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Cryptocurrencies Compared to Traditional Assets: Risk-Return Analysis

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TIIVISTELMÄ:
Tämän tutkimuksen tarkoituksena on analysoida kryptovaluuttojen ja perinteisten omaisuuserien riski- ja tuottotekijöitä. Erityisesti painopiste on dynamiikkojen keskeisten erojen havaitsemisessa, mitkä voisivat auttaa ymmärtämään kryptovaluuttoja paremmin. Lisäksi tutkimuksessa tutkitaan kryptovaluuttojen roolia portfolioteorian ja markkinatehokkuuden yhteyksissä, yli vuosikymmenen jatkuneen integroitumisen jälkeen rahoitusmarkkinoihin.

Vertailussa on mukana kolme suurta kryptovaluuttaa markkina-arvon perusteella, Bitcoin (BTC), Ethereum (ETH) ja Ripple (XRP). Perinteisiä omaisuuseriä vertailussa edustavat S&P 500-indeksi, kulta ja raakaöljy. S&P 500 toimii osakemarkkinoiden keskimääräisen suorituskyvyn mittarina ja edustaa myös eniten pidettyä sijoitusluokkaa. Kulta verrataan usein kryptovaluuttoihin, koska molemmilla havaitaan olevan tärkeitä ominaisuuksia, joita voitaisiin hyödyntää salkun hajauttamisessa. Raakaöljy on yksi maailman talouden välttämättömiä hyödykkeitä, mutta sen hintakehitys on ollut historiallisesti erittäin vaihtelevaa, mahdollistaen kiinnostavan vertailun kryptovaluuttojen volatiliteetin kanssa.

Vaikka suurimpien kryptovaluuttojen arvot on kasvaneet huomattavasti 2020-luvulla, samalla niiden kokema volatiliteetti on ollut erittäin korkea. Kryptovaluutat ovat integroituneet lähemmäs perinteisiä rahoitusmarkkinoita, mutta niillä ei ole yleisesti tunnistettua perusarvoa, ja spekulatiivinen markkinatunnelma on hallinnut vahvasti niiden hintakehitystä. Tavallisesti perinteisten omaisuusluokkien kehitys on maltillisempaa, mikä heijastuu myös niiden sijoituksen riskiin. Nämä johtuvat vakiintuneista markkinarakenteista sekä selkeämmistä sijoituksen arvonmuodostuksen tekijöistä. Aiemmat tutkimukset ovat osoittaneet näyttöä kryptovaluuttamarkkinoiden kehityksestä tehokkaammaksi markkinaksi, mutta toisaalta on myös useita tutkimuksia, jotka ovat tarjonneet erilaisia tuloksia.

Key words: Bitcoin, S&P 500, Risk-Return relationships, Volatility, Speculation, Traditional assets, Cryptocurrencies

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1 Introduction

Since the creation of Bitcoin in 2009, cryptocurrencies have seen fast increase of value. Grounded on blockchain technology, these digital currencies have become a significant part of the broader financial market. Liu et al. (2024) note that, over the past decade, the total market capitalisation of cryptocurrencies has increased from 5,75 billion to 12,38 trillion USD, with an annual growth rate of 71 %. At the same time, the Bitcoin's market share has decreased from 95,8 % to 54 %.

The market has expanded prominently, and large-cap cryptocurrencies have managed to gain market share from Bitcoin. Compared to a decade ago, the cryptocurrency market has become more accessible, while broader range of investors and funds have entered the market. Given multiple studies of academic literature have investigated cryptocurrencies, it remains under-researched market compared to traditional assets. Liu & Tsyvinski (2018) highlight that risk-return trade-offs of Bitcoin, Ethereum, and Ripple have a distinct connection to those of stocks and precious metals. Their results suggest that cryptocurrencies have no exposure to stock market and macroeconomic factors.

The cryptocurrency market experiences high levels of volatility, while the returns are influenced by speculation, investor sentiment, and technological development (Liu & Tsyvinski, 2021). Their speculative demand contributes to making cryptocurrencies prices swing over short term, causing a higher risk of volatility (Lin et al., 2025). The price swings can be significant and sudden, as market conditions are constantly changing. Among investors, the high volatility can be a risk or an opportunity, as cryptocurrencies have produced large returns in past years. According to Yang et al. (2020), unexpected events lead to discontinues jumps in behavioural changes. The changes increase the risk of volatility and result in investors gaining significant losses.

Traditional financial assets such as equities, bonds, commodities, and precious metals have been important components of the broader financial market. These assets are

commonly influenced by macroeconomic factors, including economic policy, business conditions, and geopolitical risks. Considering their established structurers, regulatory and historical performance, they are widely recognised as dependable assets. Existing literature have attempted to examine cryptocurrencies whether potential of cryptocurrencies expand our investment opportunities alongside traditional assets or even replace them in some areas, such as risk management tools.

Although cryptocurrencies are becoming more integrated into financial market, their fundamental characteristics highly differ compared to traditional financial assets. The determinants of their valuation have not been completely discovered (Jung & Park, 2024). Unlike traditional asset, cryptocurrencies are not highly affected by the economic factors. Cheraghali et al. (2024) explain that cryptocurrencies are founded on a decentralised algorithm, which can trace every transaction. Moreover, the market is not dependent on higher authorities, physical assets, and political or governmental regulation. This independence creates uncertainty among investors, as their value is not grounded in economic factors.

Saeedi & Al-Fattal (2025) discuss the cryptocurrency uncertainty and question why investors should trust cryptocurrencies. Sceptical aspects influence this uncertainty, which are connected to cryptocurrencies. Virtual value can be transmitted to any of the available cryptocurrencies. Independent developers and their currencies encounter challenges due to the absence of government backing as well. Liu & Tsyvinski (2021) validate two views which represent cryptocurrency market. The first view suggest that the cryptocurrencies are part of bubbles and fraud. The second view suggest that the cryptocurrencies may be a stake in a vital future innovation, involving blockchain technology.

1.1 Purpose of the study

The purpose of this study is to analyse the risk of cryptocurrencies and return factors compared to traditional assets, while trying to get better understanding of their dynamics. To achieve this, the study compares Bitcoin, Ethereum and Ripple (to S&P 500 Index, Gold and Crude Oil. This study focuses on the main valuation drivers and characteristics of the asset classes. It is widely known that cryptocurrency market average high levels of returns and volatility, while the absence of fundamental factors may determine the greater differences compared to traditional assets. It is also interesting to see how the market efficiency plays a role in this. This is partly inspired the study of Urquhart (2016), which was one the first studies to point out inefficiency of Bitcoin. Regarding the mentioned factors, the first hypothesis of the study is:

H1: Cryptocurrencies still possess significantly different risk-return profiles from those of traditional assets.

Due to the unique characteristics of cryptocurrencies and independency of the traditional economic factors, it is relevant to discover their possible benefits in portfolio diversification. Their efficiency as diversification tools could provide an advantage in the financial market. Since the launch of Bitcoin, academic literature has examined capabilities of cryptocurrencies to eliminate specific market risks and improve diversification of a portfolio (Briere et al., 2015; Dyhrberg, 2016). Considering the closer integration into the financial market and increased number of studies over the decade, it is important to explore if these findings are still relevant in the post-COVID-19 era. Hence, the second hypothesis of the study is:

H2: Cryptocurrencies are more effective tools for portfolio diversification than gold and crude oil in the post-COVID-19 era

1.2 Structure of the study

The introduction and purpose of the study are introduced in the first chapter. The second chapter covers risk-return profile related overviews of the cryptocurrencies and traditional assets. The third and fourth chapters are dedicated for the theoretical background, involving portfolio theory and efficient market theory. Additionally, those chapters focus on portfolio diversification, risk-preference and uncertainty, hedge possibilities, market efficiency, and the behaviours of momentum and herding. The fifth chapter includes risk-adjusted performance measurements. Finally, the last chapter covers the findings of the study.

2 Risk and return factors between cryptocurrencies and traditional assets

Risk and return relationship is regarded as one of the intriguing and contentious finance research topics, due to its crucial implications for asset-pricing analysis, portfolio selection, market efficiency, capital budgeting decisions, and corporate risk management (Ahmed, 2020). Various assumptions are related to a prediction of standard theory. The theory indicates that risk and return have a positive relationship, as risk-averse investors and the market risk premium are related to the conditional variance of the market. Consequently, understanding the relationship between risk and return is important. Especially, when estimating asset class such as cryptocurrencies.

The existing literature has widely discussed risk-return relationship and their trade-off. As the trade-off is such significant in financial economics, it can be considered as the ''first fundamental law of finance'' (Ghysels et al., 2005). According to Lundblad (2007), multiple studies have found risk-return relationship to be negative. Capital-asset pricing models are implications of the market risk premium and conditional volatility. Lundblad argues that a large data range can detect a positive risk-return relationship, suggesting the relationship to be time-varying. Ahmed (2020) acknowledge that academic researchers have attempted to examine the risk-return relationship of cryptocurrencies, yet the research area remains to be rather undiscovered. However, he discovers that the risk-return relationships of Bitcoin and Ethereum are negative.

2.1 Cryptocurrencies

Cryptocurrencies are recognised as exceptional high return and volatility assets, yet their dynamics require more understanding. The relationship between cryptocurrencies and traditional assets is rather unclear, while researchers have attempted to identify risk factors within the cryptocurrency market, that could be something else than just speculation. As the first cryptocurrency, Bitcoin possesses a dominant position in the

market. Although it doesn't represent cryptocurrencies precisely as a whole. Bengtsson & Gustafsson (2023) explain that even cryptocurrencies are different in kind. They share similarities in the influence of technical determinants and cybercrime. Due to the factors influencing Bitcoin returns, appear to separate from other cryptocurrencies, including variables such as measuring tokens in circulation and monetary velocity. The major cryptocurrencies have experienced extremely highest volatility during past five years (Figure 1). In the figure, Bitcoin's price development is represented by the darker blue line, yellow represents Ethereum, and lighter blue represents Ripple. Among the three cryptocurrencies, Ethereum exhibited highest-level volatility, whereas Bitcoin appears to be the most stable.

