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Financial Market Linkages: Gold Futures and the NASDAQ Index

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Abstract: Gold futures and the NASDAQ Index are two important asset classes that receive much attention in global financial markets. Gold futures represent a safe haven and a store of value asset that typically perform well in unstable economic and financial environments. In contrast, the NASDAQ index represents the health of the U.S. technology stock market, which is usually affected by technological innovation and economic development. Although the two assets may appear to be completely different, there is a certain linkage between them, meaning that in some cases they may be affected similarly at the same time. In order to provide investors with a better understanding of the gold futures market and the stock market, and to improve investment, this paper found that the yield of gold futures can have a negative impact on the returns of the NASDAQ stock market, and the volatility of the NASDAQ stock market can also affect the volatility of the gold futures market. For investors, both the gold and stock markets have different risk and return characteristics. To ensure that investment strategies align with their risk tolerance and to avoid unnecessary anxiety and risks. Gold is often seen as an asset to resist inflation, so it may be an attractive choice when inflation rises.

Keywords: gold futures, NASDAQ index, linkages, volatility

1. Introduction

When it comes to investing and the financial markets, gold futures and the NASDAQ are among the topics that receive a lot of attention. The two represent different asset classes and market scenarios, but both play pivotal roles in global finance. The purpose of this paper is to take an in-depth look at gold futures and the NASDAQ Index, exploring their history, characteristics, influencing factors, and relationships with other financial assets.

Gold has always been an important asset in human history, representing a symbol of wealth, power, and value. The history of gold can be traced back thousands of years to ancient civilizations, and it has a unique place in different cultures. However, in modern financial markets, gold has evolved into an important investment tool, and gold futures are a key aspect of this. Gold futures are financial contracts that allow investors to buy or sell a certain amount of gold at a price on a specified date in the future. This trading method not only provides investors with insights into the price of gold but can also be used as a tool for hedging risks. This thesis will examine how the gold futures market works, as well as its place and impact in global financial markets [1]. While gold has a long history of use as a trading medium in China, the development of a market-driven gold industry in the country has a comparatively brief timeline. It wasn't until 2001, when the People's Bank of China declared

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the termination of the centralized gold purchase and distribution plan, that the Chinese gold market started its journey toward becoming more market-oriented [2]. On January 9, 2008, the Shanghai Futures Exchange achieved a milestone by effectively commencing trading in gold futures. This event represented a noteworthy progression in the establishment of China's gold market system, which was built upon the underpinnings of the spot market [3].

The NASDAQ, meanwhile, represents a basket of stocks in the technology sector and is one of the most famous stock indexes in the United States. Known for its high-tech companies and innovation-driven economy, the NASDAQ market has become the focus of investors' attention. The NASDAQ has experienced tremendous growth over the past few decades, and its stocks include a number of well-known technology companies such as Apple, Amazon, and Google parent Alphabet. Understanding the characteristics of the NASDAQ index and its impact on global financial markets is crucial for investors and analysts. Therefore, this paper will explore the history, composition, trading characteristics, and attractiveness of the NASDAQ index to investors [4].

Whether it is gold futures or the NASDAQ Index, they both play an important role in the global financial market and have a profound impact on investors, governments, and companies. The status of gold futures as a hedging tool in the financial market and its relationship with monetary policy are worthy of study. On the other hand, the NASDAQ Index represents the development trend of the technology industry and has important reference value for global technology investors and startup companies. This paper will delve into these two themes, exploring the reasons behind them and their potential impact.

In the context of increasingly complex and interconnected global financial markets, understanding the characteristics of gold futures and the NASDAQ Index is critical for investment decision-making and risk management. This paper will provide a detailed analysis of both markets to help investors better understand how they operate and their potential contribution to a portfolio. Through in-depth research on gold futures and the NASDAQ Index, investors can better grasp the development trends of global financial markets and provide more insights and information for future investment decisions [5].

