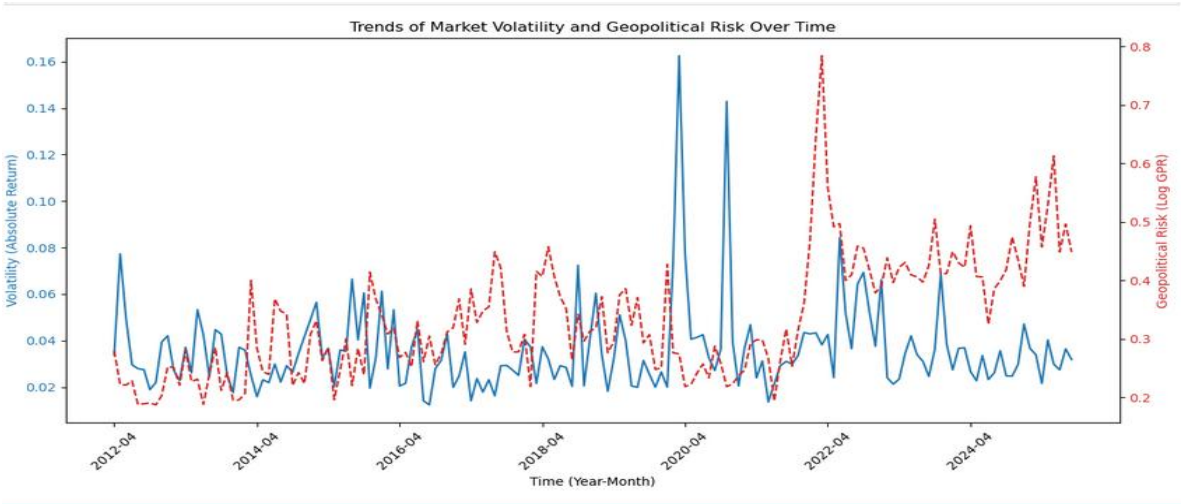

Figure 7: Trends of market volatility and geopolitical risk over time.

Figure 7 we can see how geopolitical risk and market ups and downs are connected, how they affect each other over the time. In figure 7 we can see both of them move together. That means When geopolitical risk go up that time market volatility also go up. So if geopolitical risk increase then market volatility increase. Here we can see the red line that show geopolitical risk and The blue line that show market volatility.

If we look up the chart we can see big changes can be seen in 2020 and 2022. As we know geopolitical risk is unpredictable so when event happens that time we can see the changes also. In 2020 there was the COVID-19 crisis and 2022 there were more political problems like wars Ukraine and Russia and during these times market volatility had increased. This means that global problems or uncertainity can make markets unstable. When global problem arise market become unstable. It also shows that the effect of risk does not happen immediately. It happens after some time. This is the reason to used lagged variables in the model.

And Then, we uses a Panel Fixed Effects (FE) model. It looks at how EPU and GPR affect absolute monthly return volatility. The main results are shown in Table 4.

Table 4 : Regression Results (Fixed Effects)

```
--- STEP 6: MAIN REGRESSION SUMMARY ---
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:     vol_absret_m_clean   R-squared:                        0.0124
Estimator:                   PanelOLS   R-squared (Between):             -1.2103
No. Observations:                2687   R-squared (Within):               0.0002
Date:                Mon, Mar 23 2026   R-squared (Overall):             -0.0358
Time:                        17:08:05   Log-likelihood                    6122.7
Cov. Estimator:       Driscoll-Kraay
                                        F-statistic:                      10.526
Entities:                          17   P-value                           0.0000
Avg Obs:                       158.06   Distribution:                  F(3,2506)
Min Obs:                       126.00
Max Obs:                       162.00   F-statistic (robust):             4.9778
                                        P-value                           0.0019
Time periods:                     162   Distribution:                  F(3,2506)
Avg Obs:                       16.586
Min Obs:                       15.000
Max Obs:                       17.000

                             Parameter Estimates
================================================================================
                 Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper CI
--------------------------------------------------------------------------------
Intercept           0.0151     0.0094     1.5986     0.1100     -0.0034      0.0336
lngpr_m_clean       0.0125     0.0068     1.8309     0.0672     -0.0009      0.0259
lnepu_m_clean       0.0041     0.0017     2.4222     0.0155      0.0008      0.0074
GDP_growth_clean   -0.3386     0.1089    -3.1106     0.0019     -0.5521     -0.1252
================================================================================

F-test for Poolability: 9.0021
P-value: 0.0000
Distribution: F(177,2506)

Included effects: Entity, Time
```

