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قياس ومقارنة مخاطر الاستثمار لعينة من العملات الرقمية باستخدام نموذج القيمة المعرضة للخطر VAR ونموذج القيمة المعرضة للخطر المشروطة CVAR

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المستخلص

يهدف البحث الى بيان طبيعة العملات الرقمية وخصائصها فضلا عن مخاطر الاستثمار فيها, تكمن مشكلة البحث في صعوبة تشخيص مخاطر الاستثمار في العملات الرقمية, لذلك اعتمد البحث المنهج التحليلي المقارن بين نموذج القيمة المعرضة للخطر والقيمة المعرضة للخطر المشروطة لتقدير مخاطر الاستثمار, يفترض البحث تباين مخاطر الاستثمار بين العملات الرقمية تبعا لثقة المستثمرين. تمثل مجتمع البحث في العملات الرقمية وتم اختيار عينة من 6 عملات رقمية, جمعت بيانات البحث من موقع Yahoo Finance للمدة من 2023/1/1 الى 2025/12/31 لأسعار الاغلاق بغرض حساب عوائد يومية لتداول العملات نتج عنها عدد مشاهدات 1095 لكل عملة رقمية, استخدم برنامج E-views لقياس ومقارنة نتائج مخاطر الاستثمار بين نماذج القيمة المعرضة للخطر Var والقيمة المعرضة للخطر المشروطة Cvar, اهم النتائج توصل اليه البحث ان عملة البتكوين تعد الملاذ الآمن باقل مخاطرة من بين العملات الرقمية , وان اخطر العملات لعينة البحث كانت السولانا والدوجكوين. ويوصي البحث باختيار محفظة العملات الرقمية وفق الاساليب الكفؤة.

الكلمات المفتاحية : العملات الرقمية ، محفظة العملات ، مخاطر الاستثمار ، Var ، Cvar

Measuring and comparing investment risks for a sample of cryptocurrencies using the Value at Risk (VAR) model and the Conditional Value at Risk (CVAR) model.

Mohammed H. Adnan Ali Abdulazeez Ied Alshammari

Abstract

The aim of this research is to explain what Cryptocurrencies are, their characteristics and the risks of investing in them. The research problem lies in the difficulty of diagnosing investment risks in Cryptocurrencies. Therefore, the research relied on a

comparative analytical method between the value at risk model and conditional value at risk to estimate investment risk. The research assumes that risks vary of investment risks in cryptocurrencies according to investors' confidence. The sample consisted of six cryptocurrencies selected for analysis. The closing price data was extracted from Yahoo Finance for the period of 1 January 2023 to 31 December 2025 to calculate the daily trading returns. This resulted in 1,095 observations for each currency. EViews software was used to measure and compare the investment risk results of the Value at Risk (VaR) and Conditional Value at Risk (CVaR) models. The key findings indicate Bitcoin as the "safe haven" with the least risk among the Cryptocurrencies studied, with Solana and Dogecoin having the highest risk. The study suggests building portfolios of Cryptocurrencies using efficient methods.
Keywords: Cryptocurrencies, cryptocurrency wallets, investment risks, VaR, CVaR

1. *Introduction*

Cryptocurrencies are highly rewarding and provide significant benefits to individual investors and corporations. But the high returns come with volatility, which is due to the high sensitivity of cryptocurrencies to demand volatility. The topic of investment in Cryptocurrencies is of great interest to both financial professionals and researchers. This paper presents an analytical comparison of two major econometric models: Value at Risk (VaR) and Conditional Value at Risk (CVaR) to measure and examine the risks of Cryptocurrencies.

The research focuses on the risks of investing in Cryptocurrencies, which is often neglected in favor of studies focusing on investment returns. Existing studies have mainly covered the growing market capitalization of Cryptocurrencies, the comparison of risk levels between cryptocurrency markets and global financial markets, the characteristics of cryptocurrencies, and profit-and-loss strategies. There have also been studies on what drives the value of cryptocurrencies and the risk involved in investing in them. However, within the scope of the literature reviewed, no comparative analysis has been done using VaR and CVaR to measure risk in the digital currency sector. This study aims to fill the gap between these two models in the measurement and analysis of investment risks in Cryptocurrencies.

The theoretical and practical contributions of the study are discussed in four sections. The first section describes the research methodology and previous studies. The second section describes the conceptual framework of Cryptocurrencies, their definitions, features and disadvantages, while the third section discusses the practical framework of the analysis of the investment risks associated with Cryptocurrencies.

