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The Impact of Crypto currency on the Efficiency of Investment Portfolios

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Abstract: The last ten years have seen the rise of financial technology, giving rise to a new class of asset known as cryptocurrency. Crypto currency allows its users to remain anonymous while charging a minimal transaction fee that doesn't involve a third party. It quickly gained widespread acceptance in the financial industry and turned into one of its key selling points. The price fluctuations of cryptocurrencies become erratic. For instance, when Bitcoin was first released in 2009, its value was only \$10, but as of early June 2017, its value had increased to roughly \$3000 (Bloomberg, July 5th, 2017). A lot of investors, particularly those with a high risk tolerance, are interested in making cryptocurrency investments. The purpose of this study is to determine how cryptocurrency affects well-constructed portfolios. We use stocks, ETFs, commodities, and foreign currencies as our assets. We will make use of Litecoin, Ripple, and Bitcoin as our cryptocurrency. We can construct an investment portfolio by applying the Modern Portfolio Theory methodology. The findings demonstrate that the inclusion of cryptocurrency in a portfolio does, in fact, boost the portfolio's effectiveness in two ways. Reducing the standard deviation is the first goal; giving investors more options for allocation is the second. The ideal range for a cryptocurrency allocation is between 5% and 20%, depending on the investor's tolerance for risk.

Keywords: Cryptocurrency, Bitcoin, Ripple, Litecoin, Investment Portfolio, Markowitz

1. Introduction

Virtual or cryptocurrency money has become a more popular form of payment in recent years. Blockchain is a digital accounting system that powers cryptocurrency. There are currently over 500 different kinds of alternative virtual currencies, including Bitcoin, Litecoin, Ripple, Ethereum, and so forth. Among digital currencies, Bitcoin emerged as the most popular and had the highest market capitalization (Yermack, 2013). The three cryptocurrency types with the highest trading volume—Bitcoin (BTC), Ripple (XRP), and Litecoin (LTC)—are the only ones included in this study.

Satoshi Nakamoto created Bitcoin in 2009. As the original cryptocurrency pioneer, Bitcoin is known for emphasizing decentralisation, which means that users have complete control over these currencies and there are no transactional regulations. Loss of third parties in transactions, which allows the cost to be reduced or eliminated entirely. This is the primary cause of the cryptocurrency's growth. Numerous well-known businesses have used Bitcoin. Companies like Dell, Microsoft, Valve, Tesla, Amazon, PayPal, and Subway have already started to accept payments in Bitcoin (Bloomberg, 2016). One of the risks associated with Bitcoin is its extremely volatile value movement. In January 2017, one Bitcoin was worth a thousand dollars, and by June 2017, that value had increased to three thousand dollars. Not only did Bitcoin see a sharp fluctuation in exchange rates, but so did other cryptocurrencies like Litecoin, Ethereum, and Ripple. The value of one Litecoin in 2013 was worth 6.4 USD; by 2016, that value had dropped to about 4.6 USD. In contrast, Ripple dropped from 0.035 USD in 2013 to 0.008 USD in December 2016 (Bloomberg, 2017).

The nature of cryptocurrency differs from that of traditional money. Conventional currencies, like the dollar and the euro, can be calculated more precisely because they are less dependent on the current state and conditions of the global economy, including trade, inflation, crises, politics, and so forth. But it's harder to predict how much cryptocurrency will cost and fluctuate. Along with keeping an eye on the rumours that influence the movement of cryptocurrency prices, demand and supply play a significant role

in determining the price of cryptocurrencies. According to Ciaian, Rajcaniova, and Kancs' (2014) research, three factors affect the price of bitcoin: (1) supply and demand dynamics; (2) investor appeal; and (3) macroeconomic factors and financial advancements.

2. Literature Review

According to Modern Portfolio Theory (MPT), a high risk aversion investor can create an investment portfolio that maximises return while taking into account current market risk. According to Markowitz (Portfolio Selection, 1952), one can determine the amount of return associated with each degree of risk by establishing an Efficient Frontier. The various investment instruments that make up this MPT are first measured using historical statistical techniques to determine the degree of correlation, covariance, standard deviation, and rate of return. Generally speaking, MPT mixes a number of high-risk, low-correlated portfolios and is anticipated to reduce overall risk in the end. The following action is to analyse the securities' risk and return within a predetermined window of time. Assessing the intrinsic value of securities chosen using the Capital Asset Pricing Model (CAPM) is crucial for investors. By taking into account the risk-free rate, beta is calculated to determine the relationship between market return and investment.