Here we can see both EPU and GPR increase market ups and downs. Here, the Lagged Log EPU has a positive effect (0.0041). significant at 5%. This means higher policy uncertainty makes the market more unstable. Lagged Log GPR also has a positive effect (0.0125). It is significant at 10%. This shows political problem also increases volatility. But its effect is smaller and does not last long. GDP growth has a strong negative effect (-0.3386). It is

significant at 1%. This means when the economy grows, market becomes more stable. The tests show that the FE model is a good choice. The F-test shows country effects are important.

So, FE is better than a simple model. The R squared is low (0.0124). This is normal in this type of study. The Robust F-statistic (P=0.0019) shows the results are accurate.

4.4 Robustness Analysis

This study checks the result again. It uses another two ways are used to measure volatility. These are squared monthly returns and 12-month rolling volatility. This helps make sure the results are correct. All results are shown in Table 5

Table 5: Squared Monthly Return Volatility and Rolling 12-month Volatility

Variable	(1) Absolute Vol	(2) Squared Vol	(3) Rolling Vol
Lagged log GPR	0.000171	0.000688	-0.010544*
	-0.007505	-0.00175	-0.005839
Lagged log EPU	0.009782***	0.001334***	0.006762***
	-0.00168	-0.000281	-0.00125
GDP growth	-0.107800***	-0.015414***	0.028519
	-0.035281	-0.00506	-0.031842
Fixed Effects (Country/Month)	Yes	Yes	Yes
Observations	2,687	2,687	2,687
R-squared	0.071	0.0605	0.2198

The results show that EPU is very important. It always increases market ups and downs. In all models, EPU has a positive effect. This means more policy uncertainty makes the market unstable. This is for short-term and long-term models. So, we can say that EPU always affects market risk.

Then we can see GPR is different. It is not important in long term models. But in the short-term model it is important. It has a small negative effect. This means political problems does not affect the market quickly. But it can affect the market over the time. GDP growth helps keep the market stable. In the short-term, higher growth means lower volatility. But in the long-term model, GDP growth is not important. So, its effect is strong in the short-term. The long-term model explains more changes in the market. Its R-squared is over 21%. According to the results we can say, EPU is the most important factor. It always affects market volatility.

5.0 Discussion

Now, the main goal of this study is clear. It looks at how EPU and GPR affect stock market ups and downs in 17 countries. Here we explain the main findings. And also compares the results with other studies.

5.1 Overall Findings

The results show that both EPU and GPR affect market volatility. EPU has a strong effect. It always makes market unstable. This happens in all the models. GPR also affects the market. But the effect is not always strong like EPU. It is clear in long term results. Big events show this clearly. For example, in 2020 and 2022, markets changed a lot. GDP growth helps the market. If the economy grows the market volatility goes down. This means strong economies makes market more stable.

5.2 Comparison with Existing Literature

5.2.1 The Role of Uncertainty in Market Volatility

The findings of this study show that both results match other studies. Both Economic Policy Uncertainty (EPU) and Geopolitical Risk (GPR) increase stock market volatility. That is same as what (Hachicha, 2023) and (Ahmed, 2023) have found. They say that uncertainty makes investor worried and it makes markets more unstable. Big events like COVID 19 pandemic in 2020 and the Russia and Ukraine war in 2022, support the findings of (Hachicha, 2023) and (Yang et al., 2025)**.** Big global problem can shake financial markets and affect information.

5.2.2 Differences Between GPR and EPU Effects

This study also finds that EPU affects the market for a longer time than GPR. GPR has a short term effect only. But EPU affects longer period. This result is match to (Hoque & Zaidi, 2020)**.** They said geopolitical risk depends on the overall market condition. Our results also match to (Salisu et al., 2022)**.** Who say that geopolitical risk happens when people feel threats. Overall, investors react more strongly to ongoing policy problem than to the geopolitical events that happens sometimes.