Finally, the research concludes with the fourth section, presenting its findings and recommendations.

2. Literature Review

Cryptocurrencies are modern investment assets that are traded by investors around the world. A large number of researchers have avoided the study of the investment risks associated with cryptocurrencies while much work has been done on the high returns provided by the Cryptocurrencies. This research provides an analytical study of the investment risks of a selection of Cryptocurrencies using Value at Risk (VaR) and Conditional Value at Risk (CVaR). It seeks to address the following questions:

a. How much of a portfolio of Cryptocurrencies is exposed to trading losses ?
b. What is the risk limit for each currency when traded, as measured by Value at Risk ?
c. What are the expected losses, when the loss threshold is exceeded, as measured by Conditional Value at Risk?

The study of investment risk is particularly interesting for digital currency investors because an investment decision depends on the level of risk. The importance of this study can be summarized as follows:

a. Knowledge and analysis of digital currency risks are a key consideration in making informed trading and investing decisions .
b. The Value at Risk (VaR) metric helps to determine the risk threshold and analyze the potential loss limits associated with investing in Cryptocurrencies .
c. Understanding Conditional Value at Risk (CVaR) assists in analyzing the maximum potential losses when the risk threshold is exceeded.

The study deals with the measurement and analysis of the Value at Risk (VaR) and Conditional Value at Risk (CVaR) and provides strong evidence to support the decisions of investors and those interested in Cryptocurrencies. It is intended to achieve the following **objectives:**

a. Calculation and evaluation of the shocks of the cryptocurrency portfolio (the research sample) using Value at Risk (VaR) and Conditional Value at Risk (CvaR).
b. Determining the risk threshold by applying the Value at Risk (VaR) measure to each cryptocurrency within the sample of the research.
c. Calculating the expected loss for each currency above the risk threshold using Conditional Value at Risk (CvaR).

To achieve its objectives, the research seeks to test a number of hypotheses and the key **hypotheses** are outlined below:

a. “Risk, measured by Conditional Value at Risk (CVaR), differs across cryptocurrencies, depending on the level of confidence investors have in those currencies”.

b. “Diversification of the cryptocurrency portfolio (the sample of the study) helps reduce the overall risk of the portfolio.
c. “Cryptocurrencies exhibit strong risk behavior based on the analysis of Value at Risk (VaR) and Conditional Value at Risk (CVaR) at a confidence level of 0.99 and an error rate of 0.01.

Balbás et al. (2017), in their study titled "Differential Equations Linking VaR and CVaR"
Value at Risk (VaR) has become the standard tool in financial risk management used by many stakeholders and required by regulatory bodies. However, there are some limitations of VaR which are overcome by other risk measures such as Conditional Value at Risk (CVaR). Therefore, replacing VaR with CVaR makes it possible various analytical studies. This paper investigates a system of differential equations linking VaR and CVaR, so that important issues on VaR can be studied through properties of CVaR.

Petukhina et al. (2020) “Investing in cryptocurrencies: assessing the potential of portfolio allocation strategies”
The research deals with utility-based gains for various kinds of investors considering the addition of cryptocurrencies to their traditional asset portfolios. It considers risk-averse investors and return-seeking investors. The findings show that cryptocurrencies can reduce risk, particularly when employing the maximum diversification strategy. The portfolio diversification index is highly reliant on cryptocurrencies and extensive testing reveals that the cryptocurrency returns are unique additions to the investment landscape. 3. Kozak & Gajdek (2021) “Risks of Investing in Cryptocurrencies” publication

This research aims to compare risk metrics for investments in the cryptocurrency market with those of global financial markets for the period 2011–2020. Levels of risk were estimated based on the standard deviation and semi-deviation of logarithmic daily returns. One of the major findings was that investing in cryptocurrencies is riskier than investing in stocks of major international companies. The longer a cryptocurrency is on the market, the lower the risk levels are. Conclusions: High returns are the drivers of demand and price volatility for cryptocurrencies. The risk level for investing in cryptocurrency is much higher than the risk level for investing in global stock market indices.

