EPFL

Financial applications of blockchains and distributed ledgers
FIN-413

Crypto Carry Project

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Contents

Crypto carry (100 points)
Carry trading strategy has been very well analyzed and documented. A carry trade is going long in the spot market, while selling the same amount forward via a futures contract. BIS has recently published a thorough analysis of the carry trade in crypto - see BIS working paper, No 1087. The BIS paper focuses on the carry trade based on 1-month and 3-month futures contracts.

1 Carry Trade Framework with Perpetual Futures

(10 points) Instead of fixed maturity contracts, define the framework for executing the carry trade leveraging the so-called "perpetual futures" instead. Describe how perpetual futures work, and how one can build a carry trade in crypto such as BTC and ETH.

A traditional carry trade in crypto involves buying an asset like BTC or ETH on the spot market and selling it via a futures contract to profit from the price difference between the two. While this strategy is usually implemented using fixed-maturity futures (such as 1-month or 3-month maturity contracts, as explored in BIS Working Paper No. 1087 [1]), there is another way to execute it using perpetual futures. Perpetuals do not expire like regular futures contracts; instead, they stay open indefinitely and rely on something called the funding rate to keep their prices close to the spot market. The funding rate is a periodic payment exchanged between long and short positions. If the perpetual is trading above spot, those holding long positions pay shorts, and vice versa. So, to run a carry trade with perpetual futures, we would buy the asset on the spot market and short the same amount in the perpetual futures market. If the funding rate is positive, we earn a steady stream of payments simply for holding the position. The BIS paper shows that these kinds of opportunities can be huge. Annualized carries averaged around 10% APY between 2019 and 2022 and sometimes went as high as 60% APY. These returns are largely driven by speculative demand from retail traders, who tend to push futures prices up during bull markets, while arbitrage is limited because few institutional players are willing to bear the risks of margin calls and extreme volatility. The main advantage of using perpetuals is flexibility. We can enter and exit trades at any time without worrying about expiry. But they also come with their own risks: funding rates can swing wildly, liquidity can dry up fast, and leveraged positions can be liquidated in minutes if the market moves against us. So while perpetual futures offer an attractive way to capture crypto carry, they require solid risk management and a good understanding of how these markets behave.

2 Strategy Implementation and Backtesting

(20 points) Use historical data to implement such a strategy and document the results. Use either coin settled or USD (stablecoin, e.g. Tether) settled perpetuals to implement the strategy, or both (and document if any differences in the summary statistics).

In this section, we explore different implementations of a delta-neutral carry trade strategy in crypto markets, and evaluate their historical performance through backtesting. The core idea is to extract yield from the funding rate mechanism on perpetual futures contracts, with optional enhancements through staking or DeFi innovations. All the code used to produce the plots is available on GitHub [2].

We organize our analysis into three progressive versions of the strategy:

- **2.1 Classical Carry Trade:** Holding spot BTC/ETH and shorting the perpetual future to earn the funding rate.

- **2.2 Staking-Enhanced ETH Carry:** Enhancing the classical trade by staking ETH (e.g., via Lido) to also capture staking yield.
- **2.3 USD-Settled Carry via PT-stETH:** A fully USD-denominated implementation using DeFi protocols like Pendle, involving 0-coupon tokenized yields and ETH perpetuals.

We begin with the classical implementation and progressively incorporate more advanced yield components in the following sections.

2.1 Classical Carry Trade

The classical crypto carry trade consists of buying a token (e.g., BTC or ETH) on the spot market and simultaneously shorting the same notional amount using perpetual futures. The trader then earns the funding rate, which is paid every 8 hours on Binance, when the perpetual trades at a premium to the spot (i.e., when long positions are dominant).
This setup is *delta-neutral*, as the long and short positions offset each other's price exposure. Consequently, the strategy's profit or loss derives solely from funding payments, and potential underlying staking rate if applicable, making it an appealing strategy for passive yield generation in markets where perpetuals consistently trade above spot.

We simulate this strategy from September 10th, 2019 for BTC and November 11th, 2019 for ETH, the earliest dates for which Binance funding rate data [3] is available, using daily close prices and 8-hour funding rate snapshots.
Figures 1 and 2 show the evolution of BTC and ETH spot prices [4]. These contextualize the macro market environment in which the carry trade was deployed.

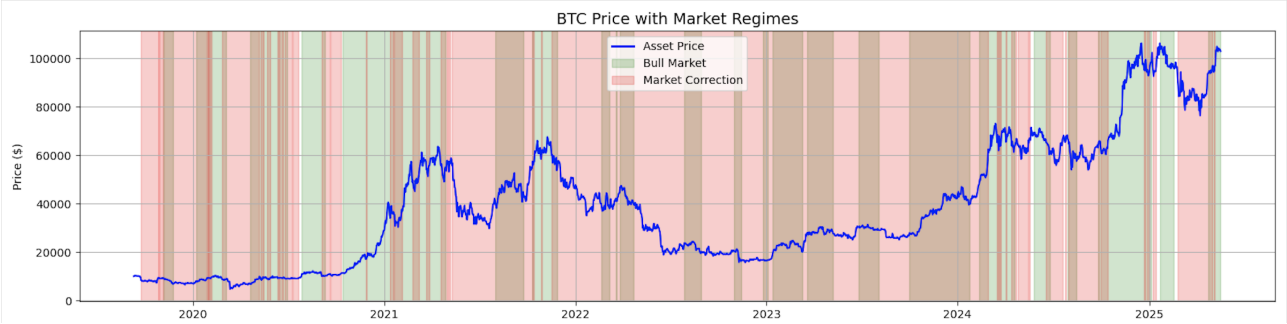


Figure 1: BTC daily close price since September 2019

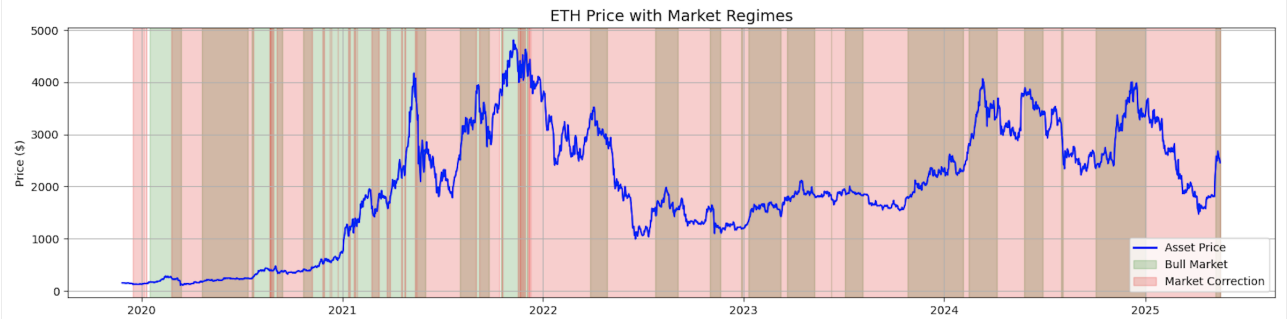
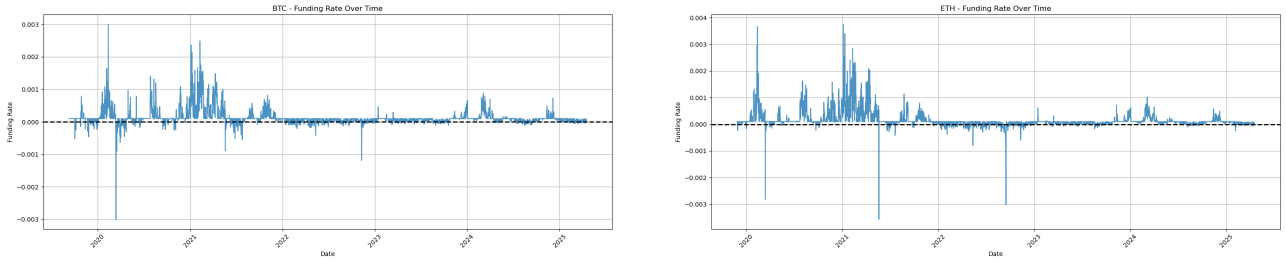


Figure 2: ETH daily close price since November 2019

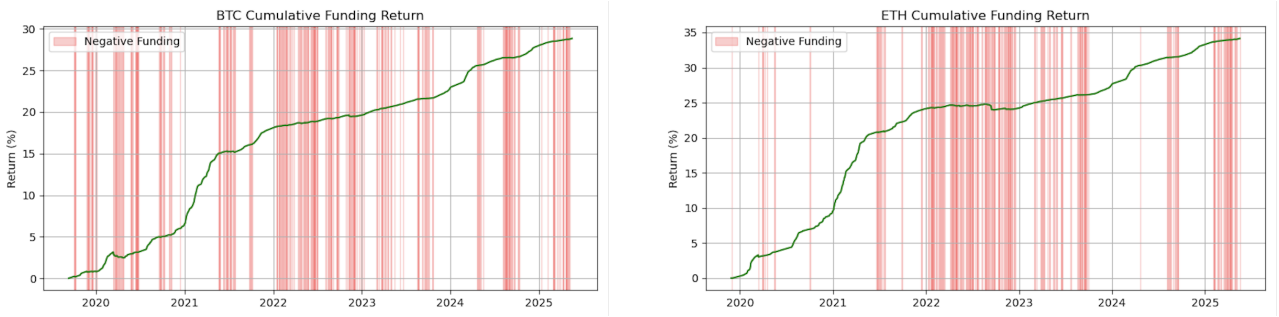
Figure 3 display the 8-hour funding rates for BTC and ETH perpetual contracts. These funding rates are the core drivers of return in the carry strategy.



(a) BTC (b) ETH

Figure 3: 8-hour funding rates over time for BTC and ETH

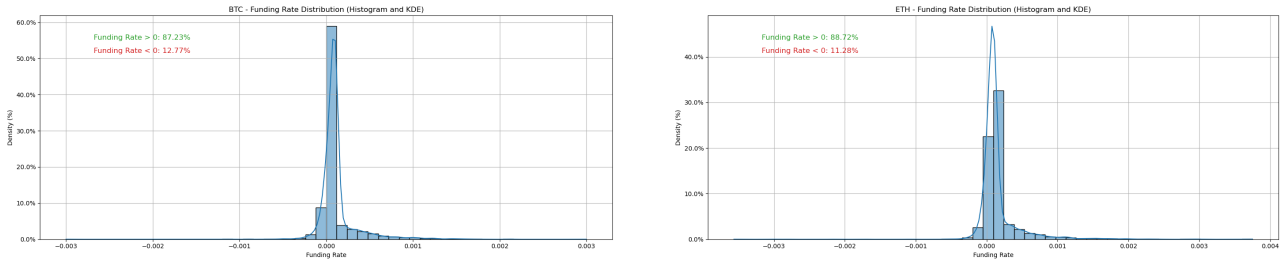
Figure 4 shows the cumulative funding return from this strategy, assuming an initial position of 1 BTC or 1 ETH, no leverage, and full delta-neutrality. Periods with positive funding lead to upward-sloping return curves, while flat or negative slopes suggest unfavorable funding environments.



(a) BTC (b) ETH

Figure 4: Cumulative funding return from the carry trade strategy (no leverage, delta-neutral, initial position size of 1 BTC or 1 ETH)

We also analyze the distribution of historical funding rates using histograms and kernel density estimations (KDE) in Figure 5. These plots highlight the asymmetry and volatility of funding markets.

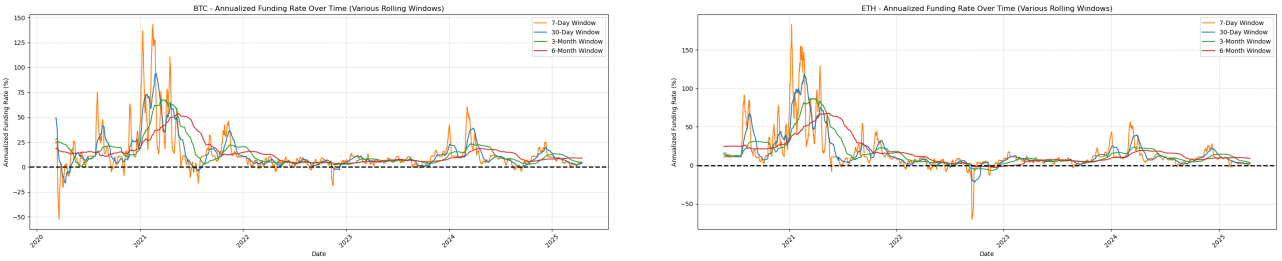


(a) BTC (b) ETH

Figure 5: Funding rate distribution for BTC and ETH (Histogram and KDE)

Funding rates are heavily right-skewed, especially during periods of speculative frenzy. BTC and ETH both show a high proportion of positive funding events: 87.23% and 88.72%, respectively. This suggests that carry trade strategies would have been consistently profitable over the long term for these assets.

To assess how attractive the carry performed across different market regimes, we compute rolling-window annualized yields using multiple time horizons, shown in Figure 6. The annualized rate is calculated by multiplying the mean funding over a rolling window by $3 \times 365 = 1095$, to account for three funding events per day.



(a) BTC (b) ETH

Figure 6: Annualized Funding Rates for BTC and ETH using 7-Day, 30-Day, 3-Month, and 6-Month Rolling Windows

Annualized yields spike dramatically during bull markets, with ETH reaching over 150% on a 7-day basis in early 2021. However, short-term windows also show sharp dips during market crashes or liquidations, underlining the carry strategy's sensitivity to speculative sentiment.

2.2 Enhancing the Carry Trade with ETH Staking (Lido APR)

While the classical carry trade provides a delta-neutral yield through funding payments, it can be further optimized for assets like ETH that offer additional passive income streams. In particular, Lido [5] allows ETH holders to earn a staking yield while maintaining liquidity via liquid staking tokens. In this section, we evaluate the impact of combining the carry trade strategy with ETH staking on Lido.

