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Exos Risk-Managed Bitcoin Strategy

November 2023

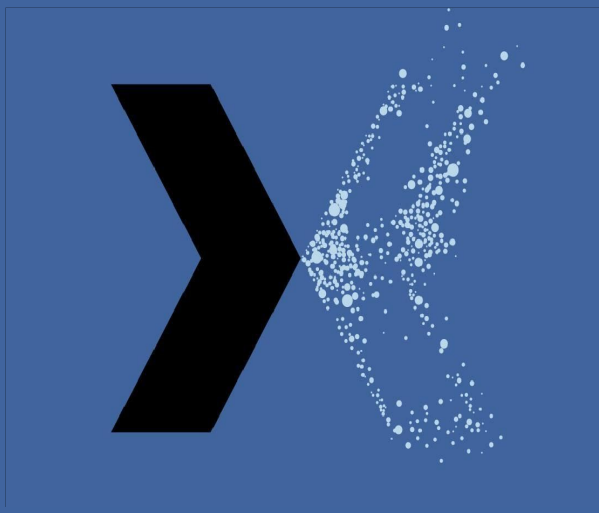

Table of Contents

Background and Motivation

Despite increasing publicity in recent years, Bitcoin has yet to gain significant traction with large traditional financial institutions such as banks and hedge funds. However, interest is growing rapidly among institutional *investors*, particularly family offices and high-net-worth individuals.[1] In addition, the concentration of Bitcoin wealth has continued its trend downward. Market liquidity has increased contemporaneously with this redistribution of wealth which suggests that broad-based adoption is increasing.

However, Bitcoin is notoriously volatile compared to traditional asset classes. During its short history, Bitcoin has undergone many significant changes with respect to liquidity, supply schedule, market structure, and regulation. Some changes are abrupt and others occur gradually over time. While the underlying trends have had an overall positive effect on the Bitcoin ecosystem, it should be kept in mind that unexpected events in a non-mature market can have an amplifying effect on volatility.

Despite the tumultuous landscape of the crypto-asset market in 2022, traditional hedge funds have demonstrated growing interest, though with a note of caution. Crypto hedge funds, an alluring investment avenue that offers dynamic market play, are continually adjusting to the shifting landscape. An analysis of the developments in this sector provides insights into the evolving attitudes, strategies, and performance outcomes.

In 2022, crypto-asset valuations observed notable volatility, marking a downward trend.[2] This turbulence influenced traditional hedge funds, with the number invested in crypto-assets dropping to 29% from the previous year's 37%.[2] However, a silver lining remains: none of these hedge funds have intentions to scale down their crypto exposure in 2023.[2] Furthermore, 23% of these hedge funds are revamping their crypto strategies, majorly influenced by the US regulatory climate, while 12% of crypto hedge funds are mulling over migrating to crypto-friendly jurisdictions.[2]

The year-on-year performance, as one might expect from the volatile crypto landscape, revealed significant shifts. Between December 2021 and December 2022, the average and median Assets Under Management (AUM) levels slumped by 31% and 52% respectively.[2] Unfortunately, most crypto hedge fund strategies, save for market-neutral, registered losses.[2] Yet, a closer analysis suggests that AUM resilience is evident despite these negative returns. Notably, the data might harbor survivorship bias.[2] Reinforcing this optimism is the fact that 20% of the surveyed crypto hedge funds commenced their operations in 2022, a slight increase from 19% in 2021.[2]

In light of these market dynamics, there's a noticeable shift in traditional hedge fund behavior. While fewer are investing in crypto-assets, the portion of AUM for those continuing their crypto ventures has nearly doubled to 7%, up from the prior year's 4%.[2] Their confidence seems unfazed by the market setbacks; half of the crypto hedge funds reported an unchanged perspective on the industry, while 27% voiced a more positive outlook.[2] The resilience and optimism observed among these entities underscore

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[1] PWC and Elwood - 2020 Global Crypto Hedge Fund Report

[2] PWC - 2023 Global Crypto Hedge Fund Report

lasting confidence in the long-term potential of crypto-assets, especially among those deeply rooted in the crypto ecosystem.