This research investigates a full set of price- and market-related return measures from the stock market and compares them with their counterparts in the cryptocurrency market. Successful profit/loss strategies that generate large and statistically robust excess returns are underpinned by a set of cryptocurrency characteristics. The results show that all these strategies can be explained by a three-factor model of cryptocurrencies, including market, size and momentum factors. Study Pakhnenko et al., (2022), in their study titled"Cryptocurrencies: Value-Forming Factors and Investment Risks "

The objective of the research is to determine the factors determining cryptocurrency value and to evaluate the investment risks associated with it. The cryptocurrency is seen as a currency, an asset with unknown returns and a product

with a price based on the cost of the energy needed to create new blocks. Consequently, this article examines the risks of cryptocurrency investment from various perspectives. The study compares cryptocurrencies with traditional currencies to determine the factors that drive value and risk, treating the cryptocurrency as if it were traditional money, and the issuance of the cryptocurrency is dependent on the computational power of the hardware used for mining. Cryptocurrency can be considered a financial asset because its price appreciation is often greater than the cost of mining.

Babiak & Bianchi (2023) in their study "A Risk-Based Explanation of Cryptocurrency Returns" We analyze the return dynamics in the cryptocurrency markets using a small scale latent factor model that takes into account the individual characteristics of each cryptocurrency. The main finding of the study is that the dynamic factor model outperforms both static latent factor models and portfolios pre-sorted by observable characteristics in explaining daily returns, realized and expected, for a range of cryptocurrencies in a risk-based manner.

A wide range of research has been carried out into the risks of investing in Cryptocurrencies, demonstrating a broad range of academic interests. Some studies compare the risks of investing in digital currency with the risks of investing in the stock market, while others study the factors that influence these risks; in contrast, some studies focus on value creation and return estimation without considering the associated risks. This diversity arises from the very nature and characteristics of Cryptocurrencies and the complex ecology in which they operate: an ecosystem of currency markets, capital markets and the government financial institutions that issue traditional currencies. The literature reviewed does not sufficiently cover the research gap related to the estimation and measurement of investment risks by quantitative methods. The main contribution of this paper is to use quantitative models to analyze and compare investment risks in digital currencies and to use Value at Risk (VaR) and Conditional Value at Risk (CVaR) to compare the risk under the two models and evaluate their relative merits.

3. A Conceptual Framework

3.1 Cryptocurrencies

First: The Concept of Cryptocurrencies

The development of financial technology appears to be an inevitability. The first generation of the technology revolution was the use of the Internet in the financial application scenarios and the second generation of financial technology focused on the underlying technological revolution (Kou et al., 2025:26). Blockchain technology, which combines distributed data storage, peer-to-peer transmission, a consensus mechanism, and an encryption algorithm, has attracted wide attention in the modern financial technology field. Blockchain technology is a significant breakthrough in data storage and information transmission and it has the potential to revolutionize existing operational models in finance and economics, ushering in a new wave of technological innovation (Kou et al., 2025:22). The revolutionary technology behind digital currency

transactions is blockchain technology, which makes data on financial activity publicly available on the internet (Yukun Liu & Aleh Tsyvinski, 2021:2).
The digital currency market has seen huge interest from regulators, the general public and traders alike in the last five years. Prices have risen substantially due to high trading volumes of Cryptocurrencies. Moreover, the efficiency of digital markets has significantly improved over time (Leirvik, 2022:2). Large corporations and individuals are in fierce competition to come up with and sell new currencies (W. Group, 2018:23). Cryptocurrencies are media of exchange on the internet that uses cryptographic functions to conduct financial transactions (Yermak & Satanievska, 2020:248). Cryptocurrencies are decentralized and do not depend on central authorities like governments or financial institutions. Transactions are recorded on a public ledger known as a blockchain. This allows transactions to be made securely and openly without any middlemen involved. This makes transactions faster and cheaper than conventional means. Also, the decentralized nature of cryptocurrencies offers security and privacy that conventional financial systems do not provide (Zhuk, 2020:3). Cryptocurrencies are the first asset class with a complete history of investment activities on their respective blockchains (Yukun Liu & Aleh Tsyvinski, 2021:1) and are built on a peer-to-peer ownership-transfer architecture. One challenge of the cryptocurrency market is that the value of a cryptocurrency is not determined by any economy of any country, not by tangible assets, nor by a company's fundamentals but rather on algorithms (Almeida & Gonçalves, 2022:1).
Cryptocurrencies are different from traditional fiat currencies in that they are not issued by any central bank or government entity. Rather, they are currencies that are mined, stored and traded peer-to-peer without financial intermediaries or institutions, all thanks to modern financial technology. In fact, investors and corporations have been very interested in them, transforming them from basic encrypted money instruments into an investment asset, with some currency prices exploding, unlike traditional money that tends to lose value over time.