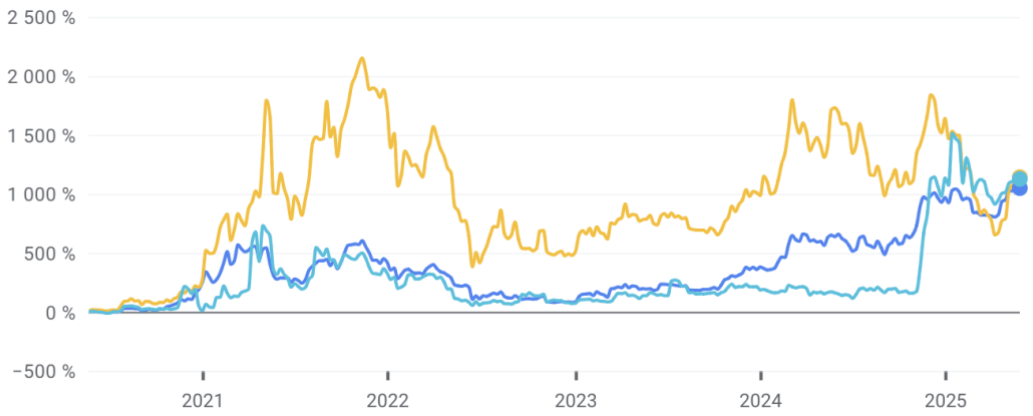

Figure 1. Price development of the major cryptocurrencies (Google Finance, 2025).

2.1.1 Bitcoin

Launched in 2008, Bitcoin (BTC) is the largest cryptocurrency in the market, with a market capitalisation of over two trillion dollars, and a value of 79 188 dollars as of March 2025 (CoinMarketCap, 2025). Bitcoin uses block-chain-based technology connected to peer-to-peer network, while accessing online payments without intermediaries. Throughout its short existence, Bitcoin has encountered valuation challenges, adding to negative conceptions among investors. Cheah & Fry (2015) note that Bitcoin prices are

influenced by speculative bubbles. The bubble component in the valuation is significant. Moreover, the long-term viability has been a concern, as Bitcoin does not contain fundamental value.

Since the launch, Bitcoin has faced concerns from uncertainty of weak fundamental foundations. Given the risk factors remain mostly unidentified, some investors have been willing to take the risk surrounding the new block-chain technology. Urquhart (2016) argues as more market participants trade and analyse Bitcoin; it will gradually become more efficient. Alvarez-Ramirez et al. (2025) observe that events such as El Salvador and Tesla recognising Bitcoin as legitimate currency, suggest it potentially shifting towards non-speculative action. Moreover, it continues to be uncertain whether prices of Bitcoin reflect to all available market information. Enhanced information efficiency could facilitate wider acceptance among various investors.

Bitcoin, alongside with other cryptocurrencies, have been noted as a speculative asset class. Short-term trading is widely common within the market. It remains to be debatable whether they are suitable for long period investment, since the volatility levels are substantial higher as of traditional assets. Given some progress has been made toward mature market, speculators seem to be main drivers of the valuation. However, Blau (2017) examines Bitcoin's volatility and does not find positive relationship between volatility and speculative trading. During 2013, Bitcoin prise rose to 1 123 dollars, just to lose 60 % of its value in the later months. According to Blau, this kind of action resembles an asset bubble, but speculative trading was not prominently high during the period.

If Bitcoin remains to move toward lesser action of speculative, it could start to resemble traditional assets or major currencies. White et al. (2020) discuss how Bitcoin's long and sustained appreciation have resemblance with emerging markets currencies. They discover that mostly Bitcoin is associated with option indices and displays a negative correlation with major currencies. Moreover, they confirm that we are just in the beginning to understand the full potential of blockchain technology and

cryptocurrencies. The transition period from a niche market technology to highly valued asset class is still in the process.

Köse et al. (2024) adopt a similar approach, while investigating if Bitcoin is a secure investment or a speculative asset. Their findings imply, that connections to traditional assets such as gold and crude oil appear as non-existent or limited. Bitcoin's price appears to be influenced by its own dynamics. This kind of behaviour indicates significant association with market expectations. Speculators are the primary drivers of Bitcoin's price instability. They conclude that Bitcoin remains to be unsuitable to classified as a currency for global commerce, given it does not hold typical characteristics of a financial currency. Moreover, they support the idea that Bitcoin requires more research to demonstrate whether its dynamics have an association with traditional assets. Bitcoin's risk-return trade-off appears to be negative. Unlike equity markets, Bitcoin's positive and negative returns are correlated with the positive innovation of volatility, which indicates to the fear of missing out (Jalan et al., 2022).

2.1.2 Ethereum

Released in 2015, Ethereum (ETH) is the second-largest cryptocurrency, with a market capitalisation of 284 billion dollars. Ethereum is valued at 2535 dollars as of March 2025, compared to just 130 dollars at the beginning of 2020's (CoinMarketCap, 2025). Ethereum is also the world's largest decentralised application platform, hosting millions of smart contracts. The discussion surrounding Ethereum point out multiple similarities to Bitcoin. However, the two cryptocurrencies contain essential differences, that potentially may let Ethereum to surpass Bitcoin in the future. Ethereum has more innovative characteristics and offers more than just peer-to-peer trading (Urquhart, 2022). The features suggest that Ethereum could be in a better position to bridge the gap with traditional assets, over the long-term period.

Cryptocurrencies are closely linked to energy consumption, as the factors such as mining and maintenance require significant amounts of electric. Sustainable development is progressively starting to influence the returns of cryptocurrencies, encouraging to investigate other energy alternatives. The academic literature provides rather unclear results regarding how much returns are driven by production factors. Cong et al. (2018) suggest that the price dynamics of cryptocurrencies are linked to production side of the coins, providing empirical evidence from Bitcoin mining. However, Liu & Tsyvinski (2021) argue that cryptocurrency returns are driven and predicted by network factors, instead of production factors.

Liu et al. (2025) explain that Ethereum transitioned from the Proof of Work (PoW) mechanism, widely used by Bitcoin and many other cryptocurrencies, to the Proof of Stake mechanism. Proof of Stake provides improvements on transaction processing, scalability, and security, while decreasing the energy consumption from the Proof of Work. The transition has improved Ethereum's liquidity compared to Bitcoin. Considering it has decreased trading activity, although positively influenced by less speculation and stronger investor confidence. Moreover, the Proof of Stake appears to have stabilising influence on cryptocurrency market by reducing short-term trading and increasing Ethereum's market appeal.

Ben Omrane et al. (2024) observe that Bitcoin returns correlate significantly to fluctuations in energy consumption, while the effect of consumption to Ethereum is insignificant. According to their results, Bitcoin's energy inefficiency compared to Ethereum appear distinct, mainly due to the transition to a more efficient mining mechanism. They claim that Ethereum has the potential to be widely recognised a unit of account and store of value. However, environmental costs continue to be a large limitation, affecting broader adoption of cryptocurrencies. A decrease in speculation, stronger investor confidence, lower volatility influenced by short-term trading may over the long-term, facilitate the transition of cryptocurrencies into highly valued assets.

The stable aspect of Ethereum indicates stronger association with traditional assets. Chen et al. (2025) find in their in their study that Ethereum has a crucial role in decentralised finance and sweeping influence on the whole cryptocurrency market. They observe that increased uncertainty in crude oil, gold and stock markets would strengthen Ethereum's role as a transmitter of liquidity. Furthermore, they point out that Ethereum is the largest transmitter and receiver of return, volatility, and liquidity in the cryptocurrency market. The connectedness of total return and volatility are discovered to be identical magnitude in the cryptocurrency market.

2.1.3 Ripple

Released in 2012, Ripple (XRP) is the fourth-largest cryptocurrency by market capitalisation, valued at 135,16 billion dollars as of March 2025. Its price stands at 2,32 dollars, while it was just 20 cents in the beginning of 2020s (Coinmarketcap, 2025). Jin et al. (2024) explain that Ripple is a global blockchain-based payment network mainly supporting digital asset exchanges, connecting institutions, and payment providers. The Ripple network facilitates fiat money transactions, involving GBP, EUR, and USD, further as cryptocurrencies such as their own cryptocurrency and Ethereum. XRP is Ripple network-based cryptocurrency, designed to enable rapid and efficient currency conversion. They state that XRP demonstrates promising integration signs into the financial market due its focus on cross-border payment and settlement, as well forming connections with banks and financial institutions.

Ripple is much smaller by market capitalisation than Bitcoin and Ethereum, but its partnerships within financial sector appear to be quite potential. Qiu et al. (2019) highlight that, while Bitcoin and Ethereum function as decentralised currencies, Ripple is considerably more centralised, meaning cryptocurrency's value and status can be monitored and tracked by the company. Ripple's system utilises its cryptocurrency as part of their network to offer remittance services, with the potential to replace SWIFT, the world's main network for international payment transactions. They conclude that

Ripple's system could transform traditional industries and arguably change the remittance market in the future.

Fernandes et al. (2025) highlight, that cryptocurrencies have potential to provide greater trustworthy investment signs, as they decrease the risk related with speculative trading and information asymmetry. Ripple exhibits high-level disorder, lesser predictability, better informational efficiency, and reduced informational asymmetry. Their findings indicate that S&P 500 and gold exhibit inefficiencies and speculation, supporting them to be more suitable as safe-haven assets than Ripple.

2.2 Traditional assets

Traditional asset's primary drivers of valuation include market sentiment, as well fundamental and technical factors (Investopedia, 2024). Given the valuation of stocks is strongly based on economic fundamentals, cryptocurrencies differ considerably in that regard. While gold and crude oil are identified as alternative assets classes in modern financial market, their well-established market structures offer a conventional comparison with cryptocurrencies. The market features shared with the assets make them relevant for the comparison. Moreover, both gold and crude oil are constantly connected to possible diversification benefits and regulation considerations within the market.

