The model for assessing currency dynamics in times of financial turbulence: empirical evidence from the U.S. Dollar, gold and cryptocurrencies

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Abstract

This study investigates the evolving dynamics of the U.S. Dollar Index (DXY) in the context of growing interactions with alternative assets, namely Bitcoin (BTC/USD) and gold (XAU/USD). Using a multiple linear regression model, we examine whether changes in these asset classes can statistically explain fluctuations in the strength of the U.S. dollar over time. The findings suggest that Bitcoin may be increasingly viewed as a risk-aligned or dollar-complementary asset, while gold retains its traditional inverse correlation with the dollar. The results underscore the growing importance of digital assets in global financial markets and raise new questions about the transformation of monetary value anchors in the digital era. The study contributes to the broader discourse on currency valuation, financial innovation, and the future composition of reserve strategies.

Keywords

Bitcoin, gold, cryptocurrency, exchange rate dynamics, digital assets, reserve currencies, financial innovation, multiple linear regression, monetary policy

1. Introduction

Financial turbulence is accompanied by profound structural shifts in global capital markets, leading to changes in investment priorities and a reallocation of capital flows. Under such conditions, traditional safe-haven assets, such as the U.S. dollar and gold, as well as new alternative assets represented by cryptocurrencies, attract particular attention [1, 2, 3, 4]. Understanding the specifics of their behavior allows for a better assessment of the risks and opportunities that arise during periods of economic instability. The purpose of this article is to analyze empirical data on the dynamics of the U.S. dollar, gold, and cryptocurrencies during times of financial turbulence and to determine the nature of their interaction with global crisis processes.

Recent developments in the cryptocurrency sector indicate a number of emerging trends that warrant close attention due to their potential to reshape the global monetary and financial system. Notably, there is an accelerated institutional adoption of digital assets as major financial institutions and central banks increasingly investigate blockchain-based infrastructures, tokenized securities, and decentralized finance (DeFi) protocols [5, 6, 7]. This trend marks a shift from speculative retail-driven activities towards more structured and regulated forms of digital asset engagement [8, 9].

Moreover, the proliferation of central bank digital currencies (CBDCs) is gaining momentum, with over 130 countries currently exploring or piloting these instruments [10]. CBDCs are poised to influence cross-border payment systems, capital flows, and monetary sovereignty, particularly within emerging and developing economies. Concurrently, the rise of stablecoins, especially those pegged to major fiat

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currencies and integrated into global payment platforms, introduces new complexities to the existing monetary order, raising concerns regarding monetary control, regulatory arbitrage, and systemic risk.

Another significant development is the ongoing evolution of crypto regulatory frameworks, particularly in advanced economies such as the European Union (with MiCA regulation), the United States, and regions of Asia. These frameworks aim to provide legal clarity, investor protection, and systemic oversight, while shaping the landscape of crypto-related innovation and capital allocation. Additionally, the increasing interconnection between crypto markets and traditional financial institutions has implications for financial stability, notably during periods of market stress or liquidity shortages.

Collectively, these trends emphasize the growing integration of the crypto sector with the global financial system. As digital assets become more embedded within mainstream financial infrastructures, they are expected to play a progressively influential role in shaping future paradigms of monetary policy, reserve management, and international financial governance.

2. Literature review

Over the past decade, the rapid growth and institutionalization of cryptocurrencies have sparked significant academic interest regarding their implications for the global financial system. Researchers have explored various dimensions of this phenomenon, including monetary policy, financial stability, reserve management, and regulatory challenges.

A foundational strand of literature has focused on the macroeconomic role of cryptocurrencies, particularly Bitcoin, in relation to fiat currencies and inflation hedging. Baur, Hong, and Lee [11] examine Bitcoin's properties as a hedge and safe haven, concluding that it exhibits unique asset characteristics not fully aligned with traditional financial instruments [11]. Similarly, Dyhrberg applies GARCH models to suggest that Bitcoin lies somewhere between a currency and a commodity in its financial behavior [12].

