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Study of the Impact of Geopolitical Uncertainty on Optimal Allocation of Multiple Asset Portfolios

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ABSTRACT
In recent years, global geopolitical conflicts have occurred frequently, and the Russia-Ukraine conflict has had a profound impact on the stability of the international financial market. This article uses this as an entry point to use the mean – variance model based on monthly data on major global stock indexes and commodities from 2019 to 2023. Empirical analysis of the impact of geopolitical uncertainty on multi-asset portfolio allocation The study found that after the conflict, the stock market as a whole showed declining returns and rising risks, while commodities, especially energy and gold assets, showed outstanding hedging attributes, and the minimum variance combination before and after the conflict and the maximum Sharpe ratio combination There are significant differences in weight distribution This difference reflects the investor's asset allocation adjustment logic under extreme uncertainty, and this paper theoretically expands the applicability of traditional portfolio models in geopolitical contexts while providing a useful reference at the practical level for investors to diversify allocations and risk hedging in times of crisis.

KEYWORDS
Geopolitics; Stocks; Commodities; Russo-ukrainian War; Portfolio optimization

1 Introduction

Since the beginning of the twenty-first century, the global economy and financial markets have been subject to frequent geopolitical shocks. In particular, the outbreak of the Russian-Ukrainian conflict in 2022 led to sudden international tensions and a general decline in equity markets, while commodity prices, such as those of energy, food and precious metals, climbed significantly. This suggests that geopolitical uncertainty not only affects a single market, but also spreads across assets through risk contagion mechanisms, exacerbating systemic risk. Traditional mean-variance modelling and portfolio theory are thus facing new challenges, as investors have to weigh risk and return while also taking into account the uncertain perturbations caused by geopolitics [1]. At the theoretical level, incorporating geopolitical risk into multi-asset portfolio analysis can help extend classical models and promote the intersection of finance and international political economy [2]. At the practical level, the Russia-Ukraine conflict provides a typical case: stocks are under pressure, while commodities show a safe-haven advantage. Comparing the risk-return differences of different assets before and after the conflict can help investors reallocate assets and diversify risks in a crisis environment [3]. It has been shown that geopolitical risk has an impact through multiple channels: capital flows, stock markets and commodity prices. Niu, Fuchang, and Ge, Yuejing (2025) find that the overall geo risk of African countries rises and generates negative spillover effects [4]; Zhu, Meng, and Xiao, Dan (2025) emphasise that host country risk has a greater impact on bilateral investment [5]; Li, Jiaqi (2023) and Chen, Min (2025) point out that geo events strengthen the risk aversion attributes of energy and gold [6-7]; and Zhang, Feipeng (2023), and Gou, Qin, and Xu, Haochen (2025) reveal that extreme events amplify equity market tail risks and trigger capital flight [8-9]. Overall, these results provide a solid theoretical and empirical foundation for this paper to analyse the optimisation of stock-commodity portfolios before and after the Russia-Ukraine conflict with a mean-variance model [10-14].

2 Model setting, method description

2.1 Research objectives

This article aims to study the impact of geopolitical uncertainty on the optimal allocation of multi-asset portfolios, using the mean –variance model for empirical analysis, based on the 2019–2023 global major stock market indexes and monthly commodity data, and explore Changes in asset portfolio weight and risk-return characteristics before and after the Russia-Ukraine conflict Thus revealing the adjustment mechanism of investor allocation behavior under geopolitical shock

2.2 Research content

2.2.1 Research design

2.2.1.1 Indicator construction

In terms of data processing, the logarithmic rate of return of each index is first calculated using the monthly closing prices. Subsequently, the following core indicators are constructed:

(1) Expected rate of return: derived from the average of the monthly rates of return, reflecting the average

performance of the asset;

(2) Risk indicators: characterizing individual market risks and correlations between different markets through the variance and covariance matrices of yields;

(3) Sharpe ratio: a measure of the risk-adjusted level of earnings, combined with a risk-free rate;

(4) Optimal combination result: Minimum variance combination (GMV) and maximum Sharpe ratio combination (MSP) obtained under constraint conditions, and further plotted effective front curve.

2.2.1.2 Research methods and steps

The mean – variance model was used for analysis in this paper. The research process is roughly divided into the following links:

(1) Collect and wash sample index data, calculate log yield;

(2) Estimate the mean vector and the covariance matrix for the two stages before and after the conflict, respectively;

(3) Construct a minimum variance combination and a maximum Sharpe combination under the conditions of full investment, no short selling allowed, and a limit on the weight of a single asset;

(4) Draw an effective frontier curve, and compare the risk –benefit characteristics and optimal weight distribution over the two stages;

(5) On this basis, the shocks of geopolitical uncertainty to asset allocation are analysed and implications for investment and risk management are presented.