5.2.3 The Stabilizing Role of Economic Growth

The results show that when GDP grows the stock market become less risky. This means a strong economy helps keep the market stable. This is same as that (Alsadan et al., 2025) say. A strong economy can lower the bad effects of global uncertainty. (Golden et al., 2024) also say that strong economy helps keep market stable during global problems.

5.2.4 Long-Term Effects and Risk Transmission

The results show that looking at 12 months of data helps us to understand the market changes better. This means it is important to study markets for a long time. This matches what (S, 2025) and (Darsono et al., 2024) found. That is geopolitical risk affects markets in both the short and long. (Yang et al., 2025) also say that the effects of uncertainty spread slowly over time and this study supports that.

6.0 Conclusion

This study shows that Economic Policy Uncertainty (EPU) and Geopolitical Risk (GPR) make stock market ups and downs in 17 countries from 2012 to 2025.Here we use a Panel Fixed Effects model and different ways to measure market changes. The results show that both global problems and policy uncertainty make markets unstable. EPU is the most important factor. It affects markets in both short term and long-term situations. This means investors worry a lot when government policies are unclear. GPR mainly causes big changes during major global events like COVID-19 in 2020 and the Russia and Ukraine conflict in 2022. But GPR's overall effect is smaller than EPU. The study also finds that GDP growth helps make markets more stable. Strong economic growth reduces ups and downs. And helps countries to handle global problems. Based on these results, governments should make clear rules and policies. And also try to make their economies strong to reduce risks.

6.1 Limitations of the Study

This study has some limits. First, it tooks only 17 countries. That means it may not show how all countries mainly smaller or new markets react to risks. Second, it uses monthly data, which is good for long term trends. But can miss sudden changes after a big event. Another limit is how uncertainty is measured. The study uses GPR and EPU, which come from news. They may not show all risks like local or less-reported problems. Some important factors like interest rates, exchange rates or industry-specific problems are not included here. Those may affect the results. Finally, the study found that risk and market changes are connected in a straight-line way. In reality, big effects may happen only after risks reach a certain level.

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8.0 Appendix

1. Implementation of Descriptive Statistics

```
import pandas as pd

from pathlib import Path

# 1. Directory Setup

OUT_STEP3 = Path("Output_Results")

OUT_STEP3.mkdir(exist_ok=True)

# 2. Variable Selection based on Methodology

selected_vars = [

    "vol_absret_m_clean",

    "vol_sqret_m_clean",

    "vol_rollsd_12m_clean",

    "lngpr_l1_clean",

    "lnepu_l1_clean",

    "GDP_growth_clean"]

# 3. Descriptive Statistics Logic

desc_df = df[selected_vars].copy()

desc_table_raw = desc_df.describe().T

desc_table_raw = desc_table_raw[["count", "mean", "50%",

"std", "min", "max"]]
```

```
# 4. Academic Label Mapping
label_map = {"vol_absret_m_clean": "Absolute monthly return
volatility",
    "vol_sqret_m_clean": "Squared monthly return volatility",
    "vol_rollsd_12m_clean": "Rolling 12-month return
volatility",
    "lngpr_l1_clean": "Lagged log geopolitical risk",
    "lnepu_l1_clean": "Lagged log economic policy
uncertainty",
  "GDP_growth_clean": "GDP growth"}
desc_table_raw.index = desc_table_raw.index.map(label_map)
desc_table_raw = desc_table_raw.rename(columns={ "count": "N",
"std": "Std. Dev.", "mean": "Mean",     "50%": "Median",
"min": "Min", "max": "Max"})
# 5. Export and Display Results
desc_table_rounded = desc_table_raw.round(6)
desc_table_rounded.to_csv(OUT_STEP3 /
"descriptive_statistics_main_sample_rounded.csv", index=True)
print("--- STEP 1: DESCRIPTIVE STATISTICS (PUBLICATION READY)
---")
print(desc_table_rounded)
```

