TALLINN UNIVERSITY OF TECHNOLOGY
School of Business and Governance

Sora Togo

The Effect of Portfolios Rebalancing Interval in Bitcoin Delta Neutral Funding Rate Strategy.

Bachelor's thesis
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Supervisor: Pavlo Illiashenko, PhD

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I hereby declare that I have compiled the thesis independently
and all works, important standpoints and data by other authors
have been properly referenced and the same paper
has not been previously presented for grading.

The document length is 8840 words from the introduction to the end of the conclusion.

Sora Togo, 12/15/2022

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ABSTRACT

Bitcoin and other cryptocurrencies have grown significantly in market capitalization since their birth, with a record price increase from approximately $5,000 in March 2020 to over $60,000 in March 2021, attracting inflows of capital from a large number of investors. Like traditional assets, there are two markets for cryptocurrencies, the spot market, and the futures market. However, each has different characteristics, and trading strategies unique to cryptocurrencies have been developed.

Perpetual futures exist for cryptocurrencies. These futures have no settlement contract month, and positions can be held indefinitely. In other words, if a trader opens a short position in Perpetual Futures at the same price as the acquisition price of the cryptocurrency they hold, the position is not subject to price fluctuations. The cryptocurrency community refers to this position as delta-neutral, using the name of a traditional options trade.

This thesis focuses on the impact of portfolios rebalancing intervals on return on a delta-neutral funding rate strategy that uses a funding mechanism that converges prices to the index price of the underlying asset in cryptocurrency perpetual futures while hedging against the risk of price volatility.

Keywords: Perpetual Futures, Funding Rate, Delta Neutral, Cryptocurrency

INTRODUCTION

Cryptocurrency exchanges have minted countless coins since Bitcoin was introduced in 2008 and have received ample funding from numerous investors. As a result of its early appearance, Bitcoin remains the most popular and well-known cryptocurrency in the world. Its price exceeded $100 in 2013 after it began trading, $10,000 in 2017, and reached an all-time high of $69,000 in 2021, boosted by the global monetary easing that started in 2020. The price has increased 690-fold in about eight years, and trading has been active, especially among individual investors, as traders can expect significant returns even with small amounts of money.

Numerous exchanges now offer cryptocurrency trading services, including Bitcoin, with a daily trading volume of more than $2 billion in single bitcoin and more than $10 billion in other cryptocurrencies combined. Although market capitalization and trading volume are not as high as those of different asset classes, trading volume has increased over the years, and according to projections, its growth will likely continue. In the past, the spot market was the only access to cryptocurrency exchanges, but with the launch of bitcoin futures, it is now possible to trade using leverage. In the days when spot trading was the mainstay of the market, investors profited from the price movements and price differentials of cryptocurrencies, such as the prolonged strategy of investing for price appreciation, arbitrage to take advantage of price differentials between exchanges, and kimchi premiums, where bitcoin was trading at a premium to other countries in South Korea. However, traditional asset class strategies have been used, such as the short strategy, which profits from price declines since futures trading services began, and the long-short strategy (L/S Strategy), which combines long and short positions. Among such strategies, a new strategy that hedges the risk of price fluctuations with cryptocurrencies and utilizes the funding rate—a price adjustment mechanism for perpetual futures—is now being used.

The funding rate refers to the cost of holding a position that accounts for the price deviation of the futures contract from the index price of the underlying asset and the supply and demand for long and short positions. A funding rate is paid as an incentive for executing trades in the direction that corrects the price deviation from the underlying asset. In other words, when the funding rate is

greater than 0%, traders in long positions pay traders in short ones; when it is below 0%, traders in long positions pay traders in long ones. By analyzing historical rates, which may be biased negatively short-term but positively long-term, and by building a short position with the same number of pieces as the cryptocurrency held, the risk of price fluctuations diminishes to near zero. Thus, producing a short position of the same number of pieces as the cryptocurrency traders hold can constitute a strategy of using the receipt of funding payments as a source of income, termed the delta-neutral funding rate strategy, by appropriating the name of the delta-neutral strategy used in traditional options trading.

The delta-neutral funding rate strategy allows investors to hold a position for an extended period with minimal risk of price fluctuation. Rate × contract value calculates the amount of funding received; likewise, the current price × position size determines the contract value. Thus, in a price increase where the short position has an unrealized loss, the contract value and the funding proceeds will increase. However, in a price decrease where the short position has an unrealized gain, that gain and the profits will decrease simultaneously. Therefore, when executing a strategy over a long period, the rate of return will increase if one can initiate it when the price of the cryptocurrency is low; still, the rate of return will decrease if the strategy commences when the price is high during that period.

Focusing on future forecasts requires forecasting the price of the spot bitcoin market, the price of perpetual bitcoin futures, and the funding rate, each at 8-hour intervals. Unfortunately, no published forecasting model currently meets these requirements. Therefore, one may assume that future prices and funding rates remain unpredictable. Although cryptocurrencies are highly volatile and future prices are accordingly problematic to predict, position rebalancing may adjust the entry price of a position periodically. Portfolios rebalancing involves closing the delta-neutral position built when the trade was initiated and rebuilding the delta-neutral position at new price levels.

Thus, this paper proposes the following research question:

R: Does portfolios rebalancing increase the ROI compared to a non-rebalanced portfolios?

Given the research question, the hypothesis is as follows:

H: Portfolios rebalancing improve return on investment

To examine the above research question and hypothesis, the author obtained historic market data from Binance, the world's largest cryptocurrency exchange, and constructed virtual delta-neutral

portfolioss. From the period of the data obtained, the author compared the results with portfolioss without rebalancing and with rebalancing.

The paper comprises three chapters. The first covers the background of cryptocurrencies, bitcoin, and perpetual futures and describes the delta-neutral funding rate strategy, and the second chapter presents the bitcoin historical market data obtained from the API functionality provided by Binance and methodology. Finally, the third chapter presents the results of the tests conducted from the data, followed by a discussion and conclusions.

1. Bitcoin and Delta Neutral Funding Rate Strategy

1.1. Bitcoin and Cryptocurrencies

In 2002, a Japanese researcher and programmer, Isamu Kaneko, introduced the Peer-to-Peer (P2P) file-sharing software "Winny." Traditional file-sharing software requires a central server or computer system running the application, with the end user communicating with the servers. However, P2P networks enable users to communicate without main servers and connect directly with computers (peers) in the network (Abe, 2009). Moreover, in P2P networks, the processing is distributed among network peers rather than on a server; thus, the network can run without stopping, even when handling numerous concentrated processes (Hoshitani, 2004). This advantage has brought about an invention in payment methods, where service cannot be interrupted.

Bitcoin, the world's first cryptocurrency, was proposed in 2008 by an anonymous group or person named Satoshi Nakamoto in his thesis (Nakamoto, 2008). It has brought a new mode of transacting in a digital form, regardless of the scale and preservation of monetary value. Although designed as a P2P electronic transaction system, Bitcoin was a new concept of financial instruments and obtained attention from both individual and institutional investors. In July 2010, the first Bitcoin exchange Mt.Gox launched, and Bitcoin began to have prices based on public demand and supply. Until then, it handled trades privately, and the sender and receiver determined prices in the transaction. One year after Mt.Gox started the service, the cryptocurrency was worth $10.9 per 1 bitcoin. Today, it trades at approximately $19,000; thus, it has recorded a meteoric rise of 174300% over 11 years.

Stablecoin is a type of cryptocurrency designed to be linked to assets, such as the U.S. dollar or gold, to stabilize trading prices (White, 2021). Conventional cryptocurrencies have been priced volatile and have repeatedly soared and crashed. For this reason, many people hold them for speculative purposes, and their lack of stability as a means of payment or asset holding has been a major issue. Stablecoin was created to eliminate these disadvantages by pegging its price to legal tender and stabilizing its value (Fujita, 2020).