A researcher contends that although numerous studies have delved into the impact of oil prices on gold prices and stock market indexes, only a scant few have explored the possibility of a nonlinear relationship. This perspective is grounded in the understanding that time series data can exhibit nonlinear behaviors attributed to various factors such as policy changes, crises, OPEC decisions, and more [6]. Another researcher posits that the relationship between gold sentiment and stock market realized volatility is not only negative but also bidirectional, highlighting a significant influence of a stock's realized volatility on gold investor sentiment [7]. Yet another perspective in the research community asserts that macroeconomic variables, encompassing gold and crude oil prices, their respective volatilities, the inflation rate, and exchange rates, exert an influence on stock prices. Consequently, the objective of this paper is to scrutinize the long-term interconnections among oil prices, gold prices, oil price volatility indices, gold price volatility indices, and the S&P price index through the application of a bounds test [8].

These studies contribute significantly to the existing literature by pioneering the utilization of Markov-Switching Bayesian VAR models to explore the nonlinear associations between gold prices and stock market indexes. However, it's worth noting that the relationships between oil prices and both gold and the stock market remain relatively limited in scope.

In conclusion, gold futures and the NASDAQ index represent different financial asset classes, and each plays an important role in the global financial market. This paper will help readers better understand the nature and value of these two markets by an in-depth study of their history, characteristics, influencing factors, and relationships with other assets. Both topics have broad appeal and importance, whether to investors, financial professionals, or to anyone who follows financial

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markets broadly. Through this research, investors will better understand how global financial markets work, providing more insights and sources of information for future investment and financial decisions.

2. Research Design

2.1. Data Source

Investing has a vast financial database, where investors can access the relevant indices for gold futures and the NASDAQ. Its website is cn-investing.com. This paper calculates and analyze the correlation between gold futures and the NASDAQ index by examining their prices, trading volume, gains, and losses. Additionally, this research uses STATA to create charts and analyze tables [9].

2.2. Weak Stationarity: Unit Root Test

At the outset, this paper should test the stability of the data. This can be done through Augmented Dickey-Fuller (ADF) tests conducted in Stata. Regarding the index values, the gold futures appear to be unstable, as indicated by a P-value greater than 0.05 (see Table 1). In contrast, the NASDAQ is stable. Most notably, this part focus on analyzing the return values. For both gold futures and the NASDAQ index, the p-values for returns are zero, indicating statistical significance. Since these variables exhibit unit roots, they are considered stable.

Table 1: Weak Stationarity Test.

		t	p
Index			
	Gold	-2.145	0.5210
	IXIC	-4.220	0.0042
Return			
	Gold	-36.122	0.0000
	IXIC	-35.900	0.0000

2.3. Vector Autoregression (VAR) Model

The Vector Autoregressive (VAR) model is widely acclaimed as a versatile and easily accessible instrument for examining multivariate time series data. It seamlessly extends the capabilities of the univariate autoregressive model to handle the intricacies of dynamic multivariate time series. The VAR model has firmly demonstrated its efficacy in capturing the evolving dynamics of economic and financial time series data and excels in predictive capabilities. When it comes to forecasting accuracy, VAR models typically outperform univariate time series models and intricate, theory-driven simultaneous equation models. Furthermore, VAR model predictions exhibit robust adaptability as they can incorporate conditions linked to potential future trajectories of specific variables within the model [10].

$$Gold_t = \beta_{10} + \beta_{11}Gold_{t-1} + \cdots + \beta_{1p}Gold_{t-p} + \gamma_{11}NASDAQ_{t-1} \cdots \gamma_{1p}NASDAQ_{t-p} + e_{1t} \quad (1)$$

$$NASDAQ_t = \beta_{20} + \beta_{21}Gold_{t-1} + \cdots + \beta_{2p}Gold_{t-p} + \gamma_{21}NASDAQ_{t-1} \cdots \gamma_{2p}NASDAQ_{t-p} + e_{2t} \quad (2)$$

