THE IMPACT OF THE COVID-19 PANDEMIC AND THE RUSSIAN INVASION OF UKRAINE ON GOLD MARKETS

Fisnik MORINA [1], Valdrin MISIRI [1], Saimir DINAJ [1], Simon GRIMA [2,3]✉

[1]*Faculty of Business, University "Haxhi Zeka", Peja, Kosovo*
[2]*Department of Insurance and Risk Management, Faculty of Economics, Management and Accountancy, University of Malta, Msida, Malta*
[3]*Faculty of Business, Management and Economics, University of Latvia, Riga, Latvia*

Abstract. *Purpose* – The study examines global Gold market performance and correlations between COVID-19, the Russian invasion, inflation, investors' fear, asymmetric shocks, and the VIX (volatility index) impact on volatility.

Research Methodology – This research uses an econometric approach to analyse the impact of COVID-19 and the Russian invasion on Gold market performance – specifically the ARCH (Autoregressive Conditional Heteroskedasticity) – GARCH (Generalized Autoregressive Conditional Heteroskedasticity) Model and the Threshold-Asymmetric ARCH Model.

Findings – The study reveals that the COVID-19 pandemic and the Russian invasion of Ukraine have significantly impacted Gold market dynamics. Inflation significantly impacts volatility, emphasising the need for monitoring inflation rates. Investor fear increases demand during uncertainty periods, while negative shocks have a higher asymmetric effect. The VIX positively affects Gold market volatility, suggesting a perceived safe-haven status during increased volatility.

Research Limitations – Gaps in the data related to COVID-19 cases, geopolitical events, and Gold market performance could potentially introduce inaccuracies, biases or limitations to the analysis.

Practical Implications – The study's findings have practical implications for investors, analysts, and policymakers involved in the financial investment of Gold markets.

Originality/Value – This study provides new insights into the relationships between inflation, investor fear, asymmetric shocks, and the impact of the VIX on Gold market dynamics during economic and geopolitical uncertainty.

1. Introduction

Investors acquire Gold as a classic safe-haven asset when financial markets are unsettled or volatile. Gold may also be used to protect against inflation, currency depreciation, and geopolitical threats. The global pandemic of COVID-19 has had a tremendous influence on the world economy, particularly the Gold market. As the virus spread and governments imposed lockdowns and economic restrictions, investors flocked to Gold as a safe-haven asset. This resulted in increased demand for Gold, which pushed up prices. Likewise, the continuing crisis between Russia and Ukraine has impacted the Gold market. Economic uncertainty and risk

may rise due to geopolitical tensions and the danger of armed conflict, driving investors to seek safe havens such as Gold. As a result, the Ukraine crisis has contributed to Gold price volatility.

To enhance comprehension of the correlation between worldwide events and Gold prices, it is possible to do a scientific investigation using econometric measures. This research entails examining data across many time periods and using statistical models to discern patterns and correlations among various variables. In this particular scenario, the study would analyse many aspects, including COVID-19 instances, economic indicators, and geopolitical tensions, to ascertain their influence on the performance of Gold markets. By acquiring a deeper under-standing of the impact of global events on financial markets, this research has the potential to provide valuable insights for informing future investment strategies. During economic instability or geopolitical turmoil, investors may modify their portfolios by increasing their allocation to Gold.

Furthermore, the results of this research might be used by policymakers to formulate effective methods to mitigate the influence of global events on financial markets. This study examines the impact of the COVID-19 pandemic and the Russian invasion of Ukraine on the performance of global Gold markets. Using data analysis and applying statistical modelling techniques, our objective is to enhance our comprehension of the correlation between these occurrences and the fluctuations in Gold prices. The present research aims to provide valuable insights into the impact of global events on financial markets and subsequently contribute to the development of informed investment strategies.

2. Literature review and meta-analysis

The COVID-19 pandemic led to a significant increase in Gold prices as investors sought refuge from the unparalleled economic and social upheaval resulting from the advent of the virus. Nevertheless, the influence of Gold on the success of the stock market during the COVID-19 pandemic remains uncertain and contingent upon a multitude of aspects encompassing market sector, geographical location, temporal duration, and investor attitude. Several research studies have been conducted to analyse the responses of various stock market segments to the influence of the COVID-19 pandemic and the extent to which Gold has contributed to its stability or volatility. In their study, Buszko et al. (2021) conducted an analysis of the Warsaw Stock Exchange, a significant market in Central and Eastern Europe. Their findings indicate that considering indicators such as profitability, volume, overbought/oversold conditions, and volatility, none of the sector indices on the exchange exhibited lower stability during the COVID-19 pandemic. In this analysis, the authors also demonstrated that various sectors exhibited distinct sources of stability, with Gold displaying a positive correlation with some sectors (such as energy) and a negative correlation with others (such as the building industry).