Stablecoins are also used for quoting prices in trading between cryptocurrencies, and the most widely used stable coin with the highest market capitalization is USDT. It is developed and issued by Tether Limited and can be exchanged for dollars at a ratio of 1:1. And it holds the biggest market cap (Grobys and Huynh, 2021).

1.2. Crypto-Instruments and Pricing

There are two types of transactions for trading bitcoin: spot and futures. Spot trading are transactions in which the crypto asset is purchased or sold; the sale requires that the crypto asset be held in advance. Therefore, spot trading must begin with a purchase transaction of the crypto asset. Generally, parties conduct purchase transactions by paying legal tender such as yen or dollars as consideration. Traders who cannot purchase more crypto assets than they have on hand characterize cash transactions.

For example, if a person makes a spot purchase of bitcoins for 10,000 euros, they will receive 10,000 euros worth of bitcoins as consideration. These coins will have a monetary value, which one can use to, for example, store value in a wallet or accept cryptocurrency payments for payment.

Bitcoin rewards miners with new coins by approving new cryptocurrency issuances and transactions, known as mining. Issuing a new cryptocurrency generates blocks containing transactions; the blockchain stores transaction data as a hash value. Transaction approval verifies the transaction data to ensure that it cannot be rewritten. Through this process, bitcoins circulate in the market as miners with newly-issued bitcoins sold in spot transactions.

1.2.1 Perpetual Futures

Traditionally, the primary way of trading Bitcoin was the spot market. However, due to the nature of spot trading, it cannot trade more than the amount in circulation, and the inability to use leverage to increase capital efficiency resulted in an increasing need for bitcoin futures trading. As a result, BitMex, the Hong Kong-based crypto derivatives, introduced the world's first Bitcoin perpetual contract in 2014 (Soska et al, 2021). Now, more than 40 crypto exchanges, centralized and decentralized, are offering it. Daily trading volume is above 20 billion dollars.

The perpetual contract has several labels, often referred to as Perpetual Swap or Perpetual Futures. In his paper, Robert J. Shiller introduced the original concept of a perpetual swap (Shiller, 1993). It is one form of a future contract with no expiry date, to open either long or short, and hold until their positions reach margin call level or close position whenever at their will.

As perpetual contracts bring flexibility to Bitcoin trading, they enable generating revenues on small price movements, maximizing capital efficiency, and hedging against price movement. When trading perpetual contracts on cryptocurrency exchanges, they can use cryptocurrency or dollar-pegged stables coins as collateral. The name of the margin type varies from exchange to exchange, but USD-M (USD-Margin) uses dollar stables as collateral, while COIN-M (Coin-Margin) uses cryptocurrency as collateral.

Trading COIN-M necessitates the purchase of underlying collateral in advance, and the price movement of the collateral will affect profit/loss in fiat currencies even before they open a new position. In addition, if they trade at 1× leverage when they purchase it and open a short or long position in perpetual futures, their effective leverage is the leverage of the futures plus 1×, or 3× if they hold a long position at 2× leverage. Thus, if a trader holds a long position with 2× leverage, the effective leverage will be 3×. Therefore, the profit and loss will be larger than the USD-Margin, and the underlying price movement will significantly affect the underlying price movement.

The USD-Margin perpetual contract uses stablecoin, which can be exchanged at a 1:1 ratio with the dollar and is not affected by the price movements of the underlying cryptocurrency in the futures contract before opening a new position. In addition, all profits and losses are determined in stablecoins, making it easy to calculate profits and losses.

1.2.2 Pricing

There are multiple types of prices for bitcoin perpetual contract and spot trading that play a role in calculating the profit/loss of a funding rate strategy. The following section describes each of these prices in detail.

The most recent price at which a bitcoin futures contract was executed is called the Future Last Price. For example, a last price of $19,000 for bitcoin dollar-denominated futures means the futures contract traded for $19,000. On the other hand, the index price, or mark price, is not the price at which the trade was executed but a price representing a market indicator or other factors. In this case, the profit and loss of the perpetual futures contract will be calculated using this last price.

The index price is a weighted average of the real-time prices of multiple exchanges that offer spot bitcoin trading in proportion to their trading volume. This price prevents market manipulation and price tampering and provides a reference to the overall market price. For example, Binance's BTC-USDT Perpetual Contract offers a weighted average of seven prices from six cryptocurrency exchanges, including Binance, to provide an index price, the same appleis to BTC-USD Perpetual Contract.

Table 1. Index price references for BTC-USDT Perpetual Contract

Exchange	Symbol
Binance	BTCUSDT
Okex	BTC-USDT
Huobi	btcusdt
Bittrex	BTC-USDT
Hitbtc	BTCUSDT
Bitmax	BTC/USDT
Binance_cross2	BTCBUSD*BUSDUSDT

Source: Binance market Data

Table 2. Index price references for BTC-USD Perpetual Contract

Exchange	Symbol
Bitstamp	btcusd
Coinbase	BTC-USD

Kraken	XBT/USD
Bittrex	BTC-USD
Binance	BTCBUSD

Source: Binance market Data

The mark price is the index price—or the fair price—as described above, multiplied by the funding rate. This price is of utmost importance in perpetual contract trades. For example, on Binance, unrealized gains/losses, current position size, and clearing price are all calculated using the mark price. This mark price is crucial because it is not subject to extreme fluctuations in market prices. For example, large market orders can significantly change the last price a trade executes. Thus, if unrealized profit/loss and clearing prices are calculated using this price, malicious traders can manipulate the price, and many traders can be affected. However, mark price uses index prices calculated from multiple exchanges, and even in the event of large fluctuations on a single exchange, MarkPrice tends to fluctuate moderately, preventing loss-cutting at significantly divergent or unfavorable prices.

The spot last price, or market price, is the most recent price at which parties executed a transaction on the spot market. For example, a bitcoin spot market price of $19,000 means a trade completed at that amount. There is no index or mark price in the spot market; the spot calculation only uses this price.

The high Price is the highest in each time frame. For example, the current strategy refers to prices for an 8-hour interval, with the last high price representing the high price a trade executed within a particular 8-hour period and the mark price high representing the highest mark price in that period.

1.3. Funding System

In conventional futures contracts, the settlement deadline is predetermined, and the price of the futures contract converges to the spot contract price at maturity, but in Perpetual Futures, there is no settlement deadline, and a trader can hold the position indefinitely as long as the asset held does

not reach the loss-cut level. In other words, perpetual contracts can potentially diverge in price from the underlying asset, requiring a mechanism to converge the price to the underlying asset and a new funding system (Binance, 2020).

1.3.1 Funding Rate

This funding system balances the supply and demand of long and short positions, with incentives for short position traders when traders' positions are concentrated in the long position and for long positions when they are focused on the short position. For example, when a trader's position is concentrated long, an incentive is paid to the short position trader. The amount of this incentive payment is calculated as Funding Rate × Position Size, and there are multiple factors to calculate each.

Table 3: Funding Rate Payment

	Long Position Holder	Short Position Holder
Funding Rate > 0	Pays	Receives
Funding Rate = 0	None	None
Funding Rate < 0	Receives	Pays

Souce: Binance, 2020

Table 4: Example of Funding Rate Payment

Mark Price	Funding Rate	Long Position Holder	Short Position Holder
$21,000	0.01%	Pays $2.10	Receives $2.10
$19,500	-0.01%	Receives $1.95	Pays $1.95
$24,000	0.01%	Pays $2.40	Receives $2.40
$22,000	-0.005%	Receives $1.10	Pays $1.10

Souce: Binance, 2020

The table 4 is the example of funding rate payment given by the author, it is based on the assumption that traders hold equivalent of 1 BTC each time. In the 2nd row the mark price of $21,000 quoted, hence the position size is $21,000 * 1 BTC = $21,000, and funding rate is 0.01%,

so the amount of funding rate payment is $21,000 * 0,01% = $2.10. Other examples can be calculated in the same way.