The interaction between cryptocurrencies and traditional financial markets has also been extensively studied. Corbet, Lucey, Urquhart, and Yarovaya provide a comprehensive review of the evolving dynamics between crypto assets and conventional markets, highlighting the increasing integration of digital currencies into global financial portfolios and the potential for contagion effects during periods of stress [13].

A rapidly expanding body of literature addresses the emergence of central bank digital currencies (CBDCs). According to the Bank for International Settlements, over 130 jurisdictions are currently researching or piloting CBDCs, motivated by goals such as payment system modernization, financial inclusion, and monetary sovereignty. Auer and Böhme explore the technological and economic design choices of CBDCs, emphasizing the balance between innovation and financial stability [14].

In addition, the regulatory dimension has become increasingly prominent in academic discourse. Zetzsche, Buckley, Arner, and Barberis analyze the global regulatory response to crypto assets, noting the tension between innovation and the need for oversight to prevent systemic risks [15]. The introduction of comprehensive legal frameworks, such as the EU's Markets in Crypto-Assets (MiCA) regulation, represents a significant step toward establishing cross-border regulatory standards [16].

More recent studies have begun to explore the geopolitical implications of digital assets, including the potential reconfiguration of the international monetary order. Prasad argues that the global adoption of digital currencies – particularly state-backed CBDCs – could alter the dominance of the U.S. dollar, depending on how such currencies are integrated into international payment systems [17].

Collectively, the literature points to an ongoing transformation of the global financial architecture, driven by technological innovations, shifting reserve strategies, and evolving regulatory paradigms. While the full impact of cryptocurrencies on monetary governance remains uncertain, scholars widely agree that digital assets are increasingly influencing the framework within which international finance operates.

This study addresses the need to understand how emerging digital assets like Bitcoin interact with established financial indicators such as the U.S. Dollar Index (DXY) and gold. By employing a multiple

Table 1
Linear Correlation Coefficient

The value of r	The level of relationship between variables
0.75 … 1.00	very high positive
0.50 … 0.74	high positive
0.25 … 0.49	average positive
0.00 … 0.24	weak positive
−0.24 …0.00	weak negative
−0.49 …−0.25	average negative
−0.74 …−0.50	high negative
−1.00… − 0.75	very high negative

linear regression model, the research seeks to determine whether fluctuations in Bitcoin and gold prices can statistically explain variations in the strength of the U.S. dollar. The findings aim to clarify Bitcoin's emerging role in the financial system – whether as a risk-aligned asset or a complement to the dollar–while reaffirming gold's inverse correlation with the dollar. This analysis highlights the shifting foundations of monetary value in the digital age and contributes to ongoing discussions about reserve strategies and currency valuation.

The aim of this study is to examine the interaction between Bitcoin, gold, U.S. Dollar Index.

3. Methodology

This investigation uses a correlation and regression analysis. Correlation analysis is a method that allows to study the relationship between several random variables. The purpose of correlation analysis is to identify an estimate of the strength of the relationship between random variables (attributes) that characterize a certain real process or object.

Correlation analysis can obtain:

- Measurement of the degree of connectivity (closeness, strength, severity, intensity) of two or more phenomena;.
- Selection of the factors that have the most significant impact on the resultant attribute based on the measurement of the degree of connectivity between phenomena.
- Identification of unknown causal relationships. The factors that are significant in this aspect are then used in regression analysis [18, 19].

There are different types of relationships between variables:
1. Direct cause and effect relationship (Figure 1a).
2. Inverse cause and effect relationship (Figure 1b).
3. The relationship is caused by one or more hidden variables.
4. There is no relationship, the observed dependence is random (Figure 1 c).

The relationship between variables is numerically characterized by the correlation coefficient r. The coefficient r is a random variable because it is calculated from random variables [20]. It is a linear correlation coefficient that shows a linear relationship between two variables and ranges from -1 to 1 (Table 1). In the absence of a linear relationship, the value of r will be close to 0.

Correlation analysis can be performed using Pearson's method or Spearman's rank method.

Pearson's method is applicable for calculations that require an accurate determination of the force that exists between variables.