Secondly: Characteristics of Cryptocurrencies

The main features that make Cryptocurrencies a focal point of interest and demand for many investors and companies can be summarized as follows (Flamur B et al., 2017:37). The main features that make Cryptocurrencies an area of interest and demand for many investors and companies can be summarized as follows (Flamur B et al., 2017:37):

1. How a peer-to-peer network works: There is no one central server doing all the work. The information, in this case money, is exchanged directly between two or more software users.
2. Unlimited transaction capabilities: A digital currency wallet holder can pay anyone, anywhere and for any amount. Transactions cannot be blocked or controlled, so transfers can be made to any part of the world where there is another user with a digital currency wallet.

3. .No inflation: The total number of coins is capped and not everybody can issue or mine them. There is no possibility of inflation within this system because no political forces or corporations can change this system.
4. Increased system usage: Payments made in this system are irreversible. The currencies cannot be copied, counterfeited or double-spent. These capabilities ensure the integrity of the whole system. More and more online stores, sources and companies are accepting Cryptocurrencies every month.
5. Decentralization: The network does not have a central governing power. Rather, the network is distributed among all of the participants and every computer that mines the digital currency is a member of the system. This means no central authority can impose rules on currency owners. Even if part of the network goes down, the payment system still works stably.

Third: Disadvantages of Cryptocurrencies.

After discussing the benefits of Cryptocurrencies, it is important to consider the drawbacks and limitations, including the issues related to scalability, volatility and risk (Zhuk, 2020:5).

1. High volatility: the value of a digital currency varies depending on the official statements of different governments. This volatility poses short-term challenges.
2. Risk: In the medium and long term, it is necessary to take into account substantial investment risks associated with Cryptocurrencies.

Fourth: Types of Cryptocurrencies

Bitcoin is the first cryptocurrency, and other currencies, called “altcoins”, have been created and can be divided into three main categories (Balakrishnan, 2025:1212; Sur, 2026:132).

1. Ethereum and Solana: These expand on or diverge from the Bitcoin framework to provide new features or use cases and are used for intelligent contracts and decentralized applications.
2. Meme Coins: Meme coins are another form of digital currency that is used for speculation and has several use cases.
3. Stablecoins: Cryptocurrencies associated with a stable asset, such as the US dollar or the euro.

Fifth: Parties Involved in Digital Currency Transactions

The ecosystem typically includes miners, users, exchanges, transaction service providers, software developers and other miscellaneous stakeholders. This can be summarized as follows (Lim, 2015:365):

1. Miners: The users or entities operating complex algorithms through specialized software to validate transactions within a cryptocurrency network.

2. Users: These are individuals or entities that buy cryptocurrencies and use them to purchase goods or services, transfer value to others or hold them for investment purposes.
3. Exchanges: People or institutions that exchange cryptocurrency for fiat currency (such as the U.S. dollar or other cash currencies) or for other cryptocurrencies.
4. Transaction Service Providers: Websites that offer transaction services for individuals to store and trade Cryptocurrencies.
5. Software developers: individuals involved in research, design, development, or testing of computer software that uses cryptocurrencies.

Sixth: Blockchain Technology in Cryptocurrencies

Cryptocurrencies use the same underlying blockchain technology, but usually operate on different transaction networks with different parameters (supply levels, transaction verification times, etc.). Some differences result from major innovations in the underlying blockchain technology (Elbahrawy et al., 2017:2). Markets in cryptocurrencies are built on a decentralized consensus system that is derived from blockchain technology—shared, immutable ledgers that allow the transparent distribution of information and the recording of transactions (Balakrishnan, 2025:1212). The use of blockchain data has three main advantages (Yukun Liu & Aleh Tsyvinski, 2021:1):

1. The data is widely available and easily accessible, unlike trading or pricing information, which is often proprietary.
2. The data is verifiable since anyone can check the public ledger for confirmation.
3. Users are provided with real-time information to ensure the accuracy and relevance of the data.

3.2 Investment Risks

First: Investment Risks

Complex digital systems exhibit very sensitive dependence on initial conditions. They appear random and exhibit the “butterfly effect,” whereby small changes in initial conditions cause a significant difference in the outcome (Balakrishnan, 2025:1212). The crypto market is attracting the attention of the financial and investment world and is attracting traditional traders, corporations and individuals. This interest creates new investment opportunities and unique challenges and complexities in the analysis of market dynamics (Nugrahani et al., 2024:1446). Investment in cryptocurrencies presents serious challenges and problems to conventional financial systems. This is because the value of cryptocurrencies is not determined by the same method as conventional financial assets. Cryptocurrencies are not connected to tangible assets or government backing. Their value depends on specific algorithms that record transactions in underlying blockchain networks (Peng et al., 2024:23).