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$$\begin{bmatrix} Gold_t \\ NASDAQ_t \end{bmatrix} = \begin{bmatrix} \beta_{10} \\ \beta_{20} \end{bmatrix} + \begin{bmatrix} \beta_{11} \\ \beta_{21} \end{bmatrix} Gold_{t-1} + \cdots + \begin{bmatrix} \beta_{1p} \\ \beta_{2p} \end{bmatrix} Gold_{t-p} + \begin{bmatrix} \gamma_{11} \\ \gamma_{21} \end{bmatrix} NASDAQ_{t-1} + \cdots + \begin{bmatrix} \gamma_{1p} \\ \gamma_{2p} \end{bmatrix} NASDAQ_{t-p} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \quad (3)$$

In equation (1), the VAR(P) model employs gold as the focal dependent variable, while equation (2) elucidates the VAR equation in which the NASDAQ index serves as the dependent variable. Equation (3), on the other hand, represents the VAR matrix equation.

2.4. ARMA-GARCH Model

The return and volatility of gold future and NASDAQ can be analyzed by the ARMA-GARCH Model, while it can be divided into two parts, ARMA and GARCH.

As for ARMA, the ARMA model, a significant approach in time series analysis, combines elements from both the AR (auto regressive) and MA (moving average) models. In essence, the AR model examines how past data influences current data by conducting thorough analysis. On the other hand, the MA model employs a linear combination of past-period random disturbances or prediction errors to estimate the current value.

The function (4) below demonstrates the general expression of ARMA model. The part $Return_t = \emptyset_0 + \sum_{i=1}^{AR} \emptyset_i \, Return_{t-i}$ is the expression of AR (auto regressive), while $\alpha_i - \sum_{i=1}^{MA} \theta_i \, \alpha_{t-i}$ is the expression of MA (moving average) [11].

$$Return_t = \emptyset_0 + \sum_{i=1}^{AR} \emptyset_i \, Return_{t-i} + \alpha_i - \sum_{i=1}^{MA} \theta_i \, \alpha_{t-i} \quad (4)$$

In the context of GARCH, the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model serves as a statistical instrument employed for the analysis of time-series data when it is presumed that the variability in errors exhibits interconnections across various time points. GARCH models are founded on the premise that the fluctuations in the error term follow a pattern reminiscent of autoregressive moving averages [12].

The function expressed in equation (5) below elucidates the generic formulation of the GARCH model. The "$\alpha_1 \varepsilon_{t-1}^2$" component corresponds to the ARCH portion, while the "$\gamma_1 \sigma_{t-1}^2$" part represents the GARCH component. Additionally, the "$\beta_t {\sigma^2}_t$" component adds to the model. Here, "σ_t^2" denotes volatility, commonly referred to as risk

$$\sigma_t^2 = \alpha_{0,1} + \alpha_1 \varepsilon_{t-1}^2 + \beta_t {Sigma^2}_t + \gamma_1 \sigma_{t-1}^2 \quad (5)$$

3. Empirical Results and Analysis

3.1. Order of VAR Model

By evaluating the data information for different lag orders, such as LR statistics, the best lag order can be determined. The lag order corresponding to the data information with the "*" suffix in the following table 2 represents the required lag order.

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Table 2: VAR Model Identification.