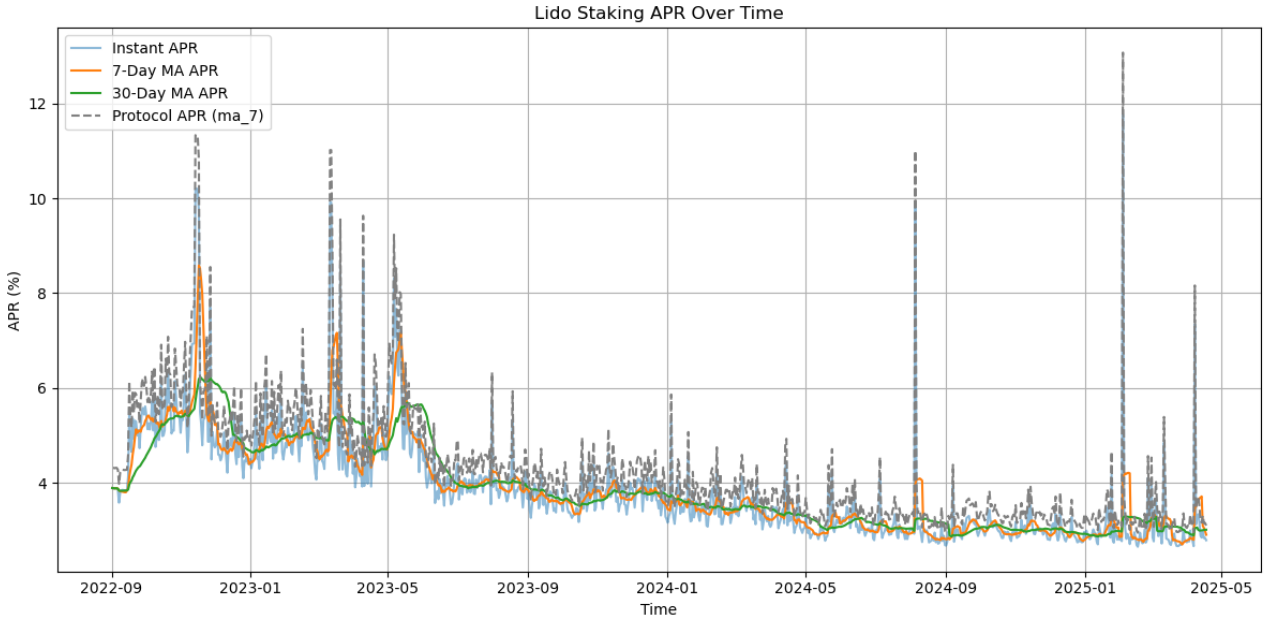


Figure 7: Lido Staking APR for ETH, Instantaneous APR, 7-day and 30-day Moving Averages, and Protocol APR (7-day MA)

Figure 7 shows the evolution of ETH staking APR on Lido since September 1st, 2022. The staking APR is retrieved from Dune Analytics [6] (query ID: 570874 [7]) and includes various smoothing windows (7-day and 30-day moving averages) to capture short- and medium-term trends. The APR generally reflects protocol earnings distributed to stakers, influenced by validator rewards and network activity. The smooth trend indicates a relatively stable yield, typically between 3% and 4% in this period, making it an appealing addition to passive strategies.

We now simulate the performance of a modified carry trade strategy that includes the Lido staking

yield on top of the funding rate. The assumption is that an investor can stake ETH (or use liquid staked ETH) while simultaneously shorting the corresponding perpetual to hedge price exposure, thus earning both staking and funding rate yields.

Figure 8 provides a direct comparison of the average annualized returns between the funding-only strategy and the combined approach. The inclusion of Lido staking consistently boosts expected returns by 3.86%, confirming the synergy between passive staking income and the carry trade structure. This hybrid strategy is especially attractive in a low-volatility environment, where alpha from funding alone may be limited.

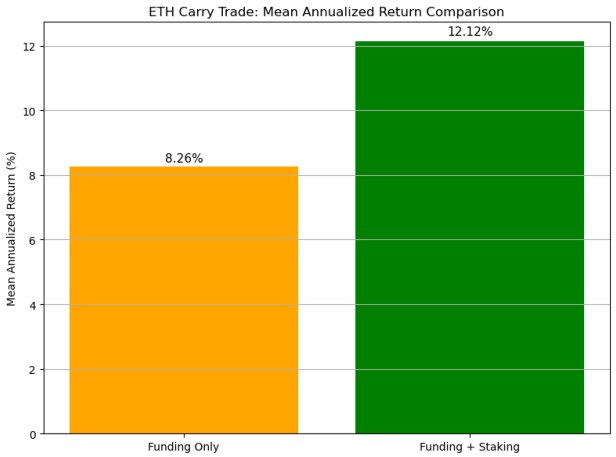


Figure 8: Mean Annualized Return: Funding vs. Funding + Staking

Overall, the results highlight that integrating staking yields into delta-neutral strategies not only enhances returns but also reduce dependence on favorable market sentiment. In the case of ETH, Lido staking provides a low-risk, protocol-native yield that complements the more variable funding income.

2.3 USD-Settled Carry Trade via PT-stETH (Pendle)

The third implementation explores a fully USD-denominated carry trade using Pendle's Principal Tokens (PT). Specifically, we use PT-stETH, a zero-coupon token that pays out 1 stETH at maturity.

Unlike the staking-enhanced carry strategy in Part 2.2, which earns variable yield in ETH (via staking rewards), this strategy locks in a fixed yield directly. This makes it attractive for investors seeking predictable, fiat-denominated returns.

The strategy involves buying PT-stETH at a discount (e.g., \$0.96 for a token that matures at \$1) and simultaneously shorting ETH via perpetual futures to neutralize price exposure. At maturity, the PT-stETH redeems for 1 stETH (worth about 1 ETH) and can be sold for \$USD, while the short ETH position is closed, locking in a fixed USD profit.

It's important to note that the strategy is only delta-neutral at maturity. If the position is exited before maturity (e.g., selling PT-stETH early and closing the short), the investor will no longer be delta-neutral and will be slightly exposed to ETH price movements—potentially realizing a loss or gain depending on market conditions.

Example: Buy PT-stETH at \$0.98 per \$, short 1 ETH via perps at \$2,000. After 90 days:

- PT-stETH redeems for 1 stETH $\simeq$ 1 ETH = \$2,000 and we bought it for 1960 \$
- Short ETH position closed at \$2,000 (no return on ETH exposure)
- Total profit = \$2,000 - \$1,960 = \$40
- Return = \$40 on \$1,960 invested over 221 days $\simeq$ 3% APY only from the Pendle PT yield.
- Total profits also include funding rates from the short perpetual (see above)

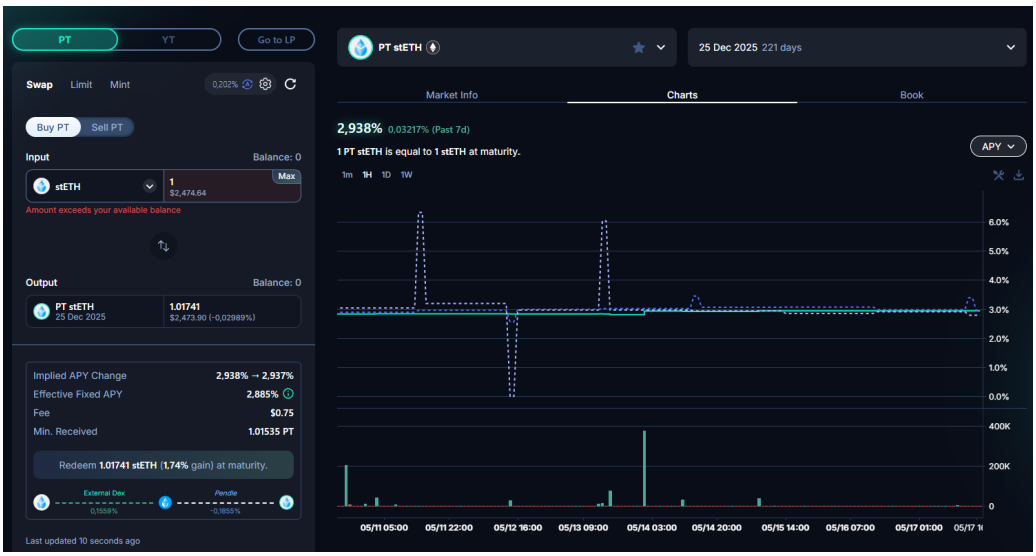


Figure 9: Pendle PT behave like zero-coupon bonds, here we buy 1.017 PT-stETH (worth same value at maturity) for only 1 stETH

3 Market Corrections and Recoveries

In this section, we will analyze the performances of the carry trade strategy during specific interesting periods. The data has been downloaded from CoinGlass API [8].

3.1 Carry Trade Performances During the 2021 Bull Market

3.1.1 BTC

The 2021 bull market created great conditions for testing the profitability and robustness of the BTC carry trade. In this period from 2020/06/29 to 2021/11/14, our data analysis shows positive price momentum, speculative leverage, and retail euphoria all combined to produce consistently positive funding conditions.

As shown in Figure 10, BTC underwent multiple bullish expansions followed by steep corrections. These price waves set the backdrop for perpetual market behavior.
Funding remained strongly positive, averaging 6.14% and spiking above 70%, altough for a very short time. This reflects sustained demand for long perp exposure in bull markets, a consistent driver of yield in delta-neutral carry trades.
This translated into a smooth and compounding return stream. Despite market pullbacks, the strategy maintained upward yield momentum, ending with over 8.5% cumulative return over 504 days.
During crashes, BTC saw 30–50% drawdowns. A spot-exposed strategy would be significantly impaired by this, but as the strategy is delta neutral thanks to its short leg, it can withstand these drawdowns as long as spot BTC remains solvent or as long as spot BTC exposure can tolerate them.
In contrast, the strategy drawdown remained mild ($\leq 0.25\%$), confirming the effectiveness of delta-neutral hedging and funding-based yield extraction when funding rates are overall positive.

Summary: The BTC carry trade thrived in this bullish environment, returns were strong and risk was minimal. The structure captured sustained positive funding without exposure to spot volatility.

3.1.2 ETH

Next, we now evaluate ETH under the same regime in Figure 11, where similar tailwinds, and even stronger funding dynamics, were present.

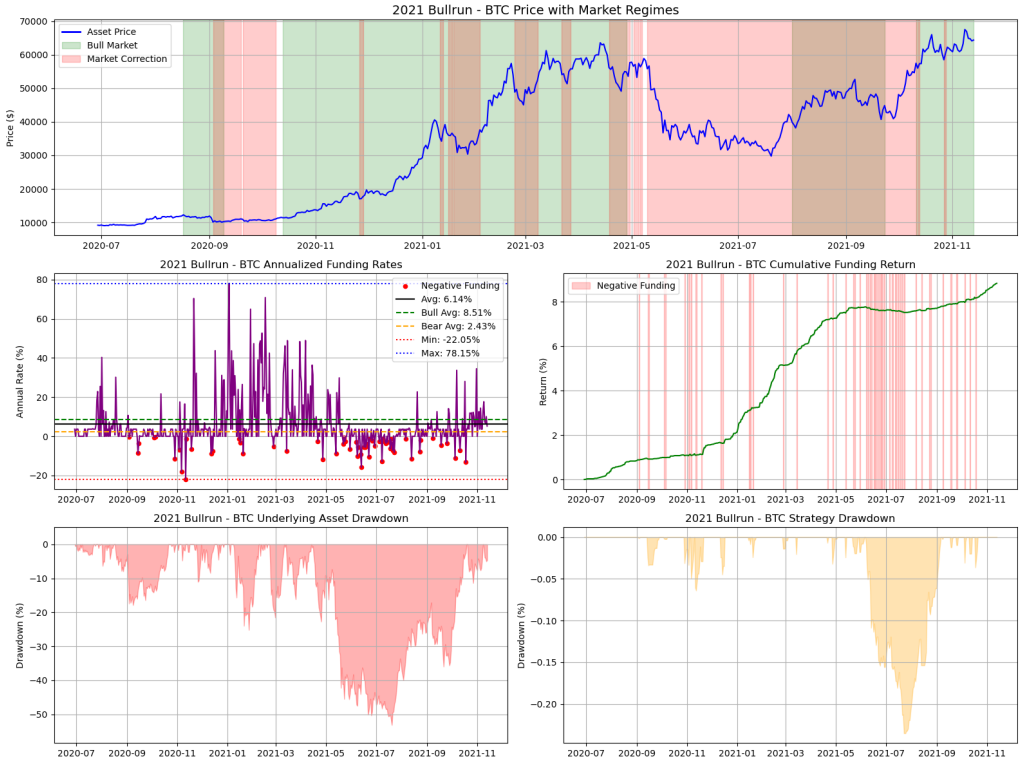


Figure 10: BTC - 2021 Bullrun

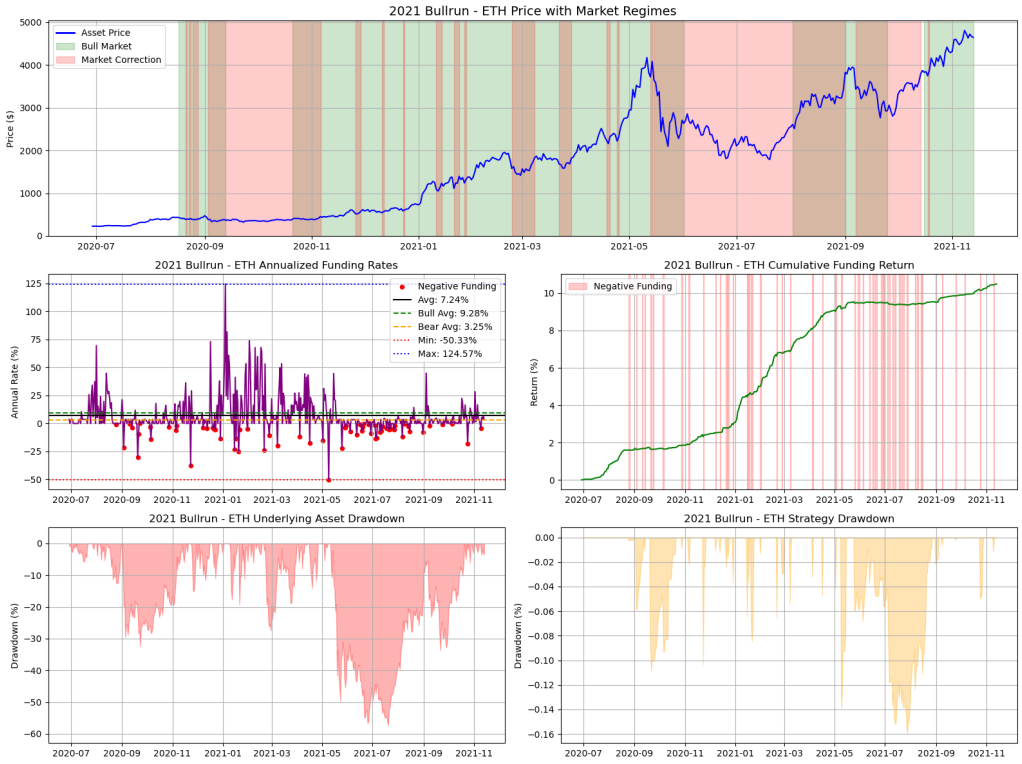


Figure 11: ETH - 2021 Bullrun

ETH tracked BTC's rally, but with even steeper gains and corrections, particularly during DeFi summer.
Funding rates for ETH were notably higher, averaging 7.24% and reaching spikes of 124.57%. The DeFi hype cycle likely amplified leverage demand, benefiting short-funded carry traders.
Cumulative returns exceeded 10%, even during volatile drawdowns. These returns are notable, especially considering that staking rewards were not included in this analysis, but we can easily add the additional gains of about 3% APY, which would total this strategy yield to about 13% APY.
ETH spot saw drawdowns of over 60%, particularly in the summer crash. Such events would devastate unhedged long portfolios.
Yet the ETH carry strategy saw only minor drawdowns (<0.16%), demonstrating the power of funding-based carry trade returns which are not affected by market evolution.