2.2.2 Empirical results

Based on pre-Russian-Ukrainian conflict (2019–2021) and post-conflict (2022–2023) financial market data, this paper selects major global stock indices and commodity prices as research objects, respectively. The asset portfolio was optimized by the mean – variance model, and the model was fitted using Python, resulting in a comparison of asset allocation efficiency before and after the conflict.

The results show: in the stock market, the average yield of post-conflict portfolios decreased significantly, the level of risk increased, and the Sharpe ratio turned from positive to negative, indicating that geopolitical conflicts had a clear disincentive effect on both return on investment and risk-adjusted returns in the stock market. In contrast, commodities showed a stronger risk-averse attribute after the conflict, with an increase in the average yield of their portfolios and an overall improvement in the Sharpe ratio, despite an increase in risk, illustrating that commodities are better able to sustain investment value in a context of geopolitical uncertainty.

Overall, Python fitting results suggest that geopolitical conflicts increase the vulnerability of stock markets but elevate the safe-haven position of commodities, providing an empirical basis for investors' asset allocation in an environment of uncertainty.

2.2.3 Summary and future prospects

This paper uses the mean – variance model as a tool and uses stock and commodity data from the Investing.com platform to comparatively analyze the differences in risk and return of asset portfolios before and after the Russo-Ukrainian conflict. The results show that, after the conflict, the yield of the stock portfolio decreased markedly and the level of risk increased, while commodities show a strong risk aversion and allocation advantage, indicating the differential impact of geopolitical uncertainty on different asset classes.

In future research, it can be further expanded from the following aspects: first, to include more financial asset types (such as bonds or digital currencies) to enhance the diversity of the portfolio; second, to use more complex measurement methods such as GARCH and Copula to describe risk spillover mechanisms in more detail; third, to extend the sample interval or examine other geopolitical events To enhance the robustness and general value of the conclusions

2.3 Key issues

During the research, the main difficulties were observed in several aspects. First, geopolitical conflicts are often sudden and accompanied by violent market fluctuations, and gaps and outliers are inevitably present in the data, which need to be processed when cleaning and aligning to ensure the reliability of yield and covariance estimates. Secondly, the mean – variance model is based on the assumption that returns obey a normal distribution, but under extreme events such as the Russo-Ukrainian conflict, the market often exhibits thick tail and fluctuation aggregation characteristics, which limits the applicability of the model to a certain extent. Again, the performance of stocks versus commodities under geopolitical shocks differs significantly, and how this heterogeneity can be compared and explained under a unified framework is a central issue for analysis. Finally, macro factors such as inflation, exchange rates, and energy prices also act on the market at the same time, posing a challenge to isolate the independent effects of geopolitical uncertainty.

2.4 Research methods

2.4.1 Model form

This paper uses the mean – variance model (Mean – Variance Model) to develop analysis from data processing, parameter estimation to combinatorial optimization, with the following specific steps:

Let the asset price be $P_{t,i}$,Where t=1,2,⋯,T for time (monthly), i=1,2,⋯,N for different assets (such as stock indices, commodities). In order to guarantee the additivity of the yield, this paper takes a logarithmic yield:$r_{t,i}=\ln\left(\frac{P_{t,i}}{P_{t-1,i}}\right)$

Collate the yields of all assets into a yield matrix R, where each row corresponds to the yield of assets at a point in time, and each column corresponds to the monthly yield series of a single asset:

$$R=\begin{bmatrix} r_{1,1} & r_{1,2} & \cdots & r_{1,N} \\ r_{2,1} & r_{2,2} & \cdots & r_{2,N} \\ \vdots & \vdots & \ddots & \vdots \\ r_{T,1} & r_{T,2} & \cdots & r_{T,N} \end{bmatrix}$$

2.4.2 Mean vs covariance estimation

Expected return on a single asset

Take the mean of the yield series for asset i, that is $\mu_i=\frac{1}{T}\sum_{t=1}^{T}r_{t,i}$, The expected return on all assets constitutes the expected return vector$\mu=[\mu ,\mu_2,\cdots,\mu_N]^T$.