2. Correlation Analysis and Pairwise Observations

```
import pandas as pd
from pathlib import Path
# 1. Directory Setup
OUT_STEP4 = Path("Output_Results")
OUT_STEP4.mkdir(exist_ok=True)
# 2. Variable Selection and Data Preparation
# Note: 'selected_vars' inherited from Descriptive Statistics stage
corr_df = df[selected_vars].copy()
# 3. Pearson Correlation Coefficients
corr_matrix_raw = corr_df.corr(numeric_only=True)
corr_matrix_rounded = corr_matrix_raw.round(6)
# 4. Pairwise Observation Counts (N)
# Ensures consistency for variables with potential missing values
pairwise_n = pd.DataFrame(index=selected_vars,
columns=selected_vars, dtype=int)
for row_var in selected_vars:
    for col_var in selected_vars:
   # Count rows where both variables have non-null observations
   pairwise_n.loc[row_var, col_var] = df[[row_var,
col_var]].dropna().shape[0]
```

```
# 5. Label Mapping
corr_label_map = {"vol_absret_m_clean": "Abs. monthly vol.",
    "vol_sqret_m_clean": "Squared monthly vol.",
    "vol_rollsd_12m_clean": "Rolling 12m vol.",
    "lngpr_l1_clean": "Lagged log GPR",
    "lnepu_l1_clean": "Lagged log EPU",
   "GDP_growth_clean": "GDP growth"}
# 6. Apply Label Mapping to Matrices
corr_matrix_rounded =
corr_matrix_rounded.rename(index=corr_label_map,
columns=corr_label_map)
pairwise_n = pairwise_n.rename(index=corr_label_map,
columns=corr_label_map)
# 7. Export Results to CSV
corr_matrix_rounded.to_csv(OUT_STEP4 /
"correlation_matrix.csv", index=True)
pairwise_n.to_csv(OUT_STEP4 / "correlation_pairwise_n.csv",
index=True)
print("--- STEP 2: CORRELATION MATRIX & PAIRWISE COUNTS ---")
print(corr_matrix_rounded)
```

3. Data Diagnostics and Distributional Analysis

```
# 1. Directory Setup for Diagnostic Results
OUT_STEP5 = Path("Output_Diagnostics")
OUT_STEP5.mkdir(exist_ok=True)
# 2. Variable Selection for Distribution Analysis
plot_vars = ["Ret_M_clean", "vol_absret_m_clean",
"vol_sqret_m_clean", "vol_rollsd_12m_clean"]
distribution_rows = []
# 3. Computing Skewness, Kurtosis, and IQR-based Outliers
for var in plot_vars:
    series = df[var].dropna()
    # Define IQR Fences
    q1 = series.quantile(0.25)
    q3 = series.quantile(0.75)
    iqr = q3 - q1
    lower_fence = q1 - 1.5 * iqr
    upper_fence = q3 + 1.5 * iqr
  # Identify Outliers
    outlier_count = ((series < lower_fence) | (series >
upper_fence)).sum()
    distribution_rows.append({
```

```
        "variable": var,
        "n": int(series.shape[0]),
        "mean": series.mean(),
        "median": series.median(),
        "std_dev": series.std(),
        "min": series.min(),
        "max": series.max(),
        "skewness": series.skew(),
        "kurtosis": series.kurt(),
        "outlier_count_iqr": int(outlier_count),
        "outlier_share_iqr": outlier_count / series.shape[0]})
```

Format and Display Summary Table

```
distribution_summary =
pd.DataFrame(distribution_rows).round(6)
print(distribution_summary)
```

4. Histogram Generation

```
hist_specs = [("Ret_M_clean", "Monthly returns",
"hist_ret_m_clean.png"),
    ("vol_absret_m_clean", "Absolute monthly return
volatility", "hist_vol_absret_m_clean.png")]
for variable_name, chart_title, output_name in hist_specs:
```

```
    plt.figure(figsize=(8, 5))
    plt.hist(df[variable_name].dropna(), bins=30,
color='skyblue', edgecolor='black')
    plt.title(chart_title)
    plt.xlabel(variable_name)
    plt.ylabel("Frequency")
    plt.tight_layout()
    plt.savefig(OUT_STEP5 / output_name, dpi=300)
    plt.close() # Close plot to save memory
```

5. Identifying Extreme Observations (Top and Bottom 20)

```
extremes_df = df[["Country", "ISO3", "Date",
"Ret_M_clean"]].sort_values("Ret_M_clean", ascending=False)
top_20 = extremes_df.head(20)
bottom_20 = extremes_df.tail(20)
```

Export results for documentation

```
distribution_summary.to_csv(OUT_STEP5 /
"distribution_summary_rounded.csv", index=False)
```