The basic principle of pricing cryptocurrencies and investment assets is that investors should be compensated for risk exposure. This principle is related to the quest of return predictability and market efficiency. The notion that a given asset generates a higher return because it is riskier applies to all risky assets (Babiak & Bianchi, 2023:1). Investment in cryptocurrencies has attracted considerable attention in terms of understanding the risks to investors and financial stability (Calissano et al., 2024:4). It also helps determine the liquidity and volatility of returns. The prices of cryptocurrencies are characterized by considerable volatility, which in turn may reflect the existence of cyclical patterns (Podgórski & Muszyński, 2025:480).

The above concepts make it clear that there is no single comprehensive definition of the risks of investing in cryptocurrencies. These risks span several sectors, mainly the technology sector. The nature of cryptocurrency investment is different from investing in fiat currencies, as cryptocurrencies are not issued by a central institution and they do not have institutional backing. Furthermore, they differ from conventional financial assets because they are not traded on regulated exchanges as are securities, nor can they be classified as commodities or derivatives. Moreover, no legislative framework exists for cryptocurrency trading. This layered risk profile makes it hard to pin down exactly what the risks are in investing in cryptocurrencies.

Second: Risky Investment Behavior in Cryptocurrencies

The main behavioral factors driving investment in cryptocurrencies can be summarized as follows (Delfabbro et al., 2021:203):

1. Illusion of control: Cryptocurrency trading is not entirely based on luck, like day-trading or sports betting. There's a degree of skill and strategy involved .
2. Social learning: Social media was rising at the same time cryptocurrency trading was rising. This has given rise to a vibrant social media culture around cryptocurrency advisors, influencers and veteran experts on platforms like YouTube .
3. Preoccupation: Preoccupation, or hyper-salience, is a well-established feature of most major conceptual models of addiction.

Third: Value at Risk (VaR) and Conditional Value at Risk (CvaR)

Value at Risk (VaR) and Conditional Value at Risk (CVaR) are among the most popular and widely used risk measures in this context, especially for the estimation of the probability of large losses faced by traders. These measures are linked to rare events (Bardou et al., 2009:1). Their estimation is a computational challenge.

Instead of the standard deviation, the measures of investment risk are the VaR and its derivative CVaR (Amédée-Manesme et al., 2019:5). Because VaR assumes that asset returns are normally distributed, its use should be carefully assessed during periods of extreme volatility in prices. Furthermore, VaR might not be convex for some probability distributions (Amédée-Manesme et al., 2019:5). Value at Risk (VaR) is defined as the expected loss in absolute terms (Amédée-Manesme et al., 2019:5). It is considered to be a very important risk measure that is used by risk management professionals and adopted by regulatory bodies and institutions around the world such

as the Basel Solvency framework. This is because it is a simple measure that is economically intuitive and helps determine sufficient capital requirements to withstand bad news and adverse scenarios (Balbás et al., 2017:247). VaR can be calculated by the following equation (1) (Bardou et al., 2009:4):

$$Var_a\ (\varphi(x)) = \inf\{\varepsilon | p(\varphi(x) \leq \varepsilon) \geq a\} \dots\dots\dots (1)$$

VaR at level α is the minimal threshold ξ such that the probability of the loss being less than or equal to ξ is greater than or equal to α. VaR has some limitations; therefore, Rockafellar and Uryasev proposed the notion of Conditional Value at Risk (CVaR) (Jha, 2023:2). CVaR was designed as a model to supplement the traditional VaR. It computes the average loss when the loss exceeds or is equal to the VaR at a specific confidence level (e.g. 95% or 99%). This metric is a more conservative measure of potential losses than VaR. (Wang et al., 2010:4918) A common measure of risk is the Conditional Value at Risk. This measure is referred to as Expected Shortfall (ES) in the financial applications and is widely used in the financial sector (Golodnikov et al., 2019:1). Conditional Value at Risk is defined by Fu et al. (2020:1011) as an improved risk analysis method developed from the Value at Risk (VaR) method, which effectively overcomes the limitations of the traditional method in the measure of loss and shortfall under partial dependence, and the method for its calculation is given by Equation (2) (Bardou et al., 2009:4):

$$CVaR_a\left(\varphi(x)\right) = E[\Psi\big(\varphi(x)\big) | \varphi(x) \geq VaR_a\left(\varphi(x)\right)\big] \dots\dots\dots (2)$$

Conditional Value-at-Risk incorporates a continuous function to transform losses prior to calculating the conditional expectation.