Similarly, the study conducted by Kao et al. (2022) explored the impact of the COVID-19 pandemic on the dynamics of stock, oil, Gold, currency, and cryptocurrency markets. The researchers used measures like volatility spreads and rates of return to analyse these relation-ships. The authors of this research discovered that the volatility spread exhibited significance throughout most financial markets, but the return spread and correlation showed significance

just inside specific financial markets. Additionally, it was discovered that the COVID-19 pandemic had a more substantial influence on return spillovers than volatility spillovers. Moreover, it has been proposed that investors consider using the euro to construct a diversified portfolio to mitigate risk while safeguarding their investments in Gold as a strategy for risk reduction.

Previous research has focused its attention on examining the impact of regional variations on the stock market's reaction to the COVID-19 pandemic and investigating the role of Gold as a mitigating or exacerbating factor in these dynamics. An empirical study conducted by Baker et al. (2020) examined the response of stock markets in 60 different nations during the COVID-19 pandemic. The researchers used an event study methodology to analyse the data. It was observed that countries with more robust health systems saw comparatively lesser losses in their stock values in contrast to those with poorer health systems. Additionally, it was shown that countries characterised by a greater presence of democratic institutions saw more substantial decreases in their stock values in comparison to countries with a lesser prevalence of democratic institutions.

Moreover, the study demonstrated a positive correlation between Gold prices and the presence of poorer health systems or less democratic institutions in comparison to nations with better health systems or more democratic institutions. Several scientific studies have been conducted to assess the repercussions of the COVID-19 pandemic on the Gold stock market. According to research conducted by Latif et al. (2021), the global pandemic has resulted in a notable surge in the demand for Gold. This heightened interest in Gold may be attributed to investors' desire to mitigate the economic uncertainties brought about by the COVID-19 crisis. Mofijur et al. (2021) conducted research that revealed that the ongoing pandemic has had a notable impact on the Gold market, resulting in heightened levels of volatility. The authors observed that shifts in global health conditions and policy measures have been influential factors contributing to the swings seen in Gold prices.

Conversely, the Gold market has had a more geographically limited influence as a result of the Russian – Ukrainian War. Implementing economic sanctions on Russia and the potential for military confrontation has heightened geopolitical uncertainty. Consequently, increased demand for Gold is possible as investors seek a safe-haven asset. The influence of Russian aggression on the Gold market is contingent upon the extent and length of the War as well as the broader economic ramifications experienced in the impacted areas. In relation to the issue of the Russian – Ukrainian War, a recent scholarly investigation conducted by Flockhart and Korosteleva (2022) revealed that the implementation of economic sanctions against Russia has resulted in a heightened desire for Gold as a secure investment option. This trend may be attributed to investors' efforts to minimise potential risks linked to geopolitical tensions. An investigation by Jiang et al. (2021) revealed that the ongoing epidemic has resulted in a surge in the desire for physical Gold as investors actively pursue tangible assets to protect their financial resources.

Similarly, Liu (2021) conducted research that revealed the significant impact of the pandemic on the demand for Gold exchange-traded funds. Investors have increasingly gravitated towards these financial products to access the Gold market. Numerous scholarly investigations have been conducted to analyse the ramifications of Russian aggressiveness on the Gold

stock market. According to Abeysekera's 2023 research findings, implementing economic sanctions on Russia has heightened the desire for Gold. Nevertheless, the ramifications of Russian aggressiveness on the Gold market are not always straightforward. According to recent research conducted by Gkillas et al. (2022), the correlation between Russian aggression and the Gold market exhibits variability contingent upon the conditions surrounding the War. In some instances, it is plausible that fluctuations in the Gold market are influenced more by shifts in global economic circumstances than by geopolitical danger.

In Table 1, an overview of the literature of recent years is presented through the meta-analysis approach, presenting the main empirical findings of scientific studies related to the impact of the COVID-19 pandemic and the Ukrainian War on the performance of global financial markets, with particular emphasis on Gold markets.