Given the tumultuous yet resilient nature of the crypto market, Exos believes its investors can benefit. The landscape, though volatile, presents a unique opportunity for those capable of navigating its intricacies. The Exos team comes from a range of technical backgrounds and has extensive experience in the financial markets, from low-latency quantitative algorithmic trading in equities to macro and relative-value trading in rates. In addition, Exos has been directly involved in the crypto space in various capacities including proof-of-work mining, staking, and trading. We believe that this combination of expertise gives us our edge. In the following sections, we will discuss existing attempts to value Bitcoin, our approach to research, and our infrastructure.

Valuing Bitcoin

Bitcoin is a difficult asset to value. From a fundamental valuation perspective, there is not much "intrinsic value" other than the cost of production. Bitcoins are "mined" by rewarding miners (operators of specialized computer hardware) for validating blocks of transactions. The computer hardware, or ASICs (application-specific integrated circuits), are designed to perform one kind of computation as fast as possible. Much like personal computers, ASICs vary in computational power, energy efficiency, and price. In addition, the wide variability of these factors, differences in energy costs across different geographical regions, and opaqueness of the ASIC market make valuation difficult. Even if a precise cost of production for Bitcoin can be calculated, it does not imply that someone will be willing to pay that price.

Many have attempted to value Bitcoin on the basis of its adoption and utilization. Metcalfe's Law, borrowed from the telecommunications industry, states that the effect (in this case, the value of Bitcoin) of a network is proportional to the square of the number of interconnected users. While this analysis may seem compelling on the surface,[3] estimating the number of unique users via Bitcoin addresses is virtually impossible given users are often encouraged to create a new address for each *transaction*.

The concept of stock-to-flow, borrowed from macroeconomics[4], has also been applied to arrive at a "fundamental; value" of Bitcoin.[5] Since the supply schedule of Bitcoin has been programmatically set, we know both the outstanding float (stock) and the rate at which coins are created (flow). The relationship between price and the stock-to-flow ratio can be graphed:[6]

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[3] Bitcoin Spreads Like a Virus by Timothy Peterson

[4] A "stock"is the amount of a quantity at a given period of time (e.g. number of outstanding shares, size of the Fed portfolio, number of circulating Bitcoin); "flow" is the rate of change of that quantity over time (e.g. amount of equity raised in a year, rate of Fed asset purchases, rate at which Bitcoin is mined). These factors are sometimes used to model and draw inferences about an asset price or a macroeconomic effect.

[5] Modeling Bitcoin Value with Scarcity

[6] Bitcoin Stock to Flow Model - S2F Live Chart (PlanB)

While this is an interesting high-level observation, the magnitude of the deviations from the logarithmic fit are massive and make it impractical for making short to medium-term investment decisions.

A model that explains the price of Bitcoin on a fundamental basis remains elusive. While these ideas yield some interesting insights, it is difficult to argue that they collectively or individually are the primary driver of prices. In the absence of a compelling fundamental valuation method, we conclude that Bitcoin prices are largely driven by investor activity and market sentiment.

Data-Driven Insight

Good research requires good data. Exos supplements granular third-party market data with order book data from major exchanges collected with our own in-house data collection infrastructure. The fine level of detail in data allows the research team to create proprietary indicators of exchange activity that go beyond the typical aggregated price bars and trading volume available on the market. Book data also enables more precise analysis of execution strategy over a variety of time horizons. In addition, Exos uses its infrastructure to gather data from alternative sources such as low-level blockchain transaction data[7] and chat messages from crypto discussion channels. These crypto domain-specific data sources can be useful in validating hypotheses and understanding investor behavior.