4. Methodology And Empirical Analysis

The research adopts a comparative analytical approach and uses two methods, the traditional Value at Risk (VaR) and Conditional Value at Risk (CVaR) both of which are recognized techniques to analyze the risk of investment. It assesses and decomposes return risk utilizing daily historical returns of a time series comprising 1,095 daily observations, including the major shocks faced by the sampled cryptocurrencies over this historical period.

The research population was cryptocurrencies, and the sample consisted of six currencies purposefully selected based on the availability of data for the entire period of the research and relevance to the research objectives. This sample includes market leaders and currencies launched after 2020 to show the differences in risk levels. The selected currencies are shown in the table (1).

Table 1. Currencies in the Research Sample

No	Code	Name	Year
1	btc	Bitcoin	2009
2	doge	Dogecoin	2013
3	eth	Ethereum	2013
4	bnb	Binance Coin	2017
5	leo	Unus Sed Leo	2020
6	sol	Solana	2020

Source : https://coinmarketcap.com/

Research Data

The daily closing prices of the cryptocurrencies in the sample were obtained from Yahoo Finance for the period January 1, 2023 to December 31, 2025. Next, daily returns were calculated for the period from January 2, 2023 to December 31, 2025, yielding 1,095 observations for each cryptocurrency and a total of 6,570 observations for the entire sample.

First: Descriptive Analysis of Research Variables

Descriptive statistics of the returns of the cryptocurrency portfolio sampled in the study are reported in Table (2). The sample consists of 1,095 daily return observations recorded in the study period. Results show that the average daily return of the portfolio was 0.178468 which indicates a tendency toward profitability. The median value was 0.119338 which is within the normal range and is not far off from the mean return. The highest daily return was 11.07932 and the highest daily loss of the sampled crypto portfolio was -11.17424.

The weights in the equally weighted portfolio were distributed equally , with each currency assigned an investment weight of approximately 16.67%. The value at risk estimates the maximum loss the portfolio experienced during the research period, while the conditional value at risk model estimates the losses that exceed the threshold in the Var model.

Table (2) Descriptive statistics for the research variables

Descriptive statistics	PORT_RET	VAR_PORT_95	VAR_PORT_99	CVAR_PORT_95	CVAR_PORT_99
Mean	0.178468	-3.91662	-6.34135	-5.69693	-8.25564
Median	0.119338	-3.91662	-6.34135	-5.69693	-8.25564
Maximum	11.07932	-3.91662	-6.34135	-5.69693	-8.25564
Minimum	-11.1742	-3.91662	-6.34135	-5.69693	-8.25564
Std. Dev.	2.603738	0.000000	0.000000	0.000000	0.000000
Jarque-Bera	231.0271	NA	NA	NA	NA
Probability	0.000000	NA	NA	NA	NA
Observations	1095	1095	1095	1095	1095

Source: EViews output.

Table 2 shows that the standard deviation is 2.603738. The results show the volatility of the portfolio's returns based on historical daily data. The Jarque-Bera

statistic is 231.0271, suggesting that the data distribution is not normal. This is supported by a p-value of 0.000000 (less than 0.05) which indicates that the return distribution for the cryptocurrency portfolio is not normal.

The results also show the risk threshold at a 95% confidence level, a Value at Risk (VaR) of -3.916622, which is the portfolio's risk threshold and the expected loss over 5% of trading days. The VaR of the cryptocurrency portfolio under study, at a 99% confidence level, is -6.341347, as an indicator of risk at that confidence level.

However, the Conditional Value at Risk (CVaR) values at 95% confidence correspond to a loss threshold of -5.696927 for the crypto-currency portfolio. This indicates the loss expected for 5 days out of 100 days through analysis of historical returns. The loss amount exceeds the VaR at the 95% confidence level.

Similarly, the CVaR loss of -8.255639 at the 99% confidence level is higher than the VaR at the same confidence level. The results reveal a significant difference between Conditional Value at Risk (CVaR) and Value at Risk (VaR), indicating the possibility of significant losses affecting the considered cryptocurrency portfolio.

Second: Measurement and Analysis of Value at Risk (VaR) and Conditional Value at Risk (CvaR)

Table 3 presents the VaR and CVaR measurements for each cryptocurrency and for the portfolio. The negative values in the table indicate the calculated losses, which reflect the investment risks according to the models used.