Measurement of a chosen asset allocation using each allocation's sharpe ratio value. William Sharpe (1994) proposed the Sharpe ratio, which expresses the amount of return obtained from each investment's measure of risk. While optimal portfolio diversification may not always result in the highest sharpe ratio, it does indicate a better return. An Efficient Frontier diagram with the X axis representing risk and the Y axis representing return was created from the different allocations that describe the return and sharpe ratio. The optimal place for investors to make investments based on their individual utility level is then indicated by the point in this hyperbola diagram. This method will ultimately minimize the risk of deviation than if only selecting a particular asset. Investors should remain cautious because of the risks that exist in Bitcoin and only allocate small portions into it (Wuand Pandey, 2014).

Gandals and Halaburda (2016) attempt to analyse the current competition between the various forms of cryptocurrency that are currently in use. According to his conclusions, Bitcoin emerged victorious in the virtual currency competition during the study period. In order to develop the analysis, researchers also consult earlier studies. Law and Mills' (2014) study examined how Bitcoin investors behaved. According to their theory, Bitcoin investors will utilise the Technical Analysis feature when deciding whether to buy or sell. The findings indicate that investors may be more likely to employ counterstrategy or less supportive data. It is impossible to identify counterstrategy deficiencies, or the best times to buy and sell, until after the event has occurred.

3. Research Methods

In order to create an ideal portfolio, the research focuses on cryptocurrency and how it should be allocated within it. The reason this study's object was selected was the growing popularity of cryptocurrency use since its launch in 2009. Due to its unique qualities compared to other traditional assets, cryptocurrency has drawn interest from a large number of investors. This phenomenon is supported worldwide by numerous powerful nations, including the US, China, and Japan.

Gathering historical asset data to be used as analytical tools is the first stage of this research. The information was obtained from www.cryptocompare.com, <https://finance.yahoo.com>, and www.investing.com. The data collection period spans from December 2013 to December 2016. The Microsoft Excel programme and a few of its formulas are used to process the data.

There are eleven asset classes in commodities and foreign exchange (FOREX). The rationale behind selecting foreign exchange as a payment method is that it is the asset class with the strongest ties to cryptocurrency. The reason commodities, particularly gold, are preferred as investments is that they are thought to be the safest. Because of its resilience to economic shocks, bitcoin is frequently compared to gold, according to Baur et al. (2016). The US dollar ruble (USD/RUB), the US dollar Danish krone (USD/DKK), the US dollar Chinese yuan (USD/CNY), the US dollar Hong Kong dollar (USD/HKD), the US dollar Canadian dollar (USD/CAD), the US dollar Singapore dollar (USD/SGD), and the US dollar Swiss franc are these assets. EUR/GBP stands for gold, silver, metal, and the British pound.

Investors' preferred asset for creating a portfolio is a portfolio of stocks. Six stocks—The Kraft Heinz Company (KHC), Wells Fargo & Company (WFC), The Coca-Cola Company (KO), International Business Machines Corporation (IBM), American Express Company (AXP), and Phillips 66 (PSX)—were used in the data to create the portfolio. These are a few of the stocks that Warren Buffett owns. According to this research, these shares are thought to be stock assets in stock portfolios.

Finding the annual return and standard deviation is the next step. A few of the functions that are utilised are average (calculate mean), covar (count covariance), correl (calculate correlation), and stdev (calculate standard deviation). Subsequently, a solver function is employed, which is highly beneficial in offering solutions for linear programming and in supplying the limitations required to create asset allocations. In order to create an ideal portfolio, Solver will distribute assets in line with the goals we have specified.

Four investment portfolios were managed by this research attempt. The first portfolio is made up of both foreign exchange and commodities; the second is made up of a pool of stock assets; and the third portfolio is made up of exchange-traded funds. The top-performing assets from each portfolio are combined to form the fourth portfolio. The researchers base their risk-free level of 0.5% on the three-month return on US Treasury Bills for each portfolio calculation.

