










# “Assessing the probability of bankruptcy when investing in cryptocurrency”

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# ASSESSING THE PROBABILITY OF BANKRUPTCY WHEN INVESTING IN CRYPTOCURRENCY

## Abstract

The cryptocurrency market is not regulated, people and companies wishing to invest in cryptocurrency do not have the same protection as when investing in other assets. In the absence of information and regulatory laws, investors should decide if cryptocurrencies make sense for their financial goals and what kind of investment strategy to choose not to go bankrupt. The aim of the study is to determine the probability of "tail events" and to assess in this way the probability of bankruptcy when investing in cryptocurrency using the Monte Carlo method. The analysis is carried out on the period from September 1, 2014 up to July 1, 2022. Despite the fact that today there are more than 10,000 types of cryptocurrencies, Bitcoin was chosen to assess the probability of bankruptcy. The reason is that Bitcoin is the world's first decentralized cryptocurrency and its data is stored in a long-term history, which allows testing a long-term investment strategy. Besides, Bitcoin has not gone through a period of persistent inflation that makes the result of testing a short-term investment strategy more reliable. To date, there are around 25 million Bitcoin holders, representing 42.2% of the crypto market. Almost all cryptocurrencies have been proven to follow Bitcoin. The probability of bankruptcy for a short-term cryptocurrency investment strategy is about 17%-23%. For a long-term cryptocurrency investment strategy, the probability of bankruptcy fluctuates from 13% to 16%. Contrary to popular belief, investors looking to avoid bankruptcy should prefer a long-term strategy. The best way for cryptocurrency investors to protect themselves from bankruptcy is to alternate long and short investment periods.

## Keywords

bankruptcy, financial indicators, cryptocurrency,  
investing, law regulation, Monte Carlo simulation

## JEL Classification

C60, G33, O16

## INTRODUCTION

The creation of cryptocurrency generated huge interest worldwide and led to excitement among financial traders and investors who have not seen anything like that before. A new currency Bitcoin was created in 2009 as an answer for the world's financial crisis of unfathomable proportions. For the post-crisis age, Bitcoin promised an alternative to the financial system of the traditional banking institutions of past decades.

Despite the fact that crypto hype peak was some years ago, today technology and financial services companies are investing huge amounts in research and development in the field of blockchain and cryptocurrencies. An analysis of the Blockchain marketplace in 2021 found the industry should grow from a value of \$4.9 billion in 2021 to \$67.4 billion by 2026 (Blockchain Statistics, 2022). It means that the most important changes in the digital finances are going to come. Considering that some countries began to adopt bitcoin as legal tender, it can be assumed that the future of currency is crypto (El Salvador's law: a meaningful test for Bitcoin, 2021). It is expected that cryptocurrency is not

devaluated by reckless monetary authorities. It should encourage both people and companies to use them as a medium of exchange and a store of value.

On the other hand, cryptocurrency funds are highly volatile and not protected by government-backed insurance. For example, in June 2022 only for three days the largest loss ever for the cryptocurrency was marked, investors lost 7.3 billion of US dollars (Irwin, 2022). Also, in July crypto companies Voyager and Celsius went bankrupt. According to preliminary calculations, only these bankruptcies could lead to well over \$1 billion in investor losses. According to Voyager, customers should get all U.S. dollar deposits returned but they cannot say what portion of their crypto holdings will be returned to customers. There is approximately 1.3 billion US dollars in customer crypto funds on its platform as of the bankruptcy filing (Browne, 2022). Although such events are rare, their occurrence has a negative impact on the cryptocurrency market.

Lack of laws governing cryptocurrency funds deprives the guarantee for investors to recoup their funds if an exchange goes bankrupt. Since there were precedents for investors not being able to withdraw cryptocurrency funds, it is important to assess the risks of investing in cryptocurrencies.