Table (3): Results of Value at Risk and Conditional Value at Risk

CRIPTOCURRANCY	Binance Coin	Bitcoin	Dogecoin	Ethereum	Unus Sed Leo	Solana	Portfolio
var 95	-3.94755	-3.62875	-6.705	-4.8798	-2.74857	-6.43377	-3.91662
var_ 99	-7.38874	-6.04275	-11.41978	-8.31901	-11.41978	-9.19916	-6.34135
cvar95	-5.98458	-5.03067	-9.65284	-7.08469	-4.61437	-8.78021	-5.69693
cvar99	-8.60904	-7.02498	-13.9994	-10.29555	-8.39176	-12.72324	-8.25564

Source: EViews output.

Measurement and Analysis of Value at Risk (VaR) Results at 95% Confidence

Table (3) indicates that the lowest risk among the other cryptocurrencies was Uniswap (UNI) with VaR of -2.74857, which means a risk level of 2.7% over five days out of 100 days at the 95% confidence level. Bitcoin follows with VaR -3.62875, and then the portfolio itself with risk level -3.91662. This shows the importance of diversification in managing risk in a cryptocurrency portfolio. The next currencies have higher risk levels, Binance Coin, Ethereum, Solana and Dogecoin. Their VaR values are, respectively, -6.70500, -6.43377, -4.87980, and -3.9475 at a confidence level of 95%. These results represent the expected losses over a five-day period within a 100-day period. 2.Measurement and analysis of Value at Risk (VaR) results at 99% confidence level

The VaR at 99% confidence level is given in Table (3). To get the best estimates and measurements, the currencies and the portfolio were ranked according to their level of risk as follows: Bitcoin, currency portfolio, Binance Coin, Ethereum and Solana. The 1-day VaR (out of 100) for these were -6.04275, -6.34135, -7.38874, -8.31901 and -

9.19916 respectively. Dogecoin and UNUS SED LEO had the same VaR of -11.41978. The VaR value at the 99% confidence level is higher than at the 95% confidence level, which means that this confidence coefficient is a better and more efficient measure to estimate the expected risk.

Conditional Value at Risk (CVaR) results at the 95% confidence level: Measurement and analysis

The investment risks of the currencies are ranked in ascending order according to the calculation of the Conditional Value at Risk (CVaR) at a 95% confidence level, and these are: UNUS SED LEO, Bitcoin, currency portfolio, Binance Coin, Ethereum, Solana, and Dogecoin. This ranking is the same as the one calculated for the VaR at the 95% level, but CVaR measures the worst possible loss when the loss exceeds the VaR previously calculated. The CVaR values for the investment risks were respectively: (-4.61437, -5.03067, -5.69693, -5.98458, -7.08469, -8.78021, -9.65284) These values show that the application of CVaR is better than the VaR model

CVaR measurement and analysis results with 99% confidence level

The model efficiency is dependent on increasing the confidence level up to 99% (1% error rate) to obtain the best results. CVaR at the 99% confidence level shows Bitcoin is the "safe haven" for cryptocurrency investment with a value of -7.02498. This finding supports the first hypothesis of the study, “Risk expressed in CVaR varies among cryptocurrencies depending on investors' confidence in these currencies.” Bitcoin is the most famous and oldest cryptocurrency and it is considered to have the least risk .