Table 1. Meta-analysis of scientific studies on the effect of global events on the performance of financial markets (source: authors' compilation)

Authors	Year	Variables	Methods	Findings
Kumari et al. (2023)	2022	Cumulative abnormal return, sanctions against Russia, recent returns and imports from Russia	Cross-sectional and network analysis	The returns in developed markets and NATO countries exhibit a good trend. Still, the imposition of economic sanctions and concerns over diminished exports have a detrimental impact on returns throughout subsequent periods after adverse global occurrences.
Gautam et al. (2022)	2020– 2022	Gold prices on the stock market and the number of daily cases of COVID-19	Augmented Dicky Fuller (ADF) Test, Vector Autoregressive Model (VAR), ARCH-GARCH Method	The study has shown the presence of cointegration and the Granger causality relationship between the Gold price and the occurrences of COVID-19 during the investigated timeframe, spanning from 2020 to 2022.
Yavas and Rezayat (2016)	2012– 2014	EWZ (Brazil), MCHI (China), INDA (India), EIDO (Indonesia), EWW (Mexico), ERUS (Russia), EZA (South Africa), EWY (South Korea), TUR (Turkey), IEV (Europe), SPYUN (USA)	MARMA and GARCH	When exchange-traded funds (ETFs) prices exhibited a significant decrease in relation to the equities comprising the underlying index, as a result of this phenomenon, investors were motivated to acquire the ETF while simultaneously divesting themselves of the underlying assets, generating a discrepancy between the price of the ETF and its intrinsic value. The potential existence of arbitrage possibilities might be attributed to the reduced transaction costs of trading ETFs.

Authors	Year	Variables	Methods	Findings
Setiawan et al. (2022)	2013–2021	MSCI, ESC, FTSE Crude Oil, Natural Gas, Gold, Silver, Bitcoin	ARCH-GARCH Model	There are discernible variations in price dynamics and risk characteristics across G7 countries, Islamic countries, and alternative asset classes. The pandemic has impacted price disparities while exhibiting few alterations in the asset's risk profile during COVID-19. Assets such as Gold and Bitcoin exhibit comparatively lower risk levels than in non-pandemic times.
Chen et al. (2022)	2011–2021	DJIA, DJBI, DJII, WTI,VIX, GOLD, FSI	TVP-VAR	Gold and oil possess significant potential as diversification assets inside a portfolio that is linked to the US financial markets and financial sector indices, such as banking or insurance.
Ha (2023)	2018–2022	Crude Oil Volatility Index, Gold Volatility Index, CBOE Volatility Index	TVP-VAR	Interstate crises and wars have a lasting influence on the oil market's volatility. The volatility of oil and Gold, as well as the performance of stock exchanges where these commodities are traded, are significantly impacted by shocks arising from conditions of uncertainty. These effects have profound ramifications for the financial markets associated with these assets.
Ozili (2022)	2022	Effect on global goods, economic effects Global stock market	Meta-Analysis Approach	The conflict between Russia and Ukraine has demonstrated that the implementation of sanctions against a bellicose country may not be the most advantageous course of action, as these measures can have unintended consequences for non-conflicting nations, particularly when the bellicose nations are engaged in trade partnerships with other non-conflicting countries.
Kumar (2013)	2000–2011	Nifty INR/USD Bovespa BRL/USD FTSE/JSE ZAR/USD	VAR, GARCH, BEEK	The significance of rates of return and volatility in stock markets surpasses that of foreign currency markets, emphasising the interplay between these two financial market categories.

End of Table 1

Authors	Year	Variables	Methods	Findings
Qin et al. (2023)	1990–2020	ICAPM, RGR, GP	VAR Analysis	Geopolitical risk, which can have both positive and negative effects, may influence the fluctuation of Gold prices. The positive consequences suggest that the decline in the geopolitical situation in Russia has the potential to impact the worldwide Gold market via the mechanisms of supply and demand and vice versa.
Izzeldin et al. (2023)	2004–2009	GFC, COVID-19, War, VIX, Stock Market	Heterogeneous Autoregressive Model (HAR)	In the short term, Russia's War in Ukraine is expected to lead to reduced economic growth and increased inflation at many global levels.
Bagchi (2017)	2009–2016	Oil Price, VIX, BRIC Stock Market	The Asymmetric Power ARCH (APARCH) Model	A negative correlation between returns and volatility indicates that negative information will create greater volatility in stock and financial markets.

The meta-analysis results provide useful insights into various categories of assets and their behaviour in diverse circumstances. The different studies reveal discernible trends pertaining to price fluctuations and associated risks among three separate groups, namely G7 assets, Islamic assets, and alternative assets. The COVID-19 pandemic influenced the price disparities among these categories, although the related risk patterns of these assets were hardly affected. During the COVID-19 pandemic, both Gold and Bitcoin risk levels were reduced compared to typical market circumstances. This implies that these assets have the potential to function as comparatively lower-risk investment alternatives in times of crisis.