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## 1. LITERATURE REVIEW

Even though Bitcoin has been on the financial market for more than 10 years, scientific articles on the prediction of bankruptcy have only begun to appear in the last 5 years. In 2019, an article was published where the authors formulated that cryptocurrency valuation was largely uncertain and subject to incalculable risks and the lack of a regulatory framework created significant legal uncertainty in this market (Kaal et al., 2017). In Sarra and Gullifer (2019) the issue was raised on cryptocurrency value estimation when creditors look to realize on their claims in the bankruptcy process. This research direction was developed in Miriam (2020) with the conclusion that considering the existing provisions and interpretations, bankruptcy laws should be rethought through the lens of today's innovative securities. In 2021, scientists have moved from theoretical to practical research, as enough historical data has been accumulated. For the period from 2014 to 2018, 146 Proof-of-Work-based cryptocurrencies were examined (Bilenko et al., 2022). It was found that about 60% of those cryptocurrencies were eventually in default (Grobys & Sapkota, 2020). Fantazzini and Calabrese (2021) considered the dataset of 144 exchanges from the first quarter of 2018 to the first quarter of 2021. The article resulted in recommendations for investors on choosing an exchange. Shawver (2021) studies whether bankruptcy courts struggle with cryptocurrencies as the currencies or commodities, a classification

that has broad implications for the recovery and valuation of cryptocurrency assets in the event of fraudulent and preferential transfers.

As it can be seen from the literature review, most of the authors focused on aspects of the probability of bankruptcy of cryptocurrency exchanges and the development of bankruptcy laws. The next logical research direction is the development of bankruptcy mechanisms depending on the probability of bankruptcy when investing in cryptocurrency. It means that investors may look to use different investment strategies to hedge against the risk of bankruptcy (Kozlovskiy et al., 2021). In turn, the bankruptcy laws should also be different for different types of investors.

The article by Alzahrani and Daim (2019) contains a literature review of past research related to cryptocurrency adoption. The main factors supporting its adoption, according to this review, include "the investment opportunity, the anonymity of the transactions and privacy, the acceptance by businesses as a payment method, the fast transfer of funds, the low cost of transactions and technological curiosity".

Lansky (2016) studied the price dynamics of 1,278 cryptocurrencies based on data from 2013–2016. The article discusses the dynamics of prices in the given period. Based on this price dynamics, it was found that the value of some cryptocurrencies has increased hundreds and even thousands of times.

At the same time, other cryptocurrencies ceased to exist altogether or their value fell below 1% of the original value.

Musialkowska et al. (2020) found that bitcoin can be freely used as a currency in Venezuela, where the national currency is devalued due to high inflation. An interesting scientific finding is that gold and oil, in this case, were considered less risky in terms of value retention than the first cryptocurrency, Bitcoin.

Lee et al. (2020) explore whether Bitcoin is a speculative financial asset or a modern innovative technology. The result of this study was that the first cryptocurrency Bitcoin can be both a speculative asset and a modern innovative technology. The authors found out that there are two large groups of traders on the Bitcoin market, “speculators ... and tech-savvy investors. While speculators seek to profit from extrapolating the price trends, tech-savvy investors trade based on the prospective value of Bitcoin, which is a function of factors that capture the market demand and technical supply of Bitcoin” (Lee et al., 2020).

The problem of the interaction of social networks and the value of Bitcoin is studied in May et al. (2018). This study concluded that there are more posts on social media about an optimistic rise in the price of Bitcoin. This study characteristically emphasizes the stable confidence in the growth of the price of Bitcoin even in May – September 2022, when the process of falling in the price of this asset is observed.

Most crypto investors are very positive about the opportunity to earn on cryptocurrencies. Crypto investors believe that investing in crypto assets will allow them to improve their financial situation, however, by doing so, they confirm their risk appetite. Mendoza-Tello et al. (2018) surveyed 125 participants (consisting of undergraduate and graduate students (52%), professors (8%), business managers (10%), employees of companies (25%) and government employees (5%)) and empirically demonstrated that these groups of participants were willing to invest in cryptocurrencies in the hope of earning additional income.

One of the tools that let predict a loss occurring due to a rare event is an analysis of “tail risk” with the help of Monte Carlo simulation. Results of

simulation show not only what could happen, but how likely each outcome could be. Monte Carlo simulation and random number generation are techniques that are widely used in financial analysis as a means of assessing the level of exposure to risk (Levy, 2016). Monte Carlo methods can be used to model risks and investments. In this case, instead of using point estimates, ranges of loss events and their costs are defined as inputs for the Monte Carlo simulation to identify thousands of possible outcomes. All the outcomes putting on a graph form the distribution that show where losses are likely to be (Ruan, 2019).

The “tail events” (Bollerslev et al., 2015) on the left represent lowest returns, and tails on the right correspond to highest returns. Although “tail events” that occur at the left of a distribution curve and negatively affect investing are rare, they may lead to bankruptcy. Investors want to hedge against these events.