Asset covariance matrix: measures the linkage of asset returns and is calculated as

$$\Sigma_{ij}=\frac{1}{T-1}\sum_{t=1}^{T}(r_{t,i}-\mu_i)(r_{t,j}-\mu_j) \quad (1)$$

The covariance of all assets constitutes the covariance matrix$\Sigma\in\mathbb{R}^{N\times N}$

2.4.3 Portfolio benefits and risks

Assume that the weight vector of the investment portfolio is $w=(w_1,w_2,\cdots,w_N)^\top$, which satisfies the complete investment constraint of funds$\sum_{i=1}^{N}w_i=1$, then:

Expected return on the portfolio:

linearly superimposed by the asset weight and the expected return, viz $\mu_p=w^T\mu$

Combination variance versus standard deviation:

Reflects the overall risk of the combination, with a variance of $\sigma_p^2=w^T\Sigma w$, a standard deviation of $\sigma_p=\sqrt{\sigma_p^2}$, and is used to measure the level of risk.

2.4.4 Minimum Variance Combination (GMV)

The goal is to find the least risky configuration of weights among all feasible combinations, that is, to solve the optimization problem:

$$\min_w w^\top\Sigma w \quad \text{s.t. } \mathbf{1}^\top w=1,\ w_i\geqslant 0$$

Constraints guarantee that the funds are fully invested and that short selling is not allowed (if short selling is allowed, the wi symbol constraint can be adjusted). The problem can be solved by numerical optimization (like quadratic programming) to obtain the minimum variance combination (GMV).

2.4.5 Max Sharpe ratio combination

When considering the risk-free rate rf, the Sharpe ratio of the portfolio is defined as the unit risk excess return:

$$\text{Sharpe}(w)=\frac{w^\top\mu-r_f}{\sqrt{w^\top\Sigma w}}$$

The largest Sharp portfolio needs to be weighed between benefits and risks, and the optimization goals are:

$$\max_w\frac{w^\top\mu-r_f}{\sqrt{w^\top\Sigma w}} \quad \text{s.t. } \mathbf{1}^\top w=1,\ w_i\geqslant 0$$

In the actual code, the configuration with the highest Sharpe ratio can be found by traversing the search across a series of candidate combinations by setting the target payoff level and introducing a penalty function.

2.4.6 Effective frontier

The effective frontier describes the risk — return duality of the optimal combination under different target yield constraints, namely

$$\text{Return}(w)=w^\top\mu, \quad \text{Risk}(w)=\sqrt{w^\top\Sigma w}$$

The impact of geopolitical conflicts on the set of investment opportunities (such as changes in the benefit-risk ratio, effective combination boundary movements, etc.) can be visually demonstrated by comparing the effective frontier morphology before the Russo-Ukrainian conflict (2019–2021) with that after the conflict (2022–2023).

2.4.7 Research design

This paper performs the following analysis on stock index data and commodity price data respectively:

(1) Calculate the log yield, construct the yield matrix R, and estimate the expected return μ and the covariance Σ;

(2) Solve the minimum combination of variances (GMV) combined with the maximum Sharpe ratio;

(3) Mapping effective frontiers, contrasting differences in risk-benefit characteristics before and after conflict.

Through the above steps, the effects of geopolitical uncertainty (using the Russo-Ukrainian conflict as an example) on the optimal combination allocation of different asset classes are systematically analyzed to provide a basis for adjustment of asset allocation strategies.

3 Data source and description

This paper selects the Russo-Ukrainian conflict as an entry point for analysis, focusing on the impact of geopolitical uncertainty on portfolio allocation. The study sample included major global equity indices for the period January 2019 to December 2023, such as RTS Index, S&P_ASX200 of Australia, DAX30 of Germany, CAC40 of France, KOSPI of South Korea, Hang Seng China (listed in Hong Kong) 100, CSI300, S&P_BMV IPC of Mexico, SWI20 of Switzerland, PFTS of Ukraine, etc. And commodity-related market data, which include: energy (crude oil futures and oil company stocks, such as BNO, USO, BP, PBR, IOC, 601857), precious metals (gold ETF GLD, gold futures, XAU/RUB), and data on companies related to energy transportation (TOP). The relevant data come from Investing.com and are uniformly processed into monthly frequencies. In order to compare market performance before and after the conflict, the study interval was further divided into two phases: 2019 –2021 for the pre-conflict phase and 2022–2023 for the post-conflict phase.

4 Analysis results

4.1 Operation results on the stock side

Table 1

	Pre_GMV	Pre_MaxSharpe	Post_GMV	Post_MaxSharpe
CAC40	0	0.103591	0	0.35
PFTS	0.35	0.128958	0.35	0.35
HSCEI100	0.080373	0	0	0
BMV_IPC	0.066332	0	0	0.28431
DAX30	0	0.051784	0	0
SWI20	0.35	0.35	0.35	0
ASX200	0	0	0.038199	0.01569
KOSPI	0	0.015667	0	0
CSI300	0.153295	0.35	0.247588	0
RTS	0	0	0.014213	0

Each column corresponds to one optimization result:

Pre_GMV: Pre-conflict minimum variance combination (Global Minimum Variance) weights

Pre_MaxSharpe: Maximum Sharp combination weight before conflict

Post_GMV: Minimum variance combination after conflict

Post_MaxSharpe: The Max Sharpe Combo After the Conflict

Each row is an asset (such as CAC40, DAX, CSI 300, Hang Seng Index, etc.)