Moreover, the inclusion of Gold and oil in a portfolio has shown their significance as effective diversification assets, particularly when paired with companies that are linked to the US financial markets and sector indexes, such as banking or insurance. The existence of armed conflicts has enduring consequences for the volatility of the oil market. The presence of insecurity shocks that often accompany wars tends to absorb volatility in oil, Gold, and stock markets, resulting in more severe repercussions for these markets. Geopolitical risk has the potential to have both positive and negative influences on the fluctuations of Gold prices. The positive consequences suggest that the decline in the geopolitical situation in Russia has the potential to stimulate the worldwide Gold market via the mechanisms of supply and demand and conversely.

3. Research methodology

The scientific methodology applied in this study is a quantitative analysis based on secondary data that has been collected in databases that are relevant and reliable in the scientific aspect (Yahoo Finance and the Federal Reserve Bank in the USA). The main purpose of this study is

to prove how inflation and investor fear have affected the performance and volatility of the Gold markets. Another goal is to analyse the effect of the COVID-19 pandemic and Russia's War in Ukraine on the performance and volatility of Gold markets from a global perspective.

The dependent variables in this study are the performance of the Gold financial markets and the volatility of the oil markets. At the same time, the independent variables in this study are inflation and investors' fear (VIX). The asymmetric effect of positive and negative shocks resulting from the COVID-19 pandemic and Russia's War in Ukraine is applied as a control variable. The econometric analysis in this study is divided into two time periods. The first period of the study includes the period during the COVID-19 pandemic (20 December 2019 – 17 December 2021), and the number of observations is 504. While the second time period of the study includes the period during Russia's War in Ukraine (24 February 2022 – 10 March 2023), the number of observations is 268.

Therefore, in this study we would like to understand and explain how inflation has affected the volatility of Gold markets, how investor fear (VIX) has affected the performance of Gold markets, the asymmetric effect of positive and negative shocks on the volatility of Gold markets and how investor fear (VIX) has affected the volatility of Gold markets.

However, after reviewing literature we hypothesised that Inflation has a significant impact on the volatility of Gold markets (H1). That Investor fear (VIX) has a negative impact on the performance of Gold markets (H2). That Negative shocks have a higher asymmetric effect than positive shocks on the volatility of Gold markets (H3) and that Investors' fear (VIX) has positively affected the increase in the volatility of the Gold markets (H4).

To analyse the impact of inflation on the volatility of the performance of Gold markets, the data on price changes (Gold market performance) and inflation must be presented in the form of a time series that includes both time periods of the study (COVID-19 and Russia's War in Ukraine). To prove the validity of the first hypothesis, the statistical test was applied through the ARCH-GARCH model, and a GARCH equation was used to model the volatility of price changes as a function of inflation changes in previous periods. The equation of the ARCH-GARCH model, in this case, will be:

$$\Delta r_t = \mu + \varepsilon_t;$$

$$\Delta \varepsilon_t = \sigma_t + z_t;$$

$$\Delta \sigma_t^2 = \omega + \Delta \alpha \times \varepsilon_{t-1}^2 + \beta \times \sigma_{t-1}^2 + \gamma \times i_{t-1}^2. \tag{1}$$

The symbols of Equation (1) for the ARCH-GARCH econometric model are explained below: Δr_t – price change (market performance) at the time(s); μ – the average performance value of the Gold market; $\Delta \varepsilon_t$ – residual values at the time (t), which express actual price changes from the average value; $\Delta \sigma_t^2$ – variance of changes in time (t); z_t – the series of independent and distributed residual values with mean zero and variance one; ω – constant that defines the base levels of variance; α – coefficient indicating how much price changes at a time ($t - 1$) contribute to the variance at time (t); β – is the coefficient indicating how much the variance of time ($t - 1$) contributes to the variance of time (t); γ – coefficient showing how much inflation changes at time ($t - 1$) contribute to the variance at time (t) and i_{t-1}^2 shows inflation changes at a time ($t - 1$). The use of the econometric model ARCH – GARCH in this context allows the identification of the effects of inflation on the volatility of the performance

of Gold markets and how changes in inflation in previous periods can affect the volatility of the Gold market at the current time.