Narayan & Kumar (2024) find out that asset classes went through high-level of risk during the COVID-19 pandemic. The global market suffered from high uncertainty, disrupting the volatility. Particularly, energy and metal commodities were affected by the extreme risk. Their findings signify that interconnections appear to be facilitating the transmission of risk. As a result, risk can travel whether assets belong to specific asset classes. Yu & Cifuentes-Faura (2024) investigate how Bitcoin, Ethereum, and Ripple are among the cryptocurrencies that receive more information than transmit it. Traditional assets such as gold, crude oil, and stocks transmit more information than receive. Price development

of the traditional assets has been significantly less volatile than cryptocurrencies (figure 2). In the figure, the S&P 500 is represented by the darker blue line, yellow represents gold, and lighter blue represents crude oil. Notably, crude oil has experienced greater level of volatility among the three assets. During the period, the S&P 500 and gold have demonstrated being secure and reliable assets with less volatile price development.

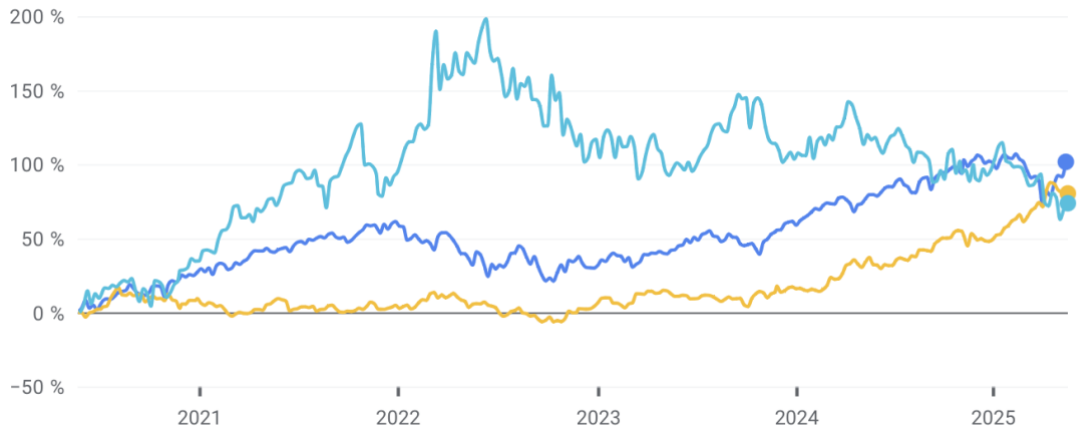

Figure 2. Price development of the traditional assets (Google Finance, 2025).

2.2.1 S&P 500

The S&P 500 index is broadly regarded as one of the best measures of large-cap U.S equities, containing 500 companies that represent approximately 80 % of the stock market's total capitalisation (S&P 500, 2025). The S&P 500 is commonly utilised as a benchmark to estimate performances in the financial market, and it also provides a reliable representation of average stock market performance. As it includes well-established and highly valued companies, the index is also considered as one of the most secure and reliable investments. In contrast to cryptocurrencies, the S&P 500 has experienced low levels of volatility and stable returns during its history. Furthermore, the market efficiency is notable, as information is commonly reflected in stock prices.

In comparison to cryptocurrencies, the stock market is widely researched asset market. The asset pricing models of Sharpe (1964), Lintner (1965) and Black (1972) have laid the foundation for multiple studies afterwards, facilitating to comprehend the risk-return relationship in the stock market. Fama & French (1993) introduce the three-factor model. They discuss the impacts of firm size, book-to-market equity, and overall market factors on market returns, stock returns and the cross section of average stock returns. In contrast to cryptocurrency market, the well-established dynamics of the stock market provide a broad understanding of its risk-return profile.

Multiple studies have attempted to explore usage of traditional models to cryptocurrencies to reveal their determinants of valuation. The findings appear to have mixed considerations among them. According to Liu et al. (2020) and Shen et al. (2020), the three-factor model of Fama & French (1993) is relevant within the cryptocurrency market, which involve market, size, and momentum. Nevertheless, Jung & Park (2024) criticise the three-factor model for having limited interpretive power. Dunbar & Owusu-Amoako (2022) note that the asset pricing model of Sharpe (1964) may also be applied to explain dynamics of cryptocurrency returns. In a result, the findings suggest that academic researchers further encounter challenges regarding valuation and risk modelling.

Annamalaisamy & Vepur Jayaraman (2024) investigate the market co-movement between the cryptocurrencies and traditional assets to discover their level of connectedness. Their findings imply that the S&P 500 do not have a significant association with Bitcoin, Ethereum, and Ripple in the short-term. Nonetheless, strong connectedness appears in the medium-term, particularly throughout the COVID-19. Subsequently, the volatility decreases in the long-term, suggesting the S&P 500 to exhibit vulnerability during the cryptocurrency market shocks in the medium-term.

2.2.2 Gold

Gold holds a global role as a stable financial asset, while its intrinsic value is determined by factors such as scarcity, durability, and industrial demand. Investors recognise gold as a strategic asset, considering its suitability for long-term portfolio diversification. Furthermore, gold provides a high level of liquidity, no credit risk, and retains its value over time (World Gold Council, 2025).

Gold can be regarded as a speculative asset, particularly during periods of market turbulence as it often draws capital flows from other asset classes to secure stability. This mainly due to gold's safe-haven features, such as its historically stable investment and retaining its value, which attract investors during times of uncertainty. Gold have been constantly classified as a safe-haven asset or a hedge for investment purposes. Baur & Lucey (2009) define hedge as ''an asset that is uncorrelated or negatively with another asset or portfolio on average." Academic research has attempted to discover whether cryptocurrencies provide a more suitable alternative for hedging or safe-haven benefits (Acikgoz, 2025; Ben Ameur et al., 2024; Echaust et al., 2024; Klein et al., 2018). However, gold remains to be the preferred option between the two.

Despite being a traditional financial asset, gold shares rather similar limitations within the market as cryptocurrencies. Qin et al. (2025) state that the gold market require greater fairness, transparency, and stability. They highlight the importance of governmental action to improve the regulation of financial markets. A layout for improvement could contain encouraging financial innovations and promoting the integrated improvement of the gold market among the rest of financial market. For instance, the gold market could provide potentially new investment products to investor demands, such as gold-linked products and gold options.

Klein et al. (2018) criticise that Bitcoin cannot be recognised as the ''new gold" from a portfolio perspective, although possessing some similar dynamics. The narrative of cryptocurrencies being established as ''the new gold'' does not hold while investigated

precisely. Despite the rather resemblance of the assets, cryptocurrencies do not obtain the same value perceptions among investors. Liu & Tsyvinski, (2021) claim that if cryptocurrencies were truly similar as metal commodities, we would not observe significant differences between the returns of the two. They conclude that cryptocurrencies do not have a significant association with precious metals.

2.2.3 Crude Oil

Crude oil is a vital energy resource enabling modern economic life. It provides a necessary link between functioning of capital markets, individual investor policy, and macroeconomic efficiency (Li et al., 2024). However, the increasing influence of sustainable development has encouraged the search for alternative energy sources. Despite the environmental factors, crude oil continues to be inevitable resource for various industrial processes.

Crude oil possesses speculative characteristics and shares specific similarities with cryptocurrencies regarding return predictability. Li et al. (2024) recognise macroeconomic variables, technical indicators and geopolitical risks as the primary drivers of crude oil prices. Nonetheless, the dynamics of crude oil require deeper insights supporting the valuation. Given the challenges predicting returns and analysing the primary factors influencing instability in the market remain to be considerable issues. Li & Miu (2024) observe the crude oil market experienced demand and supply shocks during the COVID-19, influencing volatile disruptions in the global economy. During this period, crude oil prices recorded all-time high levels of volatility in history. Most empirical findings suggest a negative return-volatility relationship in the crude oil market, mainly explained by the volatility effect.

Rehman & Kang (2021) examine the time-frequency between Bitcoin prices, Bitcoin mining, and energy commodities from January 2013 to October 2018. They discover that crude oil exhibits a significant correlation with Bitcoin over a period of 128-256 days. Crude oil obtains an influence on Bitcoin prices and mining, attributing the co-movement,

as the process of mining appears to be linked to energy consumption. Annamalaisamy & Vepur Jayaraman (2024) argue in their study that crude oil shows merely a weak level of association with Bitcoin, Ethereum and Ripple. Nonetheless, the relationship could offer hedging opportunities for the crude oil index-based investments. Chen et al. (2022) state that the influence of speculative trading is rather limited on crude oil prices and returns. In contrast to cryptocurrencies, the market share of speculative short-term traders is not significant.

3 Portfolio theory

Building on the results of the second chapter, suggesting that the risk-return dynamics of cryptocurrencies are not as established than those of traditional assets. Cryptocurrencies indicate strong signals of the integration into financial markets, although speculation still appears to be the main driver of the valuation. As an asset class, cryptocurrencies tend to experience some of the highest-level volatility within the financial market. However, their low correlation to traditional assets offers opportunities for portfolio diversification. Cryptocurrencies combined with low correlated assets in a portfolio, may lead to greater returns. In the previous chapters, the study briefly presented important portfolio concepts of hedging and safe-haven asset. This chapter explores the potential diversification benefits between the cryptocurrencies and traditional assets.

3.1 Diversification of the assets

Markowitz's (1952) modern portfolio theory suggests that a portfolio including correlated securities is lesser effective of an approach in diversifying risk. He highlights that, while building a portfolio, it is necessary to avoid using securities that are highly correlated. If all securities moved in a perfect symmetrical movement, eliminating risk would be impossible with diversification. Considering the theory, cryptocurrencies could introduce a possible solution for improving a portfolio among several investors.

Could investors find diversification benefits by combining cryptocurrencies with traditional assets? Historically, both gold and crude oil have provided effective options as hedging tools. According to Sahoo (2024), gold's capabilities to operate as an efficient diversifier and risk mitigator are superior to crude oil. Gold as well offers significant hedging against cryptocurrencies over medium- and long-term horizons, although the hedge appears to be rather limited against energy-related uncertainty (Qin et al., 2025). Sahoo (2025) concludes that both commodities exhibit great potential in risk management. When building a portfolio that contains traditional stock index, gold, and

crude oil, the index would require more weight to reach optimal portfolio efficiency. Echaust et al. (2024) do not consider cryptocurrencies, gold or crude oil to be efficient risk management tools when utilised in short hedge strategy against stock market risk.