The features studied with its help should be expressed only quantitatively. The correlation coefficient is calculated by the formula:

$$r = \frac{\sum_{i=1}^{n}(x_i - \overline{x})(y_i - \overline{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \overline{x})^2 \sum_{i=1}^{n}(y_i - \overline{y})^2}}.$$

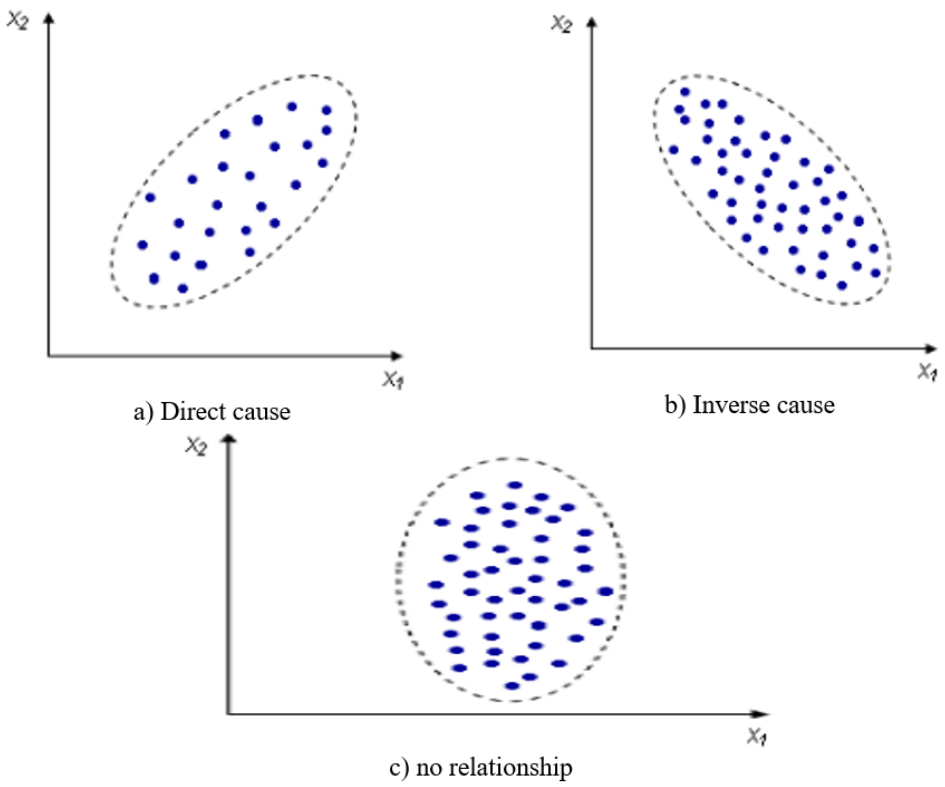

Figure 1: Options for the relationship between random variables.

Spearman's rank correlation coefficient allows to establish the existence of a relationship between phenomena. Its calculation involves assigning an ordinal number, or rank, to each feature. The rank can be ascending or descending. To apply the Spearman method or rank correlation, there are no strict requirements for the expression of features – it can be both quantitative and attributive (qualitative). This method does not establish the exact strength of the relationship and is indicative:

The features studied with its help should be expressed only quantitatively. The correlation coefficient is calculated by the formula:

$$r = 1 - \frac{6 \sum_{i=1}^{n} d_i^2}{n(n^2 - 1)},$$

where n is number of ranked features; d is the difference between the ranks on two variables; $\sum_{i=1}^{n} d_i^2$ is sum of squares of rank differences.

This study employs a multiple linear regression model to examine the influence of alternative asset prices – namely Bitcoin (BTC/USD) and gold (XAU/USD) – on the U.S. Dollar Index (DXY), which serves as the dependent variable [21, 22]. The model is formulated to assess whether fluctuations in the values of these key commodities are statistically associated with movements in the strength of the U.S. dollar in global markets.

The econometric specification of the model is as follows:

$$DXY_t = \beta_0 + \beta_1 BTS/USD_t + \beta_2 XAU/USD_t + \epsilon_t,$$

Where:
DXY_t is U.S. Dollar Index at time t;
BTS/USD_t is price of Bitcoin in USD at time t;
XAU/USD_t is price of gold in USD at time t;
ϵ_t is error term.