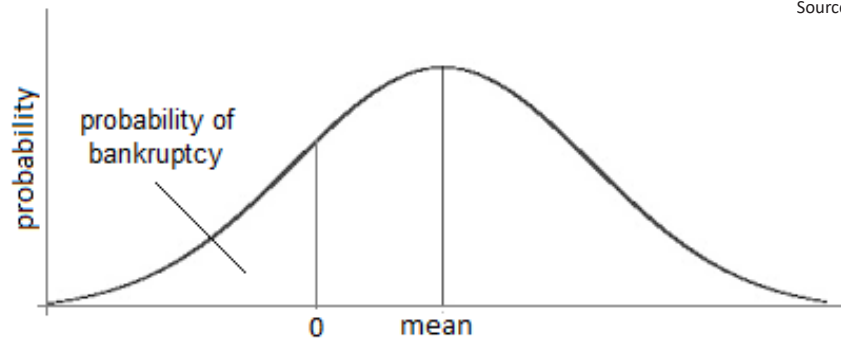
Therefore, the aim of this study is to determine the probability of “tail events” and to assess in this way the probability of bankruptcy when investing in cryptocurrency using the Monte Carlo method.

## 2. METHOD

The Monte Carlo method is the use of simulated random numbers of cryptocurrency and US dollar price quote and the investment period to assess the probability of bankruptcy in cryptocurrency investing. Then the aim is achieved by assessing the expected value of losses and profits using a simulated sample from the distribution of the random variable. Based on the obtained results of Monte Carlo simulations, tail risk hedging methods will be recommended.

The first step of the Monte Carlo simulation is to set up a model.

The model consists of predicted and risk variables. The dependent variable to be predicted is investment income or loss and the risk variable that drives the prediction, is the investment horizon. From here, the probability assessment model of bankruptcy when investing in cryptocurrency can be presented:



**Figure 1.** Monte Carlo simulation result of investing in cryptocurrency

$$y = f(x_A, x_B), \quad (1)$$

where  $y$  – cryptocurrency investment income or loss,  $x_A$  – random sample of cryptocurrency and US dollar price quote,  $x_B$  – random sample of investing period.

The next step of Monte Carlo simulation is the specification of the risk variables' probability distributions.

To assess the probability of bankruptcy in cryptocurrency investing is proposed to use a uniform distribution, derived from a random sample of size  $n$  for cryptocurrency and US dollar price quote and a random sample of size  $m$  for the investment period.

To determine a random sample of cryptocurrency and US dollar price quote, it is required to use historical data, and for the random sample of the investment period it is better to use an analyst's subjective judgment. The period of investing should be divided into long-term and short-term periods. According to the financial goal, investors who seek to avoid bankruptcy prefer a short-term strategy with less volatility, which means that the value of investments is more likely to stay stable over time. Long-term strategy is supposed that the value of your investments can change greatly because of unpredictable factors (Kozlovskiy et al., 2018). It is believed that investing in cryptocurrency onto a long period of time is a popular strategy for novice investors because it does not require careful research. Investments for the short-term period average out any dramatic peaks or depressions in the cryptocurrency market. Short-term investors seek to profit quickly and should be concerned about short-term volatility (Warren, 2016).

In the terminology of “tail events” for long-term investors, the best strategy is to minimize left “tail risk” without curtailing right tail growth potential (Bollerslev et al., 2015).

Then the simulation should be run to generate output distribution. Modern spreadsheet-based applications allow iterations up to 10,000.

The last step is to calculate the range of variation within a distribution. For normal or lognormal distribution, it should be mean and standard deviation, which are commonly used measures of spread.

The obtained results allow you to calculate not only the extreme values of the distribution such as the biggest profit and loss but also the probability of bankruptcy in cryptocurrency investing. The expected result of the Monte Carlo simulation in the form of a normal distribution is shown in Figure 1.

To assess the probability of bankruptcy in cryptocurrency investing, the mean allows you to determine how many investors profit above or below its average. The further cryptocurrency investment income or loss moves from the mean, the greater the likelihood that it is over or undervalued.

The other key feature of normal or lognormal distribution is standard deviation that is useful in financial markets analyses for its tail risk assessment. If there are five or more standard deviations from the mean, then unpredictable situations in which extreme outcomes have occurred should be more expected. Usually, standard deviation is considered the smaller the better for investors.

As Figure 2 shows, the probability of bankruptcy when investing in cryptocurrency is the part of distribution that is less than zero.

Practical implementation of the proposed approach for assessing the probability of bankruptcy in cryptocurrency investing with the help of Monte Carlo method allows to conclude whether short-term and long-term cryptocurrency investment strategies are more efficient to avoid bankruptcy.