Also, the validity of the second hypothesis was verified by applying the ARCH-GARCH econometric model. We added the impact of investor fear (as indicated by the VIX) on Gold market performance to the second hypothesis. We did this by using a time series of market price changes as a proxy for Gold market performance and a time series of changes in the investor fear index as a statistical measure of the level of fear. The equation of the ARCH-GARCH econometric model for the second hypothesis will be as follows:

$$\Delta r_t = \mu + \varepsilon_t ;$$

$$\Delta \varepsilon_t = \sigma_t + z_t ;$$

$$\Delta \sigma_t^2 = \omega + \alpha \times \varepsilon_{t-1}^2 + \beta \times \sigma_{t-1}^2 + \gamma \times f_{t-1}^2. \tag{2}$$

All the symbols in the second equation are explained above in the first equation, except for f_{t-1}^2 which represents the changes in the investors' fear index (VIX) at a time $(t-1)$. The third hypothesis of this study consists of analysing the asymmetric effect that exists between positive and negative shocks from global events (the COVID-19 pandemic and Russia's war in Ukraine) on the volatility of Gold markets. To verify the validity of this hypothesis, the econometric model of the asymmetric ARCH threshold was applied, which is an extension of the ARCH-GARC model, and this statistical test allows identifying the asymmetric effects on the volatility of Gold markets. The equation of the asymmetric threshold ARCH model is defined as follows:

$$\Delta r_t = \mu + \varepsilon_t ;$$

$$\Delta \varepsilon_t = \sigma_t + z_t ;$$

$$\Delta \sigma_t^2 = \omega + \sum_{i=1}^{p} \left(\alpha_i \times \left| \varepsilon_{t-i} \right| \right) + \sum_{j=1}^{q} \left(\beta_j \times \sigma_{t-j}^2 \right) + \sum_{k=1}^{m} \left(\gamma_k \times \left| \varepsilon_{t-k} \right| \times I_{t-k} \right). \tag{3}$$

All the symbols of the third equation are explained in the first equation except for these symbols, as follows: α_i, β_j, γ_k and I_{t-k} . Symbol α_i represents the coefficients that show how much market changes at a given time $(t-i)$ affect market volatility in the case of positive shocks. β_j represents the coefficients that show how much the variances of the period $(t-j)$ contribute to the variance of the markets, γ_k are the coefficients that show how much market changes in time $(t-k)$ affect market volatility in the case of negative shocks and I_{t-k} is an indicator variable, which takes the value of 1 if the change of markets at a time $(t-k)$ is negative and 0 if it is positive.

The fourth hypothesis of this study consists of analysing how investors' fear has affected the volatility of Gold markets globally. Also, this hypothesis has been tested for the application of the ARCH-GARCH econometric model. The fourth equation of the ARCH-GARCH econometric model, in this case, will be:

$$\Delta r_t = \mu + \varepsilon_t ;$$

$$\Delta \varepsilon_t = \sigma_t + z_t ;$$

$$\Delta \sigma_t^2 = \omega + \alpha \times \varepsilon_{t-1}^2 + \beta \times \sigma_{t-1}^2 + \gamma \times VIX_t. \tag{4}$$

All the symbols of the fourth equation are explained above in the first equation, except VIX_t , which represents the coefficient that shows how much changes in the investor fear

index (VIX) affect the volatility of the Gold markets at a time (t). This model allows for identifying the impacts of investor fear (VIX) caused by the COVID-19 pandemic and Russia's War in Ukraine on the volatility of Gold markets. Using this model can help understand the links between investor fear and market volatility and how changes in the fear index affect market volatility at the current time.

4. Hypothesis testing and interpretation

In this section of the paper, the alternative hypotheses of this study will be tested through the econometric models specified in the mathematical aspect of the scientific methodology of the research.

The first hypothesis

In the following, the first alternative hypothesis will be tested, answering the first research question: How has inflation affected the volatility of Gold markets? The impact of inflation on the volatility of Gold markets during periods of negative global events, such as economic crises, interstate conflicts, or War, can be varied and complex. Many factors are involved in these periods, and the effects vary according to context. In times of economic crises or major conflicts, inflation may increase due to market uncertainty and difficulties in the supply of goods. This inflation increase can create volatile market conditions and drive volatility. Investors can react to sudden changes in inflation by making rapid and scalable moves in the markets, causing increased volatility.

H0: Inflation has no impact on the volatility of Gold markets.

H1: Inflation has a significant impact on the volatility of Gold markets.

Table 2. The results of the ARCH – GARCH econometric analysis (source: econometric results in the STATA program, 2023)

Variables	The period of COVID-19		The period of War in Ukraine	
GOLD	Coef.	P > | z |	Coef.	P > | z |
INFL	−0.6423	0.000	0.5999	0.000

Based on the results (Table 2), we can conclude that if inflation increases by one unit, then the performance of Gold markets will increase by 0.59 units. This statement applies to the War in Russia – Ukraine, while for the COVID-19 pandemic, it has the opposite effect, and the statement applies. If inflation increases by one unit, then the performance of the Gold markets will decrease by −0.64 units. These statements are correct because the significance level is within the range of statistical significance, and the first alternative hypothesis that inflation has a significant impact on the performance of Gold markets globally is accepted.