Summary: ETH's carry trade during the bull run outperformed BTC in return, with only slightly higher drawdown. The funding structure of ETH perps appears even more favorable under speculative conditions. This can be explained by fewer liquidity, and newcommer effect, which led to more long perp positions, which in turn increased the funding received by short positions.

3.2 Carry Trade Performances During the Luna Collapse

The collapse of the LUNA ecosystem in May 2022 marked a structural failure in crypto markets. Dubbed too big to fail by many, the UST algorithmic stablecoin lost its peg in May and imploded in less than a week, causing an estimated loss of half a trillion dollars in crypto market valuation. Systemic fear caused spot prices to collapse and futures funding to falter. We evaluate how well the carry trade survived between 2022/03/09 and 2022/06/09, respectively 2 months before and 1 month after the collapse.

3.2.1 BTC

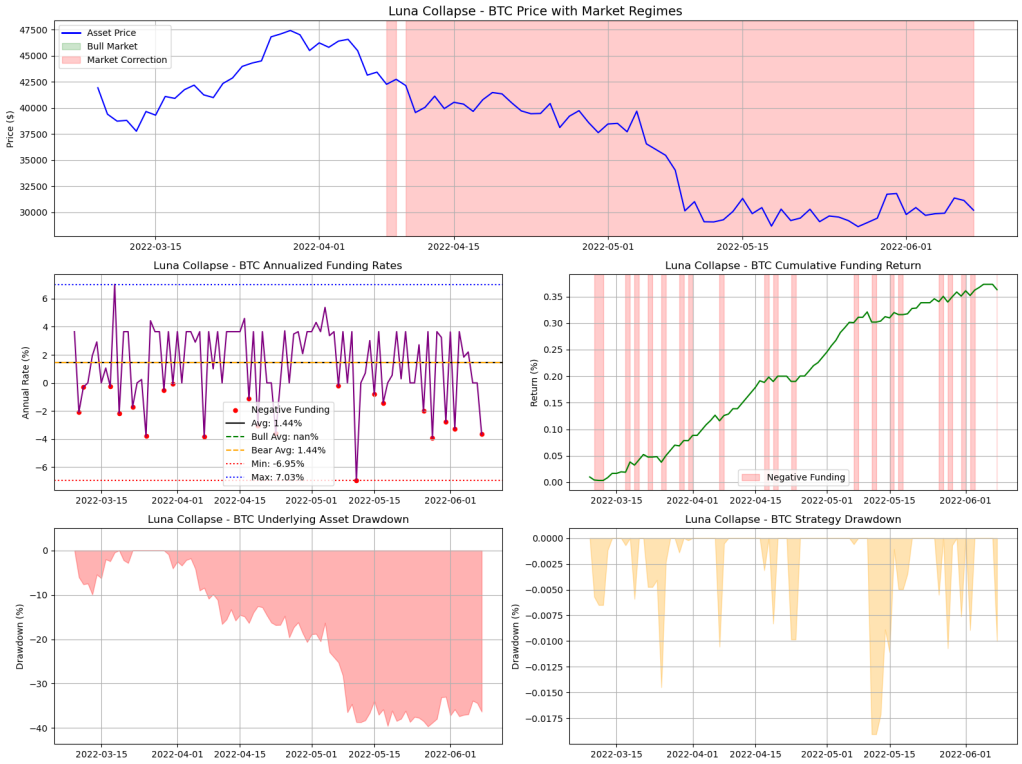


Figure 12: BTC - Luna Collapse

Figure 12 shows that the regime shift is clear: BTC entered a correction in April and plunged through May, losing over 30%.

Funding rates fell sharply but still averaged a positive +1.44%. Though funding briefly turned negative, it did not sustain backwardation, showing market inefficiency in risk pricing.
Returns remained positive and climbed steadily. Despite systemic panic, the carry trade achieved over 0.35% return over 91 days, a strong outcome in the midst of market-wide panic.
BTC drawdowns reached −39%. Any directional strategy would have faced large losses, highlighting the value of delta-neutrality.
The carry strategy had drawdowns under 0.0175%, recovering quickly. Temporary negative funding caused momentary stress, but resilience quickly returned.

Summary: The BTC carry trade survived the Luna collapse without major damage, although the strategy's yield was significantly lower than during bull markets. This confirms its ability to preserve capital even in disorderly markets, provided funding does not sustain negative values.

3.2.2 ETH

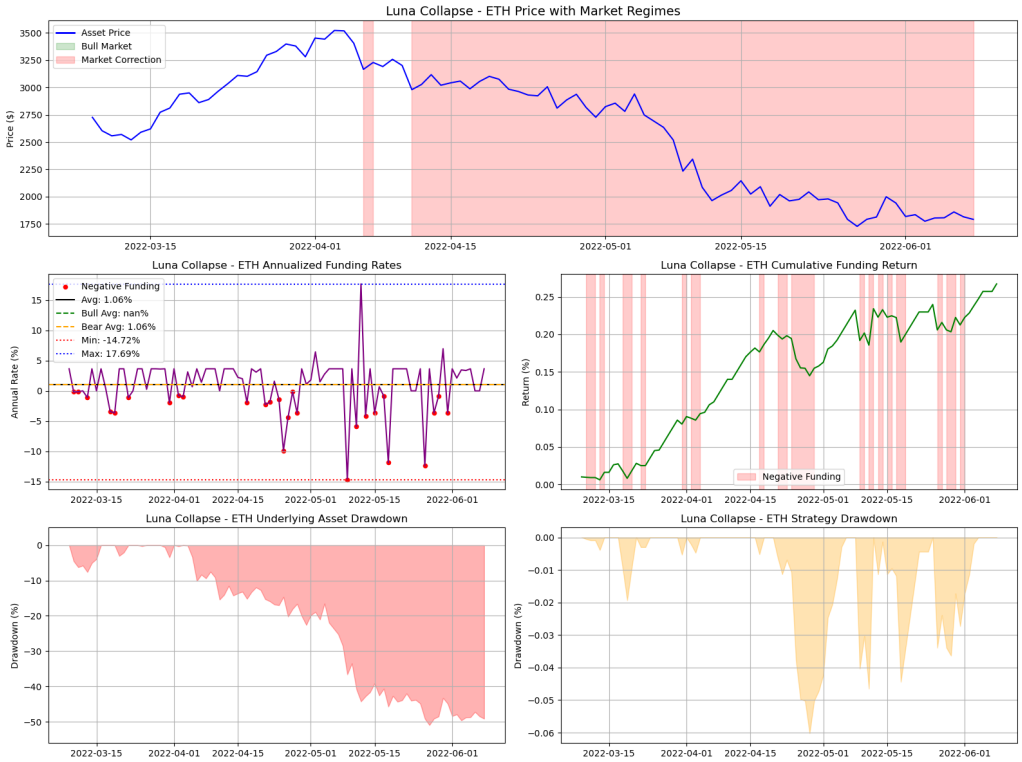


Figure 13: ETH - Luna Collapse

Figure 13 shows that ETH mirrored BTC's crash, losing nearly 50% during the same window.
Funding rates for ETH fell more deeply but still averaged +1.06%, with a minimum near −14%. Short-lived negative funding events were insufficient to derail the strategy.
Cumulative returns remained positive throughout, reaching over 0.25%. These relatively small returns also don't account for ETH staking rate, which was of about 3,6% APY during this period. So overall the carry trade with staking could yield up to 4%, mainly from the staking yield. This demonstrates strong capital preservation, especially when paired with asset price chaos.
ETH suffered deeper drawdowns than BTC, exceeding 50%. The strategy was again shielded from this thanks to its neutral structure.
ETH carry trade strategy drawdown touched 0.06% due to negative funding rates but recovered quickly, reflecting fast normalization in funding conditions.

Summary: ETH's funding was more volatile, but still offered net positive yield. The strategy withstood stress well and preserved capital while unhedged spot traders faced severe losses.

3.3 Carry Trade Performances During the FTX Collapse

The collapse of FTX in November 2022 was one of the most dramatic shocks in crypto history. As the exchange filed for bankruptcy and fears of contagion spread, markets plunged into chaos. Liquidity dried up, traders rushed to unwind positions, and funding rates turned significantly negative. In this section, we explore how our carry trade strategy held up under these extreme conditions, between 2022/09/16 and 2022/12/16, respectively 2 months before and 1 month after the collapse.

3.3.1 BTC

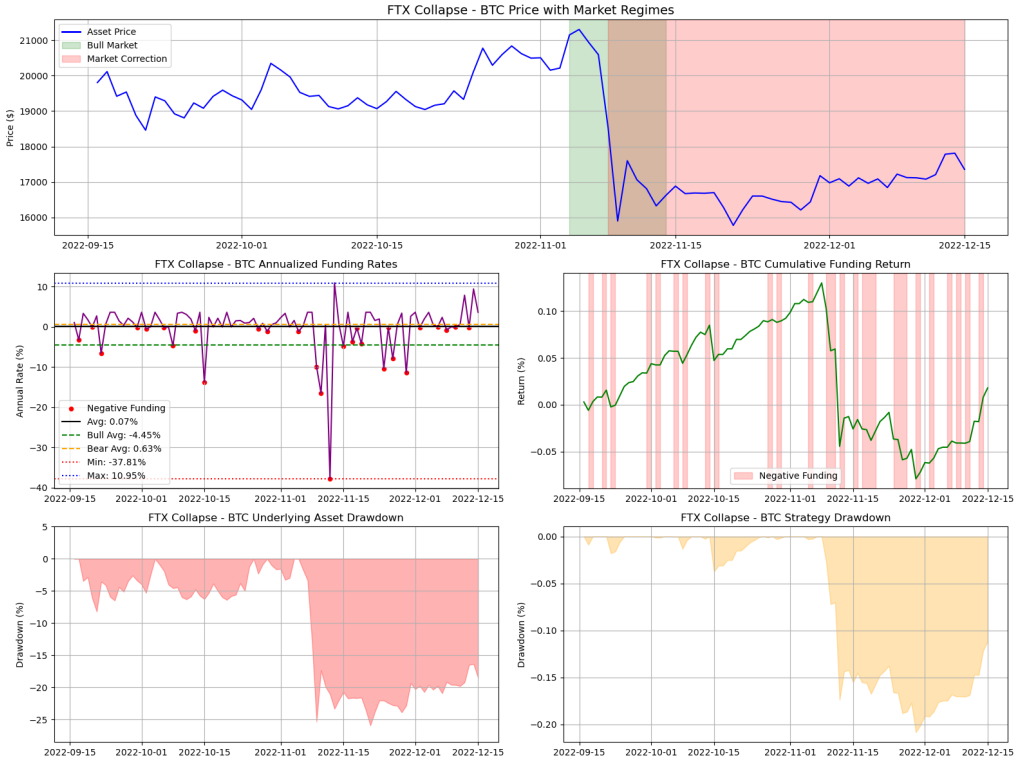


Figure 14: BTC - FTX Collapse

As we can see in Figure 14, the collapse of FTX in November 2022 marked one of the most severe trust shocks in crypto market history. As the exchange filed for bankruptcy and contagion fears spread, BTC experienced a sharp drawdown, with prices falling over 25% in a matter of days. This period was characterized by widespread deleveraging, liquidity evaporation, and cascade liquidations.
Annualized funding rates for BTC turned strongly negative at the onset of the crisis, spiking down at -37.81%. However, these short term negative spikes proved to be temporary: funding rates normalized relatively quickly, returning to slightly positive territory by mid-December. On average, the annualized funding during the event window remained close to zero at +0.07% over the 90 days period of the window.
Despite this brief period of backwardation, the BTC carry trade weathered the crisis with limited damage. The cumulative funding return dipped slightly but recovered soon after, finishing the window with a near-zero return profile. Maximum drawdown remained under 0.2%, confirming the resilience of the delta-neutral structure. The brief negative funding was not sufficient to overwhelm the strategy, especially as traders re-entered perp markets and demand for long exposure rebounded.

Summary: Despite the sharp market drop and briefly negative funding rates, the BTC carry trade remained remarkably stable and recovered quickly. The strategy showed strong resilience, with only mild setbacks before returning to baseline.