4.Panel Structure and Data Completeness Diagnostics

1. Directory Setup for Panel Diagnostics

```
OUT_STEP6 = Path("Output_Panel_Diagnostics")
OUT_STEP6.mkdir(exist_ok=True)
```

```
# 2. Global Panel Summary Statistics

# Tracks total observations, unique entities, and time periods

panel_summary = { "observations": int(df.shape[0]),

    "countries": int(df["ISO3"].nunique()),

    "months": int(df["ym"].nunique()),

    "sample_start": df["ym"].min(),

    "sample_end": df["ym"].max()}

# 3. Balanced Panel Calculations

# Evaluates the gap between actual and theoretical total observations

expected_global_size = panel_summary["countries"] *
panel_summary["months"]

panel_summary["expected_global_size_if_balanced"] =
int(expected_global_size)

panel_summary["missing_country_months"] =
int(expected_global_size - panel_summary["observations"])

panel_summary["global_fill_ratio"] =
panel_summary["observations"] / expected_global_size

# Convert to DataFrame for documentation

panel_structure_summary =
pd.DataFrame(list(panel_summary.items()),
columns=["statistic", "value"])
```

```
print(panel_structure_summary)
```

4. Variable-Specific Missingness Check

Analyzes data gaps for the dependent, independent, and control variables

```
focused_vars = [ "vol_absret_m_clean", "vol_sqret_m_clean",
"vol_rollsd_12m_clean",
    "lngpr_l1_clean", "lnepu_l1_clean", "GDP_growth_clean"]
variable_missingness = pd.DataFrame({ "variable":
focused_vars, "missing_count": [int(df[col].isna().sum()) for
col in focused_vars], "missing_share": [df[col].isna().mean()
for col in focused_vars]}).round(6)
print("\n--- FOCUSED VARIABLES MISSINGNESS ---")
print(variable_missingness)
```

5. Monthly Coverage Visualization

Verifies that all 17 countries are present in every month of the sample

```
monthly_coverage =
df.groupby("ym").agg(countries_present=("ISO3",
"nunique")).reset_index()
plt.figure(figsize=(12, 5))
plt.plot(monthly_coverage["ym"].astype(str),
monthly_coverage["countries_present"],
         marker='o', linestyle='-', color='teal')
```

```
plt.xticks(rotation=90, fontsize=8)

plt.title("Countries Present by Month (Panel Balance Check)")

plt.xlabel("Year-Month")

plt.ylabel("Number of Countries")

plt.grid(True, linestyle='--', alpha=0.6)

plt.tight_layout()
```

Save visual diagnostic for the appendix

```
plt.savefig(OUT_STEP6 / "countries_present_by_month.png",
dpi=300)

plt.close()
```

5. Main Empirical Specification and Baseline Regression

1. Temporal Alignment

Ensuring the time identifier is in datetime format for panel processing

```
df['ym'] = pd.to_datetime(df['ym'])
```

2. MultiIndex Panel Construction

Setting ISO3 (Entity) and ym (Time) as the index for PanelOLS requirements

```
df_panel = df.set_index(['ISO3', 'ym'])
```

3. Model Specification

Dependent Variable: Absolute monthly return volatility

Main Predictors: Lagged Log GPR and Lagged Log EPU

```
# Controls: GDP Growth

# Fixed Effects: EntityEffects (Country) and TimeEffects (Period)

formula = ("vol_absret_m_clean ~ 1 + lngpr_m_clean +
lnepu_m_clean + "GDP_growth_clean + EntityEffects +
TimeEffects")

# 4. Estimation with Driscoll-Kraay Robust Standard Errors

# Using cov_type="kernel" to handle heteroskedasticity and autocorrelation

model = PanelOLS.from_formula(formula,
data=df_panel).fit(cov_type="kernel")

# 5. Summary Output

print("--- STEP 6: MAIN REGRESSION SUMMARY ---")

print(model.summary)
```

6. Robustness Estimation (Driscoll-Kraay)

```
# 1. Directory Setup

OUT_STEP7 = Path("./output_results")

OUT_STEP7.mkdir(parents=True, exist_ok=True)

# 2. Temporal Indexing

# Creating a numeric time index from the 'ym' column for the DK estimator

if 'time_index' not in df.columns:

    unique_ym = sorted(df['ym'].unique())

    ym_to_index = {ym: i for i, ym in enumerate(unique_ym)}
```

```
    df['time_index'] = df['ym'].map(ym_to_index)
```