The second hypothesis

The second research question of this study consists of analysing investors' fear (VIX) of the performance of Gold markets. Investors' fear, expressed among other things through the VIX index, significantly impacts markets' performance when negative global events occur, such as economic crises, interstate conflicts, or wars. In periods of negative international

events, investor fear tends to rise sharply. In the case of an economic crisis or a conflict situation, investors feel more unstable, leading to a marked increase in uncertainty. This increase in investor fear negatively affects the performance of the markets, creating a decline in the values of commercial indices and other assets.

H0: Investor fear has no impact on the performance of Gold markets.

H2: Investor fear has a negative impact on the performance of Gold markets.

Table 3. Results of the econometric ARCH model for the impact of investor fear on the performance of Gold markets (source: Econometric results in the STATA program, 2023)

Variables	The period of COVID-19		The period of War in Ukraine	
GOLD	Coef.	P > | z |	Coef.	P > | z |
VIX	− 1.6175	0.000	− 0.7853	0.008

According to the results (Table 3) of the ARCH econometric model, we prove that the second alternative hypothesis is accepted for the period of the COVID-19 pandemic, where the fear of investors in the Gold markets negatively affects the performance of these markets. If the VIX increases by one unit, then the Gold market's performance will decrease by − 1.61 units. In the case of the period of the War between Russia and Ukraine, we can conclude that the second alternative hypothesis is accepted since it is significant at the 5% level, in which case we can conclude that the fear of investors had an impact on the Gold markets in the period of the War between Russia and Ukraine.

The third hypothesis

The third research question of this study consists of analysing the asymmetric effect that positive and negative shocks have on the volatility of Gold markets due to the COVID-19 pandemic and Russia's War in Ukraine. Positive and negative shocks that occur from economic crises, pandemics, interstate conflicts, or wars have different impacts on the volatility of Gold markets. These events influence the behaviour of investors and their expectations for the future. The effects may vary depending on the nature and sensitivity of the markets and other factors such as monetary and fiscal policy, international relations, and changes in demand and supply.

H0: Negative and positive shocks do not have an asymmetric effect on the volatility of Gold markets.

H3: Negative shocks have a higher asymmetric effect than positive shocks on the volatility of Gold markets.

Table 4. Econometric results of the asymmetric threshold ARCH model between positive and negative shocks and the volatility of Gold markets caused by the COVID-19 pandemic and the Russian invasion of Ukraine (source: econometric results in the STATA program, 2023)

Variables	The period of COVID-19		The period of War in Ukraine	
Abarch	Coef.	P > | z |	Coef.	P > | z |
L1	1.4506	0.000	0.7277	0.000
L2	0.2739	0.000	−0.2294	0.000
L3	−0.2348	0.000	0.2224	0.000

In the case of the COVID-19 pandemic, based on the results (Table 4), we can observe that in the time intervals L1 (1.45) and L2 (0.2739), negative shocks have a higher effect than positive shocks since the coefficient is positive and has sig. 0.000 < 0.05, while in the time interval L3 (–0.23), the coefficient is significant and negative, so positive shocks have a higher effect than negative shocks. In the case of the war period in Ukraine, based on the results, we can observe that in the time intervals L1 (0.72) and L3 (0.22), negative shocks have a higher effect than positive shocks since the coefficient is positive and has sig. 0.000 < 0.05, while in the time distance L2 (–0.22), the coefficient is significant and negative, so positive shocks have a higher effect than negative shocks. According to the results of the asymmetric threshold ARCH model, it can be proven that the negative shocks caused by the War in Ukraine and the COVID-19 pandemic have a higher asymmetric effect on the volatility of Gold markets than positive shocks over two-time distances. If negative shocks increase by 1%, then the volatility of Gold markets will increase by 1.45%. As the days go by, negative shocks tend to reduce their impact.

The fourth hypothesis

In the following, the fourth alternative hypothesis will be tested, answering the fourth research question: *How has investor fear (VIX) affected the volatility of Gold markets?* Investors' fears increase significantly during economic crises, interstate conflicts, or wars. A high degree of uncertainty about the performance of financial markets and the economy makes investors more anxious and feel a greater need to protect their portfolios. This causes an increase in the VIX index and, consequently, an increase in the volatility of financial markets.