3.3.2 ETH

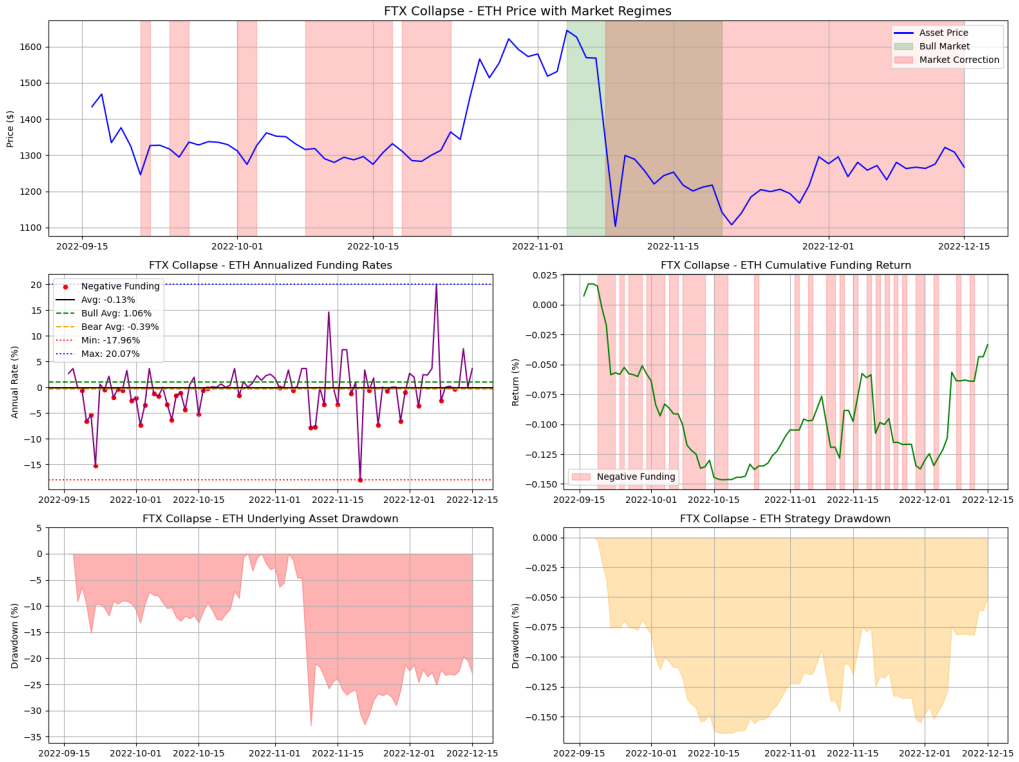


Figure 15: ETH - FTX Collapse

As Figure 15 shows, ETH followed a similar trajectory during the FTX collapse, with spot prices declining nearly 35% as systemic fears intensified. Funding markets for ETH were even more volatile than for BTC, reflecting higher leverage levels and a more retail-driven user base on the affected platforms.

Annualized funding for ETH plunged rapidly, reaching a low of -17.96%, and averaged -0.13% during the core event window. Like BTC, funding conditions normalized over the following weeks, although at a slightly slower pace. The temporary backwardation posed a challenge for the carry trade, which briefly incurred losses during peak market stress.

Nevertheless, the ETH carry trade exhibited strong capital preservation. The strategy's drawdown remained under 0.2%, and cumulative returns recovered to nearly breakeven by the end of the window of 90 days. This return could also grow to the ETH staking rate of about 3% APY if we staked the spot ETH, which would offset the slightly negative funding rates yield. The resilience of the ETH carry strategy over this short period span of 90 days, and despite more aggressive funding swings, highlights the protective power of delta-neutral positioning, even in environments of extreme market volatility.

Summary: ETH faced even more turbulence, with more volatile funding conditions than BTC. Still, the carry trade strategy managed to preserve capital and bounce back, confirming the benefits of a delta-neutral approach even in extreme market stress.

3.4 Carry Trade Performances During the ETF Bull Market

The approval of the first U.S. spot Bitcoin ETFs the January 10th 2024 marked a clear structural shift in market sentiment. With institutional inflows resuming, both BTC and ETH experienced a rebound in price and perp funding rates. This section assesses the performance of the carry trade during this "return to confidence" regime, between 2023/12/10 and 2024/03/10, and compares it to previous cycles.

3.4.1 BTC

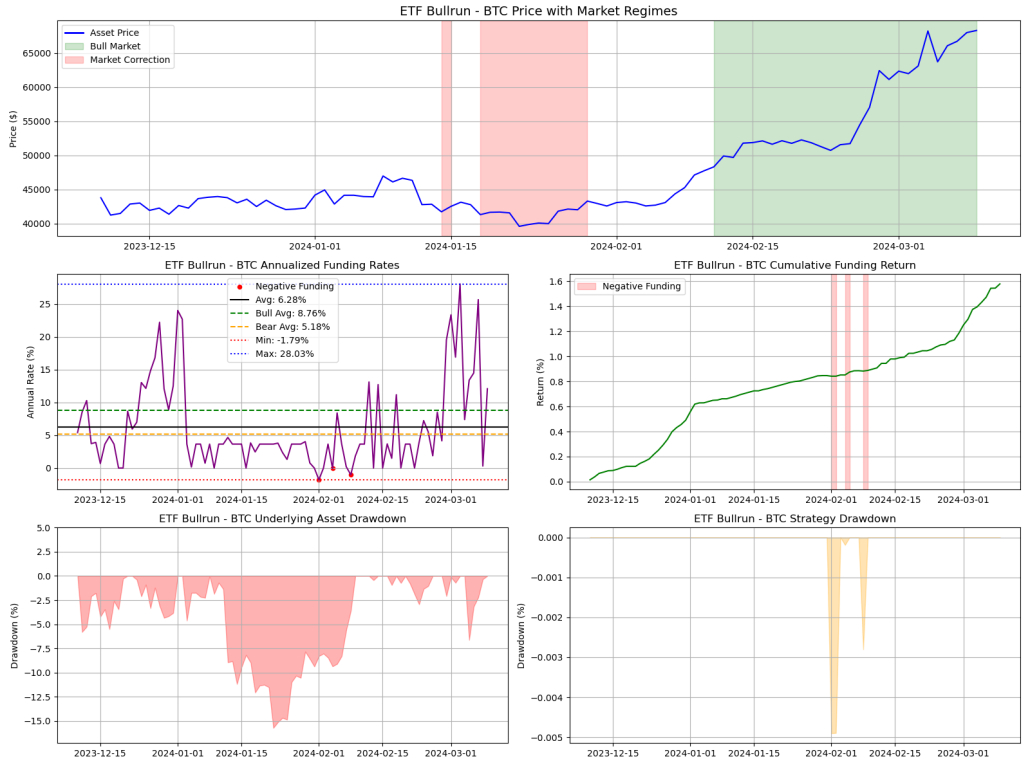


Figure 16: BTC - ETF Bullrun

As shown in Figure 16, the ETF announcement catalyzed a strong rally. After a brief correction in January, BTC experienced a sustained upward trend in February and March, driven by institutional capital rotation and risk-on flows.
Funding rates recovered swiftly and remained robust throughout the period. Average annualized funding reached 6.28%, with a peak at 28.03%. Notably, there was no prolonged period of negative funding, in contrast to events like the FTX collapse. This reflects the fact that the vast majority of perp traders were long, which is explained by the bullish sentiment arround the ETF.
The strategy accumulated over 1.5% in carry yield over just 90 days. The growth was steady, with no visible drawdowns or stagnation, making this one of the smoothest carry periods in the entire dataset.
BTC drawdowns remained under 17% and were quickly recovered. Compared to previous events, such as the 40% drop during Luna or 25% during FTX, this regime was far more orderly.
Strategy drawdown remained under 0.005%, the lowest among all market regimes analyzed. This reflects stable positive funding and low volatility in the short perp exposure.

Summary: The BTC carry trade during the ETF bullrun was characterized by high funding, negligible volatility, and fast compounding yield. In contrast to the 2022 crises, this regime restored the clean funding environment seen in early 2021 but with far lower drawdowns.

3.4.2 ETH

As we can see in Figure 17, ETH followed BTC's trend, although its rally was more gradual. While not the primary ETF beneficiary, ETH saw renewed demand as the broader market rotated risk-on.
Funding rates averaged 6.18% and peaked at 26.13%. These are slightly below BTC's, but still well above breakeven. Crucially, the minimum rate remained at zero, confirming a low-risk environment for funding capture.
Cumulative funding returns mirrored BTC: >1.5% earned over a short horizon. The upward trend was smooth, with no major inflection points or pullbacks. These returns could be further heightened by adding ETH staking yield of about 3.6% APY

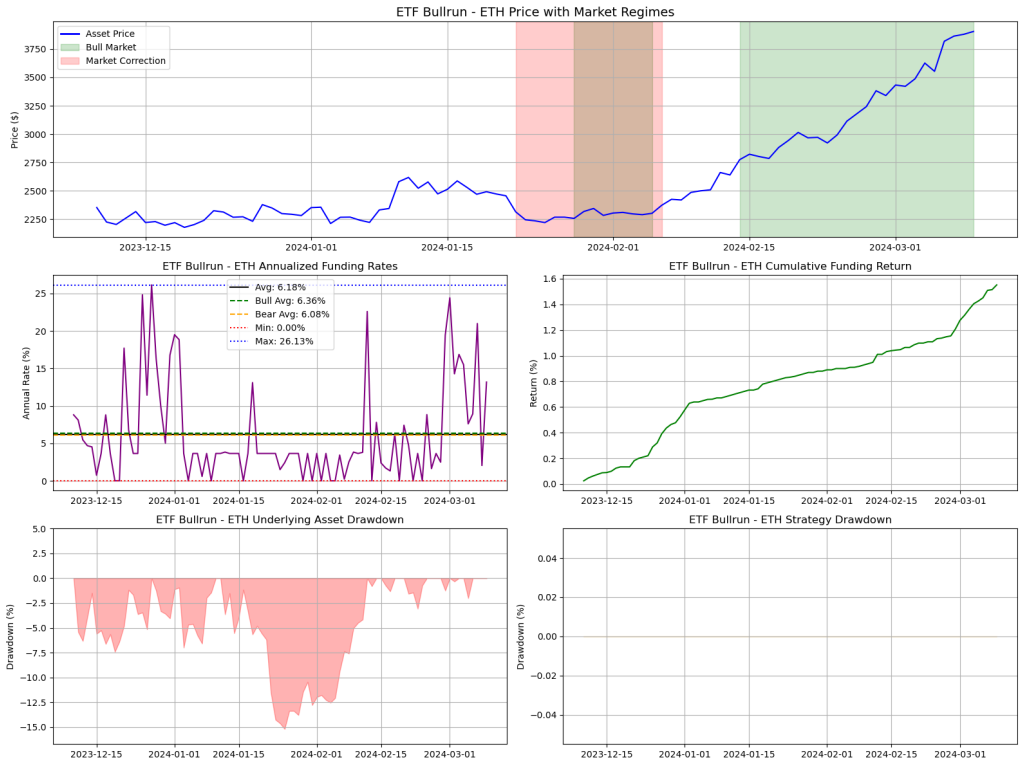


Figure 17: ETH - ETF Bullrun

ETH experienced slightly deeper drawdowns (≈15%) early in the window but recovered faster than in previous crash regimes. There were no extended periods of forced deleveraging or panic.
There were actually no drawdown for the strategy as all the funding rates were positive, hence the strategy was never in loss.

Summary: The ETH carry trade benefited from bullish sentiment without being at the center of ETF flows. Funding remained positive, volatility stayed low, and returns accrued steadily, closely mirroring BTC's performance.

Cross-Regime Comparison:

- Compared to Luna and FTX, ETF bull market had higher funding rates, lower volatility, and stronger funding resilience.
- Both BTC and ETH strategies had the smallest drawdowns of any event analyzed (<0.005%).

Conclusion: The ETF bull market offered near-optimal conditions for passive carry strategies: sharp risk-on reversal, stable perp markets, and no systemic risks. If the 2021 bull run was long and volatile, and Luna/FTX were crisis stressors, then the ETF bullrun was a clean, low-drawdown, high-efficiency yield window because the funding rates went high quick.

4 Cross-Venue Analysis and Optimization

(50 points) Since perpetual futures are being traded in different venues, analyze how your carry trade summary statistics change across the different venues. Is it worth exploring the implementation of such a strategy across different venues by changing the venue for the short futures position over time? Provide either quantitative evidence or qualitative commentary on your approach.

4.1 Theoretical Context and Market Reality

In perfectly efficient markets, the law of one price would dictate uniform funding rates across all trading venues as arbitrageurs would immediately capitalize on any discrepancies. However, the cryptocurrency ecosystem shows significant market fragmentation, creating persistent inefficiencies in cross-venue pricing. This fragmentation stems from:

- **Segregated Liquidity Pools**: Each exchange maintains independent order books and liquidity providers, resulting in what is known as liquidity fragmentation
- **Varying Participant Bases**: Different exchanges attract distinct trader demographics, based on fees, liquidity, and many other factors, with varying risk preferences and trading behaviors
- **Capital Movement Friction**: Non-trivial withdrawal/deposit delays and fees between exchanges and chains
- **Regulatory Differences**: Varying compliance requirements across jurisdictions affecting user access and capital flows

As a result, persistent funding rate divergences exist across exchanges, creating potential for enhanced returns through strategic venue selection. This market inefficiency forms the foundation of our multi-venue optimization approach.

4.2 Empirical Analysis of Cross-Venue Funding Rate Divergence

To quantify these inefficiencies, we focused on the recent ETF Bullrun period, analyzing funding rates across major exchanges such as Binance, BitMEX, Bybit, Deribit, OKX, and HTX, downloaded from CoinGlass API [8]. This period offers particularly relevant insights into current market conditions. We developed a dynamic venue selection strategy that:

- Maintains a constant long position in spot BTC/ETH across the analysis period
- Re-evaluates the short perpetual futures position, selecting the venue with the highest funding rate
- Executes venue switches only when the funding rate differential exceeds switch fees
- Incorporates realistic fee structures based on exchange VIP tiers as shown in Figures 18 to 25, as well as a no-fee baseline (Figures 26, 27).