Funding Rate is calculated in the following formula.
Funding Rate = Premium Index + clamp (interest rate − Premium Index, 0.05%, -0.05%)*
(Binance, 2020)

The Premium Index is Binance's proprietary index, calculated from the volume and price of the order book and the index price, or the weighted average price of the exchange. The value of the funding rate equals the interest rate, provided +/−0.05 is the damper, and the Premium Index value falls within the range of −0.04 to 0.06 (Binance, 2020).

1.3.2 Funding Rate Analysis

Funding occurs thrice daily, at 00:00, 08:00, and 16:00 GMT. The following were obtained using the API provided by the exchange: Binance's BTCUSDT Perpetual for December 23, 2019, to October 9, 2022, and BTCUSD Perpetual for December 22, 2021, to data for the period from December 23, 2019, to November 20, 2022, for Binance's BTCUSDT Perpetual, was obtained using the API provided by the exchange.

BTCUSDT Perpetual experienced 3064 funding events during this period, with 2624 funding rates above 0% and 440 below 0%, for a total funding rate of 51.44%. The correlation coefficient between the funding rate and the mark price (the price of the current funding rate time – the price of the former funding rate time) results in R = 0.07342, indicating that there is no correlation between the price movement and the funding rate. The graph demonstrates this lack of correlation between the price movement and the funding rate. Thus, when visualized as a graph, it is clear that the correlation coefficient is biased above 0% regardless of the range of price movements. Analysis using Excel's descriptive statistics tool reveals a mean of 0.0168%, a median of 0.01%, a mode of 0.01%, a kurtosis of 15.156, and a skewness of 2.213. The table 5 reperesents the results of descriptive statistics.

Table 5: Descriptive Statistics for BTCUSDT Perpetual Funding Rate

Funding Rate Analysis

Mean	0.0168%
Standard Error	5.37E-06
Median	0.0100%
Mode	0.0100%
Standard Deviation	0.000297069
Sample Variance	8.82497E-08
Kurtosis	15.15617211
Skewness	2.213207926
Range	0.6000%
Minimum	-0.3000%
Maximum	0.3000%
Sum	51.44%
Count	3064
FR Positive	2624
FR Negative	440

Source: Author's Calculations

BTCUSD Perpetual experienced a total of 1000 funding events during the period, with 651 funding rates above 0% and 349 below 0%, for a total funding rate of 1.51%. The correlation between mark price movement and funding rate was R = 0.1161; price movement and funding rate show no correlation. Statistical analysis yielded a mean of 0.0015%, a median of 0.0031%, a mode of 0.01%, a kurtosis of 26.238, and a skewness of -3.190. The table 6 reperesents the results of descriptive statistics.

Table 6: Descriptive Statistics for BTCUSD Perpetual Funding Rate

Funding Rate Analysis	
Mean	0.0015%
Standard Error	0.0003%
Median	0.0031%
Mode	0.0100%
Standard Deviation	9.04936E-05
Sample Variance	8.18909E-09
Kurtosis	26.23840994
Skewness	-3.190057277
Range	0.1151%
Minimum	-0.1051%
Maximum	0.0100%
Sum	1.51%

Count	1000
FR More Than 0	651
FR Less Than 0	349
Sum	1000

Source: Author's Calculations

Both factors are essential because the amount paid or received is calculated as Funding Rate × Position Size for the timing of funding payments, which occur thrice daily. Therefore, if the unrealized loss on the short position is significant when the funding rate is negative, the amount paid by the short position holder will be higher; the total proceeds from the funding will be negative or a loss— even if the cumulative funding rate for the period is positive. Conversely, if all funding rates are positive during the aggregation period, total revenue will be positive because the long position holder will only receive payments from the long position holder. However, if funding is negative during the period, the holder could lose the total profit. Therefore, the final total profit or loss should include the price of the position construction to determine how much profit one can expect from the funding.

1.4 Delta Neutral

Delta Neutral is an option-trading strategy where the delta expresses the percentage change in the option price relative to the difference in the underlying asset price, and it is a sttegy that combines multiple assets with different price movements and aims to generate profit in the aggregate (Nakamura et al, 2020). In this strategy, traders open positions where the sum of the call and put option delta is zero. Hence, it eliminates the risk of price volatility in options. Furthermore, it creates a neutral position toward the market because the portfolios's gains or losses are limited, even if the underlying asset's price fluctuates up or down. After the launch of Bitcoin Perpetual Swap, this mechanism for eliminating the risk of underlying asset price fluctuations became applicable to bitcoin perpetual swap trading. To practice this strategy, traders open long and short positions simultaneously in a perpetual swap, with an equivalent amount in each position. Or, they open a long position in the spot market, meaning the purchase of a bitcoin and a short position equal to the spot holding amount.

In a coin-margin futures contract collateralized by a cryptocurrency, traders initially purchase the cryptocurrency as collateral in the spot market and build a short position equal to the number of coins they purchased. For example, one could buy one bitcoin at $20,000 in the spot market and

establish a short position for one bitcoin in perpetual futures at the $20,000 price. If bitcoin rises to $30,000 after the position sets, the $10,000 is an unrealized loss on the short position. Regardless, the value of the bitcoin collateral has also increased by $10,000, so the total gain or loss in dollar terms is zero. Also, if the price falls, the unrealized gain on the short position will cover the loss on the cash position, so the total gain/loss for a delta-neutral position with 1x leverage at the Coin-Margin will be 0.

USD-Margin futures, collateralized by dollar-stable coins, similarly establish a short position in the same quantity as the cryptocurrency purchased on the spot market but with a significant difference in the calculation of profit and loss. For example, if a trader buys one bitcoin for $20,000, they create a short position in BTCUSDT Perpetual at an entry price of $20,000 with 1× leverage. If the price of bitcoin subsequently rises to $40,000, the trader will have an unrealized loss of $20,000 on the futures and an unrealized gain of $20,000 on the cash asset. However, they will not be able to reflect the increase in value of the cash asset in their collateral, so they must deposit enough stable coins to cover their unrealized loss.

The total profit/loss between perpetual futures and cash assets will be 0 if the price rises significantly. Then, the unrealized loss becomes more than the collateral assets, and the holder of the short position must cut their loss. Subsequently, their delta-neutral status will be removed. Therefore, when building a delta-neutral position in USD-Margin, liquidation is risky unless assets are unlimited, which differs from Coin-Margin Futures.

1.4.1 Delta Neutral Funding Rate Strategy

With the Funding Rate and Delta Neutral Strategy combination, the new trading strategy has been invented exclusively for crypto-specific perpetual trading. As explained above, this involves holding a 1× leveraged short position in perpetual futures and a cash position equal to the short position to accumulate the funding received on the short position as profit.

To execute this strategy on USD-Margin Perpetual Futures, one would (1) purchase the cryptocurrency on the spot market and (2) open a short position equal to the quantity of cryptocurrency purchased, with 1x leverage. Only stablecoins can function as collateral for a short position, so, for example, if they purchase 10,000 USDT worth of BTC, they will need approximately 10,000 USDT as collateral for their short position to open a short position equal to

the quantity they purchased. Therefore, successful traders must hold around 20,000 USDT as assets before strategy execution.