H0: *Investor fear (VIX) does not affect the increase in volatility of Gold markets.*

H4: *Investors' fear (VIX) positively affects the increase in volatility in Gold markets.*

Table 5. Econometric results of the ARCH – GARCH model for the impact of investors' fears on the volatility of Gold markets (source: econometric results in the STATA program, 2023)

Variables	The period of COVID-19		The period of War in Ukraine	
Atarch	Coef.	P > | z |	Coef.	P > | z |
L1	0.1837	0.000	0.1076	0.004

Based on these econometric results (Table 5), we can conclude that the fourth alternative hypothesis is accepted in the case of the period of the COVID-19 pandemic, which means that investors' fear positively affects the increase in the volatility of Gold markets during the period of the COVID-19 pandemic. If the VIX increases by 1 unit, then the volatility of the Gold markets will increase by 0.18 units. Also, according to the econometric results of the ARCH model, it can be proven that even during the period of the Russia-Ukraine war, investors' fear influenced the increase in the volatility of the Gold markets.

According to the graphic presentation in the Figure 1, it can be proven that there was an accumulation of volatility in the performance of the Gold markets during the period of the COVID-19 pandemic and during the period of the Ukrainian War. An unexpected negative event, such as the outbreak of the COVID-19 pandemic or Russia's invasion of Ukraine, can bring about an immediate shift in investor fears. Because of this unexpected event, investors
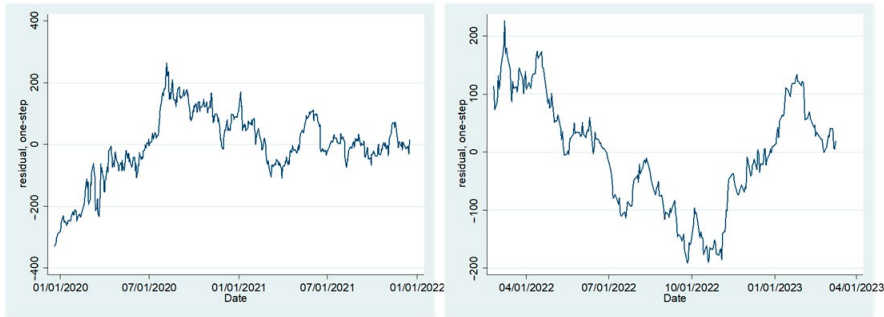
Figure 1. Volatility between the VIX index and the performance of Gold financial markets during the period of the COVID-19 pandemic and Russia's War in Ukraine (source: econometric results in the STATA program, 2023)

may become more nervous and take quick action to protect their investments. This can lead to an increase in the VIX index and, consequently, an increase in the volatility of the markets. Investors tend to react to important news and developments emotionally. As their fears grow, they may be more affected by the market's rapid and varied reactions, causing large price movements and increased volatility.

5. Discussions

This section will discuss the hypotheses approved through econometric measurements and their implications based on research on the effects of COVID-19 and the Russian invasion of Ukraine on the performance of Gold markets from a global perspective.

H1: Inflation has a significant impact on the volatility of Gold markets.

The acceptance of the first hypothesis suggests that inflation significantly impacts the volatility of the Gold market, even in the context of COVID-19 and the Russian invasion of Ukraine. This finding shows that corresponding changes in the volatility of the Gold market have accompanied changes in inflation rates during the studied period. It highlights the role of inflation as a fundamental factor affecting the demand and price of Gold. Investors and market participants should consider inflation dynamics as a major driver of Gold market volatility.

H2: Investor fear (VIX) has a negative impact on the performance of Gold markets.

The approval of the second alternative hypothesis shows that investor fear plays a role in shaping the performance of Gold markets, even in the face of the effects of COVID-19. It suggests that during the period studied, the fear or sentiment of market participants significantly impacted the demand and performance of Gold. Since Gold is often considered a safe haven asset during periods of uncertainty and fear, increased investor fear will likely increase demand for Gold, resulting in improved performance. This finding highlights the importance of understanding investor sentiment and its impact on Gold market dynamics. On the other hand, the approval of this hypothesis, even during the war period in Ukraine, suggests that investors' fear, especially related to the effects of the Russian occupation in Ukraine,

significantly impacts the performance of the Gold markets. This finding implies that during the studied period and in the specific circumstances of the geopolitical event, investors' fear caused substantial changes in the performance of the Gold market. It may suggest that other factors or market dynamics played a more prominent role in shaping the performance of the Gold markets during that time.

H3: Negative shocks have a higher asymmetric effect than positive shocks on the volatility of Gold markets.

The endorsement of the third hypothesis suggests that negative shocks had a higher asymmetric effect on the volatility of Gold markets compared to positive shocks, even in the context of COVID-19 and the Russian invasion of Ukraine. This finding is consistent with the concept of asymmetric volatility, indicating that adverse events or shocks exerted a stronger influence on Gold market volatility than positive events. This means that negative economic or geopolitical news during the studied period had a more significant impact on the volatility of the Gold market. This insight is valuable for investors in terms of risk management and understanding the dynamics of Gold market volatility.