3. Model Specification

Two-Way Fixed Effects (TWFE) using Country (ISO3) and Time (ym) categorical dummies

```
baseline_formula = ("vol_absret_m_clean ~ lngpr_l1_clean + lnepu_l1_clean + "
    "GDP_growth_clean + C(ISO3) + C(ym)")
```

4. Initial OLS Estimation

```
baseline_ols_results = smf.ols(formula=baseline_formula, data=df).fit()
```

5. Determining Driscoll-Kraay Optimal Lags

Applying the standard heuristic for HAC kernel lag selection

```
number_of_time_periods = len(df['ym'].unique())
dk_lags = int(np.floor(4 * (number_of_time_periods / 100) ** (2 / 9)))
dk_lags = max(dk_lags, 1)
```

6. Implementation of Driscoll-Kraay Robust Covariance

Using Bartlett kernel with cluster correction to handle spatial correlation

```
baseline_dk_results = baseline_ols_results.get_robustcov_results(
    cov_type="hac-groupsum",
```

```
    time=df["time_index"].to_numpy(),
    maxlags=dk_lags,
    kernel="bartlett",
    use_correction="cluster",
    df_correction=True)
```

7. Presentation and Significance Mapping

```
def significance_stars(p_value):
    if p_value < 0.01: return "***"
    if p_value < 0.05: return "**"
    if p_value < 0.10: return "*"
    return ""
term_labels = {"lngpr_l1_clean": "Lagged log geopolitical
risk", "lnepu_l1_clean": "Lagged log economic policy
uncertainty","GDP_growth_clean": "GDP growth"}
```

8. Extracting and Displaying Key Results

```
baseline_results_df = pd.DataFrame({
    "term": baseline_dk_results.model.exog_names,
    "coefficient": baseline_dk_results.params,
    "p_value_dk": baseline_dk_results.pvalues})
```

Filter for main independent variables

```
baseline_summary =
baseline_results_df[baseline_results_df["term"].isin(term_labe
ls.keys())].copy()

baseline_summary["Variable"] =
baseline_summary["term"].map(term_labels)

baseline_summary["Significance"] =
baseline_summary["p_value_dk"].apply(significance_stars)

print(f"Optimal Driscoll-Kraay Lags: {dk_lags}")

print(baseline_summary[["Variable", "coefficient",
"p_value_dk", "Significance"]].round(6))
```

7. Heterogeneity Analysis by Market Development

1. Market Classification (Developed vs. Emerging)

Categorizing countries based on institutional and economic development levels

```
developed_list = ['USA', 'GBR', 'FRA', 'DEU', 'JPN', 'CAN',
'ITA', 'AUS']

if 'developed' not in df.columns: df['developed'] =
df['ISO3'].apply(lambda x: 1 if x in developed_list else 0)
```

2. Dataset Splitting

```
df_dev = df[df['developed'] == 1].copy()

df_emg = df[df['developed'] == 0].copy()

def run_dk_subsample(data, label):
```

```
    """ Executes Driscoll-Kraay robust regression for a
specific sub-sample."""
    if data.empty: return None
  # Model Specification with Two-Way Fixed Effects
    formula = ( "vol_absret_m_clean ~ lngpr_l1_clean +
lnepu_l1_clean + " "GDP_growth_clean + C(ISO3) + C(ym)" )
  # OLS Estimation
  model = smf.ols(formula=formula, data=data).fit()
  # Dynamic Calculation of Optimal Lags for DK Covariance
    num_periods = len(data['ym'].unique())
    lags = max(int(np.floor(4 * (num_periods / 100) **
(2/9))), 1)
  # Applying Driscoll-Kraay Robust Standard Errors
  results = model.get_robustcov_results( cov_type="hac-
groupsum",time=data["time_index"].to_numpy(),maxlags=lags,
kernel="bartlett",
use_correction="cluster",df_correction=True)
  # Result Tabulation and Significance Mapping
    res_df = pd.DataFrame({"Variable":
results.model.exog_names, "Coefficient": results.params,"P-
value": results.pvalues})
```

```
  # Filter for Primary Uncertainty and Control Variables
    key_vars =
["lngpr_l1_clean","lnepu_l1_clean""GDP_growth_clean"]
    res_key = res_df[res_df["Variable"].isin(key_vars)].copy()
  # Mapping Statistical Significance Levels
  res_key['Significance'] = res_key['P-value'].apply(
        lambda x: '***' if x < 0.01 else ('**' if x < 0.05
else ('*' if x < 0.10 else '')))
    print(f"\n--- {label} Markets Analysis (Lags: {lags}) ---
")print(res_key.round(6))
    return res_key
# 3. Execution of Comparative Analysis
res_developed = run_dk_subsample(df_dev, "DEVELOPED")
res_emerging = run_dk_subsample(df_emg, "EMERGING")
```