The procedure is similar for CoinMargin: (1) purchase the cryptocurrency on the spot market, and (2) open a short position with 1× leverage in an amount equal to the purchased cryptocurrency. This type of futures allows them to use the underlying asset of the futures contract as a collateral asset; thus, they do not need to hold any assets other than the amount of cryptocurrency they purchase.

1.4.2 Portfolios Rebalancing

In the funding rate strategy, a short position is constructed by permanently contracting the same number of bitcoins purchased at the spot rate; when one implements this strategy with USD-Margin contracts, the spot position will generate a profit when the price rises, a loss when the price falls. The opposite occurs for a short position. In other words, falling prices generate profits, and rising prices create losses. For spot positions, the lower price limit is as close to zero as possible, and the maximum loss is up to the amount invested; for instance, if they buy $10,000 worth of bitcoin and the price drops significantly, their maximum loss is $10,000. However, since there is no upper limit to the price of bitcoin and the price will continue to rise as long as new investment capital flows in, the maximum loss on a short position is infinite. Assuming that the traders executing this strategy's assets are unlimited, they can leave the position open once it opens. However, in reality, assets are finite, and additional funds must be provided in addition to the initial collateral to cover unrealized losses. Another factor determining the number of funding payments is the position size. Since the difference between the entry and current prices will increase or decrease the amount that can be received, traders must adjust the entry price to maximize their ROI.

When building a delta-neutral hedging position with a Coin-Margin and using a funding rate strategy, no additional assets are needed because the increase in the value of the collateral asset can cover the unrealized losses. However, as with USD-Margin futures, the difference between the current price and the entry price will change the amount they can receive in funding. Also, with CoinMargin, funds are paid in the underlying cryptocurrency, so the profit or loss is determined when converted to legal tender. Therefore, how often the cryptocurrency received in funding is converted to legal tender also affects one's ROI.

Therefore, we suggest that ROI can be increased by regularly considering the above points and periodically rebalancing the portfolios. Rebalancing, in this case, means trading both spot and short positions at a profit or loss and creating a new position with an amount equal to the initial investment.

1.5 Risks

This funding rate strategy lowers the risk of bitcoin price volatility. While the main risk is funding rate fluctuation, other risks such as exchange closures or bankruptcies, hacking into exchanges, and funding rate bias could significantly damage the strategy. Funding rate strategies hedge only price fluctuations and cannot hedge these risks so that an incident could result in the loss of all assets in the worst-case scenario.

1.5.1 Exchange Closure, Bankruptcy and Exploits

One of the most significant risks concerns the potential for an exchange to close or that deposited assets may become irrecoverable. For example, FTX, one of the world's top three exchanges for bitcoin and other cryptocurrency futures, reported on November, 2022 (Pilkington, 2022). This could default on its customer obligations, leading to a significant day-to-day drop in bitcoin of over -20% (Allen, 2022). Compared to traditional financial assets such as stocks and bonds, cryptocurrencies do not have precise regulations regarding the protection of customer assets. The FTX incident was triggered by an attempt to invest customer funds in other businesses and withdraw more than the liquid assets held by the company. At this time, FTX may not be able to return client assets due to a lack of funding or other resources needed. Thus, even if a trader makes a profit from a funding rate strategy, they may not be able to withdraw their funds. The funds deposited with the exchange may become unrecoverable receivables, leading to a loss of assets (Saul, 2022).

While each country regulates how assets are held, in Japan, exchanges must comply with the Crypto Asset Act and be licensed by the Financial Supervisory Agency (FSA, 2021). The agency's guidelines dictate that exchanges must hold customers' crypto assets in a "cold wallet," or an account disconnected from the Internet, and legal tender in a separate "trust account." This separation makes it highly probable that assets will be returned in the event of an exchange's

bankruptcy. However, significant derivatives exchanges such as Binance, Bybit, and FTX are based in offshore locations such as Dubai and the Bahamas. In the event of bankruptcy or other incidents, it may be challenging to determine which country has priority over the laws and regulations: where the trader is located or where the exchange is based. In an incident such as bankruptcy, it is necessary to be aware of the risk of closure or insolvency when using international exchanges.

Another illustrative example was the August 2021 incident in which the CEO of Thodex, a Turkish cryptocurrency exchange, fled Turkey with hundreds of millions of dollars worth of customer assets(Ercan, 2021). Cryptocurrencies are characterized by the ease with which funds can be transferred across borders and the ability to store funds in computer programs or USB-type hardware wallets. Accordingly, if a malicious employee enters an exchange, they can transfer customer assets to their wallet and take the assets.

Cryptocurrency exchanges are constantly vulnerable to attacks; many incidents of all sizes have borne this out. There are two types of cryptocurrency exchanges, CEXs (Centralized Exchanges), where there is a central administrator or legal entity, and DEXs (Decentralized Exchanges). DEXs are called DApps that utilize the smart contract functionality of the blockchain, and unlike centrized exchanges, they allow for direct wallet-to-wallet transactions (Iwashita, 2020). Both can be subject to attack. For example, in 2016, a hacking attack was launched against Bitfinex, a CEX-style exchange in Hong Kong, in which 120,000 BTC were stolen (Oxford Analytica, 2018). Because all transfers and transactions through the Bitcoin network are recorded in the blockchain, it is possible to track the whereabouts of funds even if theft occurs. However, it is only possible to recover funds if the hardware wallet is lost or the wallet recovery phrase is figured out. The deposited assets will be lost if the exchange does not have sufficient assets to cover the loss.

Without a central administrator, DEX-type exchanges have suffered asset outflows from numerous attacks. This remains a risk when implementing a funding rate strategy with DEX futures contracts. Attacks that have occurred in the past include cyber-attacks and exploits that exploit vulnerabilities in the exchange's algorithms and smart contracts (Carter and Jeng, 2021). In the event of these attacks, non-refundable assets deposited with the DEX could be taken. Furthermore, the DEX does not comply with the laws of each country and may not be protected by law in the event of an incident.

1.5.2 Market Conditions

While bitcoin funding rates have been statistically more likely to be positive, examples from other cryptocurrency perpetual futures contracts indicate a short-term negative bias that could lead to significant losses on hedged positions. In the case of FTX bankruptcy, the FTT for FTX-issued tokens and the perpetual contract for Solana tokens—in which FTX was supporting the project as an investor—market demand was shifted significantly toward a short position. Intervals were every two hours to bring the position back to equilibrium, and a maximum funding rate was raised to 2.5% of the absolute. Thus, daily funding payments could reach up to 20% of the position if a short position were held. Although the specific losses would vary greatly depending on the entry price of the short position and subsequent price fluctuations, the loss might be greater than the expected profit in a short period.

Major cryptocurrency futures, such as Bitcoin and Ethereum, have daily trading volumes of hundreds of millions of dollars or more. There are multiple references for index prices to prevent price manipulation. However, with fewer liquid futures and spot cryptocurrencies, there are few price references, which can lead to extreme market conditions such as funding rates and loss-cutting. Of course, price and interest rate manipulation can occur with Bitcoin and Ethereum; nevertheless, the market's high liquidity and the provision of index prices with multiple price references will lower the risk of loss cuts due to liquidation, even if sudden price changes occur. However, since market manipulation may potentially target illiquid markets, it is necessary to consider historical funding rate statistics, market liquidity, and index price references when incorporating a funding rate strategy.

2. Data and Methodology

In this chapter, the author uses historical market data obtained from Binance to construct simulated portfolioss for the delta-neutral funding rate strategy.