H4: Investors' fear (VIX) has positively influenced the increase in volatility of Gold markets.

The approval of the fourth hypothesis shows that the VIX (Volatility Index) had a positive impact on the increase in the volatility of the Gold market during the effects of COVID-19. The VIX is a widely followed indicator of market volatility and investor sentiment. A higher VIX suggests increased volatility and potential market turmoil. The positive relationship between VIX and Gold market volatility suggests that during the period studied, market participants viewed Gold as a safe haven asset and sought its protection during periods of heightened market uncertainty. This finding supports the notion that the VIX serves as an indicator of Gold market volatility.

On the other hand, the approval of this hypothesis, even during the war period in Ukraine, shows that the VIX (Volatility Index) has significantly impacted the volatility of the Gold markets during the studied period and in the context of the Russian occupation of Ukraine. This finding suggests that the sentiment of market participants, as measured by the VIX, also strongly influenced the volatility of the Gold market during that time. This implies that some other factors or events may have had a more dominant role in driving the volatility of the Gold markets during the specified period.

Overall, the adopted hypotheses provide valuable insights into the effects of COVID-19 and the Russian invasion of Ukraine on the performance of Gold markets globally. They highlight the role of inflation, investor fear, the asymmetric effects of shocks, and the impact of the VIX on Gold market dynamics. These findings can help investors, analysts, and policy-makers understand the factors that drive the Gold market's volatility and performance during economic and geopolitical uncertainty.

6. Research limitations and mitigations

While this study aims to provide valuable insights into the effects of the COVID-19 pandemic and the Russian invasion of Ukraine on the performance of Gold markets from a global

perspective, some limitations must be acknowledged. These limitations may affect the scope and generalizability of the study's findings.

The accuracy and reliability of the study are highly dependent on the availability and quality of the data. Inaccuracies or gaps in the data related to COVID-19 cases, geopolitical events, and Gold market performance could potentially introduce biases or limitations to the analysis. However, by using multiple data sources and cross-referencing information, we tried as much as possible to mitigate data quality concerns. Sensitivity analyses were also performed to assess the impact of potential data inaccuracies on the study results.

Moreover, the time frame of this study may not include the long-term effects of the events studied on the Gold market. Short-term fluctuations can overshadow more gradual and stable trends. However, using different time frames for analysis and performing robustness checks helped to capture immediate and long-term effects, providing a more nuanced understanding of the relationship.

Recognising and addressing these limitations will contribute to a more nuanced and reliable interpretation of the study's findings. While these challenges present potential limitations, they also open avenues for further research and exploration to understand the intricate interactions between global events and financial markets.

7. Conclusions

Based on the hypotheses adopted by the research on the effects of COVID-19 and the Russian invasion of Ukraine on the performance of the Gold markets, we can conclude that Inflation plays an important role in the volatility of the Gold market, even in times of economic and geopolitical uncertainty. Monitoring inflation dynamics is essential to understanding the movements of the Gold market.

Investor fear has a noticeable impact on the performance of Gold markets. During periods of market uncertainty, Gold tends to be perceived as a safe asset, leading to increased demand and improved performance. Also, negative shocks have a stronger asymmetric effect on Gold market volatility compared to positive shocks. Adverse economic or geopolitical events tend to impact Gold market volatility more than positive events significantly.

Moreover, The VIX, as a measure of market volatility and investor sentiment, positively affects the volatility of the Gold market. Market participants regard Gold as a safe-haven asset during times of increased volatility and seek its protection.

Therefore, we recommend that given the significant impact of inflation on Gold market volatility, investors and market participants should closely monitor inflation rates and their potential impact on Gold demand and price, that due consideration of inflation dynamics is taken. Also, understanding and analysing investor fears and sentiments can provide insight into the performance of Gold markets. Monitoring fear and market sentiment indicators can help predict Gold demand changes during market uncertainty.

One should recognise that downside shocks have a more substantial impact on Gold market volatility. It is important to have risk management strategies to protect against adverse events and their potential impact on Gold investments. Moreover, the VIX can serve as a useful tool for understanding and predicting the volatility of the Gold market. Monitoring

the VIX and its relationship to Gold market performance can provide insight into market sentiment and potential changes in volatility.

Overall, these conclusions and recommendations highlight the importance of considering inflation, investor sentiment, asymmetric risk, and the VIX in analysing and managing investments in the Gold market. However, it is essential to note that these findings are based on the specific research context and should be interpreted in light of the period and events studied. Continued analysis and research are needed to validate these conclusions and extend them to a broader global perspective.

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