[7] Low-level Bitcoin blockchain data can be obtained from running a full Bitcoin "node." A node maintains an up to date copy of the entire blockchain which includes details such as transaction fees and pending transactions. For more information visit: https://bitcoin.org/en/full-node

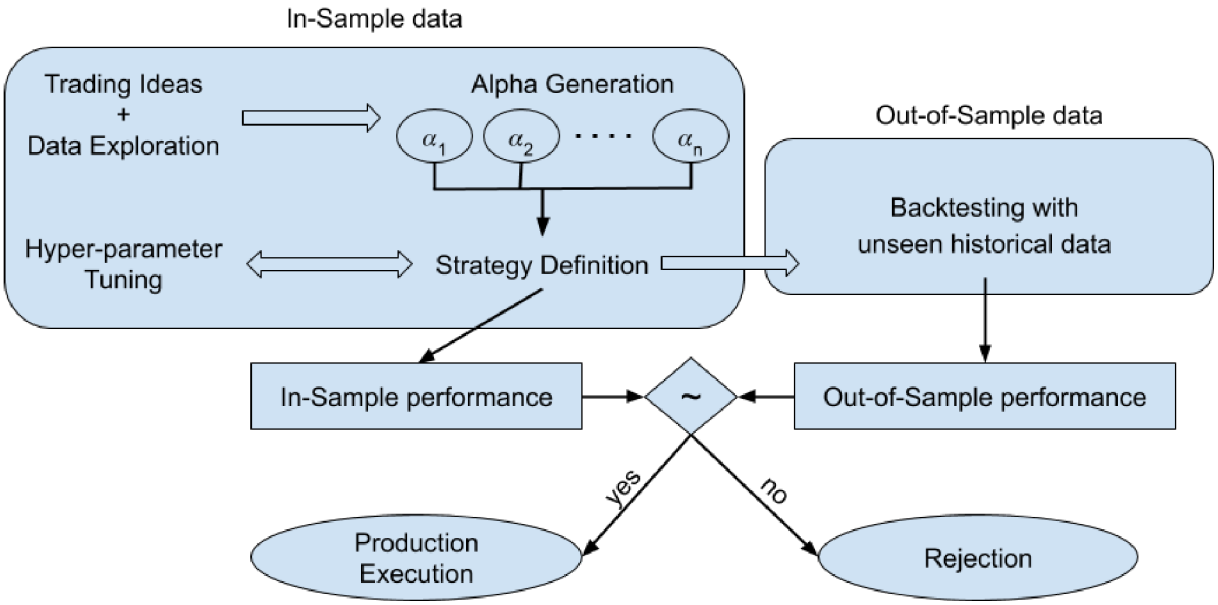
Strategy Development

In nature, simple organisms often prove more robust over a wider range of environments than complex ones. Our approach to trading strategies draws from the same concept. As a governing principle, we favor simple strategies that perform well over a range of environments and rely heavily on our systematic development process to ensure that correlations are not spurious. The relative immaturity of the crypto markets enables the use of similar trading techniques that have historically proven successful in traditional rates and equity markets.

The strategy is fully exposed to Bitcoin (beta) when several risk-reward metrics (alphas) suggest a future rise in price. Conversely, exposure is reduced when its indicators suggest a future fall in price. It is important to understand when sentiment is reversing and to increase or mitigate exposure accordingly. There are several ways to potentially achieve risk mitigation, but our analysis has highlighted the difficulties of hedging a portfolio that includes Bitcoin. For example, a classical idea like mean-variance portfolio optimization does not perform well in this context because of the non-stationary nature of the correlations between Bitcoin and other cryptocurrencies or traditional financial instruments. Historical data show that during bust cycles, the vast majority of cryptocurrencies tend to be correlated with Bitcoin and that risk mitigation through diversification is a mirage of a market condition that no longer holds. Exos has developed alphas which can potentially enable us to mitigate losses during downturns without sacrificing too much of the upside potential of Bitcoin.

The paradigm - data in, trading decision out - is the cornerstone of our research process. Each alpha is directly computed from data with no human decision involved at any stage of the pipeline. Moreover, we strongly believe that each alpha must stand on its own and needs to provide a statistically significant edge to the main strategy in terms of information ratio. We utilize techniques from modern machine learning to uncover the complex and non-linear interactions exhibited in financial markets, and we allow the strategy to adapt its parameters over time as new data and market regimes are encountered. Blending individual alphas into a fully automated trading strategy can be more art than science so we lean on our trading intuition to make some decisions.

The flowchart below outlines our strategy development process. Extensive data exploration allows us to highlight market inefficiencies and generate trading signals (alphas) that can be blended together into a more complex trading strategy. Trade ideas generally originate from intuitions that are supported by quantifiable observations in the data.