Bodie et al. (2014) discuss how Markowitz's (1952) portfolio optimalisation model is summarised by the concept of minimum-variance frontier (Figure 1). The first step in applying the concept involves recognising the available risk-return combinations from a broad range of assets. Subsequently, the intention is to decide the weights of the assets that lead to the steepest capital allocation line. Individual assets are placed to on the right of the frontier, demonstrating that single-asset portfolios are inefficient.

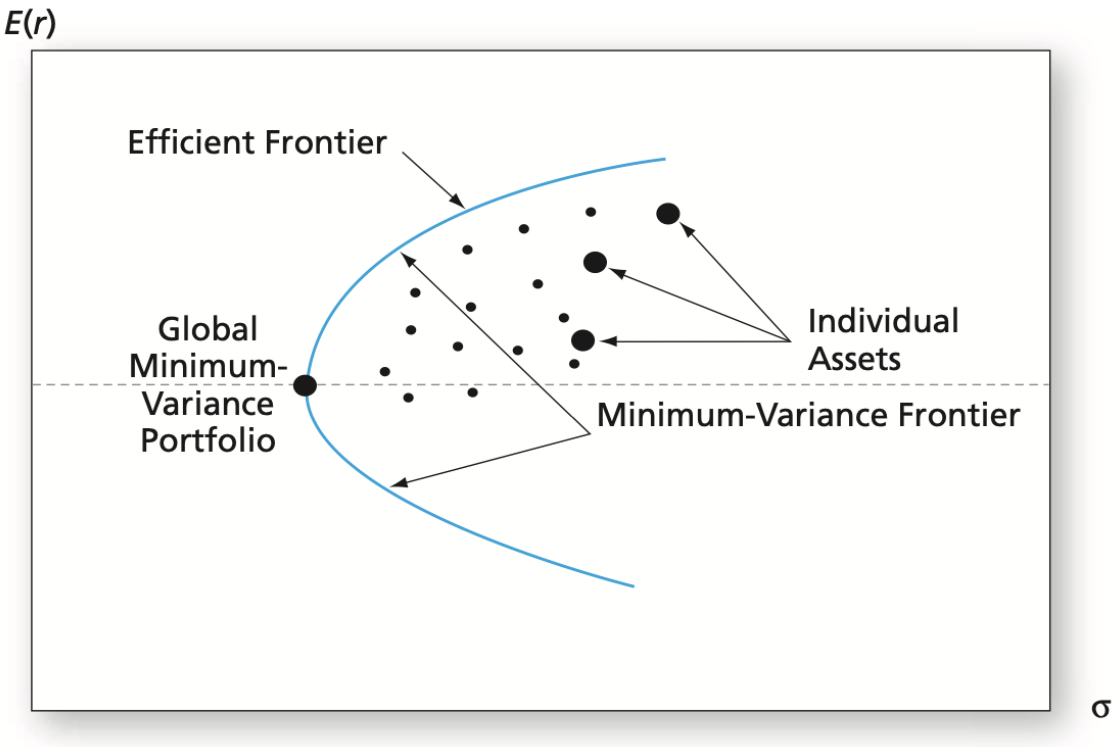

Figure 3. Efficient frontier for risky assets (Bodie et al., 2014).

Just & Echaust (2024) discover that precious metals have lost part of their effectiveness to operate as a hedge in recent years. As cryptocurrencies are not influenced by

macroeconomic factors in the similar way as traditional assets, they were visioned as possible replacements. However, they do not support that cryptocurrencies could replace precious metals as effective hedging tool against financial market risk. To illustrate the hedge inefficiency, they pair cryptocurrencies with S&P 500 in a portfolio. Between the examined cryptocurrencies, Bitcoin appears as the best, closely followed by Ethereum, while Ripple operates as the worst hedge (figure 2). In their research, the positive values indicate a decrease in risk, while the negative values indicate increase in risk. The findings present that increasing the weight of the cryptocurrencies in the portfolios result to the higher overall risk as well, making them inefficient as hedges and as safe-haven assets. Osman et al., (2023) find similar results, confirming that portfolio strategies containing Bitcoin, Ethereum and S&P 500 appear to be inefficient.

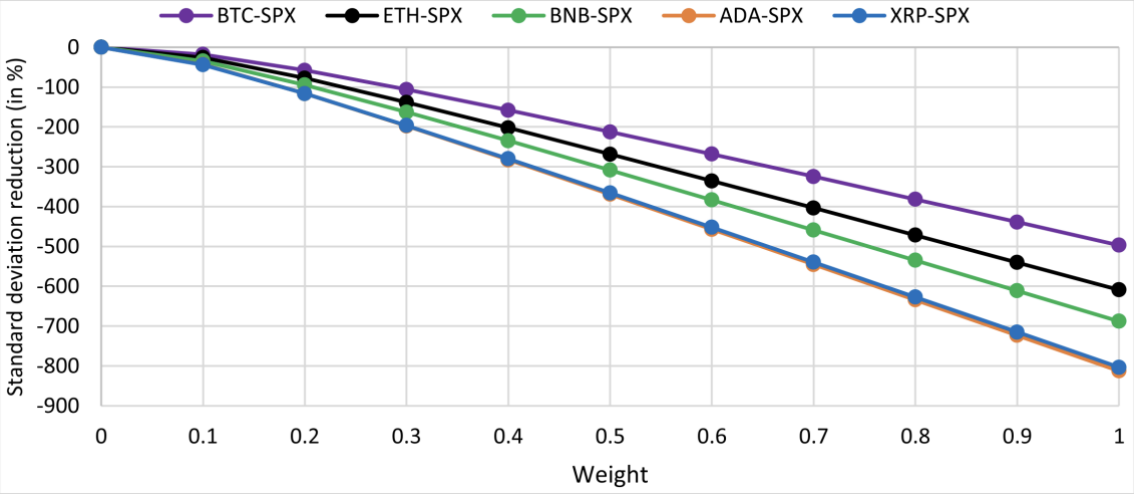

Figure 4. Mean of reduction in portfolio standard deviation (Just & Echaust, 2024).

3.2 Diversification differences between pre- and post-COVID-19

Investors are constantly exploring opportunities to utilise different assets for an optimal portfolio. As cryptocurrencies have integrated closer to traditional assets, it appears to have possible negative effects on their contribution for portfolio diversification. Gorman & Hughen (2024) argue that the opportunities for cryptocurrency diversification is

different after the COVID-19. Correlations have increased between cryptocurrencies and traditional assets, as a result decreasing the benefits of the diversification. They claim that Bitcoin should promise higher returns to justify its contribution from a portfolio perspective. Conservative investors do not favour cryptocurrencies, as the utility gains appear to be outweighed by increased risk, uncertainty, and complexity. In conclusion, expectations with the benefits of acquiring Bitcoin into an established portfolio should be lowered.

Tarchella et al. (2024) discuss the diversification differences from pre- and post-COVID-19 periods. They investigate whether Bitcoin and Ethereum possess better safe-haven, hedging, and diversification capabilities than crude oil and gold under different market conditions. Their findings reveal that, during normal market conditions traditional assets are the best hedge for stock market risk. Moreover, cryptocurrencies present them as the best hedge for stocks during market stress, such as the COVID-19. The results support held claims of other studies which suggest that the diversification benefits of cryptocurrencies have decreased after the pandemic, while gold offers the most promising option for a stock-based portfolio.

Leong et al. (2025) also argue against the portfolio diversification of cryptocurrencies, suggesting that the increasing interconnectedness between cryptocurrencies and traditional assets may lead to worsen systematic risk. Furthermore, higher-level of systematic risk decreases the efficiency of a portfolio diversification. A portfolio's diversifiable risk is represented by formula $\sigma^2(e_p) = \sigma^2(e)/n$, where $\sigma^2(e)$ denotes the portfolio variance and n denotes the amount of assets in the portfolio (Figure 3). This part of the risk can be reduced by diversification. Diversifiable risk decreases, when the amount of assets increases. However, after the certain limit, increase of additional assets has a negligible impact. Systematic risk is represented by $\beta_p^2\sigma_M^2$, where β_p^2 denotes portfolio's vulnerability to the market variance. Systematic risk cannot be eliminated, as risk impacts the entire market and remains even after building well-diversified portfolios.

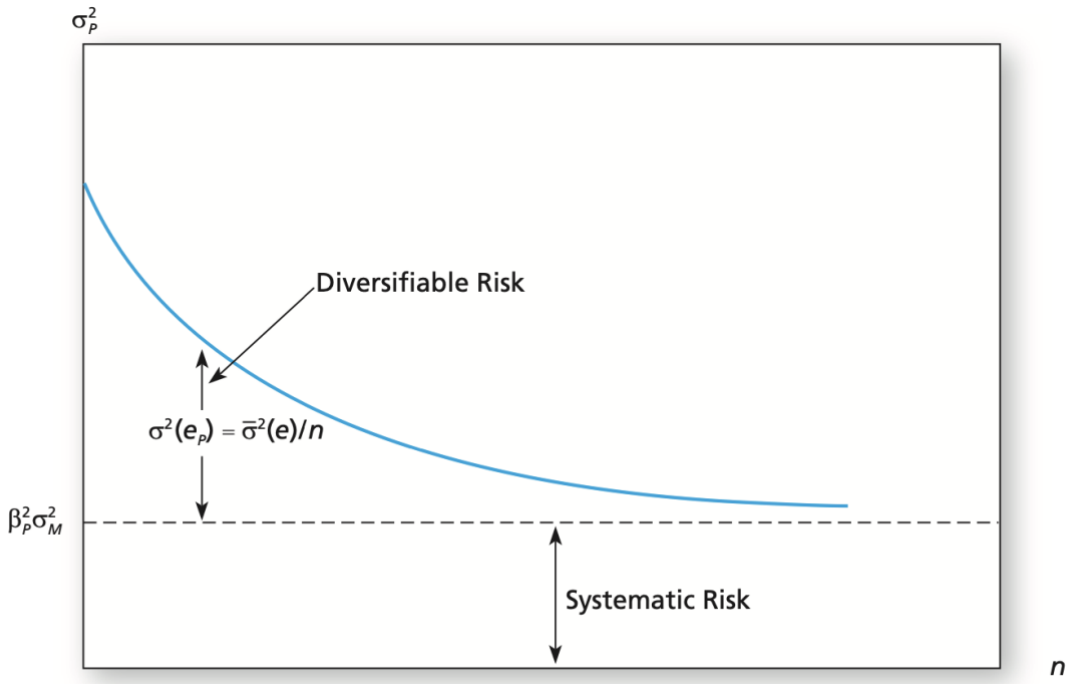

Figure 5. Risk components (Bodie. et al, 2014).