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,865556408							
R Square	0,749187895							
Adjusted R Square	0,738950667							
Standard Error	1,33106424							
Observations	52							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	2	259,3202142	129,660107	73,1826858	1,92326E-15			
Residual	49	86,81486854	1,77173201					
Total	51	346,1350827						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	110,7928033	1,900978618	58,2819829	6,36566E-47	106,9726437	114,6129629	106,972644	114,612963
BTC/USD	0,000166139	1,40573E-05	11,8186406	5,90864E-16	0,000137889	0,000194388	0,00013789	0,00019439
XAU/USD	-0,007163647	0,000842232	-8,5055537	3,25578E-11	-0,008856176	-0,005471119	-0,0088562	-0,0054711

Figure 2: Calculation of parameters for regression model.

4. Results

Table 2 presents the weekly data used in the multiple linear regression analysis. The dataset covers the period from April 28, 2024, to April 20, 2025, and includes observations for the U.S. Dollar Index (DXY), Bitcoin prices (BTC/USD), and gold prices (XAU/USD). This time frame captures recent market dynamics and fluctuations in alternative asset values relevant for modeling the determinants of DXY performance.

The data were obtained from the following sources: DXY Data [23], BTC/USD Data [24], XAU/USD Data [25].

The model was estimated using 52 weekly observations. Key regression statistics are as follows:

- R-squared: 0.749.
- Adjusted R-squared: 0.739.
- Standard error of regression: 1.331.
- F-statistic: 73.18.
- p-value (Significance F): < 0.00001.

These results suggest that approximately 74.9 percents of the variability in the U.S. Dollar Index is explained by the variations in BTC/USD and XAU/USD. The model is statistically significant at the 1 percents level, indicating that the relationship is unlikely to have occurred by chance.

The correlation between BTC/USD and XAU/USD is 0.535. This represents a moderate positive relationship.

It suggests that the prices of Bitcoin and gold tend to move in somewhat similar directions, but not to a degree that would interfere with using both variables in the regression model (Figure 2).

As a result, we got the following regression model:

$$DXY_t = 110.79 + 0.0017BTS/USD_t - -0.0071XAU/USD_t.$$

This equation models the value of the U.S. Dollar Index (DXY) at time t as a linear function of the prices of Bitcoin (BTC/USD) and gold (XAU/USD), based on empirical data. The model seeks to quantify how variations in these two major alternative assets are associated with changes in the relative strength of the U.S. dollar.

The intercept represents the estimated value of the DXY when both BTC/USD and XAU/USD are equal to zero. Although this scenario is not realistic in practical terms, the intercept serves as a baseline