In the final step of the in-sample process, we explore the hyper-parameter space by extensive in-sample backtests and select the values that optimize performance metrics such as Sharpe ratio and maximum drawdown, to name a few. We also check for stability and consistency of the results through sensitivity analysis of the hyper-parameters.

The dangers of back test overfitting cannot be overstated, and at Exos we take these risks very seriously. We are extremely parsimonious when testing alphas with out-of-sample data. We eschew from a fast and repetitive cycle of in-sample fitting and out-of-sample testing since bias can potentially be introduced with knowledge of the out-of-sample test results.

Alphas selected for out-of-sample backtesting must deliver statistically significant performance and be robust to hyper-parameter perturbations. If these criteria are met, the strategy is promoted to out-of-sample backtesting to determine whether it will ultimately be added to our portfolio. Trivially, even from a large number of potential portfolio strategies, we can find statistically significant winners that survive out-of-sample testing yet do not provide the portfolio with significant additional risk-adjusted performance. The Exos team also assumes, as is the case historically, that alphas have a tendency to decay over time, and ongoing research is required to maintain and improve overall model performance.

Machine Learning and Artificial Intelligence

The integration of Machine Learning (ML) in the financial sector, specifically within asset management, has become a focal point of exploration. Machine learning (ML) is a form of artificial intelligence that involves the use of algorithms to analyze large datasets and make predictions or decisions without explicit programming. ML systems learn from experience, adapting and improving their performance over time as they process more data. Instead of relying on human-coded instructions, ML algorithms use trial and error to self-adjust, enabling them to identify patterns, make predictions, and generate insights in various domains, including finance.

Positive Aspects of ML in Cryptocurrency Asset Management

Enhanced Data Analysis: The transformative potential of ML in the identification of outperforming cryptocurrencies is underscored by its prowess in analyzing intricate patterns within existing datasets. This capability extends beyond traditional financial metrics, delving into diverse sources such as social media sentiment, transaction volumes, and granular market data, providing a comprehensive basis for informed decision-making.[8]

New Forms of Data: The versatility of ML in processing various data formats, including images and sounds, propels the emergence of alternative datasets. These encompass unconventional yet influential variables like social media sentiment, GPS locations, and point of sale data, thereby enriching the analytical spectrum for cryptocurrency market predictions.[8] [9]

Bias Reduction: The inherent human biases in cryptocurrency investment decisions are addressed through ML's retrospective scrutiny of historical trading records. This analytical lens serves to unearth patterns and anomalies, thus mitigating cognitive biases and fostering a more objective investment environment.[8]

Challenges and Limitations

Algorithmic Biases: The nuanced challenge of algorithmic biases manifests as ML models inherently assimilate biases prevalent within training data. Vigilant ongoing efforts are requisite to identify and rectify these biases, ensuring the integrity and fairness of predictions within cryptocurrency markets.[8]

Inability to Predict Rare Events: The intrinsic limitation of ML in forecasting rare events, such as unforeseen market fluctuations or regulatory interventions, poses a substantial challenge. Cryptocurrency markets, being susceptible to unpredictable occurrences, demand a level of adaptability that current ML models may find challenging to achieve.[8]

Correlation vs. Causation: ML's identification of patterns in data introduces a critical caveat — the distinction between correlation and causation. The imperative role of human judgment surfaces here, necessitating the interpretative finesse to differentiate between mere correlations and genuinely causative market indicators.[8]

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[8] 'What Machine Learning Will Mean for Asset Managers' - Harvard Business Review

[9] 'Machine learning for cryptocurrency market prediction and trading.' - Jaquart, P., Köpke, S. and Weinhardt, C.