2.1. Data

Two types of perpetual bitcoin futures are offered on Binance: USDT-margined and COIN-margined. Data were obtained for different periods. For the USDT-Margin perpetual futures, self-developed code in Python retrieved data in 8-hour intervals from the API provided by Binance from December 23, 2019, to April 11, 2022, for a total of 2520 data pieces. The data acquired included the funding rate in calculating funding payments, mark price and mark high price in calculating position size and maximum unrealized loss, market price, the price at which the trade occurred to close the short position, and the cash spot price to calculate the acquisition and sale prices. Chart 1 is BTCUSDT Historical Chart and Chart 2 is BTCUSDT Perpetual Historical Chart, and highlited areas show price movements duing the period of December 23, 2019, to April 11, 2022.

Chart 1: BTCUSDT Historical Chart

Source: https://www.tradingview.com/chart/DalHg2O8/?symbol=BINANCE%3ABTCUSDT

Chart 2: BTCUSDT Perpetual Historical Chart

Source:
https://www.tradingview.com/chart/DalHg2O8/?symbol=BINANCE%3ABTCUSDTPERP

Similarly, for the COIN-margined perpetual futures, Binance's API was used to obtain 840 data from February 13, 2022, to November 20, 2022, at 8-hour intervals. Again, as with the USDT-Margin data, the retrieved data includes the Funding Rate, market price, mark price, and spot price but not the mark high price, which facilitates calculating the maximum unrealized loss. The reason for not including the mark high price is that COIN-margined futures can cover unrealized losses as the price of the collateral asset rises. Chart 3 is BTCUSDT Historical Chart and Chart 4 is BTCUSD Perpetual Historical Chart, and highlited areas show price movements duing the period of February 13, 2022, to November 20, 2022.

Chart 3: BTCUSDT Historical Chart

Source: https://www.tradingview.com/chart/DalHg2O8/?symbol=BINANCE%3ABTCUSDT

Chart 4: BTCUSD Perpetual Historical Chart

Source: https://www.tradingview.com/chart/DalHg2O8/?symbol=BINANCE%3ABTCPERP

The data above are historical, as indicated by the period; the Delta Neutral Funding Rate Strategy requires not only the spot bitcoin price, but also the market price and mark price of perpetual futures. Although these prices are close, they are different. There are several published spot bitcoin price forecast models at this time, but none forecast the 8-hour interval required for this strategy. In addition, forecast models for perpetual futures prices and funding rates have not been published, and only historical data is used since future data is unavailable.

2.2. Methodology

Based on the discussion above, this study will construct virtual portfolioss that purchases bitcoin equivalent to $10,000 in the spot market; simultaneously, the portfolios will open a short position equal to $10,000 to create a delta-neutral position. This type of futures trading also requires an additional $10,000 for a dollar-pegged stablecoin as collateral, thus bringing the portfolios total to $20,000. Another futures type, COIN-margined, allows bitcoin to serve as the collateral asset for a futures position, so a portfolios that starts the strategy by buying bitcoin equivalent to $10,000 would only require a total portfolios value of $10,000.

Table 7: Sample Portfolios

	USD-Margin	Coin-Margin
Spot	Long $10,000 worth of Bitcoin	Long $10,000 worth of Bitcoin
Future	Short $10,000 worth of Contract	Short $10,000 worth of Contract

Ticker	BTCUSDT Perpetual	BTCUSD Perpetual
Collateral Asset	10,000 USDT	Spot Bitcoin
Total Value	$20,000	$10,000 (As spot used as collateral asset)
Interval Days	14, 30, 60, 12, and 210	7, 14, 35, 70 and 140

Source: Author's Test

When rebalancing, the short position and spot bitcoin are closed after the funding rate occurs, and a new spot bitcoin position is purchased for $10,000 when the next funding rate occurs. Then, a new short position is created to match what is purchased, specifically the purchased volume.

The USDT-margined futures compare results at six rebalancing intervals: no rebalancing, a 14-day interval, a 30-day interval, a 60-day interval, a 120-day interval, and a 210-day interval. The period covered by the calculations is from December 24, 2019, to April 11, 2022. As the USDT-margined use a stablecoin that can be exchanged 1:1 with USD, USDT is denoted in $ for notational convenience. The following formula calculates each element. First, the perpetual futures trade commission is set at 0.02%, and the Spot trade commission at 0.1%. The result from the COIN-margined compares six different rebalancing intervals: no rebalancing, a 7-day interval, a 14-day interval, a 35-day interval, a 70-day interval, and a 140-day interval. The period covered by the calculation is from February 13, 2022, to November 20, 2022. Unlike USDT-margined, the perpetual futures trade commissions are set for the COIN-margined at 0.01% and spot trade commissions at 0.1%.

If the collateral assets fall below $10,000 due to losses on trades or funding, and if unrealized losses exceed the collateral assets, the shortfall will, assumingly, be covered by raising new funds. Therefore, the funds raised will be calculated as follows: Cost of Money (with an annual interest rate of 5% to match the 8-hour interval) × (3 × 365) ÷ 5%.

Excel is used to calculate the portfolios's return the case for no rebalancing, which is calculated using the following formula:

$$Profit = Ps + P_P + P_{FR} - C$$

Where:
Ps = Profit from Spot Asset

$\mathrm{Ps} = (\text{Exit Price} - \text{Entry Price}) * \text{Amount}$

$\mathrm{P_P} = \text{Profit from Perpetual Futures}$

$\mathrm{P_P} = (\text{Entry Price} - \text{Exit Price}) * \text{Amount}$

$\mathrm{P_{FR}} = \text{Profit from Funding}$

$$\mathrm{P_{FR}} = \sum_{\mathrm{T=1}}^{\mathrm{n}} (\mathrm{FR_{T^*}MP_{T^*}PO})$$

$\mathrm{FR} = \text{Funding Rate}$

$\mathrm{MP} = \text{Mark Price}$

$\mathrm{PO} = \text{Position Size}$

$\mathrm{C} = \text{Cost of Money}$

$\mathrm{T} = \text{Funding Time Frame}$

$$\mathrm{C} = \text{Borrowed Money} * (\frac{3 * 365}{5\%})$$

The similar formulas are applied to the calculation of portfolios rebalancing cases and are below:

$$Profit = Ps + P_P + P_{FR} - C$$

Where:

$\mathrm{Ps} = \text{Profit from Spot Asset}$

$$\mathrm{Ps} = \sum_{\mathrm{I=1}}^{\mathrm{n}} ((\mathrm{Ex\,P_I} - \mathrm{EnP_I}) * \mathrm{Amount_I})$$

$\mathrm{ExP} = \text{Exit Price}$

$\mathrm{EnP} = \text{Entry Price}$

$\mathrm{I} = \text{Rebalancing Interval Frame}$

$\mathrm{P_P} = \text{Profit from Perpetual Futures}$

$$\mathrm{P_P} = \sum_{\mathrm{I=1}}^{\mathrm{n}} ((\mathrm{EnP_I} - \mathrm{ExP_I}) * \mathrm{Amount_I})$$

$\mathrm{ExP} = \text{Exit Price}$

$\mathrm{EnP} = \text{Entry Price}$

$\mathrm{I} = \text{Rebalancing Interval Frame}$

$\mathrm{P_{FR}} = \text{Profit from Funding}$

$$\mathrm{P_{FR}} = \sum_{\mathrm{T=1,\ I=1}}^{\mathrm{n}} ((\mathrm{FR_{T^*}MP_{T^*}}) * \mathrm{PO_I})$$

$\mathrm{FR} = \text{Funding Rate}$

$\mathrm{MP} = \text{Mark Price}$

$\mathrm{PO} = \text{Position Size}$

$\mathrm{C} = \text{Cost of Money}$

$\mathrm{T} = \text{Funding Time Frame}$

$\mathrm{I} = \text{Rebalancing Interval Frame}$

$$C = \text{Borrowed Money} * (\frac{3 * 365}{5\%})$$

3. Result and Findings

3.1 Result for USD-Margin Perpetual Futures

Table 8: The result for USD-Margin Perpetual Futures

Interval Days	No Reb	14	30	60	120	210
ROI	107.13%	20.09%	24.50%	29.47%	40.64%	46.10%
APY	46.55%	8.73%	10.65%	12.81%	17.66%	20.03%
Profit	$21,426.17	$4,018.69	$4,900.84	$5,894.46	$8,128.95	$9,220.70
Maximum unrealized loss	-$82,100.79	-$5,154.85	-$8,007.12	-$11,316.80	-$17,810.38	-$44,221.60
Cost of Money	$2,856.37	$0.00	$0.00	$0.00	$38.07	$154.70

Source: Author's Calculation

The following results were obtained for each of the six intervals discussed above. Without rebalancing during the period, the loss from the short position was $45,704.86, and the profit from the spot position was $45,657.65 for a total trade profit/loss (P & L) of -$47.20 and a total return from the funding rate of $24,328.43. The total trade P & L was -$47.20 and the total return from the funding rate was $24,328.43. The total cost of money was $2,855.05, for a final P & L of $21,426.17. Hence, the ROI in the period was 107.13%.