### 3. RESULT

Bitcoin and US dollar price quote (BTC-USD) is taken over the period from September 1, 2014 up to July 1, 2022 (CoinDesk, 2022). The information base of the study is the site data (CoinDesk, 2022).

Different time horizons are allocated for long-term and short-term investment strategies. Cryptocurrency market analysis shows that for a short-term investment strategy, a horizon is usually less than 30 days, while for a long-term investment strategy, it can reach up to 2 years.

The Monte Carlo simulation is run in the MS Excel tables using the spreadsheet-based application Oracle Crystal Ball (<https://www.oracle.com/pl/applications/crystalball/>).

The result of testing a short-term cryptocurrency investment strategy by the Monte Carlo simulation technique for 250 iterations is normally distributed data with fatter tails. The average result is presented in Figure 2.

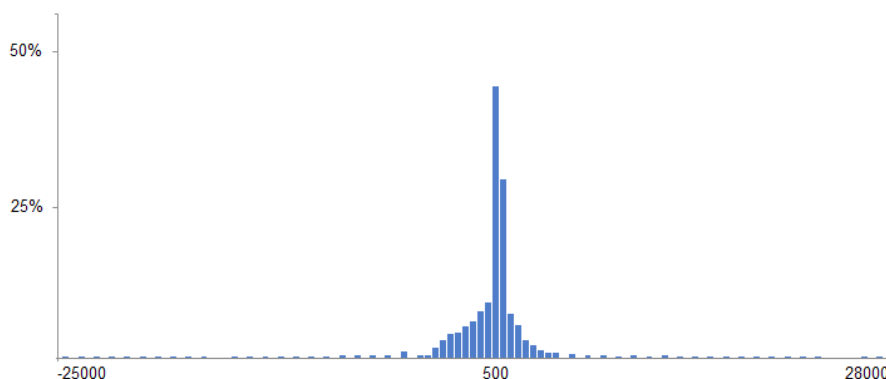
As it can be seen from Figure 2, the mean for all outputs ranges from -2 to 1.5 thousand US dollars per one Bitcoin, standard deviation is approximately 13.5 thousand. 95% of investment losses and profits are between -4 and 6.5 thousand of US dollars per one Bitcoin. The most frequent probability (50%) is profit that reaches 0.5 thousand US dollars per one Bitcoin.

The biggest loss per one Bitcoin is 25 thousand US dollars. The probability of such event is 0.4%, which is the same as for the biggest profit from investing that reaches 28 thousand US dollars. On average, extreme values of the normal distribution fluctuate between losses of 25-20 thousand US dollars and profit of 25-280 thousand US dollars per one Bitcoin.

The probability of bankruptcy for a short-term cryptocurrency investment strategy is about 17%-23%.

If there are two standard deviations on the left side of the tail, then investments are not in the risk zone. If there are three standard deviations beyond the mean, then investments are in tail-risk event territory (Bollerslev, 2015). Monte Carlo simulation result of a short-term cryptocurrency investment strategy shows that there are few outputs in the tail-risk event territory.

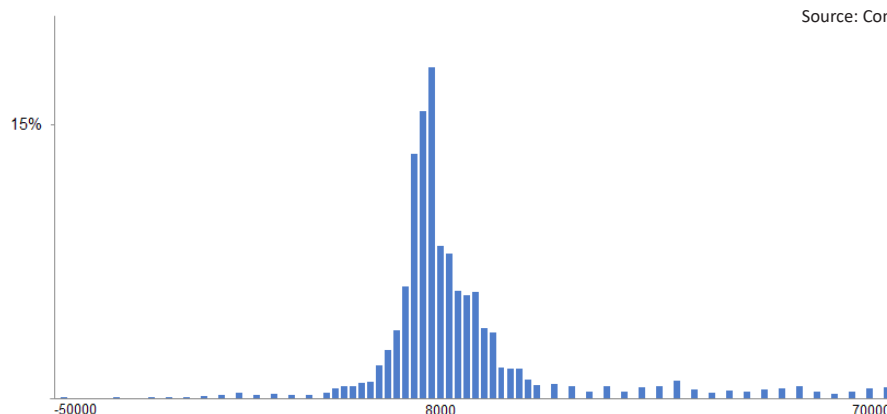
The result of testing a long-term strategy using the Monte Carlo simulation is log-normally distributed data with fatter tails that is right skewed. The average result is shown in Figure 3.