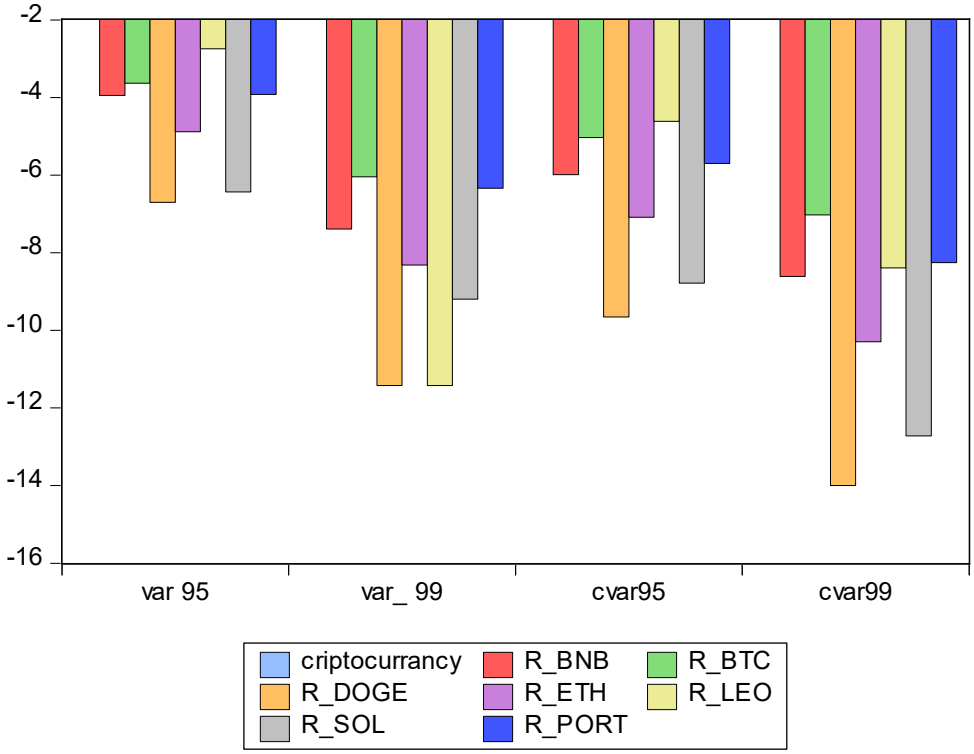
From Table (3), the other cryptocurrencies can be ranked from lowest to highest investment risk as: UNUS SED LEO, Binance Coin, and Ethereum. The investment risks for these cryptocurrencies were -8.39176, -8.60904 and -10.29555 respectively. This ranking is in agreement with the best results obtained by using CVaR which measures losses when they exceed the previously calculated VaR (at a confidence level of 99%) that is the potential loss on a single trading day out of 100 days .

This pattern is evident across all results. Diversification appears to be an important strategy to reduce the risks of investing in cryptocurrencies, with the portfolio risk (measured by the CVaR at a 99% confidence level) being -8.25564, which indicates a moderate risk profile. In contrast, the riskiest currencies (Dogecoin and Solana) had high levels of investment risk with values of CVaR at -12.72324 and -13.9994, respectively. This confirms the third hypothesis of the study, which states that “Cryptocurrencies show extreme risk behavior based on value at risk (VaR) and conditional value at risk (CVaR) analysis at the confidence level of 0.99 and error rate of 0.01.”

The CVaR result of -8.25564 for the sampled cryptocurrency portfolio shows a reduction of the investment loss associated with the high-risk currencies (Dogecoin and Solana) after classifying the currencies according to their investment risk. This approach helps ensure a balanced return of the portfolio based on a diversified mix of cryptocurrencies. This demonstrates how diversification of a portfolio can reduce the risk of investment. This confirms the second hypothesis of the study: “Diversification of the sampled cryptocurrency portfolio helps to reduce the overall risk of the portfolio”.

The research results are summarized in Figure 1, which shows two confidence levels for measuring risk by VaR to achieve the objectives of the study and two confidence levels for measuring risk by CVaR.

Figure (1): Investment risk results using Value at Risk (VaR) and Conditional Value at Risk (Cvar)



Source: EViews output.

The figure shows the different levels of risk for investing in the cryptocurrency portfolio examined in the study. The cryptocurrencies and portfolio are ranked from lowest to highest risk as follows: Bitcoin, the cryptocurrency portfolio, UNUS SED LEO, Binance Coin, Ethereum, Solana, and Dogecoin.

5. Conclusions

The research yielded several important conclusions, the risks of investing in Cryptocurrencies are surrounded by a complex set of factors, making it difficult to pinpoint their risk levels accurately because they are sensitive to various variables. The research results show that Bitcoin is the safest currency among the currencies presented in the sample. UNUS SED LEO, Binance Coin, and Ethereum are the currencies identified to be at moderate to high risk. Dogecoin and Solana were the riskiest currencies in the sample, with their returns being significantly volatile. The VaR model estimates potential losses, whereas the CVaR model better measures extreme losses extreme risks beyond the loss calculated by the VaR model. Effective diversification reduces risk, as the analysis of the cryptocurrency portfolio showed a balanced level of investment risk.

It is recommended to invest more in Bitcoin, as it is the best choice for minimizing investment risk compared to the other currencies in the sample studied. Dogecoin and Investment in Solana should be avoided or limited to a very small proportion of the portfolio, because the investment risk is high and the return volatility is extreme. Furthermore, it is recommended that investments in cryptocurrencies should not exceed 5% of one's diversified portfolio of assets and securities, given their high risk and extreme volatility.

In this paper, we propose using VaR and CVaR models alongside advanced artificial intelligence models to identify.

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