This approach allows us to always be on the exchange with the highest funding rates, hence earning them in the process as we have a short perpetual contract on ETH/BTC.

4.3 Backtesting on Data

- *Fee sensitivity:* For high maker/taker fee structures (e.g., 1%/1%), the dynamic strategy underperforms static benchmarks in terms of absolute return, as observed in Figures 18, 19. The dynamic strategy does not change as the prohibitive switch cost (close short perpetual on exchange A, open it back on exchange B) prevents it from being worth it, so the strategy sticks to only 1 exchange (the one we started at).
- *Low-fee tiers (e.g., VIP6+):* As fees decrease, either via higher volume tiers,holding large quantities of the exchange token, or alternative venues with lower fee structures, the relative attractiveness of dynamic venue selection improves. At 0.0002/0.0005 and 0.00006/0.00025 levels, the dynamic strategy begins to slightly outperform the best static benchmark (Figures 20 to 23). Especially, at 0.0002/0.0002 fee level, this strategy can yield non-negligible results during earlier exchange stages (Appendix Figures 28 to 33). This can be explained by less liquidity available at the time, leading to big differences of funding between exchanges.

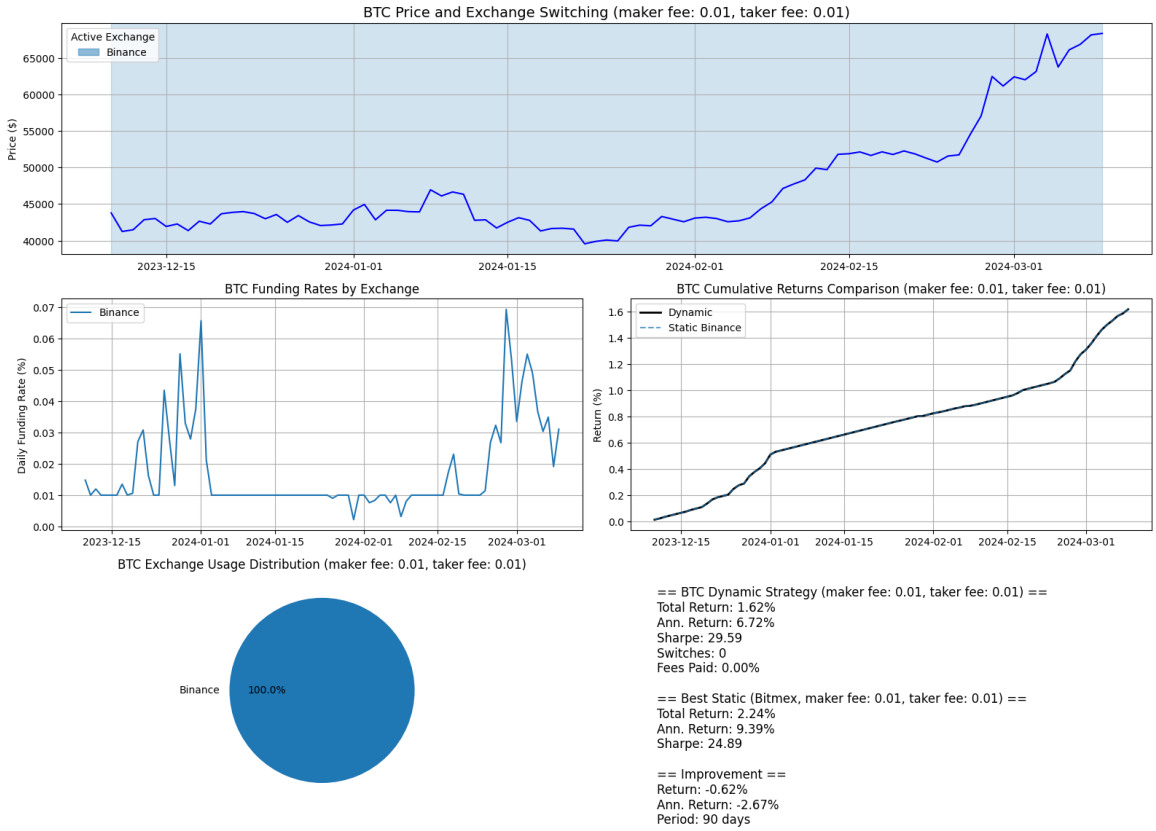


Figure 18: Maker 1%, Taker 1%: BTC, ETF Bullrun

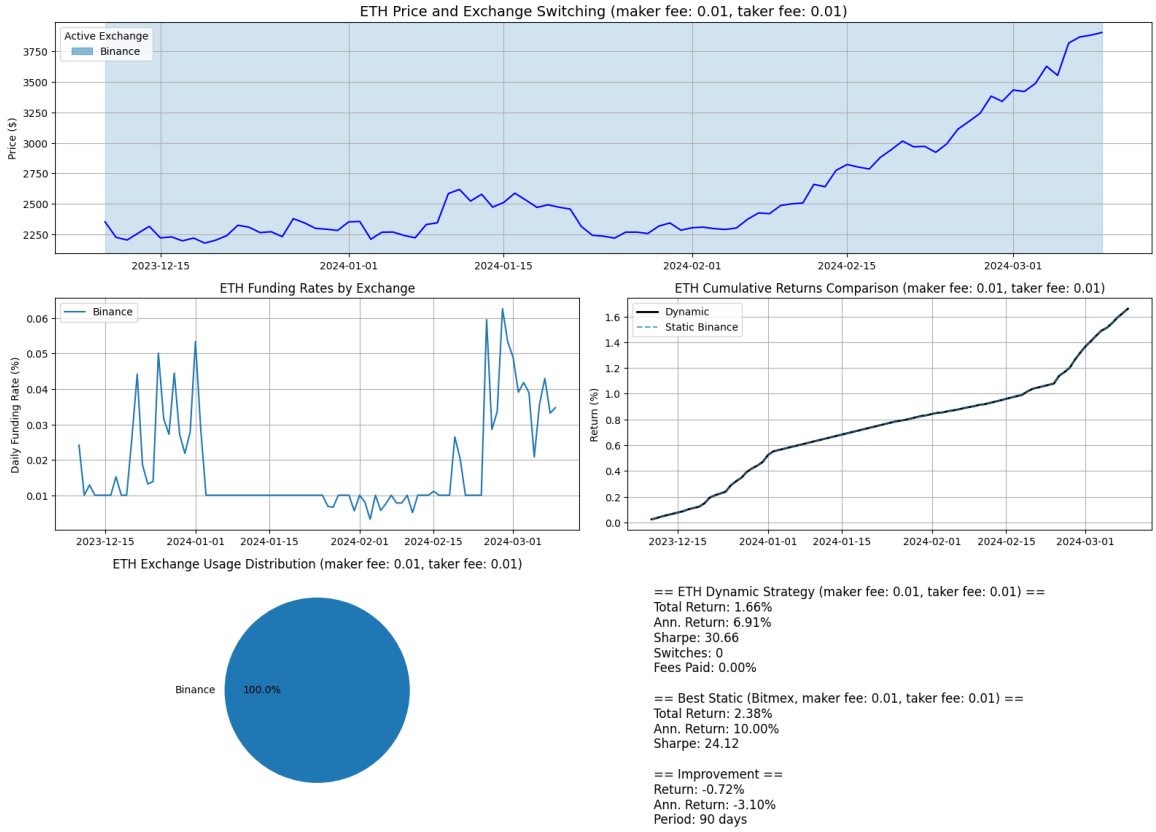
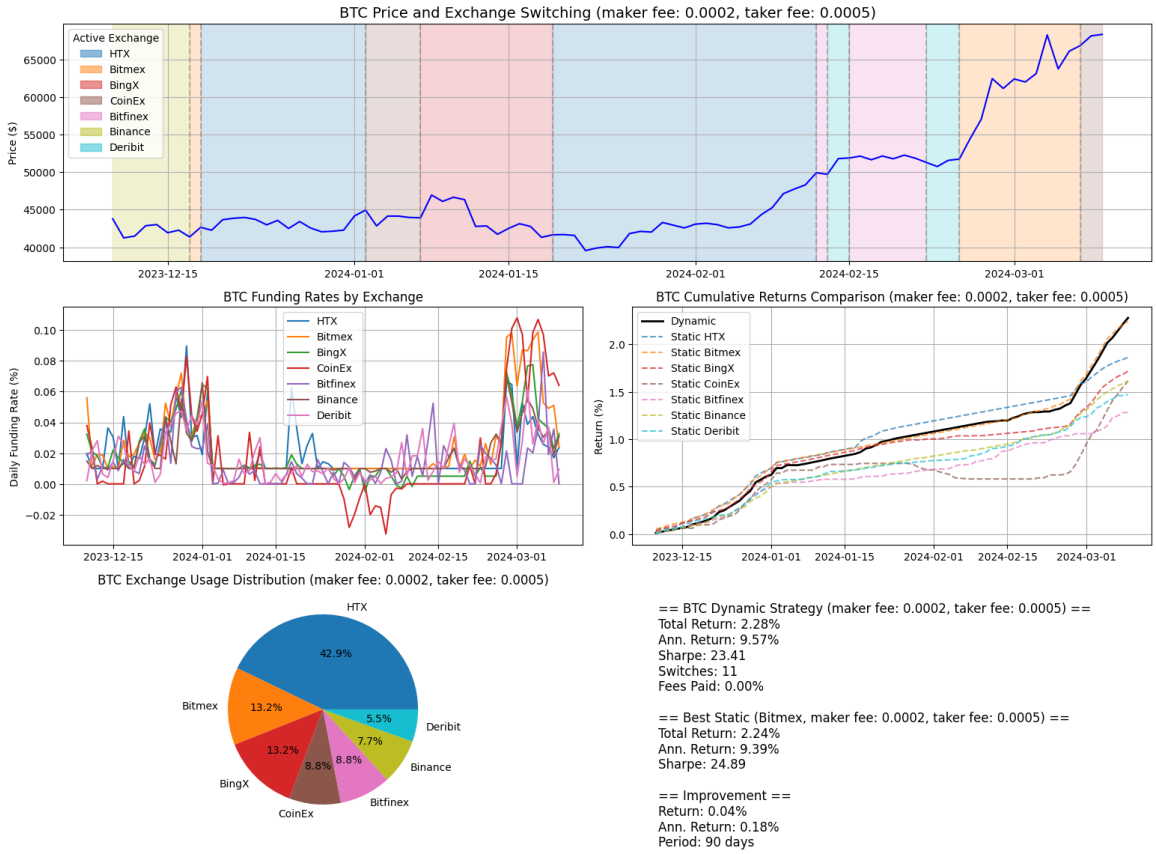


Figure 19: Maker 1%, Taker 1%: ETH, ETF Bullrun

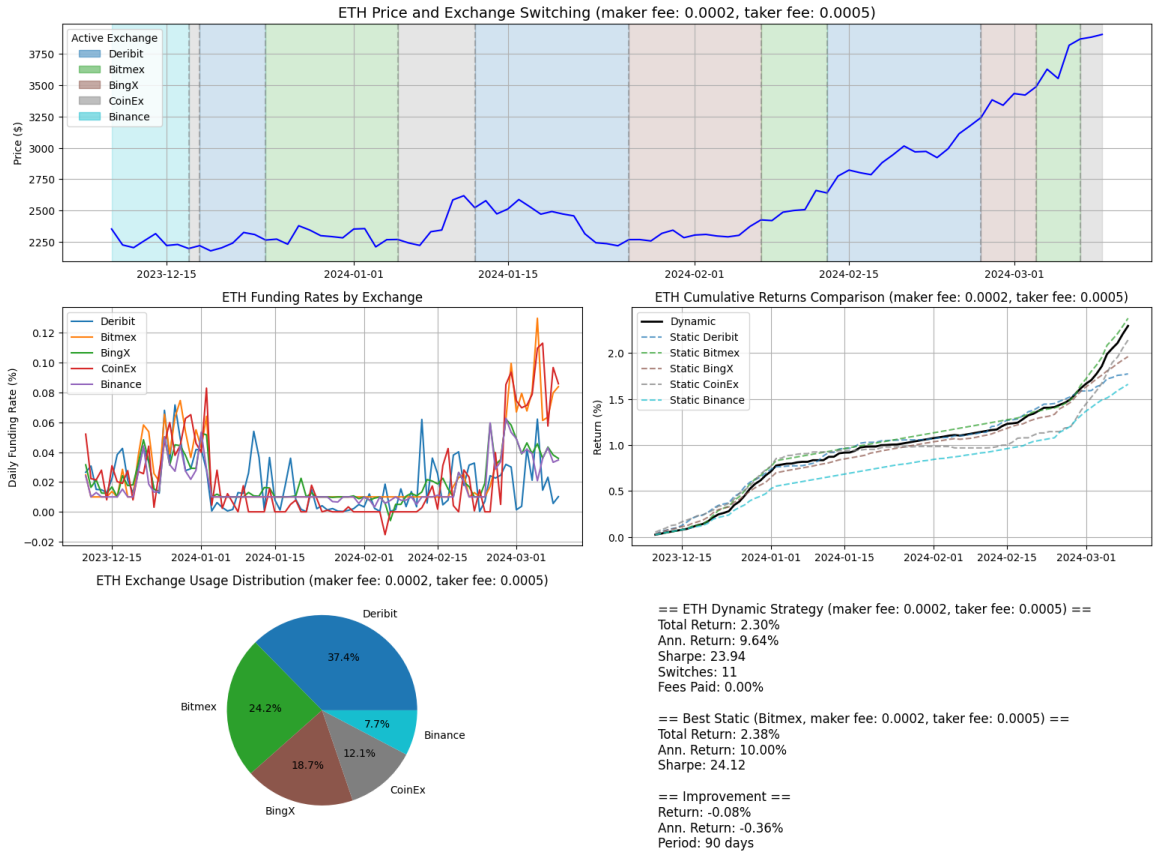


== BTC Dynamic Strategy (maker fee: 0.0002, taker fee: 0.0005) ==
Total Return: 2.28%
Ann. Return: 9.57%
Sharpe: 23.41
Switches: 11
Fees Paid: 0.00%