At first, diversification strategies involving cryptocurrencies were reflected efficient, as they did not respond market risk in the same way as traditional assets. Their correlation to the rest of the market was mainly insignificant. Particularly in the pre-COVID-19 era, academic studies suggested that cryptocurrencies could provide diversification benefits (Aslanidis et al., 2019; Corbet et al., 2018; Guesmi et al., 2019). Doan et al. (2024) claim that cryptocurrencies have experienced an increase in systematic risk over time. The Betas of Bitcoin and Ethereum showed significant grow during the 2015-2023 period, reducing their diversification benefits.

Regarding the studies presented in this chapter, the addition of cryptocurrencies does not appear be worthwhile from a portfolio perspective. The diversification would not offer the wanted benefits that investors occasionally seek. Presumably, the contribution of cryptocurrencies may lead to greater portfolio losses. Cryptocurrencies are rather inefficient for risk management tools as hedges or as safe-haven assets. Moreover, their higher beta raises concerns about their opportunities for portfolio diversification.

3.3 Individual risk preference and uncertainty

Referred as risk-preference, is the level of risk that investor willing to tolerate. According to Markowitz (1952), investors should maximise return for a given level of risk. As risk-preference is individual, it can differ considerably among investors. Investors who tend to be more risk-averse prefer portfolios with less volatility, even lowering their expectations with returns. Cohn et al. (1975) finds signs of intertemporal uncertainty influencing investor behaviour. His findings suggest that relative risk aversion decreases while investors wealth increases, resulting in individuals allocating a higher proportion of their total capital to riskier assets.

Bajwa (2025) finds cryptocurrency risk tolerance to appear less notable with relation to cyber security, while liquidity and regulatory risk impact all types of investors, regardless of their risk preferences. Lammer et al. (2020) note that cryptocurrency investors are mainly males and tend to experience investment biases, while owning risky portfolios. When compared to noncryptocurrency investors, both groups exhibit greater risk tolerance than the benchmark. Furthermore, neither are compensated with superior returns for the additional risk taking. As a result, many investors manage to underperform the benchmark, questioning their portfolio efficiency.

According to Hayashi & Routh (2025), specifically cryptocurrency transactors may be financially more sensitive than investors, mix users (transactions and investment), and individuals who do not own any cryptocurrencies. Moreover, they highlight that all three groups compared to nonowners appear to be males, self-employed, or work for family business. The cryptocurrency investor group involves people who tend to be either young or middle-aged, employed for public or private companies, and experience credit needs. They conclude that cryptocurrency owners with sufficient financial literacy and suitable risk tolerance may avoid or reduce risks with cryptocurrencies. Fujiki (2020) discovers similar results, regarding the positive association between financial literacy

and cryptocurrency investors, supporting that investors with greater financial knowledge are likely to invest in cryptocurrencies.

Lucey et al. (2022) highlight that uncertainty is an essential driving factor of volatility in cryptocurrency market, considering its relationship with future returns. Uncertainty may appear as different types with varying effects and predictive capabilities. Price volatility and price uncertainty are two different factors. While price volatility measures return variations, the price uncertainty measures level of unpredictably in prices. According to Knight (1921), it is important to recognise differences between risk and uncertainty. He notes that risk applies to scenarios with known probabilities, while uncertainty applies to scenarios with unknown probabilities.

The global economy has suffered from the increasing uncertainty of various factors, such as geopolitical conflicts, financial crisis and inflation. Regarding securing the future, efficient portfolio management has become more crucial than ever. Macroeconomic uncertainties impact how investors tolerate risk and eventually build their portfolios. Furthermore, market uncertainty is highly associated with risk. Particularly during post-COVID-19 period, where macroeconomic shocks have shown a stronger influence on cryptocurrencies. Sakariyahu et al. (2024) state that the constant crashes of cryptocurrency market have increased investor fear and anxiety, thus weakening the asset's safe-haven characteristics. The lack of confidence not only leads to greater levels of volatility but could also cause financial crisis.

4 Efficient market theory

This chapter is motivated by the noted inefficiency of cryptocurrencies within financial markets. While the cryptocurrency market continues to evolve toward greater efficient system, the transition is still in progress. Futher development may turn them into efficient components of blockchain technology in the future. Traditional assets have been tested under the structure of market efficiency theory, while cryptocurrencies introduce a new set of challenges for academic researchers. In one of the first studies of cryptocurrency efficiency, Urquhart (2016) states that Bitcoin operates inefficiently, yet is in transition becoming efficient. As referred in the previous chapters, cryptocurrencies lack factors important under the efficient market hypothesis. This chapter investigates underlying factors contributing to the market inefficiency.

4.1 Market efficiency

Fama (1970) claims that a primary assumption of the Efficient Market Hypothesis is that security prices completely reflect all information available at the considered time. Regarding the concept, investors should have no opportunities to achieve abnormal returns. The hypothesis consists of three information subsets. The weak form test implies that information set of historical prices and volumes are included into current prices. The semi-strong form test indicates that public information should be entirely price adjusted. The strong form is based on the premise that all known information is reflected in prices.

Multiple studies have examined the inefficiency of cryptocurrencies. The existing literature has either discovered evidence of their inefficiency or signs that the market is evolving toward greater maturity and efficiency over time. According to Sigaki et al. (2019), 37 % of the 437 cryptocurrencies are efficient 80 percent of the time, while 20 % are efficient less than 20 % of the time. They explain cryptocurrencies still as being in the ‘’coming-of-age’’, gradually shifting toward market maturity. Yaya et al., (2020) find

indications of market efficiency during both pre-crash and post-crash periods, while examining Bitcoin, Ethereum, Ripple, and nine other cryptocurrencies. Al-Yahyaee et al. (2020) discover time-varying inefficiency in the market. Their findings highlight that liquidity improves market efficiency, while the volatility has a negative effect.

Bouteska et al. (2025) suggest that increasing liquidity and decreasing volatility are related to improved price efficiency and shorter delays in responsiveness to market news. The authors explain that reforms aimed at enhancing the market efficiency of cryptocurrencies could have a considerable impact on targeting issues connected to illiquidity. The reforms could introduce a government-backed option, such as Central Bank Digital Currencies. This option could have a significant impact on market efficiency, liquidity, decreasing inefficiencies in currency conversion and settlement times and contributing to the entire market.

Polyzos et al. (2024) find that, in the early stages of entering the market, investors tend to be more responsive to the market movements of cryptocurrencies. Although, this responsiveness declines after six months. They suggest that factors such as uncertainty and behaviour of cryptocurrencies have an influence on the market movements. New cryptocurrencies usually attract hype and speculation, although they lack adequate information about their potential. According to the authors, early-stage responsiveness can be described by a ‘’learning curve’’, in which initial investor base is filled with speculative traders and early market adopters. As information becomes more available, the ‘’learning curve’’ matures, long-term investors become the majority, and speculative traders exit.

The cryptocurrency market has a relatively brief history, with only over a decade of active trading. Although, this is a short period in comparison to traditional assets, the market shows progressive indications that efficiency has improved over time. The Efficient Market hypothesis is built on various assumptions, and no financial market is perfectly efficient. Theory may not always fully apply into practical implications such as real-world

market behaviour, thus providing a limited perspective. Bodie et al. (2014) highlights that the three tests share one principle in common: prices should reflect all available information. While no one expects prices to be correct all the time, if markets act rationally, we can expect prices to be correct on average.

4.2 Momentum trading

Momentum trading is a strategy based on buying outperforming assets on a rise, while selling underperforming assets that have reach their peak. The entire concept is to ''buy winners and sell losers,'' dependent on noted market trends. Momentum strategy has been highly common in the cryptocurrency market. As cryptocurrency market is well-known for its short-term trading behaviour and high levels of volatility, it provides a suitable environment for strategies such as momentum. In the previous chapters, this study discussed that cryptocurrencies are not regarded secure assets and are mostly driven by speculation. Given the absence of fundamental value and speculation bubbles influencing prices, investors tend to rely on market trends and sentiment to guide their actions.

Jegadeesh & Titman (1993) discover that using momentum strategy in the stock market can lead to abnormal returns during their research period from 1965 to 1989. The trading strategies included buying past winners and selling past losers over three to twelve months of holding. Their findings clash with market efficiency. Moskowitz et al. (2012) examine the trading activity of speculators to recognise out the patterns of returns regarding momentum strategy. They observe that the trading appears with time series momentum. On average, traders seek to benefit of the positive trends in returns during the first twelve months, decreasing their position as early signs of price decline start to appear.

Grobys & Sapkota (2019) do not support the widely held claims that suggest momentum trading being a successful strategy in the cryptocurrency market. They find no evidence

on momentum trading, leading up to abnormal returns. Liu et al. (2022) find that the momentum effect is more pronounced among the large capitalisation coins such as Bitcoin, Ethereum, and Ripple. According to their results, the momentum effect tends to be increasing stronger during periods of high attention.

Borgards, (2021) tests the momentum effect by comparing twenty cryptocurrencies to the S&P 500. He discovers that a momentum strategy consisting of cryptocurrencies achieves higher returns, risk and risk-adjusted returns across all momentum directions and frequencies. Moreover, the momentum periods are both larger and longer for the cryptocurrencies. The strategy as well outperforms a buy-hold strategy for both assets, making cryptocurrencies specifically compelling for utilising the momentum effect.

Kogan et al. (2024) discuss that investors in the cryptocurrency market are more accustomed to tolerating large price fluctuations than in traditional asset markets, making momentum more effective. The same set of investors exploit different strategies investing in gold and stocks, as they exhibit more stable markets. Regardless of the price dynamic, the constant demand to invest in cryptocurrencies appears to be present. In contrast to traditional assets, the valuation is commonly influenced by expectations of their future wider adoption. In turn, the expectations may as well be influenced by the current value levels, strengthening momentum-based behaviour.