4. Results

Portfolio Performance of FOREX and Commodities

There are eleven different commodity and foreign exchange asset classes in this portfolio. Since foreign exchange functions as a means of payment exchange, it is the asset type that most closely resembles crypto currency. The reason commodities, particularly gold, are preferred as investments is that they are thought to be the safest. Due to its resilience to economic shocks, bitcoin is frequently compared to gold (Baur, 2016). The asset is examined in the first step for returns and risks between December 2013 and December 2016. The creation of a portfolio will be based on an analysis of returns and risks. The performance of each asset in this portfolio is displayed in the following table.

The next step, there searchers for me deport folio with optimal asset allocation. The constraint that the researcher uses is total asset allocation equal to 100%, asset allocation greater than or equal to 0, and return from portfolio equal to return from target that the researcher specify. In addition, the researchers also used the objective of maximizing the sharperatio. Sharperatioisameasureusedtoassesstherateofreturngeneratedfromeachrisk. Theresultsareasfollows:

Table 1. Asset Allocation Portfolio of FOREX and Commodities

Allocation	1	2	3	4	5	6
Return	4.45%	5.00%	6.03%	10.00%	15.00%	20.00%
STD.DEV	4.09%	2.54%	3.06%	6.14%	10.80%	17.12%
Sharpe	108.8%	196.5%	197.1%	162.8%	138.9%	116.84%
USD/RUB	9.09%	5.31%	7.2%	23.3%	44.8%	81.55%
USD/DKK	9.09%	17.6%	21.3%	35.13%	55.21%	18.45%
USD/CNY	9.09%	51.2%	57.8%	38.4%	0.00%	0.00%
USD/HKD	9.09%	12.7%	0.00%	0.00%	0.00%	0.00%
USD/CAD	9.09%	0.00%	0.12%	0.00%	0.00%	0.00%
USD/SGD	9.09%	0.00%	0.00%	0.00%	0.00%	0.00%
USD/CHF	9.09%	0.5%	0.05%	0.44%	0.00%	0.00%
EUR/GBP	9.09%	8.6%	9.4%	0.00%	0.00%	0.00%
Metal	9.09%	0.04%	0.00%	0.04%	0.00%	0.00%
Gold	9.09%	1.7%	1.3%	0.84%	0.00%	0.00%
Silver	9.09%	2.4%	2.9%	1.85%	0.00%	0.00%

The test result shows that the allocation of assets proportionally yields only 4.45% return and risk of 4.09%. Sharperatio is highest in allocation 3 of 197.11% with a return rate of 6.03% and a risk of 3.06%. At allocation 6, the researcher allocates to two assets ie USD / RUB and USD / DKK. There searcher did not conduct a simulation of continued asset allocation by fully encoding on USD / RUB. Researchers argue that it is incompatible with Markowitz's theory that promotes diversification as an effort to minimize risk.

Portfolio Performance of FOREX and Commodities Adding Cryptocurrency

The next step is to include Cryptocurrency assets into the asset portfolio to see the effect in portfolio performance. Here is the return and standard deviation of Bitcoin (BTC), Ripple(XRP) and Litecoin(LTC):

Table 2. Return & Standard Deviation Cryptocurrency

	Return	Standard Deviation
BTC/USD	35.53%	72.43%
XRP/USD	-2.80%	106.11%
LTC/USD	31.86%	94.24%

Bitcoin calculation results show better performance than Ripple and Litecoin with a return rate of 35.53% and a standard deviation of 72.43%. Bitcoin and Litecoin return rates are also seen to outperform the returns of forex and commodity assets in the previous portfolio. But in general these three assets are seen to have a very high risk level when compared with other conventional assets. After the calculation of the covariance can be searched the value of the variant needed to form an optimal asset allocation. Here are the results of the foreign exchange and commodity portfolio by including Cryptocurrency assets.