Impact on Cryptocurrency Asset Management Industry

Technology and Human Complementarity: A strategic fusion of technological prowess and human judgment emerges as imperative. ML, while augmenting decision-making processes, cannot supplant the nuanced insights and strategic acumen offered by human professionals. A harmonious amalgamation of technological and human capabilities is essential for the effective deployment of ML tools in cryptocurrency asset management.[8]

Industry Adoption: The trajectory of ML adoption within the cryptocurrency asset management landscape is palpable, with larger entities like BlackRock and Fidelity spearheading the charge. However, the pace of adoption varies, and smaller asset managers grapple with the challenges posed by talent acquisition and the substantial costs associated with ML development.[8]

Long-term Sustainability and Future Directions

The prospect of substantial investments in ML raising questions about long-term sustainability comes to the fore. The specter of insights quickly being replicated by competitors introduces an element of vulnerability, casting doubts on the enduring viability of ML as a standalone business model for asset managers operating in the cryptocurrency domain.[8]

A study by Jaquart, Kopke, and Weinhardt provides a nuanced exploration into the efficacy of Machine Learning (ML) in predicting and trading within the daily cryptocurrency market.[9] Deploying various ML models, with a specific focus on Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) ensembles, the study unfolds a comprehensive narrative challenging the weak form efficiency of cryptocurrency markets. The models are meticulously trained to predict binary relative daily market movements for the 100 largest cryptocurrencies, yielding statistically robust predictions. The average accuracy spans from 52.9% to 54.1%, with notable enhancements observed when considering predictions with the highest model confidences, reaching an accuracy range of 57.5% to 59.5%.[9]

The study underscores the practical viability of ML-based strategies, particularly in the context of long-short portfolio dynamics. The application of LSTM and GRU ensemble models outperforms traditional buy-and-hold benchmarks, signifying a formidable challenge to the prevailing weak form efficiency paradigm within the cryptocurrency market.[9] However, the study also acknowledges the nuanced influence of certain limits to arbitrage, introducing an element of caution into the assessment of ML's unfettered efficacy.[9]

Of paramount significance are the annualized out-of-sample Sharpe ratios post-transaction costs, which serve as a robust metric for evaluating the performance of the employed models. Impressively, the LSTM and GRU ensemble models exhibit Sharpe ratios of 3.23 and 3.12, respectively, markedly surpassing the benchmark market portfolio's ratio of 1.33. This not only accentuates the efficacy of ML-based strategies but also substantiates their practical superiority in generating risk-adjusted returns within the cryptocurrency market.[9]

Along with this, a BlackRock report supplements these insights, emphasizing the continuous evolution of technology in asset management.[10] It underscores the pivotal role of risk management and human oversight in the development and continual monitoring of ML models, a sentiment aligned with broader industry sentiments towards responsible AI implementation.[10] The report further advocates for collaborative efforts between regulators and the private sector to establish consistent regulatory frameworks for AI and ML usage in finance.[10]

In summary, Machine Learning's transformative potential in cryptocurrency asset management is underscored by its multifaceted contributions, spanning enhanced data analysis, novel data formats, and bias reduction. However, attendant challenges, such as algorithmic biases and the inherent limitation in predicting rare events, necessitate a nuanced approach to ensure the judicious deployment of ML tools. The trajectory of industry adoption varies, with larger entities taking the lead, while smaller asset managers grapple with impediments related to talent acquisition and costs. The balance between technological innovation and human expertise emerges as the linchpin for sustainable success in this dynamic domain.

Strategy Deployment and Monitoring

When strategies are deployed to production, they are deployed into Exos' custom cloud-based infrastructure. Given the 24/7 nature of the cryptocurrency market, it is imperative to ensure that deployed strategies run reliably in production. Exos primarily relies on its own data pipeline which collects data directly from the relevant exchanges. In addition, real-time data feeds from third-party distributors ensure redundancy.

If there is a change in market conditions or a strategy signals an imminent trade, the team is alerted automatically by the system. The dashboards also allow the team to evaluate the performance of the strategies or areas of interest that might warrant further study.

Strategy Performance

Since the Strategy benchmark is the return of Bitcoin, the amount of alpha added is sensitive to the prevailing price of Bitcoin at time of entry, particularly in the short term. Much of the strategy alpha, according to our backtests, has been shown to be generated through tactical risk reduction to avoid losses during market downturns. While boom and bust cycles tend to cancel out over time, this benchmarking effect can influence short-term returns.