Source: Compiled by the authors.

**Figure 2.** Monte Carlo simulation result of a short-term cryptocurrency investment strategy (the profit/loss per one Bitcoin)

Source: Compiled by the authors.



**Figure 3.** Monte Carlo simulation result of a long-term cryptocurrency investment strategy (the profit/loss per one Bitcoin)

Figure 3 shows that the mean for all outputs is between 7-9 thousand US dollars per one Bitcoin, standard deviation is approximately 27.5 thousand. In the diapason of -5.5 and 30 thousand US dollars per one Bitcoin lays 95% of investment losses and profits during the last six years. Unlike the short-term strategy, the long-term strategy does not have the distribution peak that covers 50% of the outputs. As a result of the Monte Carlo simulation, it was found that 25-30% of outputs fluctuate in the range from 0.5 to 4 thousand US dollars, and in 20%-25% cases it does not exceed profit of 10 thousand US dollars per one Bitcoin.

For a long-term strategy, the biggest loss per one Bitcoin is twice bigger than for a short-term strategy and reaches 50 thousand US dollars. At the same time, the profit is almost 2.5 times more. The probability of extreme values is the same for both strategies and is 0,4%.

The result of the Monte Carlo simulation of a long-term cryptocurrency investment strategy that follows log-normal distribution experienced returns that exceed three standard deviations beyond the mean more than 0.3% as well as losses. On the one

hand, it can be observed that the graph of the obtained results is shifted to the right, which means that the long-term strategy is more profitable than the short-term one, on the other hand, the graph is characterized by fat tails to the downside. So long-term investors may face higher losses than they expected.

For a long-term strategy, the probability of bankruptcy cryptocurrency investment fluctuates from 13% to 16%.

Comparison of Monte Carlo simulation results of investing in cryptocurrency is presented in Table 1.

According to the results obtained during the Monte Carlo simulation, a long-term strategy is more efficient for investors.

Contrary to the widespread point of view, investors who seek to avoid bankruptcy should prefer a long-term strategy. The probability of bankruptcy with a long-term strategy is 4-7% lower, compared to a short-term strategy. Half of the long-term investors profit as same or up to 20 times more than short-term investors. The main disadvantage of a long-term cryptocurrency investment strategy is

**Table 1.** Monte Carlo simulation results for short-term and long-term cryptocurrency investment strategies (the profit/loss per one Bitcoin in dollars USA)

Source: Compiled by the authors.

Statistics	Short-term strategy	Long-term strategy
Mean	from -2,000 to 1,500	from 7,000 to 9,000
50% probability	from 0 to 500	from 500 to 10,000
95% probability	from -400 to 6,500	from -5,500 to 30,000
Probability of bankruptcy	from 17% to 23%	from 13% to 16%

**Table 2.** Monte Carlo simulation results for short-term and long-term cryptocurrency investment strategies (average profit/loss per one Bitcoin in dollars USA)

Source: Compiled by the authors.

Cumulative frequency	Short-term strategy	Long-term strategy
0%-25%	from -12,500 to -10,500	from -15,500 to -12,000
0%-50%	from -8,000 to 1,000	from -10,000 to -16,000
0%-75%	from -4,000 to 1,500	from -8,000 to -13,000
0%-100%	from -2,000 to 1,500	from 7,000 to 9,000

the much wider diapason of profit/losses (see Table 1) for 95% investors. But at the same time, the fact obtained by simulating is that the accumulated losses are only 15% more with a long-term strategy than with a short-term one. It requires additional research to determine cumulative average profit/loss per one Bitcoin in US dollars. This information can be obtained from the Monte Carlo simulation. Comparison of the cumulative frequency and average profit/loss for every frequency period is presented in Table 2.

From Table 2, the disproportion of average profit/loss per one Bitcoin in dollars USA for 25% frequency periods can be observed for a long-term cryptocurrency investment strategy. The jumps between the average profit/loss per one Bitcoin in dollars USA in each frequency period are extremely high. Up to 75% of observations, the average profits/losses are negative, although in general they are positive and significantly exceed the average profit/loss for a short-term strategy. This can be explained by fat tails of the distribution. In the case when the number of observations increases, but the average profit/loss does not change proportionally, the “tail risk” outweighs the average value of the distribution.

It can be concluded that tail risk hedging should be aimed at enhancing profits over the long period. Investors should protect themselves from bankruptcy not by cryptocurrency portfolio diversification but by length of investing horizon alternating long and short periods.