== Best Static (Bitmex, maker fee: 0.0002, taker fee: 0.0005) ==
Total Return: 2.24%
Ann. Return: 9.39%
Sharpe: 24.89

== Improvement ==
Return: 0.04%
Ann. Return: 0.18%
Period: 90 days

Figure 20: Maker 0.02%, Taker 0.05%: BTC, ETF Bullrun



== ETH Dynamic Strategy (maker fee: 0.0002, taker fee: 0.0005) ==
Total Return: 2.30%
Ann. Return: 9.64%
Sharpe: 23.94
Switches: 11
Fees Paid: 0.00%

== Best Static (Bitmex, maker fee: 0.0002, taker fee: 0.0005) ==
Total Return: 2.38%
Ann. Return: 10.00%
Sharpe: 24.12

== Improvement ==
Return: -0.08%
Ann. Return: -0.36%
Period: 90 days

Figure 21: Maker 0.02%, Taker 0.05%: ETH, ETF Bullrun

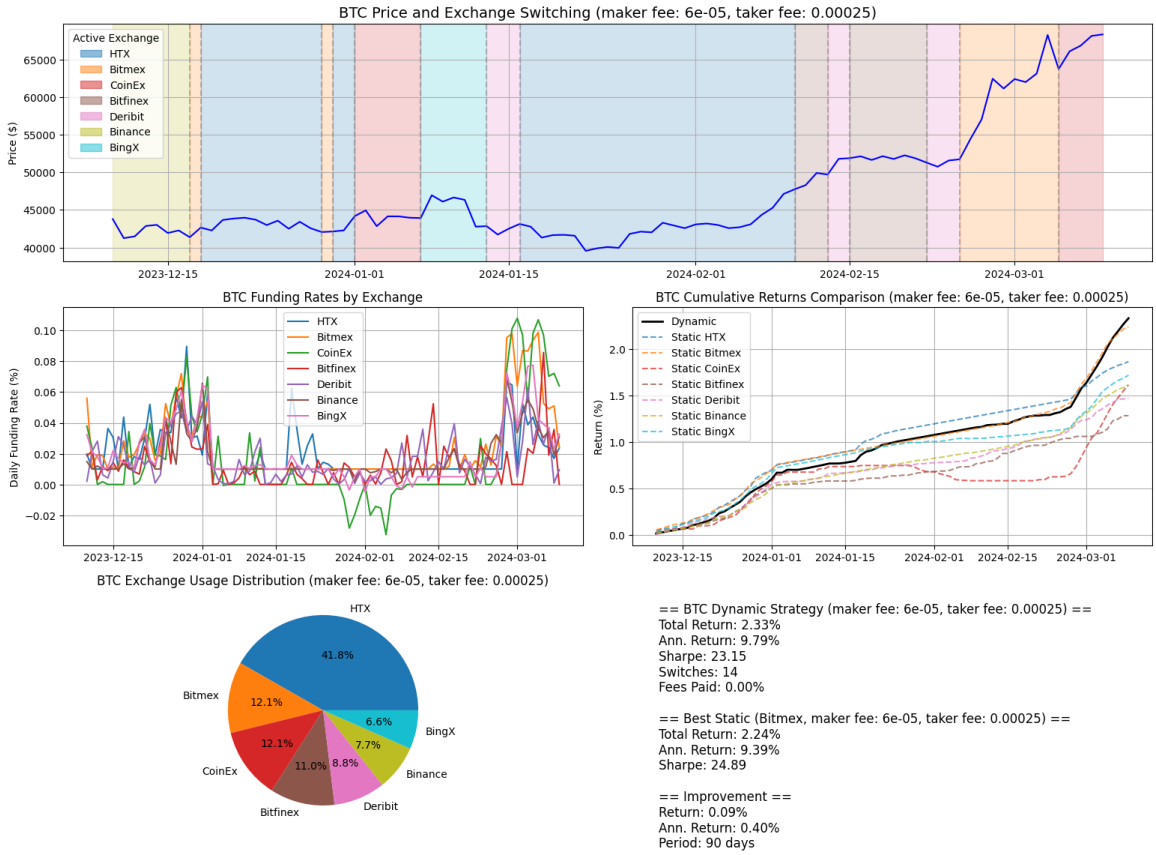


Figure 22: Maker 0.006%, Taker 0.025%: BTC, ETF Bullrun

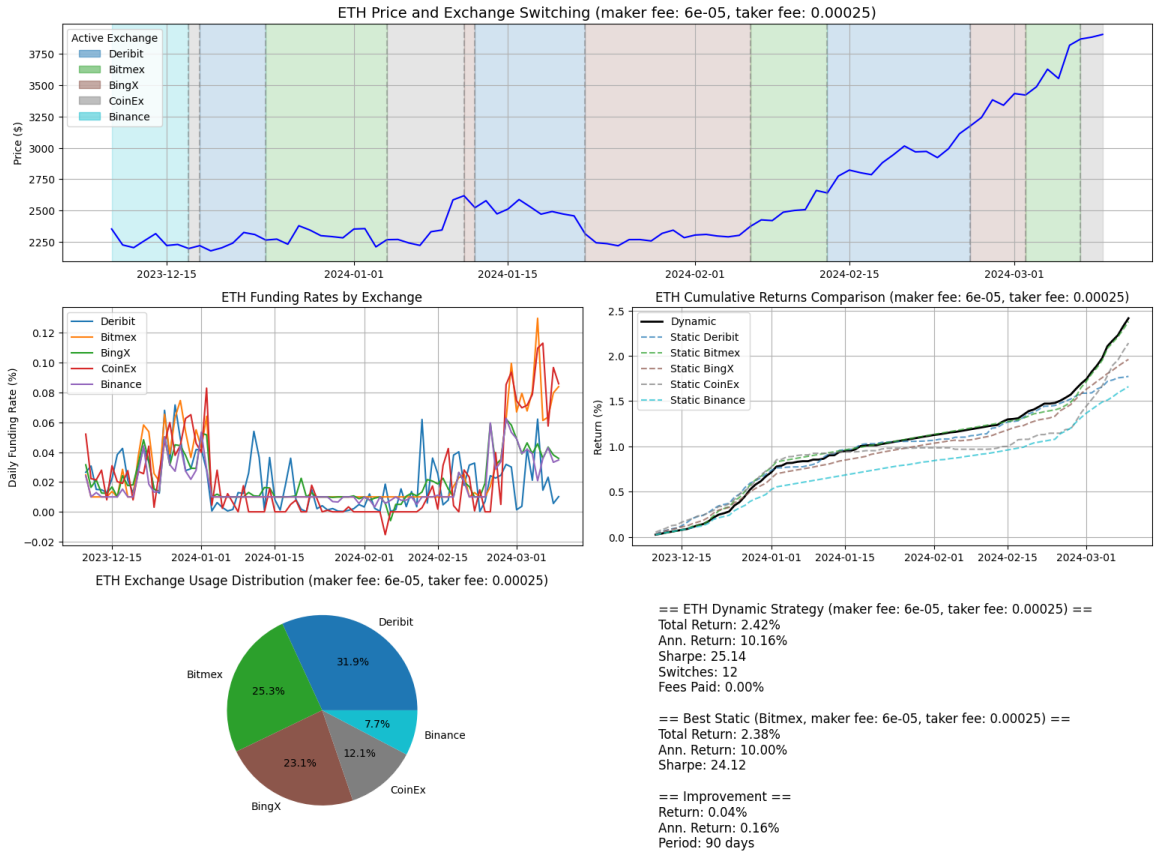


Figure 23: Maker 0.006%, Taker 0.025%: ETH, ETF Bullrun

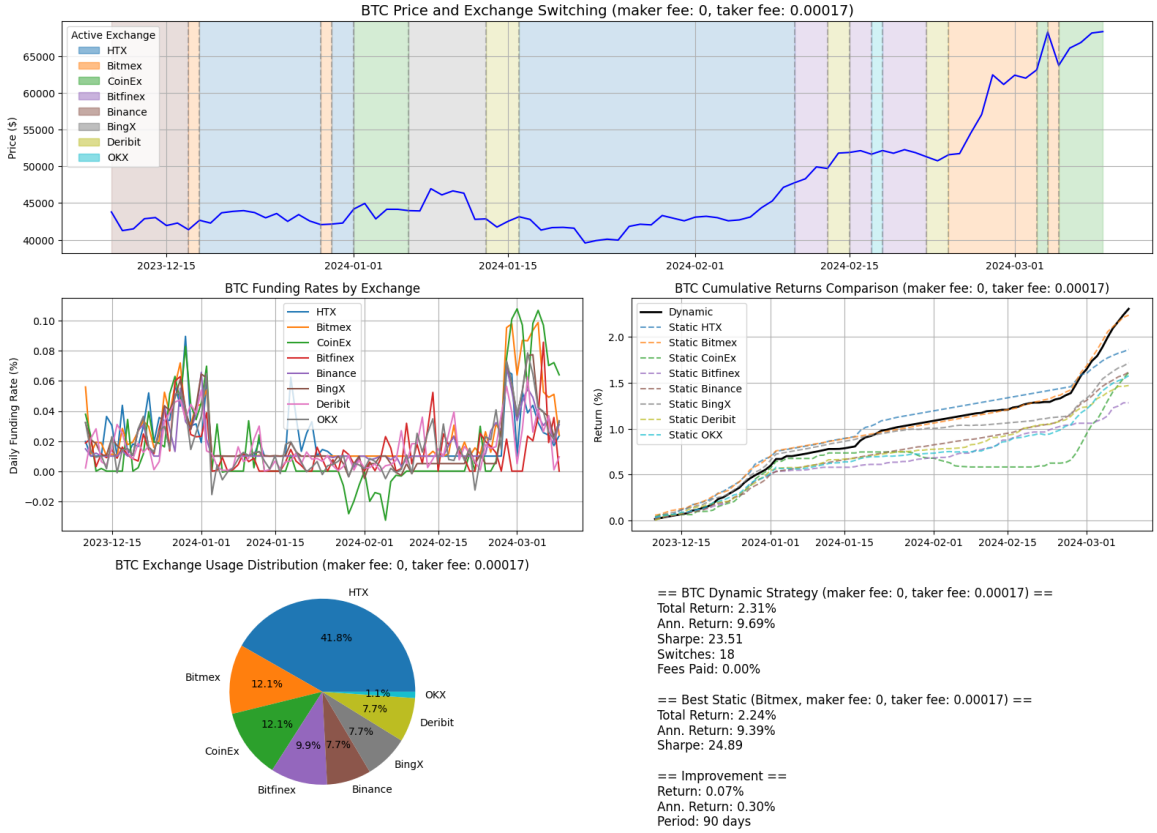


Figure 24: Maker 0%, Taker 0.017%: BTC, ETF Bullrun

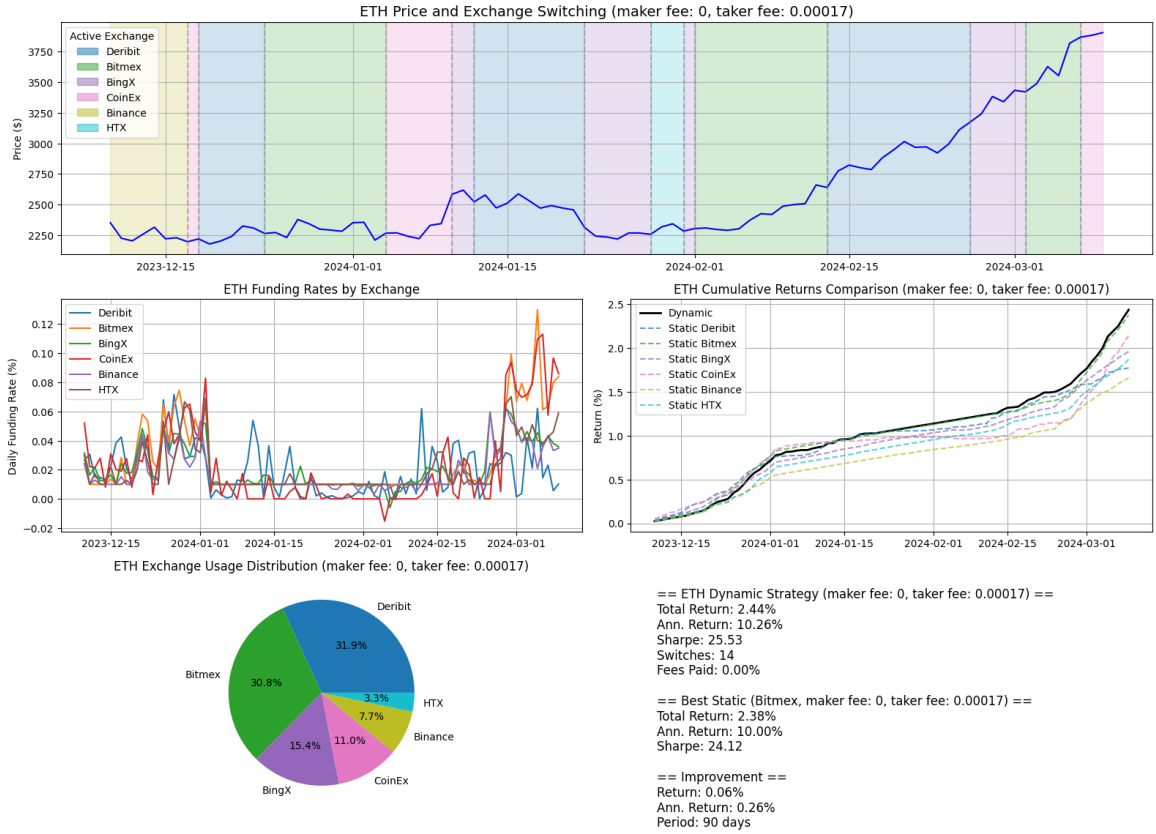


Figure 25: Maker 0%, Taker 0.017%: ETH, ETF Bullrun

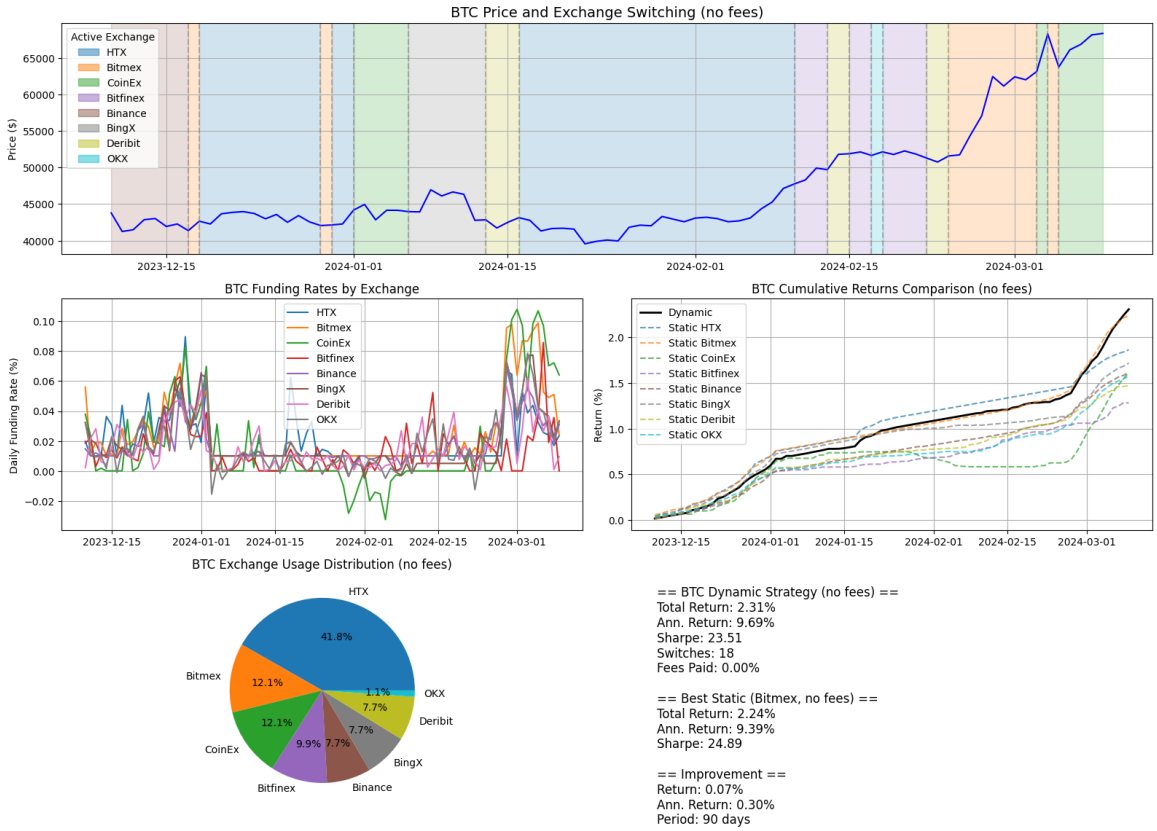


Figure 26: No Fees Scenario: BTC, ETF Bullrun

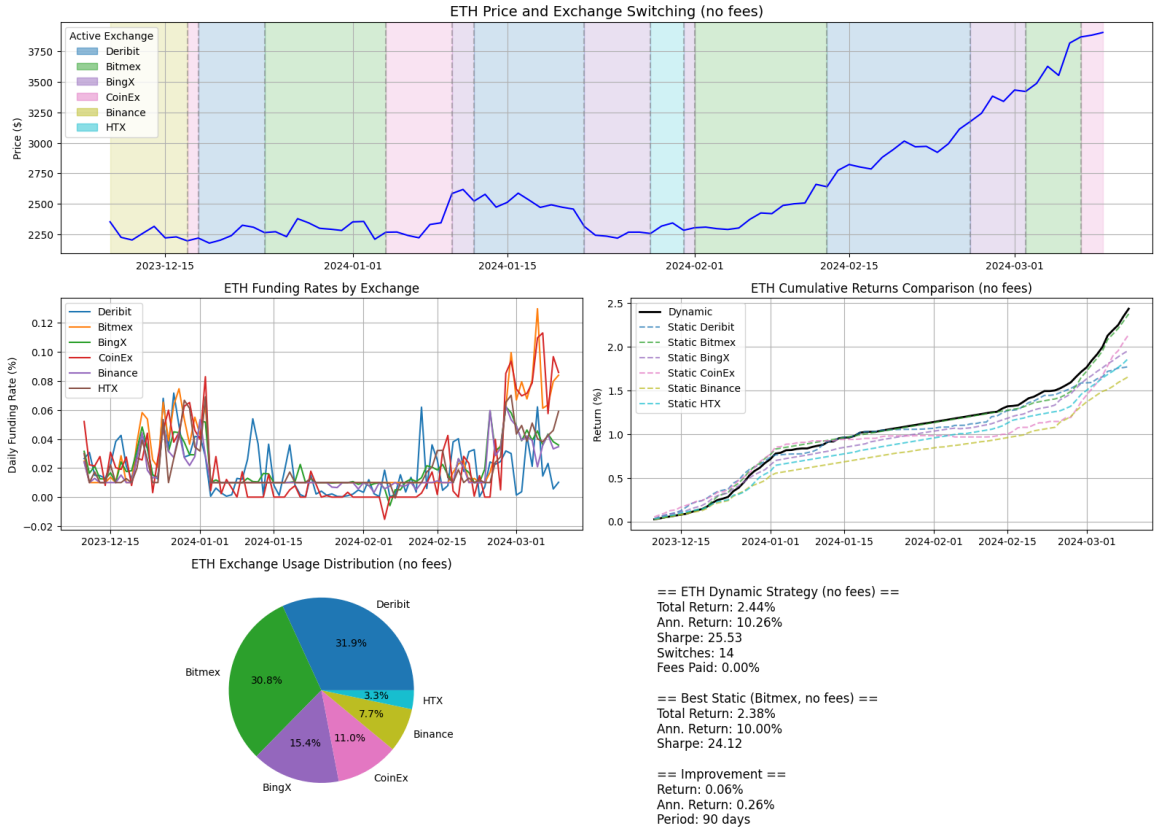


Figure 27: No Fees Scenario: ETH, ETF Bullrun

- *Optimal performance at zero maker fee:* In the extreme case (e.g., 0/0.00017 fees, accessible only to VIP 9+ traders on Binance with over $25B monthly volume), the dynamic strategy extracts the greatest benefit from funding rate arbitrage (Figures 24, 25). This confirms the intuitive advantage of frictionless execution in multi-venue trading.
- *No-fee baseline (idealized case):* The hypothetical no-fee setup provides a benchmark upper bound. Here, the dynamic strategy consistently dominates static alternatives in both BTC and ETH (Figures 26, 27). This suggests that, when fees are negligible, the flexibility of switching to the highest-yielding venue significantly improves carry trade efficiency.
- *Diminishing returns at high volumes:* While lower fees are attractive, achieving such tiers entails extremely high trading volumes and/or large locked collateral (e.g., thousands of BNB on Binance). In practice, this creates a trade-off: the theoretical benefits of fee reduction may be offset by operational frictions such as price impact, slippage, capital inefficiency, and exposure concentration. These are not reflected in our current quantitative metrics but are critical for practical deployment.

4.4 Practical Implementation Considerations