4.3 Herding

The herding effect is a concept in behavioural finance and a strong argument against the assumptions of market efficiency. This behavioural appears especially prevalent during periods of market turbulence, as investors follow decisions of others without sufficient market information, forming a "herd’’. Herding behaviour is identified as contributing factor to influence greater volatility in financial markets. As previously discovered, increased volatility decreases the market efficiency within cryptocurrency market. Bikhchandani & Sharma (2001) acknowledge that herding behaviour is closely associated with momentum strategies. They further discover that herding may be implemented

intentionally, where investors purposely imitate others, possibly leading to spurious outcomes. Unintentional herding can also appear, where investors make similar decisions independently by market information and sentiment.

Inexperienced investors may view herding as rational behaviour in global stock markets. They usually imitate financial experts and rely on their guidance to determine their personal financial actions (Chiang & Zheng, 2010). Phenomenon is a rather common issue within financial markets. New investors struggle to act on the available information and instead follow experienced investors, whose decisions appear as credible and justified. However, even the most experienced investors can make wrong evaluations, and unpredictable scenarios may still occur.

Gemayel & Preda (2024) find significant indications of herding behaviour in the cryptocurrency market, mainly driven by investors imitating their past trades. They discover that intentional herding is associated with informational cascades, especially in less liquid cryptocurrencies. Given their valuable information is more likely to influence substantial price movements. Intentional or cascading effects may appear when investors disregard market information and instead follow popular trends, influencers, or other investors with the same assets (Tavares et al., 2025).

Vidal-Tomás et al. (2019) identify that smaller cryptocurrencies appear to experience herding behaviour with larger cryptocurrenies such as Bitcoin and Ripple. Investors tend to base their investements decisisons on the performance of major cryptocurrencies due to the limited information surrounding smaller cryptocurrencies. Considering the findings, emotions may drive investement decisions more than fundamentals. Almeida & Gonçalves (2023) find clear signs of herding in the cryptocurreny market. Market sentiment influences irrational investors to act on their investements decions. Uncertainty within the market leads to pessimistic beliefs, while also reinforcing speculative bubbles and increased trading volume.

We are currently living in the social media era, where freedom of speech is more accessible for broader crowds. While the freedom has various benefits, many abuse its usage. The intentional herding can be easily implemented through social media platforms such as Reddit and X (formerly Twitter). A prominent example of this is the GameStop phenomenon, where investors encouraged others to invest in the stock on Reddit, resulting in intentional herding. The cryptocurrency market has also exhibited intentional herding, as influential individuals can reshape market dynamics. Agrrawal & Agarwal (2023) point out Tesla CEO Elon Musk as a driving factor in this behaviour. His public statements can establish bubbles and influence cryptocurrency decision-making, trading, and overall market efficiency.

5 Measures of risk-adjusted performance

Considering this study examines risk and return factors, it is relevant to introduce the measuring methods of risk-adjusted performance. Measuring risk-adjustment performance have several approaches, one of the most used is the Sharpe ratio. The Sharpe ratio is considered as a reliable performance indicator, as it involves both the risk and return of an asset. It measures how much return is earned over the risk-free rate, per unit of risk. Sharpe ratio is calculated as follows:

$$Sharpe\ ratio = \frac{R_p - R_f}{\sigma}$$

Also referred as reward-to-volatility ratio, the Sharpe ratio is commonly used to estimate performance of investor managers (Bodie et al., 2014). Risk and return are positively correlated, although their relationship is not always exactly proportional. When comparing two assets, the Sharpe ratio reveals which one holds more risk in reaching a given level of return. Sharpe ratio is rather convenient when comparing two assets with different risk profile, as it allows investors to decide based on their individual risk tolerance.

Table 1. Sharpe ratios of the assets (Yahoo Finance, 2025).

Asset	R_p	σ	**Sharpe-ratio**
Bitcoin	4,05 %	71,41	**0,02**
Ethereum	0,24 %	96,37	**-0,02**
Ripple	-0,01 %	176,42	**-0,01**
S&P 500	0,12 %	18,38	**-0,13**
Gold	0,1 %	61,33	**-0,04**
Crude Oil	0,02 %	40,40	**-0,06**

In this historical data, Sharpe ratios of the assets were calculated by using annualised monthly return rates, represented as R_p in the formula, and subtracted by the risk-free rate (R_f) of 2,5 %. It is then divided by the standard deviation (σ). Between 2018 and 2025, only Bitcoin achieved a positive Sharpe ratio, although it was well below the generally accepted benchmark of 1. The results show that cryptocurrencies experienced higher annualised returns but were accompanied by significantly greater levels of volatility. In contrast, traditional assets demonstrated lower levels of volatility, making them relatively less risky assets. Moreover, Bitcoin's positive ratio may have been achieved due to its possible low correlations with traditional assets, gaining occasional returns even throughout turbulent periods such as the COVID-19.

A variant of the Sharpe ratio, the Sortino ratio is another common risk-adjusted measuring method. The Sortino ratio uses standard deviation of negative asset returns as the denominator in the formula, rather than the normal standard deviation. As a result, the ratio estimates how much return is received over the risk-free rate per unit of downside risk. The standard deviation of negative return is known as the lower partial standard deviation, as it focuses separately on the downside risk instead of total risk (Bodie et al., 2014). The Sortino ratio is calculated as follows:

$$Sortino\ ratio = \frac{R_p - R_f}{\sigma_d}$$

Table 2. Sortino ratios of the assets (Yahoo Finance, 2025).

Asset	R_p	σ_d	**Sortino-ratio**
Bitcoin	4,05 %	33,98	**0,05**
Ethereum	0,24 %	42,35	**-0,05**
Ripple	-0,01 %	43,62	**-0,06**
S&P 500	0,12 %	13,55	**-0,18**
Gold	0,1 %	6,5	**-0,37**

Crude Oil	0,02 %	34,54	**-0,07**

The risk-adjusted returns measured by the Sortino ratios appear to have similar results to the Sharpe ratios. Bitcoin once again measured the only positive ratio, yet it was far below the benchmark value of 1. Ethereum and Ripple obtained slightly negative ratios, while traditional assets' results were even worse. Gold produced considerably the lowest ratio despite its safe-haven capabilities, although it exhibited the least downside risk over the seven-year period. Overall, traditional assets provide more protection for the downside risk at the cost of moderate returns, while risk-adjusted performance of the cryptocurrencies are superior.

6 Conclusions

This thesis analyses the risk and return factors of the cryptocurrencies and traditional assets by comparing Bitcoin, Ethereum, and Ripple to the S&P 500, gold and crude oil. The primary focus is on recognise primary differences in the dynamics of the assets that may contribute to the greater levels of returns and volatility within the cryptocurrency market. This thesis involves a theoretical background that explains the key distinctions of the cryptocurrencies and traditional assets. Additionally, previous and relevant studies are examined to answer the research hypotheses.

In view of the previous studies, the risk-return profile of cryptocurrencies demonstrates clear indications of the differences compared to traditional assets. The market remains prominently less inefficient, mostly due to high volatility, which decreases overall liquidity of the market. It remains to attract a high number of speculative, short-term traders that are heavily influenced by the momentum and herding behaviour. Regardless of the high risk, their risk-adjusted performances are still superior compared to the traditional assets. Overall, connections to the real-world demonstrate significant progress in the market, such as the adoption of Bitcoin as a legitimate currency, transition of Ethereum toward sustainable development and Ripple's efforts to form connections with bank and financial institutions. Nonetheless, the absence of fundamental value proceeds to characterise the cryptocurrency market, with speculation and volatility being the main drivers of valuation.

As demonstrated by the findings, cryptocurrencies do not longer offer similar herding or safe-haven benefits such as in the pre-COVID-19 era, mainly due the increase of the correlation between the assets, especially with the S&P 500. As a result, the benefits of portfolio diversification appear negligible. Considering the possible increase in portfolio standard deviation, including cryptocurrencies in a portfolio with S&P 500, gold, and crude oil, could result in greater losses. In addition, the rising systematic risk of cryptocurrencies further decreases their efficiency as diversification tools. In contrast, gold and crude oil remain to be more effective risk diversifiers and risk mitigators.

The results demonstrate evidence against cryptocurrencies as a secure asset class and efficient risk management tools in traditional portfolios. The implications of these findings provide relevant information for individual investors and traders, who may consider investing first time in cryptocurrencies or adding them into an established portfolio. The results could as well be of interest to regulators, as they can implement reforms to achieve effective policies and improve the stability of financial markets.

However, the study encounters limitations. It is mostly based on the existing studies from just over a decade. The period is relatively short for deeper financial analysis purposes, especially for emerging asset class such as cryptocurrencies. In addition, the study only includes three cryptocurrencies and traditional assets, which may not capture overall market dynamics. The risk and return factors of cryptocurrencies require further research to develop a full scale of understanding.

This study leaves several directions for future research, encouraging to continue the research into the aftermath of deeper integration between cryptocurrencies and traditional assets, especially regarding risk and return behaviour and diversification benefits. Moreover, researchers should also include newer cryptocurrencies, such as DeFi tokens or small-cap cryptocurrencies. Focusing solely on the dynamics of large-cap cryptocurrencies and their risk-return profiles may not represent accurately the development of the entire cryptocurrency market. Due to their early-stage development, these DeFi assets and cryptocurrencies could also offer enhanced diversification benefits alongside traditional assets, potentially due their low correlations.