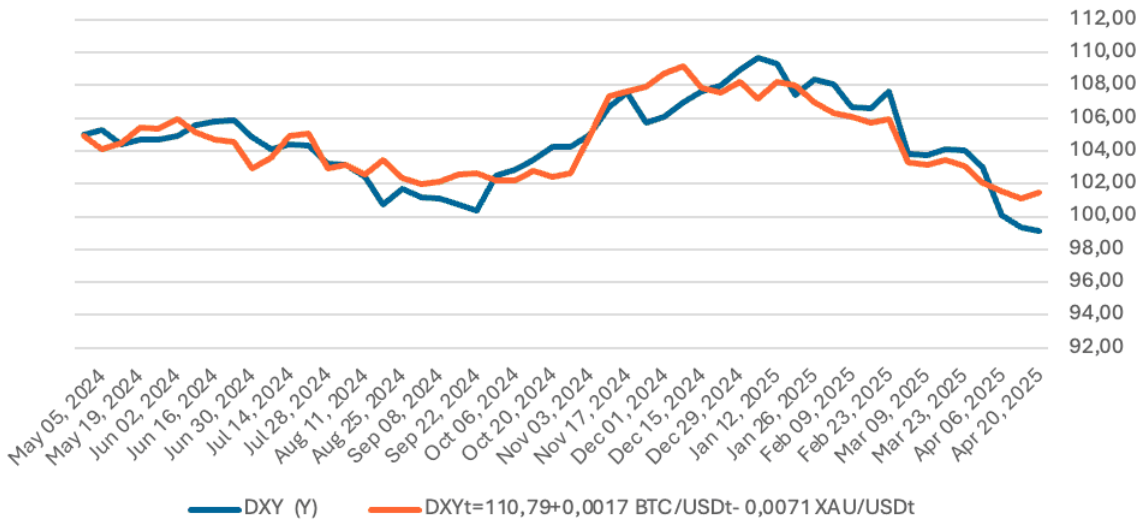

Figure 3: Real and forecasted values of DXY.

from which the effects of the independent variables are evaluated. It anchors the model and adjusts the predicted values accordingly.

The coefficient for BTC/USD is positive (0.0017), indicating that an increase in the price of Bitcoin is associated with an increase in the U.S. Dollar Index. Specifically, for each 1 U.S. Dollar increase in the price of Bitcoin, the DXY is expected to rise by 0.0017 points, holding all other factors constant.

In more interpretable terms:a 1,000 U.S. Dollar increase in BTC/USD corresponds to an expected 1.7-point increase in the DXY.

This finding may suggest that Bitcoin, often considered a risk-sensitive or speculative asset, has a reinforcing effect on the strength of the dollar during certain market conditions. Alternatively, this could reflect investor behavior where confidence in U.S. – based crypto markets supports demand for the dollar.

The coefficient for XAU/USD is negative (–0.0071), implying an inverse relationship between the price of gold and the DXY. That is, for every 1 U.S. Dollar increase in the price of gold, the DXY is expected to decline by 0.0071 points, all else being equal.

This relationship is consistent with traditional economic theory, wherein gold is considered a safe-haven asset. Investors tend to buy gold when there is a loss of confidence in fiat currencies like the U.S. dollar. As demand for gold increases, demand for the dollar may fall, weakening its relative value.

The model demonstrates that both Bitcoin and gold have statistically and economically meaningful relationships with the U.S. Dollar Index. Bitcoin appears to move in tandem with the dollar. Gold tends to move in opposition to the dollar.

Together, these variables help explain fluctuations in DXY, offering valuable insight into the interaction between digital assets, commodities, and global currency strength.

The comparison of real and forecasted values of DXY is shown in Figure 3.

The chart in Figure 3 illustrates a comparison between the actual values of the U.S. Dollar Index (DXY) and its forecasted values derived from a multiple linear regression model that incorporates Bitcoin (BTC/USD) and gold (XAU/USD) prices as explanatory variables. The econometric results suggest a positive association between Bitcoin and the DXY, indicating that an appreciation in Bitcoin's market value corresponds with a marginal increase in the projected strength of the U.S. dollar. In contrast, gold prices exhibit a negative correlation with the DXY, implying that rising gold valuations tend to coincide with a depreciation in the dollar index. The graphical comparison underscores the degree of alignment between forecasted and actual DXY values, highlighting both the model's explanatory potential and the possible limitations due to unaccounted-for market forces and macroeconomic variables.