While our analysis demonstrates theoretical advantages to dynamic venue selection, several practical considerations moderate its implementation:

- **Capital Efficiency**: Maintaining margin across multiple venues reduces overall capital efficiency
- **Operational Complexity**: Multi-venue trading requires more sophisticated infrastructure and monitoring capabilities, necessiting frequent changes to be optimal.
- **VIP Tier Requirements**: Achieving optimal fee tiers on each exchange requires substantial trading volume, creating a paradoxical situation where the strategy performs best for traders who least need its marginal improvements
- **Market Impact**: Large position transfers between venues may impact execution quality

4.5 Conclusion

Our analysis demonstrates that even thought crypto market fragmentation creates persistent funding rate inefficiencies that can be exploited through strategic venue selection, in practice it is often very hard or near impossible to perfectly exploit funding arbitrage, unless very big resources are employed. For institutional traders with access to preferential fee structures and robust trading infrastructure, a dynamic multi-venue approach could generate meaningful returns beyond traditional single-venue carry trades. In practice, market makers and big traders often arbitrage the market by going long on the exchange with lowest funding for some asset, and conversely short on the asset with highest funding rate, also known as funding arbitrage. This in turn, tends to bring back funding rates to be nearly the same on all exchanges, especially for majors cryptocurrencies like BTC and ETH.

The efficiency of this approach increases with:

- Lower transaction costs (higher VIP tiers)
- Greater market volatility (which typically amplifies funding rate dispersion)
- More sophisticated execution infrastructure

These findings underscore the unique characteristics of cryptocurrency markets, where structural inefficiencies resulting from market fragmentation create alpha opportunities that would be rapidly arbitraged away in more centralized financial systems. While perfect efficiency remains elusive in traditional markets, the magnitude and persistence of crypto funding rate divergences represent a distinctive feature of this emerging asset class. It is often very hard for individuals to arbitrage these markets, and is often executed by market makers and professional investment firms.