Lag	LL	LR	p	AIC	HQIC	SBIC
0	15779.9			-12.6072*	-12.6055*	-12.6025
1	15782.8	5.8511	0.211	-12.6063	-12.6013	-12.5924
2	15784	2.3158	0.678	-12.6041	-12.5956	-12.5808
3	15786.9	5.7576	0.218	-12.6032	-12.5913	-12.5706
4	15787.5	1.192	0.879	-12.6005	-12.5852	-12.5586
5	15792.5	9.965	0.041	-12.6012	-12.5827	-12.55
6	15793.6	2.2231	0.695	-12.5989	-12.577	-12.5384
7	15795.9	4.6689	0.323	-12.5976	-12.5723	-12.5278
8	15801	10.179*	0.038	-12.5985	-12.5697	-12.5193
9	15804.3	6.7176	0.152	-12.598	-12.5659	-12.5095
10	15806.3	3.8383	0.428	-12.5963	-12.5608	-12.4985
11	15809.3	6.1393	0.189	-12.5956	-12.5567	-12.4885
x12	15810.4	2.1045	0.717	-12.5932	-12.551	-12.4768

It is easy to observe that most data marked with "*" is concentrated in the first row, indicating that there is no order when the lag order is zero. Therefore, this option should be excluded. Next, this paper can customize it as lag order 8 and analyze LR.

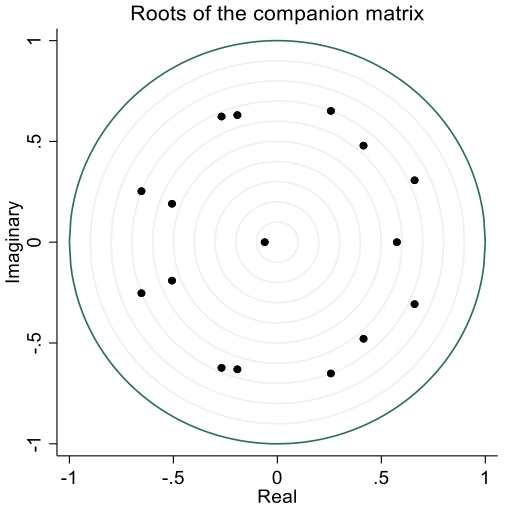

Figure 1: Model stability.

Photo credit: Original

Once the order of the VAR model is defined, it becomes essential to assess the stationarity of the VAR model. If the VAR model is non-stationary, it means that the impulse-response function won't converge to zero. To determine the model's suitability, a unit root test was performed, and the unit circle was illustrated with the model's roots. As shown in Figure 1, all the roots fall well within the circle, signifying that there's no need for a reassessment of the lag order and confirming that the bivariate VAR (8) model is stable.

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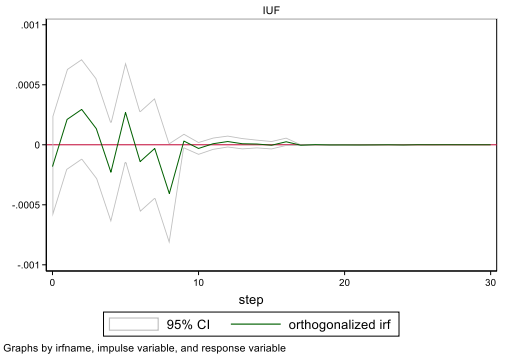
3.2. Impulse Response

According to Figure 2, it can be observed that when gold is used as the response variable and NASDAQ is used as the pulse variable. The rate of change of gold is positive and negative, gradually approaching a stable zero. It can be observed that the frequency and fluctuation size of gold changing into positive and negative numbers are similar. And the absolute value of the fluctuation is less than 0.05%. So the NASDAQ stock market cannot have a significant impact on the gold futures market. On the contrary, when gold is used as a pulse variable and NASDAQ is used as a response variable. The volatility of NASDAQ is significantly negative on a large scale and gradually approaching zero, although there is also a very small positive trend. This trend can infer that the volatility of the gold futures market can significantly affect the NASDAQ stock market and have a negative impact. Although the absolute value of returns in the NASDAQ stock market is also less than 0.05%, every unit increase in gold futures will cause a downward trend in the NASDAQ stock market, and people will turn to investing in the precious metal market.