For the 14-day interval rebalancing, the total P & L for the short position and spot bitcoin was -$1,383.54, and the return from the funding rate was $5,402.23. In other words, the total P & L during the 14-day interval was $4,018.69. Because the maximum unrealized loss would be -$5,154.85 and no additional collateral would be required, the ROI was 20.09% from the total assets of $20,000 at the beginning of the strategy.

Rebalancing at the 30-day interval resulted in a total P & L of -$697.04 for the short position and spot bitcoin and $5,597.88 from the funding rate. In other words, the total P & L during the 14-day interval was $4,900.84. The maximum unrealized loss was -$8,007.12. As with the 14-day interval, no additional collateral was required, so the ROI was 24.50% when calculated from the total assets of $20,000.00 at the beginning of the strategy.

The 60-day interval rebalancing resulted in a total P & L of -$378.43 for the short position and spot bitcoin and $6,272.89 in revenue from the funding rate. In other words, the total P & L during the 60-day interval was $5,894.46. The maximum unrealized loss would be -$11,316.80. However, since the unrealized loss could be covered by adding the funding rate earnings prior to the maximum unrealized loss to the collateral, the ROI was calculated to be 29.47% based on the original asset of $20,000.00.

Rebalancing at 120-day intervals resulted in a total P & L of -$268.46 for the short position and spot bitcoin and $8,430.55 in income from the funding rate. In addition, $33.14 was incurred as the cost of money because the maximum loss exceeded the sum of the collateral assets and funding revenue combined. This means a total profit of $8,128.95 and an ROI of 40.64%.

For the 210-day interval, the total P & L from the short position and spot bitcoin was -$163.83, and the profit from the funding rate was $9,536.39, for a total P & L of $9,372.56. Also, the sum of $151.86 was incurred as the cost of money. Hence, the total profit was $9,220.70 and the ROI was 46.10%.

3.2 Result for Result for Coin-Margin Perpetual Futures

Table 9: The result for USD-Margin Perpetual Futures

Interval Days	No Reb	7	14	35	70	140
ROI	0.178596%	-7.916357%	-3.336043%	-0.898409%	-0.095435%	-0.237795%
Profit	$17.68	-$791.64	-$333.60	-$89.84	-$9.54	-$23.78
APY	0.219778%	-10.319537%	-4.348770%	-1.171140%	-0.124406%	-0.309983%
Cost of Money	$0.00	$16.38	$7.87	$3.04	$1.22	$0.26

Source: Author's Calculation

Without coin margin rebalancing, the combined cash and short position P & L was - $16.86, the return from the funding rate was $34.54, and the total P & L was $17.68. Dividing the total P & L by the asset at the beginning of the period, a $10,000 yield and an ROI of 0.18% were obtained.

Rebalancing at 7-day intervals resulted in a total P & L of -$877.11 for the short position and spot bitcoin and $101.85 in revenue from the funding rates and by adding the cost of money ($16.38). The total earnings were -$791.64 for an ROI of -7.92%.

For the 14-day interval rebalancing, the loss due to the short position and spot bitcoin was -$430.41, the return due to the funding rate was $104.68, the cost of money was $7.87, and the total return was -$333.60. The ROI calculated from this was -3.33%.

In the 35-day interval rebalancing, the total loss on the short position and spot bitcoin was -$175.60, the return from the funding rate was $88.80, the cost of money was $3.04, and the total return was -$89.84. Therefore, the ROI was -0.90%.

In the 70-day interval rebalancing, the total loss on the short position and spot bitcoin was -$87.31 and the return from the funding rate was $78.98. Adding the cost of money ($1.22) to this resulted in a total return of -$9.54 and an ROI of -0.1%.

The 140-day interval rebalancing resulted in a total loss of -$41.62 on the short position and spot bitcoin and $17.57 in revenue from the funding rates. Thus, the total return including the cost of money ($0.26) was -$23.78 and the ROI was -0.24%.

3.3 Findings and Discussion

Based on the results obtained, we analyzed the impact of the rebalancing intervals on the portfolioss when the delta-neutral funding rates of the USD margin and coin margin perpetual futures were executed. In the case of the USD margin, out of the six interval periods given, the ROI without rebalancing was the highest at 107.13%, followed by that of the 210-day interval at 46.10%, the 120-day interval at 40.64%, the 60-day interval at 29.47%, the 30-day interval at 24.50%, and the 14-day interval at 20.09% (Table 6). Converting the returns over the period to APY, the return without rebalancing was the highest at 46.55%, followed by that of the 210-day interval at 20.03%, the 120-day interval at 17.66%, the 60-day interval at 12.81%, the 30-day interval at 10.65%, and the 14-day interval at 8.73%.

The reason for the highest return without rebalancing is that the strategy started with a mark price of $7,584.66 at the beginning and ended at $42,286.25. During almost the entire period, the short position grew in size with unrealized losses and received a large amount of funding. For unrealized losses in excess of collateral assets, the above results include the assumption of funding at 5%, using the functionality provided by Binance. This means that the virtual portfolioss estimation

performed for the period from December 2019 to April 2022 showed that higher returns would be achieved by not rebalancing the portfolios and covering the unrealized losses while paying the cost of money.

For the coin margin (Table 7), the total returns were all negative when rebalancing was performed, and the only case where no rebalancing was performed ended with a profit and an ROI of 0.18%. The ROI without rebalancing was 0.22% per annum. A detailed analysis of each rebalancing case shows that the return without rebalancing was the highest, as was the USD margin because the trading losses exceeded the return from the funding rate. A detailed analysis of the profits showed that the losses tended to be more substantial as the frequency of rebalancing increased, with losses (including transaction fees incurred on trades) exceeding both the entry price adjustments on short positions and the revenue from funding rates.

So, from those given results, it is concluded that the hypothesis is disproved: Portfolios rebalancing improves return on investment. The two data above are historical, as indicated by the period; the Delta Neutral Funding Rate Strategy requires not only the spot bitcoin price but also the market price and mark price of perpetual futures. Although these prices are close, they are different. There are several published spot bitcoin price forecast models at this time, but none forecast the 8-hour interval required for this strategy. In addition, forecast models for perpetual futures prices and funding rates have yet to be published, and only historical data is used since future data is unavailable. However, these results are conclusions based on market data from 2019 to 2022 or 2022 alone, and there is still room for debate. Compared to traditional assets such as stocks and bonds, the cryptocurrency market has been in formation for about ten years, and bitcoin futures trading is even shorter. In other words, the simulation results are for the short period of time that bitcoin futures and spot trades have been in existence, and similar tests over a more extended period of time could yield different results as the market changes.