Table 3. Asset allocation of Cryptocurrency in Forex & Commodity Portfolio

Allocation	1	2	3	4	5	6	7	8	9
Return	5.00%	6.39%	8.11%	10.00%	15.00%	20.00%	25.00%	30.00%	35.00%
STD.DEV	2.43%	3.06%	13.29%	5.55%	9.70%	14.70%	21.16%	41.98%	69.22%
Sharpe	185%	192.5%	57.24%	171.2%	149.5%	132.7%	115.8%	70.27%	49.84%
USD/RUB	5.2%	7.18%	7.14%	19.3%	36.51%	61.31%	80.88%	42.48%	4.08%
USD/DKK	14.9%	19.21%	7.14%	31.12%	49.84%	28.35%	0.00%	0.00%	0.00%
USD/CNY	49.4%	55.40%	7.14%	40.6%	6.55%	0.00%	0.00%	0.00%	0.00%
USD/HKD	20.5%	0.00%	7.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
USD/CAD	0.00%	0.00%	7.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
USD/SGD	0.00%	0.00%	7.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
USD/CHF	0.5%	2.71%	7.14%	0.44%	0.00%	0.00%	0.00%	0.00%	0.00%
EUR/GBP	4.5%	9.06%	7.14%	2.69%	0.00%	0.00%	0.00%	0.00%	0.00%
Metal	0.00%	0.00%	7.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Gold	2.3%	2.18%	7.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Silver	1.8%	2.74%	7.14%	2.60%	1.19%	0.00%	0.00%	0.00%	0.00%

The portfolio performance has significantly improved, as evidenced by the above table, where the return rate has reached 35%. Allocation 2 exhibits the highest Sharpe Ratios, with a return rate of 6.39% and a standard deviation of 3.06%. The level of returns in the equally divided asset allocation is shown in Allocation 3. This allocation performs poorly because, with a return of 8.11%, it has a standard deviation of 13.29%, which is higher than that of Allocation 4, which can yield a return of 10% but only has a standard deviation of 5.55%. The outcome of the computation that includes cryptocurrency assets has a positive impact on portfolio performance. For instance, the initial portfolio's 20% return rate has a 17.12% standard deviation.

Portfolio Performance of Stocks Adding Cryptocurrency

Researchers created 11 asset selections for this portfolio, ranging in return rate from the lowest 5% to the highest 35%. With a return of 11.40% and a standard deviation of 22.98%, Allocation 3 demonstrates a balanced allocation of all assets. Overall, the performance of this allocation is subpar. The allocation with the highest sharpe ratio, 88.59%, is allocation number five. With this allocation, the standard deviation is 18.70% and the return is 17.07%.

Table 4. Asset allocation of Cryptocurrency in Stocks Portfolio

Allocation	1	2	3	4	5	6	7	8	9	10	11
Return	5.00%	10.00%	11.40%	15.00%	17.07%	20.00%	25.00%	30%	31%	32%	35.00%

STD.DEV	12.45%	13.46%	22.98%	16.74%	18.70%	22.69%	31.51%	47.51%	51.7%	56%	69.71%
Sharpe	36.13%	70.56%	47.44%	86.61%	88.59%	85.92%	77.74%	62.09%	59%	56.2%	49.49%
KHC	4.25%	18.88%	11.11%	31.35%	38.15%	49.39%	68.53%	36.42%	29.9%	23.3%	3.49%
WFC	27.58%	35.66%	11.11%	42.30%	36.81%	21.85%	0.00%	0.00%	0.00%	0.00%	0.00%
KO	48.25%	32.27%	11.11%	4.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
IBM	12.34%	1.60%	11.11%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
AXP	2.72%	0.00%	11.11%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PSX	0.89%	4.85%	11.11%	10.80%	10.94%	8.65%	0.48%	0.00%	0.00%	0.00%	0.00%
BTC/USD	1.93%	5.35%	11.11%	10.45%	13.89%	20.11%	30.99%	63.58%	70.2%	76.8%	96.51%
XRP/USD	1.67%	1.39%	11.11%	1.08%	0.21%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
LTC/USD	0.36%	0.00%	11.11%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

It is evident that asset portfolios involving cryptocurrency outperform portfolios without it when we try to compare them. This is evident from the 20% return rate, for instance. In the normal portfolio, the standard deviation of this return rate is 30.97%; however, in the cryptocurrency portfolio, the standard deviation rate is 22.69%, which is 8.28% lower. The portfolio with cryptocurrency exhibits a standard deviation rate that is only 0.54% higher at a 25% return rate than the portfolio without cryptocurrency's 20% return rate. Naturally, this helps investors diversify their assets, which is a good thing.