References

Acikgoz, T. (2025). Gold and Bitcoin as hedgers and safe havens: Perspective from nonlinear dynamics. *Resources Policy*, *102*, 105489. https://doi.org/10.1016/j.resourpol.2025.105489

Agrrawal, P., & Agarwal, R. (2023). *A Longer-Term evaluation of Information releases by Influential market Agents and the Semi-strong market Efficiency*. https://www.econstor.eu/handle/10419/273555

Ahmed, W. M. A. (2020). Is there a risk-return trade-off in cryptocurrency markets? The case of Bitcoin. *Journal of Economics and Business*, *108*, 105886. https://doi.org/10.1016/j.jeconbus.2019.105886

Almeida, J., & Gonçalves, T. C. (2023). A systematic literature review of investor behavior in the cryptocurrency markets. *Journal of Behavioral and Experimental Finance*, *37*, 100785. https://doi.org/10.1016/j.jbef.2022.100785

Alvarez-Ramirez, J., Espinosa-Paredes, G., & Vernon-Carter, E. J. (2025). Causal wavelet analysis of the Bitcoin price dynamics. *Physica A: Statistical Mechanics and Its Applications*, *658*, 130307. https://doi.org/10.1016/j.physa.2024.130307

Al-Yahyaee, K. H., Mensi, W., Ko, H.-U., Yoon, S.-M., & Kang, S. H. (2020). Why cryptocurrency markets are inefficient: The impact of liquidity and volatility. *The North American Journal of Economics and Finance*, *52*, 101168. https://doi.org/10.1016/j.najef.2020.101168

Al-Yahyaee, K. H., Mensi, W., & Yoon, S.-M. (2018). Efficiency, multifractality, and the long-memory property of the Bitcoin market: A comparative analysis with stock, currency, and gold markets. *Finance Research Letters*, *27*, 228–234. https://doi.org/10.1016/j.frl.2018.03.017

Annamalaisamy, B., & Vepur Jayaraman, S. (2024). Do cryptocurrencies integrate with the indices of equity, sustainability, clean energy, and crude oil? A wavelet coherency approach. *International Journal of Finance & Economics*, *29*(3), 3372–3392. https://doi.org/10.1002/ijfe.2843

Aslanidis, N., Bariviera, A. F., & Martínez-Ibañez, O. (2019). An analysis of cryptocurrencies conditional cross correlations. *Finance Research Letters*, *31*, 130–137. https://doi.org/10.1016/j.frl.2019.04.019

Bajwa, I. A. (2025). Reinvestment intentions in cryptocurrency: Examining the dynamics of risks and investor risk tolerance. *Digital Business*, *5*(1), 100104. https://doi.org/10.1016/j.digbus.2024.100104

Baur, D. G., & Lucey, B. M. (2009). *Is Gold a Hedge or a Safe Haven? An Analysis of Stocks, Bonds and Gold* (SSRN Scholarly Paper No. 952289). Social Science Research Network. https://doi.org/10.2139/ssrn.952289

Ben Ameur, H., Jamaani, F., & N. Abu Alfoul, M. (2024). Examining the safe-haven and hedge capabilities of gold and cryptocurrencies: A GARCH and regression quantiles approach in geopolitical and market extremes. *Heliyon*, *10*(22), e40400. https://doi.org/10.1016/j.heliyon.2024.e40400

Ben Omrane, W., Saadi, S., & Savaser, T. (2024). Sustainable energy practices and cryptocurrency market behavior. *Energy Economics*, *139*, 107937. https://doi.org/10.1016/j.eneco.2024.107937

Bengtsson, E., & Gustafsson, F. (2023). Are cryptocurrencies homogeneous? *European Financial Management*, *29*(1), 150–195. https://doi.org/10.1111/eufm.12399

Bikhchandani, S., & Sharma, S. (2000). *Herd Behavior in Financial Markets: A Review* (SSRN Scholarly Paper No. 3923377). Social Science Research Network. https://papers.ssrn.com/abstract=3923377

Bitcoin BTC (BTC-USD) Live Price, News, Chart & Price History. (2025). Yahoo Finance. Retrieved 2025-05-18 from https://finance.yahoo.com/quote/BTC-USD/

Black, F. (1972). Capital Market Equilibrium with Restricted Borrowing. *The Journal of Business*, *45*(3), 444–455. JSTOR.

Blau, B. M. (2017). Price dynamics and speculative trading in bitcoin. *Research in International Business and Finance*, *41*, 493–499. https://doi.org/10.1016/j.ribaf.2017.05.010

Bodie, Z., Kane, A., & Marcus, A. J. (2014). *Investments* (10. ed). Mc-Graw-Hill Education.

Borgards, O. (2021). Dynamic time series momentum of cryptocurrencies. *The North American Journal of Economics and Finance*, *57*, 101428. https://doi.org/10.1016/j.najef.2021.101428

Bouteska, A., Sharif, T., Isskandarani, L., & Abedin, M. Z. (2025). Market efficiency and its determinants: Macro-level dynamics and micro-level characteristics of cryptocurrencies. *International Review of Economics & Finance*, *98*, 103938. https://doi.org/10.1016/j.iref.2025.103938

Brent Crude Oil Last Day Financ (BZ=F) Stock Price, News, Quote & History. (2025). Yahoo Finance. Retrieved 2025-05-18 from https://finance.yahoo.com/quote/BZ%3DF/

Briere, M., Oosterlinck, K., & Szafarz, A. (2015). *Virtual Currency, Tangible Return: Portfolio Diversification with Bitcoin* (SSRN Scholarly Paper No. 2324780). Social Science Research Network. https://doi.org/10.2139/ssrn.2324780

Cheah, E.-T., & Fry, J. (2015). Speculative bubbles in Bitcoin markets? An empirical investigation into the fundamental value of Bitcoin. *Economics Letters*, *130*, 32–36. https://doi.org/10.1016/j.econlet.2015.02.029

Chen, Q., Zhu, H., Yu, D., & Hau, L. (2022). How does investor attention matter for crude oil prices and returns? Evidence from time-frequency quantile causality analysis. *The North American Journal of Economics and Finance*, *59*, 101581. https://doi.org/10.1016/j.najef.2021.101581

Cheraghali, H., Molnár, P., Storsveen, M., & Veliqi, F. (2024). The impact of cryptocurrency-related cyberattacks on return, volatility, and trading volume of cryptocurrencies and traditional financial assets. *International Review of Financial Analysis*, *95*, 103439. https://doi.org/10.1016/j.irfa.2024.103439

Chiang, T. C., & Zheng, D. (2010). An empirical analysis of herd behavior in global stock markets. *Journal of Banking & Finance*, *34*(8), 1911–1921. https://doi.org/10.1016/j.jbankfin.2009.12.014

Cong, W., He, Z., & Li, J. (2018). Decentralized Mining in Centralized Pools. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3143724

Corbet, S., Meegan, A., Larkin, C., Lucey, B., & Yarovaya, L. (2018). Exploring the dynamic relationships between cryptocurrencies and other financial assets. *Economics Letters*, *165*, 28–34. https://doi.org/10.1016/j.econlet.2018.01.004

Doan, B., Jayasuriya, D., Lee, J. B., & Reeves, J. J. (2024). Cryptocurrency systematic risk dynamics. *Economics Letters*, *241*, 111788. https://doi.org/10.1016/j.econlet.2024.111788

Dunbar, K., & Owusu-Amoako, J. (2022). Cryptocurrency returns under empirical asset pricing. *International Review of Financial Analysis*, *82*, 102216. https://doi.org/10.1016/j.irfa.2022.102216

Dyhrberg, A. H. (2016). Hedging capabilities of bitcoin. Is it the virtual gold? *Finance Research Letters*, *16*, 139–144. https://doi.org/10.1016/j.frl.2015.10.025

Echaust, K., Just, M., & Kliber, A. (2024). To hedge or not to hedge? Cryptocurrencies, gold and oil against stock market risk. *International Review of Financial Analysis*, *94*, 103292. https://doi.org/10.1016/j.irfa.2024.103292

Ethereum ETH (ETH-USD) Live Price, News, Chart & Price History. (2025). Yahoo Finance. Retrieved 2025-05-18 from https://finance.yahoo.com/quote/ETH-USD/

Fama, E. F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal of Finance*, *25*(2), 383–417. https://doi.org/10.2307/2325486

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, *33*(1), 3–56. https://doi.org/10.1016/0304-405X(93)90023-5

Fernandes, L. H. S., Figueirôa, J. R. A., Martins, C. M. F., & Martins, A. M. F. (2025). The battle of informational efficiency: Cryptocurrencies vs. classical assets. *Physica A: Statistical Mechanics and Its Applications*, *664*, 130427. https://doi.org/10.1016/j.physa.2025.130427

Gemayel, R., & Preda, A. (2024). Herding in the cryptocurrency market: A transaction-level analysis. *Journal of International Financial Markets, Institutions and Money*, *91*, 101907. https://doi.org/10.1016/j.intfin.2023.101907

Ghysels, E., Santa-Clara, P., & Valkanov, R. (2005). There is a risk-return trade-off after all. *Journal of Financial Economics*, *76*(3), 509–548. https://doi.org/10.1016/j.jfineco.2004.03.008

Google Finance – osakekurssit, reaaliaikaiset tarjoukset ja yritysuutiset. (2025). Google Finance. Retrieved 2025-05-18 from https://www.google.com/finance

Gorman, M., & Hughen, W. K. (2024). Does bitcoin still enhance an investment portfolio in a post Covid-19 world? *Finance Research Letters*, *62*, 105170. https://doi.org/10.1016/j.frl.2024.105170

Grobys, K., & Sapkota, N. (2019). Cryptocurrencies and momentum. *Economics Letters*, *180*, 6–10. https://doi.org/10.1016/j.econlet.2019.03.028

Guesmi, K., Saadi, S., Abid, I., & Ftiti, Z. (2019). Portfolio diversification with virtual currency: Evidence from bitcoin. *International Review of Financial Analysis*, *63*, 431–437. https://doi.org/10.1016/j.irfa.2018.03.004

Hayashi, F., & Routh, A. (2025). Financial literacy, risk tolerance, and cryptocurrency ownership in the United States. *Journal of Behavioral and Experimental Finance*, *46*, 101060. https://doi.org/10.1016/j.jbef.2025.101060

Jalan, A., Matkovskyy, R., & Urquhart, A. (2022). Demand elasticities of Bitcoin and Ethereum. *Economics Letters*, *220*, 110877. https://doi.org/10.1016/j.econlet.2022.110877

Jegadeesh, N., & Titman, S. (1993). Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *The Journal of Finance*, *48*(1), 65–91. https://doi.org/10.1111/j.1540-6261.1993.tb04702.x

Jin, A., Ye, Y., Lee, B., & Qiao, Y. (2024). Topology analysis of the Ripple transaction network. *International Journal of Network Management*, *34*(2), e2253. https://doi.org/10.1002/nem.2253