The Exos RM Bitcoin Strategy may not always show an immediate advantage over a passive buy-and-hold strategy, but the backtest analysis has shown outperformance over time, fairly independent of the entry point. While past performance is never a guarantee of future results, we believe the results of our backtests are supportive of our process.

[10] 'Artificial intelligence and machine learning in asset management.' - BlackRock

Disclosures

These materials are based on current data and historical trends and from sources believed to be reliable. The performance of the asset class is subject to inherent risks and uncertainties, some of which are described below. Nothing contained in this material is, or should be, relied upon as a representation as to past or future performance of Bitcoin, and no assurance, promise, or representation can be made as to actual returns. Actual results could be impacted by future events which cannot be predicted or controlled. These materials are valid only for the purpose stated herein and as of the date of such materials. No obligation is assumed to revise this report to reflect changes, events or conditions, which occur subsequent to the date hereof.

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Digital Assets such as Bitcoin were introduced within the past decade and, as a result, the medium to long-term value of Bitcoin is uncertain. Its value could ultimately be subject to a number of factors relating to the capabilities and development of blockchain technologies, which are also uncertain. The allocation of capital to only one asset – Bitcoin - could increase the risk of investing in Bitcoin or in any Strategy investing in Bitcoin due to a lack of diversification in the portfolio.

Bitcoin and Digital Assets Risks - Digital assets such as Bitcoin were only introduced within the past decade, and the medium-to-long term value of the investment is subject to a number of factors relating to the capabilities and development of blockchain technologies, such as the infancy of their development, their dependence on the internet and other technologies, their dependence on the role played by miners and developers and the potential for malicious activity.

Bitcoin, cryptocurrencies and other digital assets are loosely regulated and there is no central marketplace for currency exchange. Supply is determined by cryptography, not by a central bank, and prices have been extremely volatile. Digital asset exchanges have been closed due to fraud, failure or security breaches. Any of the Strategy's investments that reside on an exchange that shuts down may be lost.

Malicious Actor Risk- If a malicious actor or botnet obtains a majority of the processing power dedicated to mining on the Bitcoin Network, it may be able to alter the Blockchain on which transactions in Bitcoin rely.

Bitcoin Exchange Risk- Negative perception, a lack of stability in the Bitcoin markets and the closure or temporary shutdown of Bitcoin Exchanges due to fraud, business failure, hackers or malware, or government-mandated regulation may reduce confidence in the Bitcoin Network and result in greater volatility in the prices of Bitcoin. Furthermore, the closure or temporary shutdown of a Bitcoin exchange used in calculating the Bitcoin Index Price may result in a loss of confidence in the Partnership's ability to determine its Bitcoin holdings on a daily basis. These potential consequences of such a Bitcoin exchange's failure could adversely affect the value of the Partnership.

Irrevocable Transaction Risk- Bitcoin transactions are typically not reversible without the consent and active participation of the recipient of the transaction. Once a transaction has been verified and recorded in a block that is added to the Blockchain, an incorrect transfer or theft of Bitcoin generally will not be reversible and the Trust may not be capable of seeking compensation for any such transfer or theft. To the extent that the Partnership is unable to seek redress for such error or theft, such loss could adversely affect the value of the Partnership.

Regulatory Change Risk- Ongoing and future regulatory actions with respect to digital assets generally or Bitcoin in particular may alter, perhaps to a materially adverse extent, the nature of an investment in the Shares or the ability of the Trust to continue to operate.

Tax Risks- Due to the new and evolving nature of digital currencies and the absence of comprehensive guidance with respect to digital currencies, many significant aspects of the U.S. federal income tax treatment of digital currency are uncertain, and the Partnership does not intend to request a ruling from the IRS on these issues.

Risk of Default or Bankruptcy of Third Parties- The Partnership may engage in transactions in securities and financial instruments that involve counterparties. The Partnership could suffer losses if a counterparty to a transaction were to default or if the market for certain securities and/or financial instruments were to become illiquid. In addition, the Partnership could suffer losses if there were a default or bankruptcy by certain other third parties, including brokerage firms and banks with which the Partnership does business, or to which securities have been entrusted for custodial purposes.