1.1. Portfolio Performance of Exchange-Traded Fund

Investors who want their assets to be well-diversified without having to set it up themselves can consider exchange-traded funds (ETFs). An index-based collection of assets is known as an ETF. ETFs come in a variety of forms, and they all relate to distinct indexes. Compared to index funds or even mutual funds that rely on professional services to manage portfolios, which will naturally cost more, exchange-traded funds (ETFs) are comparatively less expensive because there are no commission fees. This portfolio consists of five ETFs. Researchers are taking into account exchange-traded funds (ETFs), some of which are well-liked by investors. The allocation of assets with a minimalist objective variant is shown in the following table, which is based on the solver's results:

Table 5.Asset Allocation of ETF

Allocation	1	2	3	4	5	6
Return	3.00%	4.00%	4.68%	5.00%	6.00%	7.00%
STD.DEV	2.91%	3.68%	4.34%	4.68%	5.81%	7.00%
Sharpe	85.88%	95.19%	96.20%	96.06%	94.65%	92.88%
VTI	10.40%	14.49%	16.80%	17.88%	21.28%	24.67%
BND	58.66%	44.74%	34.85%	30.15%	15.56%	0.97%
VEU	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
UUP	30.50%	40.76%	48.35%	51.97%	63.17%	74.37%
XME	0.43%	0.00%	0.00%	0.00%	0.00%	0.00%

From this table shows that the greatest allocation tendency is in UUP assets. All allocations appear to have a return rate and a standard deviation that is only slightly adrift. For example Allocation 6, has the same return and standard deviation of 7%. This allocation also shows the allocation with the highest sharpe ratio value. Other allocations also illustrate differences that do not differ greatly, only in the range below 0.5%. When viewed from the diversification of asset allocations, VEU and XME rarely even get allocation. It is reasonable to see the asset's performance during this study period.

Portfolio Performance of Exchange-Traded Fund and Cryptocurrency

Additionally, the researchers can form an ideal portfolio by using solver. This is to investigate the potential impact of cryptocurrency on the creation of a pre-determined ETC portfolio allocation. Nine asset allocations with return rates ranging from 5% to 35% are the end result. In general, diversification is not very equitable; the same as in the previous portfolio, more assets are allocated to UUP assets. The division of assets in Allocation 2 yields the highest sharpe ratio of 110%; however, the low return rate of 5.76% may make the investment less alluring to certain investors. An equitable distribution of assets is seen in Allocation 3. With a return rate of only 9.24% and a high standard deviation rate of 23.93%, it seems that this allocation does not perform well. This portfolio can yield a return rate of up to 35% when

compared to the prior portfolio; however, because of its high standard deviation and lack of diversification, researchers strongly advise against investing in this allocation. The researchers conclude that allocation 4, which yields a good return of 10% along with a relatively high sharpe ratio, is the most optimal allocation.

Table 6.

	1	2	3	4	5	6	7	9	8
Return	5.00%	5.76%	9.24%	10.00%	15.00%	20.00%	25.00%	30.00%	35.00%
STD.DEV	4.12%	4.78%	23.93%	9.52%	20.43%	32.68%	45.21%	57.95%	70.83%
Sharpe	109%	110%	37%	100%	71%	60%	54%	51%	49%
VTI	14.66%	16.43%	12.50%	24.88%	30.92%	36.95%	37.56%	19.73%	1.89%
BND	40.84%	32.42%	12.50%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
VEU	0.00%	0.00%	12.50%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
UUP	41.92%	47.94%	12.50%	64.86%	41.47%	18.08%	0.00%	0.00%	0.00%
XME	0.00%	0.00%	12.50%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
BTC	2.58%	3.20%	12.50%	10.26%	27.61%	44.97%	62.44%	80.27%	98.11%
XRP	0.00%	0.00%	12.50%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
LTC	0.00%	0.00%	12.50%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

The Efficient Frontier diagram's results show the appropriate allocation level for each investor. Allocations 4 and 5 exhibit good allocation. Allocation 4 appears to be a carryover of the prior portfolio, with a return rate that is comparable to the rate of standard deviation that was produced. Standard deviation rates are adequate, so investments that yield 5% to 15% return are appropriate for investors with low tolerance levels. For investors with a high risk tolerance, the rate of return mentioned above may be something to think about. Generally speaking, this portfolio seems to include Bitcoin, with allocations ranging from 2.58% to 98.11%. In contrast to Bitcoin, Ripple and Litecoin receive no allocation at any rate of return from the solver.