8. Multi-Model Robustness

```
# 1. Data Standardization
# Normalizing column names to lowercase and removing whitespace for consistency
df.columns = df.columns.str.strip().str.lower()
# 2. Robustness Model Function
def run_paper_model(dep_var, model_label):
```

```
    """Estimates a TWFE OLS model with HAC robust standard
errors."""
    formula = (f"{dep_var} ~ lngpr_m_clean + lnepu_m_clean +
gdp_growth_clean + " "C(country) + C(month)")
  try: # Applying Driscoll-Kraay/HAC adjustment (maxlags=4)
    # to account for temporal and spatial dependence.
        model = smf.ols(formula=formula,
data=df).fit(cov_type='HAC', cov_kwds={'maxlags': 4})
        res = pd.DataFrame({ "term": model.params.index,
            "coefficient": model.params.values,
            "std_error": model.bse.values,
            "p_value": model.pvalues.values,
            "model_id": model_label })
   # Mapping Significance Levels
   res["significance"] = res["p_value"].apply(lambda p: "***"
if p < 0.01 else ("**" if p < 0.05 else ("*" if p < 0.1 else
"")))
   return res, model
    except Exception as e: print(f"Error in {model_label}:
{e}")
return None, None
```

```
# 3. Model Execution

# Testing across three different volatility proxies

res0, fit0 = run_paper_model("vol_absret_m_clean", "Model 0")

res1, fit1 = run_paper_model("vol_sqret_m_clean", "Model 1")

res2, fit2 = run_paper_model("vol_rollsd_12m_clean", "Model2")

# 4. Compilation of Publication-Ready Results Table

valid_dfs = [r for r in [res0, res1, res2] if r is not None]

if valid_dfs:

    all_res = pd.concat(valid_dfs, ignore_index=True)

    col_labels = {"Model 0": "(1) Absolute Vol",

        "Model 1": "(2) Squared Vol",

        "Model 2": "(3) Rolling Vol"}

  # Constructing the main variable rows (Coefficients and Standard Errors)

    final_rows = []

    independent_vars = [("Lagged log GPR", "lngpr_m_clean"),

        ("Lagged log EPU", "lnepu_m_clean"),

        ("GDP growth", "gdp_growth_clean")]

    for label, var in independent_vars:

        row_c = {"Variable": label}

        row_se = {"Variable": ""}
```

```
        for m_id in ["Model 0", "Model 1", "Model 2"]:
            sub = all_res[(all_res['model_id'] == m_id) &
(all_res['term'] == var)]
            if not sub.empty: r = sub.iloc[0]
                row_c[col_labels[m_id]] =
f"{r['coefficient']:.6f}{r['significance']}"
row_se[col_labels[m_id]]f"({r['std_error']:.6f})"
        final_rows.extend([row_c, row_se])
```

Adding Summary Statistics and Fixed Effects Controls

```
    fe_row = {"Variable": "Fixed Effects (Country/Month)",
**{col_labels[m]: "Yes" for m in col_labels}}
    obs_row = {"Variable": "Observations"}
    r2_row = {"Variable": "R-squared"}
    for m_id, fit in [("Model 0", fit0), ("Model 1", fit1),
("Model 2", fit2)]:
        if fit: obs_row[col_labels[m_id]] = int(fit.nobs)
r2_row[col_labels[m_id]] = f"{fit.rsquared:.4f}"
final_rows.extend([fe_row, obs_row, r2_row])
    final_table = pd.DataFrame(final_rows)
    print(final_table)
```