Respond variable: Gold
Impulse variable: IXIC



Respond variable: IXIC
Impulse variable: Gold

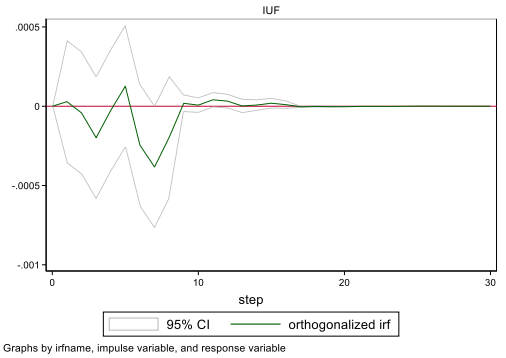


Figure 2: Impulse and response.

Photo credit: Original

3.3. Order of ARMA

In this section of the article, the initial step involves arranging the initial log-return series using the PACF and ACF pairs, and the outcomes of this process are displayed below.

As shown in the Figure 3, some points are floating outside the gray area, so the order should be 9.

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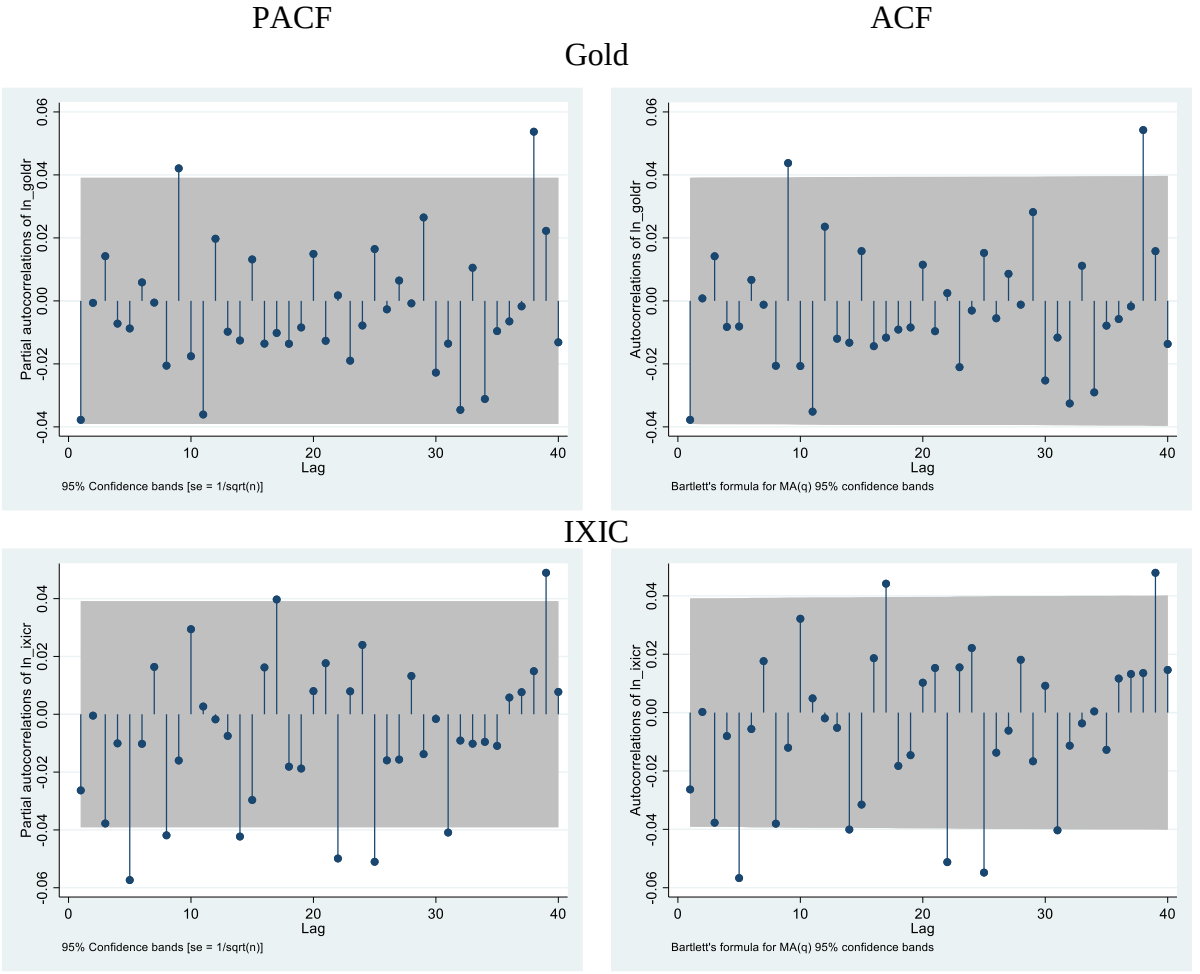