PricewaterhouseCoopers' annual Crypto Hedge Fund Report publishes the average and median rates of return by trading strategy. The delta-neutral funding rate strategy, which is analyzed in this thesis, is a strategy that hedges against market fluctuations and falls under the market-neutral category. In the latest report, the average and median 2021 returns for the market-neutral strategy are 37% and 26%, respectively (PwC, 2022). In this thesis, we constructed two different delta-neutral positions combining Binance's BTCUSDT, BTCUSDT perpetual, and BTCUSD perpetual, each with a revenue stream from funding, and estimated them in vritual portfolioss. The strategies

included in the market-neutral referenced in the report are not specified for hedge fund confidentiality and other reasons, and we cannot make an exact comparison. However, we can say that by using exchanges with statistically higher funding rates than Binance's indefinite futures, or by optimizing the cost of money, rates of returns that may exceed the above values could be achieved.

Various strategies have been established for trading cryptocurrencies, including systematic trading, econometrics on cryptocurrency, machine learning technology, and cryptocurrency trading software systems (Fang et al, 2022). In addition, discretionary long/short, discretionary long only, quantitative long/short, and quantitative long-only strategies are also available (PwC, 2022). However, these methods require a deep understanding of cryptocurrency and financial terminology and mechanisms. Moreover, arbitrage also requires knowledge of blockchain technology. By contrast, the delta-neutral funding rate strategy addressed in this paper stands out for its reproducibility as it allows for the immediate creation of a delta-neutral position by combining a cryptocurrency asset purchased on the spot market with perpetual futures. Specifically, one needs to buy one bitcoin and open a short position for one bitcoin at the same time to complete the process. In addition, the results obtained from the virtual portfolioss demonstrate that if the portfolios is not rebalanced after a delta-neutral position is created and if the unrealized loss exceeds the collateral assets, the cost of money is paid to raise funds, and a larger return is expected compared to rebalanced portfolioss.

Conclusion

Since the invention of Bitcoin in 2008, cryptocurrencies have evolved dramatically, increasing the size of the market as digital assets that attract funds from investors. In the past, trading mainly occurred in the spot market. However, since the advent of futures trading, trading volume has surpassed that of the spot market. Other phenomena of this digital assets-influenced mode of trading include short positions that generate profits from falling prices and leverage that traders can utilize to build positions that exceed the collateral assets to generate profits more efficiently than spot trading. Furthermore, the daily trading volume is over $50 billion, attributable to trading as a hedge against a decline in asset holdings.

Cryptocurrencies offer futures trading similar to traditional asset classes but are unique in that they provide perpetual futures, which have no trade maturity and allow traders to hold positions for as long as they are willing or as long as the collateral asset can cover unrealized losses. In addition, this study introduces funding rates as a mechanism to bridge the gap between the perpetual futures price and the index price of the spot asset and the delta-neutral funding rate strategy as applicable only to cryptocurrencies. Finally, this paper presents a trading strategy in which a short position equivalent to the cryptocurrency held is constructed in perpetual futures—minimizing the impact of price fluctuations—while using the payout received when the funding rate is positive as a source of income.

The funding payout is calculated based on the position size and the funding rate, and the larger the position size, the more money they can receive. In other words, the more significant the unrealized loss of the short position, the higher the return from funding. Conversely, an increase in the profit of a short position implies a decrease in the position size, which means a reduction in the profit derived from the funding rate. It is difficult to accurately predict the price of a cryptocurrency because of its volatility and requires portfolios rebalancing to adjust the open price of a position.

There are two types of perpetual futures: USD-Margin, collateralized by dollar-stabled coins, and Coin-Margin, collateralized by the underlying cryptocurrency. Each has a different meaning for portfolios rebalancing. For example, they are similar in adjusting the entry price of a short position, but in USD-Margin futures, both unrealized and realized gains and losses occur in stablecoins, so the losses on the short position may exceed the collateral assets. Also, with Coin-Margin, as long as traders hold the short position at 1× leverage, the loss will never exceed the deposited collateral. Nevertheless, funding payments in cryptocurrency must be converted to legal tender to lock in profits.

In this thesis, following research question and a hypothesis are condtructed.

R: Does portfolios rebalancing increase the ROI compared to a non-rebalanced portfolios?

H: Portfolios rebalancing improve return on investment

To study hypothesis, data from the cryptocurrency exchange Binance facilitated an examination of the effect of portfolios rebalancing intervals on the rate of return of a delta-neutral funding rate strategy for bitcoin perpetual contract trading. The perpetual futures used in the analysis were BTCUSDT with USD-Margin and BTCUSD with Coin-Margin for the periods December 23, 2019, to April 11, 2022, and December 22, 2021, to November 20, 2022, respectively.

The study compared six different timeframes for the USD-Margin: no rebalancing, 14-day interval, 30-day interval, 60-day interval, 120-day interval, and 210-day interval, with the highest ROI being + 107.13% for the period without rebalancing, followed by 46.10% for the 120-day interval, and 40.64% for the 120-day interval. The 60-day interval was + 29.47%, the 30-day interval was + 24.50%, and the lowest was the 14-day interval at + 20.09%. This ROI is the total profit divided by the required assets plus additional collateral to cover unrealized losses, i.e., the final rate of return on capital invested. At the Coin-Margin, the ROI without rebalancing was 0.18%, -0.24% at the 140-day interval, -0.083% at the 70-day interval, and negative at all other rebalancing intervals. In other words, when utilizing the delta-neutral funding rate strategy with Coin-Margins, the highest ROI was achieved when one did not perform rebalancing. Based on those results, the hypothesis is disproved.

The volatility of cryptocurrencies is so severe that it is difficult to predict prices accurately, and uncertain factors such as celebrity pronouncements and regulations also affect the market. Therefore, this strategy is unique to cryptocurrencies. Traders who use this strategy may consider it a safe method because they are hedging against the risk of price volatility. However, some risks,

such as exchange bankruptcy, theft of deposited assets, and extreme market conditions, are difficult to predict. In addition, this strategy cannot hedge against the risks, which could significantly damage their profits or cause them to lose assets.

A bitcoin price forecasting model is essential for building a future profit and loss (PnL) model. A well-known price forecasting models include the stock-to-flow model (S2F model) predeicts future prices (Morillon & Chacon, 2022). However, while these models forecast prices based on a single day, an 8-hour interval price model is needed to create the FR strategy's PnL model. This strategy requires a certain amount of long-term validation, requiring 1) 8-hour intervals and 2) price forecasts over a year. No publicly available price forecast models currently meet these requirements, and the program will need to be created using machine learning software and statistical methods. Based on published models, it is assumed that these will require additional data and new algorithms to forecast prices in 8-hour intervals.

In addition to price forecasting, the order book requires constructing forecast models for the impact bid price and the impact ask price. However, a negative maker fee that Binance will introduce on an irregular basis will increase the activity of futures trading, so the market-making strategy using this fee will be an uncertain factor in the future. Therefore, further research is needed to utilize existing techniques and models or develop new algorithms and mathematical models. The PnL model can be verified after building a predictive price and order book model.

The variety of cryptocurrency futures grows daily, with Binance offering more than 50 futures contracts. Although those futures differ in terms of their underlying assets for indefinite futures, they share the same funding rate and price reference method. Thus, the FR strategy used for this bitcoin may be applicable. Similar to the expanding variety of cryptocurrency futures, the number of exchanges offering them continually increases. Trading strategies such as the market-making strategy require massive liquidity in the order book to accumulate profits through leveraged, short-term trading. In contrast, FR strategies only trade for position building and rebalancing. Consequently, it is a strategy that can be implemented even on exchanges with low trading volume, depending on the size of the position. It may generate profit margins higher than Binance, which was examined in this study.