Table 2

	mean_m	std_m	sharpe_m
Pre_GMV	0.004903816	0.021841172	0.14890383003409277
Pre_MaxSharpe	0.009472828	0.031579948	0.2476649782474082
Post_GMV	-0.006519496	0.018965253426713517	-0.43084463
Post_MaxSharpe	0.001222561	0.032477094	-0.013209932

mean_m: the average monthly yield of the portfolio

std_m: the monthly volatility (risk) of the combination

sharpe_m: the monthly Sharpe ratio of the combination

Lines: Pre_GMV, Pre_MaxSharpe, Post_GMV, Post_MaxSharpe.

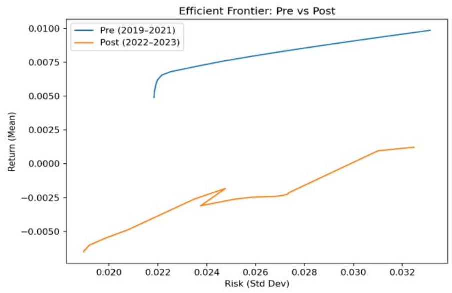

Figure 1

4.2 Results of operations on commodities (oil, gold)

Table 3

	Pre_GMV	Pre_MaxSharpe	Post_GMV	Post_MaxSharpe
XAU_RUB	0.30090340254011877	0.8097580436108149	0	0.096296166
TOP	1.0299920638612292e-18	9.938068163545255e-16	0	8.521829075736065e-17
601857	0.11920402257844878	2.8593121793873966e-16	8.62457432908972e-18	0.052395280933286714
USO	0	1.0847442735717472e-15	0	0
Gold_Futures	0.18486536860768746	0	0.2913728155200541	0.066077014
PBR	7.589415207398531e-19	2.4226497544188597e-16	0.019142587	8.212831456577696e-18
BP	0.22121427074092914	2.6164508927506436e-16	0.23712852330045492	0.2669522712456071
IOC	1.5720931501039814e-18	0	0.074838941	0.384882618
BNO	0.012787405707225467	0.19024195638918362	0.060062897	0.079146562
GLD	0.16102552982559037	0	0.3174542362103825	0.054250088361107236

Table 4

	mean_m	std_m	sharpe_m
Pre_GMV	0.002921359	0.026713759837117268	0.10935782847187453
Pre_MaxSharpe	0.011601929732742027	0.035668284	0.32527299696663203
Post_GMV	0.009098405	0.027595113	0.3297107554757658
Post_MaxSharpe	0.016246286538322947	0.03801312	0.4273862908197756

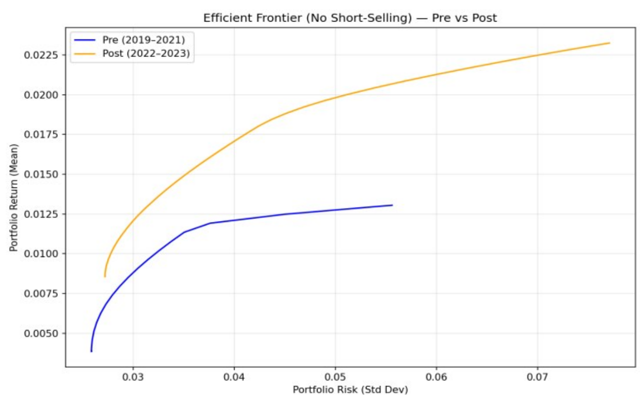

Figure 2

4.3 Research conclusion

4.3.1 Stock (Figure 1) result analysis

Pre-conflict (2019–2021): The effective frontier as a whole is in the upper right, indicating that at the same risk level, the portfolio achieves higher yields.

Post-conflict (2022 – 2023): The effective frontier moves downward as a whole, and some regions even experience negative returns, indicating that geopolitical shocks have significantly reduced expected returns in the stock market, while risks have not improved.

Conclusion: After the Russo-Ukrainian conflict, the risk-benefit characteristics of the stock portfolio deteriorated significantly, making it more difficult for investors to obtain positive returns at reasonable risk.