A Appendix: Additional graphs

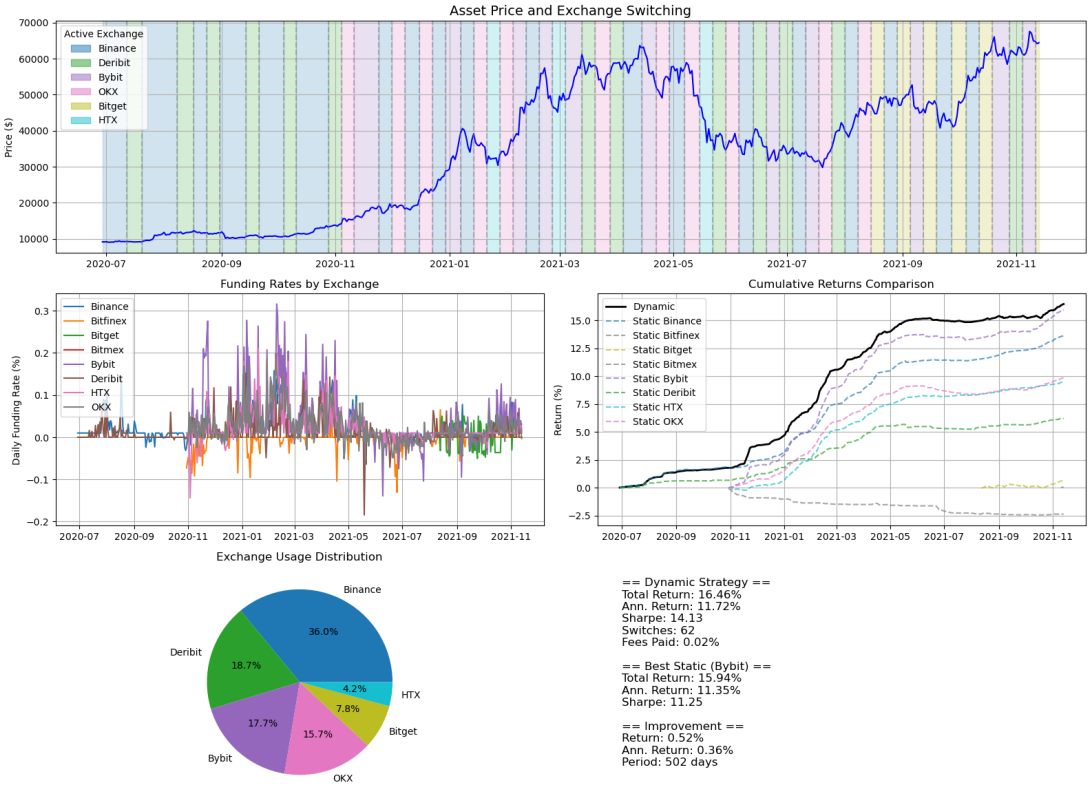


Figure 28: Maker 0.02%, Taker 0.02%: BTC, Bull Run 2021

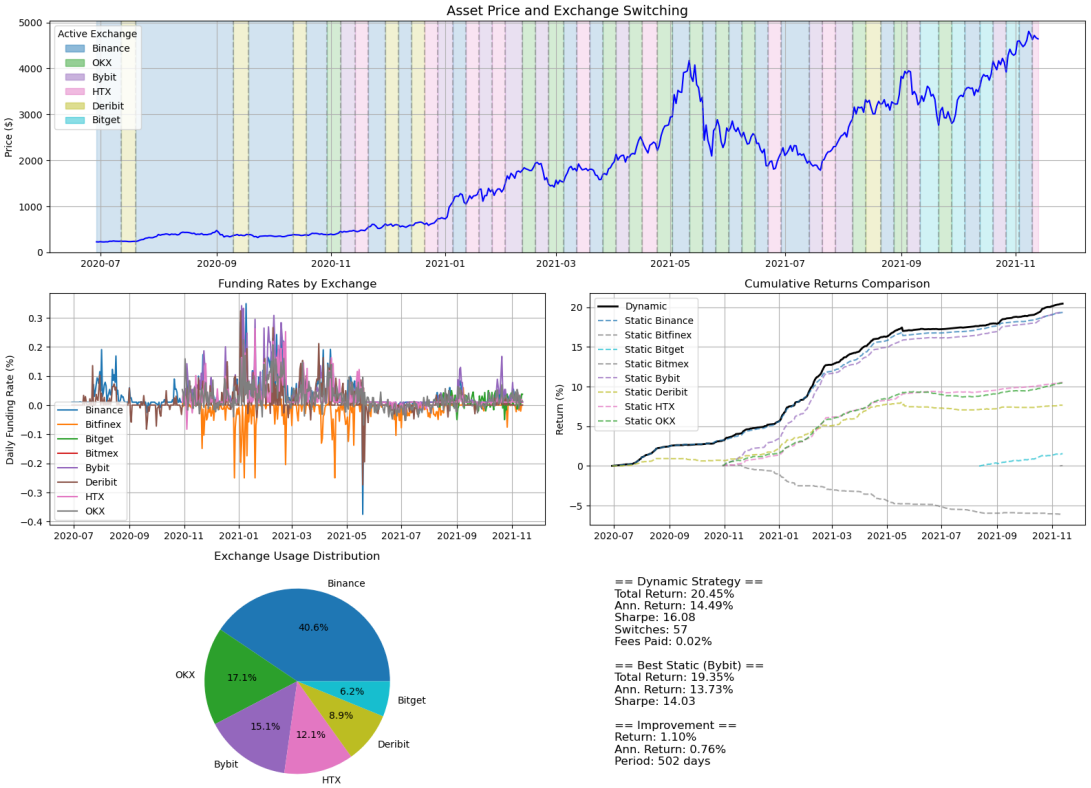


Figure 29: Maker 0.02%, Taker 0.02%: ETH, Bull Run 2021

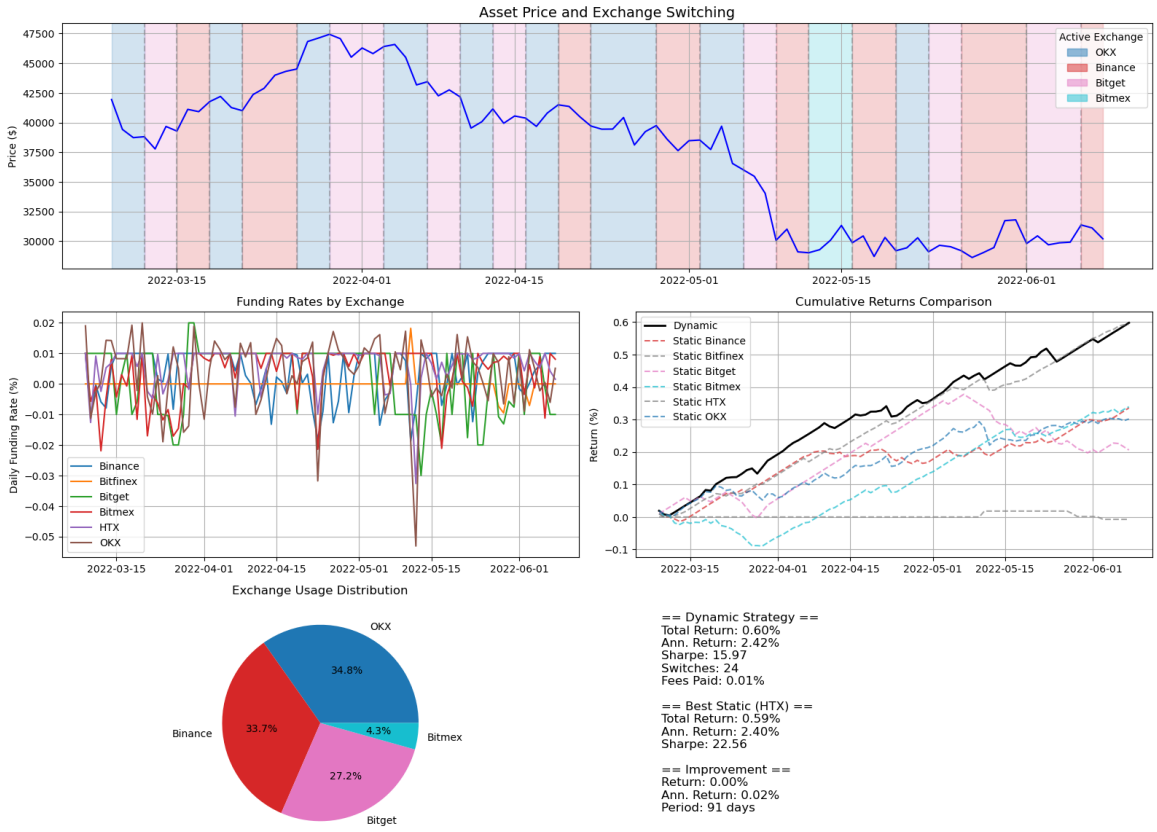


Figure 30: Maker 0.02%, Taker 0.02%: BTC, Luna Collapse

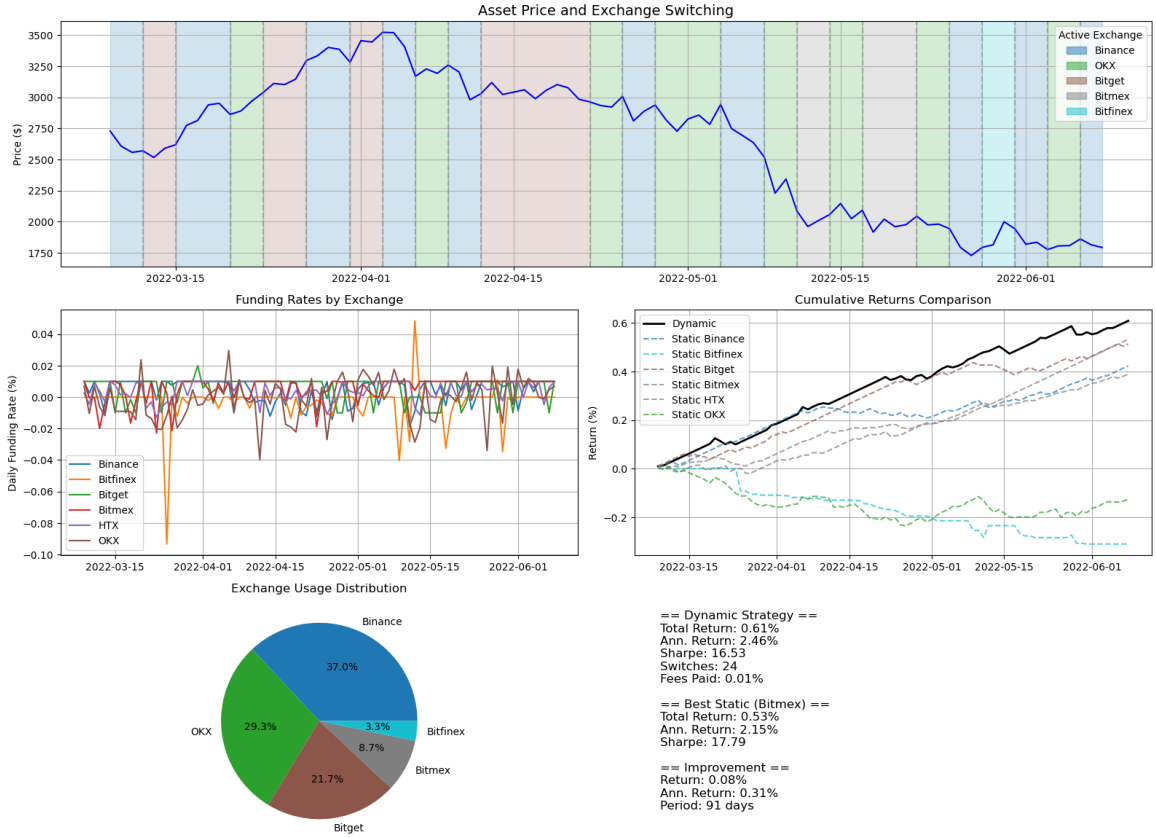


Figure 31: Maker 0.02%, Taker 0.02%: ETH, Luna Collapse

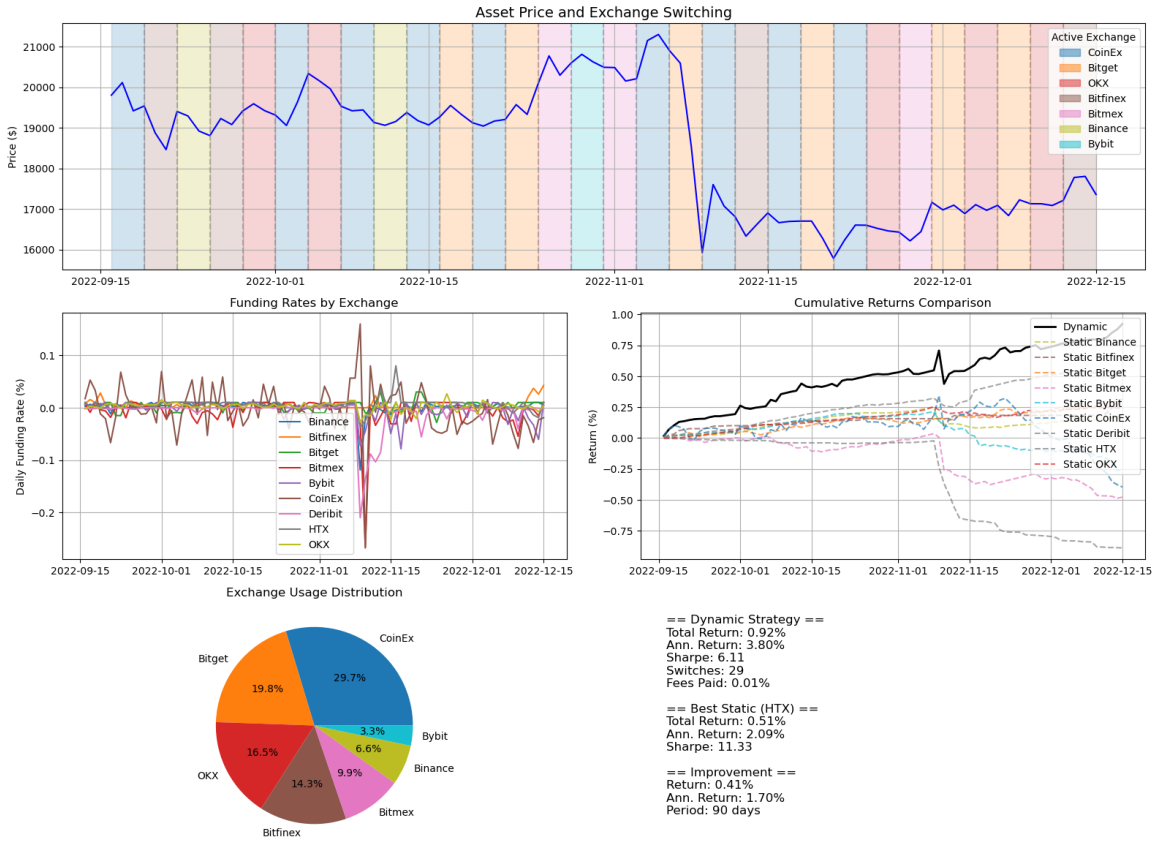


Figure 32: Maker 0.02%, Taker 0.02%: BTC, FTX Collapse

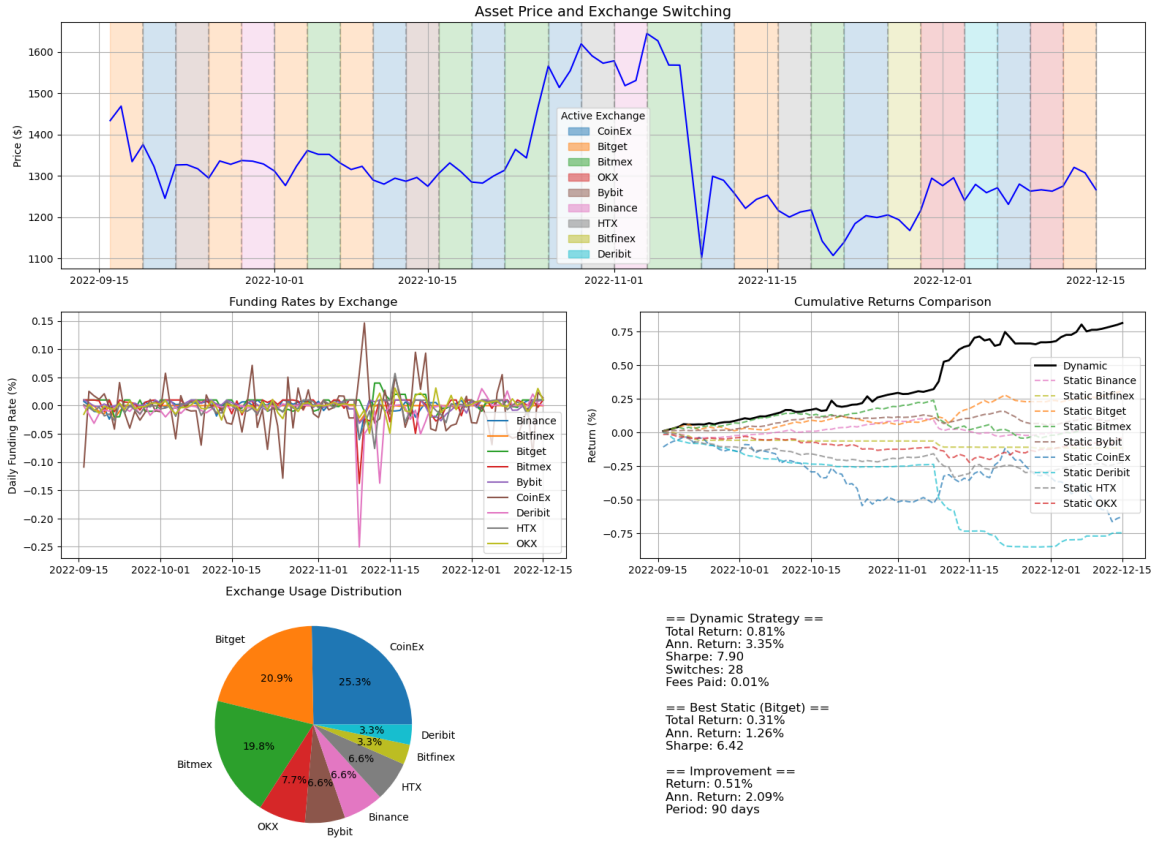


Figure 33: Maker 0.02%, Taker 0.02%: ETH, FTX Collapse

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