Since cryptocurrency trading has only existed for about ten years, and futures trading periods are even shorter, this study recommends that further research accumulates. Then, as time passes and

more data is collected, portfolios rebalancing over different timeframes or conclusions about this strategy's usefulness can be analyzed.

SUMMARY

The Effect of Portfolios Rebalance on Bitcoin Delta Neutral Funding Rate Strategy

Sora Togo

Text The aim of this paper is to research the impact of portfolios rebalancing on the profitability of the Delta Neutral Funding Rate Strategy, a trading strategy for bitcoin perpetual futures. The Funding Rate is a mechanism that converges the price of the Perpetual Futures to the price of the underlying asset. This Rate can take positive or negative values, with the trader in the long position paying when it is positive and the trader in the short position paying when it is negative. Analysis of historical data on the Funding Rate shows that it can be positive in the long run, and a strategy to use this funding as a source of profit can be established by constructing a delta-neutral position.

In order to build this delta-neutral position, a short position of equivalent volume must be opened at the same time the spot bitcoin is purchased. There are two types of perpetual futures contracts available for trading today: USD-Margin, where the collateral asset is a USD storable coin, and Coin-Margin, which uses the underlying asset as collateral. For each, the author hypothesized that periodic portfolios rebalancing at different intervals would improve the rate of return since the entry price of the position and price fluctuations affect the return.

To simulate the hypothesized impact of portfolios rebalancing on earnings, the author obtained market data from Binance, the world's largest cryptocurrency exchange, using API and Python Code. The data obtained included historical portfolioss, spot bitcoin prices, perpetual bitcoin prices, and mark prices.

Portfolios simulations performed on these data showed that when implementing the Delta Neutral Funding Rate Strategy, the portfolios with no portfolios rebalancing in both USD-Margin and Coin-Margin had a higher rate of return than the portfolios with rebalancing. The results, however, are not consistent with the historical data. However, these results are shown with historical data

and could be different depending on future market conditions, and the author recommends further simulation by building a forecasting model of funding rates and bitcoin prices.

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APPENDICES

Appendix 1. Python code to obtain historical mark prices

```
import requests
import json
import pandas as pd

URL = "https://fapi.binance.com"
endpoint = '/fapi/v1/markPriceKlines'

"""symbol tiker must be capital letters
startTime must be entered in unix time format
limit max is 1500 and min is 1, in case if there is no valued entered for
limit, 500 will be set"""

params = "?symbol=BTCUSDT&interval=8h&startTime=1578934800&limit=1500"

url = URL + endpoint + params

response_1 = requests.request("GET", url)
r = response_1.json()

df = pd.DataFrame(response_1.json()).iloc[:, 0:2]

df.columns = ['Time', 'Open']
df = df.astype(float)
pd.set_option('display.max_rows', 1500)
print(df["Open"])

df = response_1.json()

with open("response_1", "w") as outputFile:
   json.dump(df, outputFile, indent=2)
```

Appendix 2. Python code to obtain historical mark prices

```
import requests
import json
import pandas as pd

URL = "https://fapi.binance.com"
endpoint = '/fapi/v1/markPriceKlines'

"""symbol tiker must be capital letters
startTime must be entered in unix time format
```

```
limit max is 1500 and min is 1, in case if there is no valued entered for
limit, 500 will be set"""

params = "?symbol=BTCUSDT&interval=8h&startTime=1663488000000&limit=64"

url = URL + endpoint + params

response_perpmarkpricehigh = requests.request("GET", url)
r = response_perpmarkpricehigh.json()

df = pd.DataFrame(response_perpmarkpricehigh.json()).iloc[:, 0:3]

df.columns = ['Time', 'Open', 'high']
df = df.astype(float)
pd.set_option('display.max_rows', 1500)
print(df["high"])

df = response_perpmarkpricehigh.json()

with open("response_perpmarkpricehigh", "w") as outputFile:



   json.dump(df, outputFile, indent=3)
```

Appendix 3. Python code to obtain historical market open price

```
import requests
import json
import pandas as pd

URL = "https://fapi.binance.com"
endpoint = '/fapi/v1/klines'

"""
symbol tiker must be capital letters
endTime must be entered in unix time format
limit max is 1500 and min is 1, in case if there is no valued entered for
limit, 500 will be set
"""
params = "?symbol=BTCUSDT&interval=8h&startTime=1578934800&limit=1500"
url = URL + endpoint + params

response_marketopenprice = requests.request("GET", url)
r = response_marketopenprice.json()

df = pd.DataFrame(response_marketopenprice.json()).iloc[:, 0:5]

df.columns = ['Time', 'Open', 'High', 'Low', 'Close']
df = df.astype(float)
pd.set_option('display.max_rows', 1500)
print(df["Open"])

df = response_marketopenprice.json()
```

```
with open("response_marketopenprice", "w") as outputFile:


    json.dump(df, outputFile, indent=2)
```

Appendix 4. Python code to obtain historical mark prices

```
import requests
import json
import pandas as pd
import pybit
import ccxt

URL = "https://api.binance.com"
endpoint = '/api/v3/klines'

"""
symbol tiker must be capital letters
endTime must be entered in unix time format
limit max is 1000 and min is 1, in case if there is no valued entered for
limit, 500 will be set
"""

params = "?symbol=BTCUSDT&interval=8h&endTime=1579046400000&limit=1000"
url = URL + endpoint + params

response_spot = requests.request("GET", url)
r = response_spot.json()

df = pd.DataFrame(response_spot.json()).iloc[:, 0:2]

df.columns = ['Time', 'Open']
df = df.astype(float)
pd.set_option('display.max_rows', 1000)
print(df["Open"])

df = response_spot.json()

with open("response_spot", "w") as outputFile:


    json.dump(df, outputFile, indent=2)
```

Appendix 5. Python code to obtain historical Coin-M mark price

```
import pandas as pd
import requests
import json

URL = "https://dapi.binance.com"
endpoint = '/dapi/v1/markPriceKlines'

"""
symbol tiker must be capital letters
endTime must be entered in unix time format
limit max is 1500 and min is 1, in case if there is no valued entered for
limit, 500 will be set
"""
params = "?symbol=BTCUSD_PERP&interval=8h&startTime=1640102400000&limit=600"
url = URL + endpoint + params
response_1 = requests.request("GET", url)
r = response_1.json()

df = pd.DataFrame(response_1.json()).iloc[:, 0:5]

df.columns = ['Time', 'Open', 'High', 'Low', 'Close']
df = df.astype(float)
pd.set_option('display.max_rows', 1000)
print(df["Open"])

df = response_1.json()

with open("response_1", "w") as outputFile:



   json.dump(df, outputFile, indent=2)
```

Appendix 6. Python code to obtain historical Coin-M market price

```
import pandas as pd
import requests
import json

URL = "https://dapi.binance.com"
endpoint = '/dapi/v1/klines'

"""
symbol tiker must be capital letters
endTime must be entered in unix time format
limit max is 1500 and min is 1, in case if there is no valued entered for
limit, 500 will be set
```

```
"""
params = "?symbol=BTCUSD_PERP&interval=8h&startTime=1640044800000&limit=1000"
url = URL + endpoint + params
response_1 = requests.request("GET", url)
r = response_1.json()

df = pd.DataFrame(response_1.json()).iloc[:, 0:5]

df.columns = ['Time', 'Open', 'High', 'Low', 'Close']
df = df.astype(float)
pd.set_option('display.max_rows', 1000)
print(df["Open"])

df = response_1.json()

with open("response_1", "w") as outputFile:
   json.dump(df, outputFile, indent=2:)
```

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