4.3.2 Commodity (Figure 2) result analysis

Pre-conflict (2019–2021):

Commodity effective frontier is relatively flat, with limited levels of earnings.

Post-conflict (2022–2023):

Effective frontiers move upward overall and expand significantly into high-risk ranges, illustrating that commodities show higher earnings potential after conflict.

After the Russo-Ukrainian conflict, commodities became the main safe haven and profit channel, outperforming the stock portfolio, especially in energy and gold assets.

4.3.3 Comprehensive conclusion

The Russo-Ukrainian conflict has heightened uncertainty in global financial markets:

The performance of the stock portfolio deteriorated significantly, with the risk — yield trade-off getting worse;

The commodity mix has instead improved its performance, highlighting its role as a safe haven and hedging against inflation.

This illustrates that commodities outperform stocks and are better suited as core allocations for optimal portfolios in times of heightened geopolitical uncertainty.

5 Conclusion

My study used the mean-variance model to compare the risk and return performance of asset portfolios before and after the Russia-Ukraine conflict with monthly data on major global stock indexes and commodities from 2019 to 2023. As a result, it was found that after the conflict broke out, the average return of the stock portfolio decreased and the fluctuations became larger; but commodities are different, especially assets such as energy and gold, which have a more obvious hedging effect and are more valuable when allocated.

It can be seen that when geopolitics is uncertain, the responses of different types of assets to shocks are quite different. In this crisis situation, investors are more willing to allocate money to commodities to hedge risks.

As for the value of this research, on the one hand, it puts geopolitical risks into the classic mean-variance framework, adding new practical data support to the traditional portfolio theory; on the other hand, it also helps everyone understand the extreme events, how asset allocation will operate. When actually used, this conclusion can also help investors optimize the combination of multiple types of assets and do better risk management during periods of high uncertainty. However, this research also has shortcomings: first, the range of assets selected is not broad enough, and emerging assets such as bonds and digital currencies are not included; second, the mean-variance model does not describe "thick tail distribution " " fluctuation aggregation" in extreme events. These situations are not described accurately enough. In future research, more complete data can be used, and then try more flexible nonlinear methods such as GARCH and Copula, or machine learning models, so that the conclusions will be more reliable and have a wider scope of application

References

[1] Qin X. Y. (2019). Literature review on new advances in portfolio selection and optimization. China Economic & Trade Herald, (12), 87–88.

[2] Xu M. (2014). Measurement and volatility analysis of household financial asset portfolio integration risks. Contemporary Economic Management, 36(07), 71–75.

[3] Li Y., Luo J. Q., & Jiang Y. M. (2021). Policy uncertainty spillovers and financial risk contagion in the Asia-Pacific network. Pacific-Basin Finance Journal, 68, 101–125.

[4] Niu F. C., Ge Y. J., Dou W., et al. (2025). Spatial effects of geopolitical environmental risks in African countries on China's outward direct investment. Acta Geographica Sinica, 80(08), 2241–2260.

[5] Zhu M. N., & Xiao D. (2025). Geopolitical risk, investor preferences and bilateral direct investment inflows. Journal of Xiamen University (Philosophy and Social Sciences), 75(04), 78–91.

[6] Chen M. (2025). Analysis of the impact of geopolitical risks on international gold prices in 2024. Jiangsu Commercial Forum, (05), 83–87.

[7] Li J. Q. (2023). Study on the impact of geopolitical risks on international commodity prices (Doctoral dissertation, Jilin University).

[8] Gou Q., Xu H. C., & Shi J. P. (2025). The impact of geopolitical risk on cross-border stock capital flows. Journal of Central University of Finance and Economics, (07), 95–110.

[9] Zhang F. P., Xu Y. X., & Chen Y. (2025). Measuring tail risk and spillover effects in stock markets under extreme events. Systems Engineering Theory and Practice, 45, 1–25.

[10] Chen X. B., & Long L. (2024). Geopolitical risk and China's short-term cross-border capital flows: Theoretical mechanism and empirical analysis. International Finance Research, (03), 39–50.

[11] Liu Y. (2025). Normative construction of cross-border digital currency payments under geopolitical risks. New Finance, (08), 44–53.

[12] Xu L. Q., Zhang W. B., Li J., et al. (2025). The impact of geopolitical risk on global value chain positioning. International Finance Research, (07), 28–38.

[13] Xiao Z. Y. (2025). The impact of RMB exchange rate fluctuations on foreign direct investment in China: A perspective of geopolitical risks and economic freedom. Northern Finance, (04), 42–49.

[14] Yao Y. Y. (2025). Risk management of overseas investment of state-owned enterprises under changes in the international political and economic environment. Business 2.0, (09), 40–42.