Table 2
Observation for the Regression Model

Number	Date	DXY (Y)	BTC/USD (X1)	XAU/USD (X2)
1	Apr 20, 2025	99.15	85174.3	3275.63
2	Apr 13, 2025	99.38	85174.301	3327.54
3	Apr 06, 2025	100.1	83684.979	3236.21
4	Mar 30, 2025	103.02	78214.481	3037.36
5	Mar 23, 2025	104.04	82334.522	3084.03
6	Mar 16, 2025	104.09	86054.371	3037.36
7	Mar 09, 2025	103.72	82579.69	3023.63
8	Mar 02, 2025	103.84	80601.041	2984.42
9	Feb 23, 2025	107.61	94248.35	2858.6
10	Feb 16, 2025	106.61	96273.919	2936.03
11	Feb 09, 2025	106.71	96175.032	2883.18
12	Feb 02, 2025	108.04	96500.094	2860.39
13	Jan 26, 2025	108.37	97688.979	2801
14	Jan 19, 2025	107.44	102682.497	2771.30
15	Jan 12, 2025	109.35	101089.606	2701.55
16	Jan 05, 2025	109.65	94488.441	2689.63
17	Dec 29, 2024	108.95	98314.959	2639.12
18	Dec 22, 2024	108	93530.228	2620
19	Dec 15, 2024	107.62	95104.934	2620.77
20	Dec 08, 2024	107	104298.695	2648.39
21	Dec 01, 2024	106.06	101236.013	2632.91
22	Nov 24, 2024	105.74	97279.792	2653.55
23	Nov 17, 2024	107.55	98013.82	2712.55
24	Nov 10, 2024	106.69	89845.851	2561.24
25	Nov 03, 2024	105	80474.185	2683.77
26	Oct 27, 2024	104.28	68741.115	2735.16
27	Oct 20, 2024	104.26	67929.298	2747.69
28	Oct 13, 2024	103.49	69001.706	2720.25
29	Oct 06, 2024	102.89	62851.374	2656
30	Sep 29, 2024	102.52	62818.954	2652.25
31	Sep 22, 2024	100.38	65635.308	2657.97
32	Sep 15, 2024	100.72	63648.709	2621.96
33	Sep 08, 2024	101.11	59182.835	2576.5
34	Sep 01, 2024	101.18	54841.566	2497.03
35	Aug 25, 2024	101.7	57325.487	2503.03
36	Aug 18, 2024	100.72	64333.544	2512.07
37	Aug 11, 2024	102.46	58483.964	2507.28
38	Aug 04, 2024	103.14	58719.483	2430.93
39	Jul 28, 2024	103.21	58116.976	2443.29
40	Jul 21, 2024	104.32	68255.865	2385.57
41	Jul 14, 2024	104.4	68154.522	2400.79
42	Jul 07, 2024	104.09	60787.792	2411.27
43	Jun 30, 2024	104.88	55849.11	2391.46
44	Jun 23, 2024	105.87	62678.292	2325.71
45	Jun 16, 2024	105.8	63180.798	2320.34
46	Jun 09, 2024	105.55	66639.046	2332.52
47	Jun 02, 2024	104.89	69647.993	2292.71
48	May 26, 2024	104.67	67751.602	2326.97
49	May 19, 2024	104.72	68518.089	2333.76
50	May 12, 2024	104.44	66278.37	2414.89
51	May 05, 2024	105.3	61448.394	2360.14
52	Apr 28, 2024	105.03	64031.132	2301.56

5. Discussion

The relevance of this empirical relationship extends beyond theoretical analysis, particularly in the context of recent macrofinancial developments involving digital assets. In recent years, the growing integration of cryptocurrencies into international financial systems has attracted substantial interest from both policymakers and monetary authorities. One significant initiative in this regard is the United States' exploration of a partial cryptocurrency-backed reserve model, a measure that could fundamentally alter the global financial architecture. Given the U.S. dollar's dominant role in global financial settlements, the inclusion of a digital asset component within the Federal Reserve's reserve framework may signal a structural transformation in the way central banks conceptualize and manage monetary policy, external imbalances, and systemic financial risks [10].

This evolving dynamic is further supported by emerging research, including recent findings by the Atlantic Council (2024), which report that several central banks – including the Federal Reserve – are actively experimenting with digital assets under hybrid reserve configurations. These initiatives are emblematic of a broader shift toward monetary digitalization, driven by the imperative to modernize reserve systems in light of accelerating technological advancement and heightened financial market volatility. The integration of cryptocurrencies into reserve holdings may establish a new paradigm for reserve management, characterized by greater diversification, reduced reliance on traditional safe-haven assets such as gold or sovereign bonds, and expanded policy instruments for achieving exchange rate and macroeconomic stability.

A growing competitive dynamic is unfolding between decentralized cryptocurrencies and central bank digital currencies (CBDCs). While cryptocurrencies such as Bitcoin operate independently of state institutions and offer decentralized, borderless transactions, CBDCs are state-backed digital currencies designed to modernize payment systems and preserve monetary sovereignty. This competition reflects a broader struggle over control of the future financial infrastructure: cryptocurrencies promote financial autonomy and innovation, while CBDCs aim to maintain regulatory oversight and monetary stability. The outcome of this rivalry may reshape global financial governance and influence the evolution of digital money.