Jung, W., & Park, H. (2024). Common factors in the returns on cryptocurrencies. *Finance Research Letters*, *65*, 105485. https://doi.org/10.1016/j.frl.2024.105485

Just, M., & Echaust, K. (2024). Cryptocurrencies against stock market risk: New insights into hedging effectiveness. *Research in International Business and Finance*, *67*, 102134. https://doi.org/10.1016/j.ribaf.2023.102134

Klein, T., Pham Thu, H., & Walther, T. (2018). Bitcoin is not the New Gold – A comparison of volatility, correlation, and portfolio performance. *International Review of Financial Analysis*, *59*, 105–116. https://doi.org/10.1016/j.irfa.2018.07.010

Kogan, S., Makarov, I., Niessner, M., & Schoar, A. (2024). Are cryptos different? Evidence from retail trading. *Journal of Financial Economics*, *159*, 103897. https://doi.org/10.1016/j.jfineco.2024.103897

Köse, N., Yildirim, H., Ünal, E., & Lin, B. (2024). The Bitcoin price and Bitcoin price uncertainty: Evidence of Bitcoin price volatility. *Journal of Futures Markets*, *44*(4), 673–695. https://doi.org/10.1002/fut.22487

Lammer, D. M., Hanspal, T., & Hackethal, A. (2020). *Who are the Bitcoin investors? Evidence from indirect cryptocurrency investments* (Working Paper No. 277). Frankfurt a. M.: Leibniz Institute for Financial Research SAFE. https://doi.org/10.2139/ssrn.3501549

Leong, M., Alexeev, V., & Kwok, S. (2025). Managing cryptocurrency risk exposures in equity portfolios: Evidence from high-frequency data. *Journal of International Financial*

Markets, Institutions and Money, *99*, 102123. https://doi.org/10.1016/j.intfin.2025.102123

Li, K., Zhang, Z., Wang, Y., & Zhang, Y. (2024). Forecasting crude oil returns with oil-related industry ESG indices. *Journal of Commodity Markets*, *36*, 100444. https://doi.org/10.1016/j.jcomm.2024.100444

Li, L., & Miu, P. (2024). Diversifying crude oil price risk with crude oil volatility index: The role of volatility-of-volatility. *Journal of Commodity Markets*, *36*, 100425. https://doi.org/10.1016/j.jcomm.2024.100425

Lin, M., Liu, Y., & Sheng, V. N. K. (2025). Analysis of the impact of macroeconomic factors on cryptocurrency returns—Based on quantile regression study. *International Review of Economics & Finance*, *97*, 103757. https://doi.org/10.1016/j.iref.2024.103757

Lintner, J. (1965). The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets. *The Review of Economics and Statistics*, *47*(1), 13–37. https://doi.org/10.2307/1924119

Liu, B., Prodromou, T., Suardi, S., & Xu, C. (2025). Ethereum's Merge: Market liquidity, efficiency and volatility in the Proof of Stake Era. *Economics Letters*, *247*, 112202. https://doi.org/10.1016/j.econlet.2025.112202

Liu, J., Julaiti, J., & Gou, S. (2024). Decomposing interconnectedness: A study of cryptocurrency spillover effects in global financial markets. *Finance Research Letters*, *61*, 104950. https://doi.org/10.1016/j.frl.2023.104950

Liu, W., Liang, X., & Cui, G. (2020). Common risk factors in the returns on cryptocurrencies. *Economic Modelling*, *86*, 299–305. https://doi.org/10.1016/j.econmod.2019.09.035

Liu, Y., & Tsyvinski, A. (2018). *Risks and Returns of Cryptocurrency* (Working Paper No. 24877). National Bureau of Economic Research. https://doi.org/10.3386/w24877

Liu, Y., & Tsyvinski, A. (2021). Risks and Returns of Cryptocurrency. *The Review of Financial Studies*, *34*(6), 2689–2727. https://doi.org/10.1093/rfs/hhaa113

Liu, Y., Tsyvinski, A., & Wu, X. (2022). Common Risk Factors in Cryptocurrency. *The Journal of Finance*, *77*(2), 1133–1177. https://doi.org/10.1111/jofi.13119

Lundblad, C. (2007). The risk return tradeoff in the long run: 1836–2003. *Journal of Financial Economics*, *85*(1), 123–150. https://doi.org/10.1016/j.jfineco.2006.06.003

Markowitz, H. (1952). Portfolio Selection. *The Journal of Finance*, *7*(1), 77–91. https://doi.org/10.2307/2975974

Moskowitz, T. J., Ooi, Y. H., & Pedersen, L. H. (2012). Time series momentum. *Journal of Financial Economics*, *104*(2), 228–250. https://doi.org/10.1016/j.jfineco.2011.11.003

Narayan, S., & Kumar, D. (2024). Unveiling interconnectedness and risk spillover among cryptocurrencies and other asset classes. *Global Finance Journal*, *62*, 101018. https://doi.org/10.1016/j.gfj.2024.101018

Osman, M. B., Galariotis, E., Guesmi, K., Hamdi, H., & Naoui, K. (2023). Diversification in financial and crypto markets. *International Review of Financial Analysis*, *89*, 102785. https://doi.org/10.1016/j.irfa.2023.102785

Ph.D, J. R. (2024, July 19). *Ethereum Price History: 2015 To 2024*. Bankrate. https://www.bankrate.com/investing/ethereum-price-history/

Polyzos, E., Rubbaniy, G., & Mazur, M. (2024). Efficient Market Hypothesis on the blockchain: A social-media-based index for cryptocurrency efficiency. *Financial Review*, *59*(3), 807–829. https://doi.org/10.1111/fire.12387

Qin, M., Shao, X., Hu, C., & Su, C. W. (2025). Can gold hedge against uncertainty in the cryptocurrency and energy markets? *Technological Forecasting and Social Change*, *214*, 124050. https://doi.org/10.1016/j.techfore.2025.124050

Qiu, T., Zhang, R., & Gao, Y. (2019). Ripple vs. SWIFT: Transforming Cross Border Remittance Using Blockchain Technology. *Procedia Computer Science*, *147*, 428–434. https://doi.org/10.1016/j.procs.2019.01.260

Rehman, M. U., & Kang, S. H. (2021). A time–frequency comovement and causality relationship between Bitcoin hashrate and energy commodity markets. *Global Finance Journal*, *49*, 100576. https://doi.org/10.1016/j.gfj.2020.100576

Saeedi, A., & Al-Fattal, A. (2025). Examining trust in cryptocurrency investment: Insights from the structural equation modeling. *Technological Forecasting and Social Change*, *210*, 123882. https://doi.org/10.1016/j.techfore.2024.123882

Sahoo, S. (2024). Harmony in diversity: Exploring connectedness and portfolio strategies among crude oil, gold, traditional and sustainable index. *Resources Policy*, *97*, 105281. https://doi.org/10.1016/j.resourpol.2024.105281

Sharpe, W. F. (1964). Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk. *The Journal of Finance*, *19*(3), 425–442. https://doi.org/10.1111/j.1540-6261.1964.tb02865.x

Shen, D., Urquhart, A., & Wang, P. (2020). A three-factor pricing model for cryptocurrencies. *Finance Research Letters*, *34*, 101248. https://doi.org/10.1016/j.frl.2019.07.021

Sigaki, H. Y. D., Perc, M., & Ribeiro, H. V. (2019). Clustering patterns in efficiency and the coming-of-age of the cryptocurrency market. *Scientific Reports*, *9*(1), 1440. https://doi.org/10.1038/s41598-018-37773-3

S&P 500®. (2025). S&P Dow Jones Indices. Retrieved 2025-05-27 from https://www.spglobal.com/spdji/enhttps://www.spglobal.com/spdji/en/indices/equity/sp-500/

SPDR Gold Shares (GLD) Stock Price, News, Quote & History. (2025). Yahoo Finance. Retrieved 2025-05-18 from https://finance.yahoo.com/quote/GLD/

SPDR S&P 500 ETF (SPY) Stock Price, News, Quote & History. (2025). Yahoo Finance. Retrieved 18 May 2025, from https://finance.yahoo.com/quote/SPY/

Tavares, N. A., da Gama Silva, P. V. J., & Klotzle, M. C. (2025). Investigation of the intentional and spurious herding effects in the cryptocurrency market with global events. *The Quarterly Review of Economics and Finance*, *102*, 101992. https://doi.org/10.1016/j.qref.2025.101992

Urquhart, A. (2016). The inefficiency of Bitcoin. *Economics Letters*, *148*, 80–82. https://doi.org/10.1016/j.econlet.2016.09.019

Urquhart, A. (2022). Under the hood of the Ethereum blockchain. *Finance Research Letters*, *47*, 102628. https://doi.org/10.1016/j.frl.2021.102628

Vidal-Tomás, D., Ibáñez, A. M., & Farinós, J. E. (2019). Herding in the cryptocurrency market: CSSD and CSAD approaches. *Finance Research Letters*, *30*, 181–186. https://doi.org/10.1016/j.frl.2018.09.008

What Drives the Stock Market? (n.d.). Investopedia. Retrieved 2025-05-03 from https://www.investopedia.com/articles/basics/04/100804.asp

White, R., Marinakis, Y., Islam, N., & Walsh, S. (2020). Is Bitcoin a currency, a technology-based product, or something else? *Technological Forecasting and Social Change*, *151*, 119877. https://doi.org/10.1016/j.techfore.2019.119877

World Gold Council | The Authority on Gold. World Gold Council. Retrieved 2025-05-18 from https://www.gold.org

XRP XRP (XRP-USD) Live Price, News, Chart & Price History. (2025). Yahoo Finance. Retrieved 2025-05-18 from https://finance.yahoo.com/quote/XRP-USD/

Yang, B., Sun, Y., & Wang, S. (2020). A novel two-stage approach for cryptocurrency analysis. *International Review of Financial Analysis*, *72*, 101567. https://doi.org/10.1016/j.irfa.2020.101567

Yaya, O., Ogbonna, A., Mudida, R., & Abu, N. (2020). Market Efficiency and Volatility Persistence of Cryptocurrency during Pre-and Post-Crash Periods of Bitcoin: Evidence based on Fractional Integration. *International Journal of Finance & Economics*, *26*. https://doi.org/10.1002/ijfe.1851