Portfolio Evaluations:

The S & P 500 generated an annual return of 7.77% with a standard deviation of 12.43%, while the Dow Jones yielded a return of 7.61% with a standard deviation of 12.54%. From this it can be seen that the portfolio formed using Modern Portfolio Theory can produce better return performance. Modern Portfolio Theory offers a simpler method than the Black-Litterman model. Some of the limitations that appear when using the Black-Litterman model include: 1) Portfolio formation is highly dependent on the index as a benchmark. This is a problem because until now there is no index that represents Crypto currency, so difficult to do analysis. 2) The views of analysts or experts in a market, sector or securities are needed to establish equilibrium formation. The need for this expert view becomes an obstacle because Cryptocurrency is a new type of asset that has not many experts on it. Views are also so diverse that it is difficult to determine the best input. After obtaining the asset composition for optimal portfolio formation, the researcher then tries to see how the asset allocation performance in several periods, ie monthly, semiannual, and annual. The portfolio that researchers use is a mixed portfolio of some of the best performing assets and includes Cryptocurrency. This portfolio researchers use because it shows the best performance among other portfolios. While the allocation of selected assets is the allocation that produces the largest sharpe ratio of 182.05% and generate return of 14.58% and standard deviation of 7.73%.

Table 7. Asset Portfolio Allocation with the highest Sharpe Ratio

USD/RUB	USD/DKK	KHC	WFC	VTI	UUP	BTC/USD	XRP/USD	LTC/USD
30.71%	28.57%	8.34%	0.00%	28.8%	0.0%	3.55%	0.00%	0.00%

On average, the return per month in 2014 was 0.56%, by 2015 by 0.20% and by 2016 by 0.19%. If we calculate again on average from all periods of 2013 to 2016, it is found that the average monthly return is 0.31%. Similarly, the calculation of the return period of monthly and six monthly, 2014 still shows the best performance, while the year 2016 showed poor performance. This poor performance is due to weakening USD / RUB exchange rate and showing a return -0.17%, plus asset allocation in a large portfolio of 30.71%. On average, the calculation of the annual period yields a return of 0.29%. Using asset allocation based on Modern Portfolio Theory, the results of monthly, semi-annual, and

annual analysis show that monthly investments yield a higher return (0.31%). However, there is not much of a difference in the actual return generated between the investment for six months or a year and the actual return generated; the difference is only 0.02% to 0.05%. This suggests that investors have greater latitude in selecting positions based on their preferences and liquidity levels. Due to the extremely volatile nature of cryptocurrency assets, the researcher advises investors to think about making monthly investments. This way, in the event of a significant price movement, investors can promptly rebalance or create new portfolios. It is simple for an investor to obtain Cryptocurrency without having to spend large capital or through difficult steps.

5. Conclusions

A standard deviation rate of more than 100% indicates that cryptocurrency carries a high risk. This aligns with the elevated rate of return. Two factors indicate this increase: first, the standard deviation rate from the same rate of return has decreased, and second, there are more allocation options to generate higher returns, which may appeal to investors with higher risk tolerance. The portfolio becomes more effective when cryptocurrency is used. The portfolio's allocation to bitcoin varies from less than 1% to more than 90%. 5% to 20% is the ideal allocation range to obtain a decent Sharpe ratio. The performance of other assets will also influence this assumption, i.e., the worse the Bitcoin allocation. Despite the fact that the returns are not significantly higher than in the medium or yearly periods, it appears that investing in monthly periods is more profitable for investors when compared to semiannual and annual historical data. The foundation for this portfolio's creation has shown to be quite effective: modern portfolio theory.

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