For countries such as Ukraine, which are particularly sensitive to external shocks and are in the process of strengthening their financial systems, these developments pose both strategic opportunities and critical policy challenges. The potential reconfiguration of global reserve practices compels such economies to reassess their reserve composition, risk management strategies, and degree of alignment with emerging international financial standards. As the role of cryptocurrencies continues to expand, their influence on traditional indicators c such as the DXY – will likely intensify, reinforcing the importance of integrating digital asset analysis into broader macrofinancial frameworks.

Operating under heightened external threats, economic turbulence, and hybrid warfare, the development of a multi-component reserve strategy that includes digital assets – particularly stable cryptocurrencies and central bank digital currencies (CBDCs) issued by allied countries – could represent a promising direction for strengthening financial resilience. Such a strategy would not only enable greater diversification of international reserves, but also enhance the country's capacity to respond flexibly to external shocks, improve liquidity during periods of peak financial stress, and support overall macroeconomic stability.

As highlighted in the IMF's 2023 report on central bank digital currencies, this transformation in reserve policy necessitates a high degree of regulatory adaptation and institutional capacity-building. Moreover, it would align with broader global trends in financial innovation and contribute to reinforcing Ukraine's international agency in the digital era. However, the successful implementation of such a strategy would require the establishment of a clear regulatory and legal framework, robust risk management mechanisms, and close coordination between the National Bank of Ukraine, the Ministry of Finance, and national cybersecurity agencies.

6. Conclusions

Financial turbulence, arising from economic crises, geopolitical conflicts, or global shocks, significantly impacts the dynamics of major currencies and alternative assets. Studying the behavior of the U.S. dollar, gold, and cryptocurrencies under conditions of instability allows for the identification of key patterns in market reactions and the specific features of investor strategies during crisis periods.

The U.S. dollar has traditionally served as the primary safe-haven asset in the global financial system. During the initial phases of financial crises, demand for the dollar typically surges, leading to its strengthening. However, prolonged periods of low interest rates and excess liquidity, driven by the Federal Reserve's monetary stimulus policies, often result in the gradual weakening of the dollar. Empirical studies confirm that over the long term, inflation expectations and macroeconomic policies play a decisive role in shaping the dollar's value during turbulent times.

Gold maintains its status as one of the most reliable assets for capital preservation during periods of uncertainty. Its price shows an inverse correlation with stock market indices and economic confidence indicators. Gold tends to exhibit positive dynamics in both the short and medium term in response to heightened financial risks, inflationary threats, or rising geopolitical tensions. Empirical observations also demonstrate that gold serves as an effective portfolio diversification tool in unstable market conditions [15, 26].

Cryptocurrencies, particularly Bitcoin, display a more complex and contradictory dynamic during periods of turbulence. On the one hand, interest in cryptocurrencies as alternative financial assets independent of state monetary systems increases. On the other hand, the high volatility of the cryptocurrency market, its sensitivity to investor sentiment, speculative activity, and regulatory risks contribute to significant price fluctuations. At the same time, empirical data indicate a growing correlation between cryptocurrencies and stock markets during general crisis trends, calling into question their role as independent safe-haven assets.

Comparative analysis shows that during financial shocks:

- The U.S. dollar strengthens rapidly, but its long-term stability depends on fundamental macroeconomic factors.
- Gold consistently demonstrates stable growth regardless of the nature of the crisis.
- Cryptocurrencies remain volatile yet potentially attractive assets, requiring a cautious investment approach during periods of heightened uncertainty.

Thus, the analysis of the dynamics of the U.S. dollar, gold, and cryptocurrencies during periods of turbulence reveals varying degrees of resilience and riskiness among these assets, which is crucial for developing portfolio diversification strategies and risk management approaches in conditions of global economic uncertainty.

Declaration on Generative AI

The author(s) have not employed any Generative AI tools.

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