Figure 3: ARMA (p, q) identification.

Photo credit: Original

3.4. ARMA-GARCH Esitimation Results

Table 3 presents the correlation between NASDAQ index volatility and gold futures volatility. In the initial section, where NASDAQ index volatility is the dependent variable and gold futures volatility is the independent variable, the observed correlation is negative (-12.02211), suggesting that fluctuations in gold futures volatility exert a negative influence on the NASDAQ stock market's volatility. However, it's noteworthy that the p-value in this context exceeds 0.05 (0.356), indicating that this impact lacks statistical significance and should not be considered. In contrast, the p-values for both ARCH and GARCH are 0, signifying their significance, thus affirming the applicability of ARCH GARCH in the first part.

Moving to the second section, a positive correlation (35.48282) is observed between NASDAQ volatility and gold futures volatility, and the associated p-value is zero, indicating statistical significance. Consequently, this analysis leads to the conclusion that fluctuations in gold futures volatility do not significantly influence NASDAQ volatility. Conversely, fluctuations in NASDAQ volatility significantly impact the gold market's volatility.

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Table 3: ARMA-GARCHX Regression: Variance Equation.

	(1)			(2)		
	IXIC			Gold		
	Coef.	Std. Err.	P	Coef.	Std. Err.	P
Gold, sigma-sq	-12.02211	13.03621	0.356			
IXIC, sigma-sq				35.48282	3.522587	0.000
ARCH	.1338594	.0122823	0.000	.0279311	.0014783	0.000
GARCH	.8198953	.015803	0.000	.9643844	.0021246	0.000
Constant	-12.04886	.1420761	0.000	-14.60567	.2149999	0.000

4. Conclusion

This research reveals the perception of gold as a frequently favored safe-haven asset, with investors often choosing to invest in gold when faced with stock market turbulence or uncertain economic prospects. From a policy-making perspective, the realm of financial stability is subject to regulation, with policymakers generally directing their attention toward the interplay between gold and stock markets. This focus is based on the recognition that the volatility exhibited by these markets has the potential to significantly impact overall financial stability. Governments and central banks may take measures to mitigate market fluctuations and prevent financial crises. Similarly, they can continuously monitor and improve monetary policy, and policymakers need to consider the impact of gold prices on monetary policy. A rise in gold prices may reflect concerns about currency depreciation, which may necessitate adjustments in monetary policy.

For investors, they can utilize the correlation between gold and the stock market for asset allocation. Holding a certain proportion of gold can help diversify risks, especially when the stock market is unstable or inflation is rising. Moreover, investors can use gold to manage the risks of their investment portfolios. When the stock market is unstable, gold can serve as a safe-haven asset, helping to balance risks.

This article illustrates the correlation between gold futures and the NASDAQ index to a broad audience of investors through a comprehensive study. We employed the Vector Autoregression (VAR) model and ARMA GARCH model, along with the Week Stationarity Unit Root Test method for our research. The results reveal that the returns of the gold futures market can have a negative impact on the returns of the NASDAQ market, and the volatility of the NASDAQ market can significantly increase the volatility of the gold futures market.

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