## 4. DISCUSSION

Solving the problem of reducing the risk of bankruptcy in the crypto business is one of the most dynamic and relevant problems of our time. The search for a solution to this problem

is based on the choice of the most optimal and high-quality methods of economic and mathematical analysis. Existing approaches to assessing the probability of bankruptcy are based on the methods of technical and fundamental analysis. But these methods and approaches do not allow predicting the risks of investing in cryptocurrency with a very high probability.

Virtually any economic entity experiences the influence of cryptocurrency price changes on its financial results. In these conditions, the urgent task is not only to minimize cryptocurrency risks, but also to forecast its level. The influence of cryptocurrency risks on a state's financial sector is highlighted in the works of numerous modern economists. Thus, Radhwan et al. (2015) propose to use the differential evolution method for forecasting rates and the genetic algorithm method for model optimization. The authors also compared the accuracy of their proposed model with modeling based on regression of support vectors.

Classical and modernized linear programming and regression analysis methods were shown in the work of Meade (2002), in which the author concluded that linear modeling of the rate shows a more accurate forecast compared to non-linear modeling for a local, short period. Meade (2002) used a linear AR-GARCH model in contrast to the work of Sharma et al. (2021), which proved the effectiveness of using both symmetric and asymmetric models of autoregressive conditional heteroscedasticity (GARCH) in forecasting the volatility of five developing countries, such as China, India, Indonesia, Brazil, and Mexico.

One of the discussion points of this study is the result obtained on the example of cryptocurrency and US dollar price quote. To deepen understanding of the probability of bankruptcy when



investing in cryptocurrency, it is important to study other cryptocurrencies, because for today Bitcoin is not the only cryptocurrency available. There are more than ten popular cryptocurrencies that have held on throughout price climbs and downs. The reason why the cryptocurrency and dollar USA price quote was chosen as the object of this study is that Bitcoin has become the standard for cryptocurrencies for more than ten years.

The other discussion point is that past tendencies is not a guarantee of future results. Monte Carlo simulation results for a short-term and long-term cryptocurrency investment strategies reflect only all items of the present market and can change dramatically. This statement is difficult to refute, that is why the Monte Carlo method was used to assess the probability of bankruptcy when investing in cryptocurrency as the most flexible and effective pattern conclusion tool.

The quite important is the issue whether cryptocurrency investment strategy depends on portfolio diversification and different cryptocurrency shares. This question was risen in the previous articles devoting to the comparative assessment of the investment efficiency between Bitcoin and Ethereum, Bitcoin and Litecoin, and Ethereum and Litecoin. The conclusion was that the investor does not care what currency to invest in to obtain profitability. With a strong correlation between values of cryptocurrencies, the investor does not need to construct a crypto portfolio based on its profitability (Kozlovskiy et al., 2021).

Obviously, the conclusion about alternating long and short investment periods is not enough for cryptocurrency investors who seek to avoid risks. It can be useful to calculate the length of investment periods. However, such calculation requires the development of another methodology, which may be another study.

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## CONCLUSION

According to the purpose of the paper, the expected values of losses and profits using a simulated sample from the distribution of the random variable were obtained. The Monte Carlo simulation model was set up and run in the spreadsheet-based application Oracle Crystal Ball.

While the result of testing a short-term cryptocurrency investment strategy using the Monte Carlo simulation method is normally distributed data with fatter tails, the result of testing a long-term strategy is log-normally distributed data with fatter tails that is right skewed. Comparison of cumulative frequency and average profit/loss for every frequency period allowed drawing two main conclusions.

The first conclusion is that for a short-term strategy, the probability of bankruptcy when investing in cryptocurrency fluctuates from 17% to 23%. For a long-term strategy, this probability is from 13% to 16%. So, compared to each other, a long-term strategy is more effective.

The other results of the Monte Carlo simulation allow us to conclude that for a short-term strategy, average profit/loss per one Bitcoin in US dollars for accumulated 25% frequency periods is more stable and predictable than for a long-term strategy. This is related to fat tails of the log-normal distribution obtained for a long-term strategy, when “tail risk” is extremely high and in most cases is unacceptable for the investor. These two conclusions allow us to assume that the best way for cryptocurrency investors to protect themselves from bankruptcy is to alternate long and short investment periods.

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Writing – original draft: Serhii Kozlovskiy.

Writing – review & editing: Serhii Kozlovskiy, Hennadii Mazur.

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