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To cite this article: Andrew M. Hornback & Robert E. Whaley (2025) Spot Bitcoin ETFs: The Struggle Was Worth It, Financial Analysts Journal, 81:2, 39-50, DOI: [10.1080/0015198X.2025.2458054](https://doi.org/10.1080/0015198X.2025.2458054)

To link to this article: <https://doi.org/10.1080/0015198X.2025.2458054>



Published online: 10 Mar 2025.



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# Spot Bitcoin ETFs: The Struggle Was Worth It

Andrew M. Hornback  and Robert E. Whaley 

Andrew M. Hornback is a PhD candidate in computer science at Georgia Institute of Technology, Atlanta, Georgia. Robert E. Whaley is Valere Blair Potter Professor of Management, and Director, Financial Markets Research Center, The Owen Graduate School of Management Vanderbilt University, Nashville, Tennessee. Send correspondence to Robert E. Whaley at [whaley@vanderbilt.edu](mailto:whaley@vanderbilt.edu).

Bitcoin has emerged as a promising addition to long-term investment portfolios due to its lack of correlation with traditional asset classes. Spot bitcoin exchange-traded funds (ETFs) provide a secure, familiar, and convenient way to invest in bitcoin. Since their launch on 11 January 2024, they have garnered more than \$75 billion in new assets under management and their performance relative to bitcoin futures and futures-based bitcoin ETFs has been nothing short of extraordinary. This study examines the performance of spot bitcoin ETFs during their first year of trading. In doing so, it highlights the complexities and inconsistencies in US regulatory decision-making.

**Keywords:** Bitcoin; bitcoin ETFs; bitcoin futures; contango; creation/redemption arbitrage; futures arbitrage; spot bitcoin

**Disclosure:** No potential conflict of interest was reported by the author(s).

The pace of financial innovation over the past five decades has been remarkable. In the 1970s, foreign exchange and long-term interest rate futures were introduced. The 1980s brought short-term interest rate futures and stock index futures and options, while the 1990s saw the emergence of volatility futures and options. These innovations fundamentally transformed financial markets, enabling the trading of hundreds of billions of dollars in such contracts daily. Today, these instruments are ubiquitous, often taken for granted as if they had always existed. Yet the struggles of the entrepreneurs and exchanges that pioneered these products are largely forgotten. They spent years—sometimes decades—educating regulators and advocating for the social value of these contracts before product launch.

This article is about innovation and regulation in the exchange-traded fund (ETF) industry and emphasizes the need for collaboration between the two. For instance, the 1987 stock market crash highlighted the necessity of real-time stock basket trading. In response, the Toronto Stock Exchange (TSE) partnered with the Ontario Securities Commission (OSC) to launch the Toronto Index Participation Shares (TIPS) ETF in 1990, just three years later. By contrast, the United States (US) faced a protracted six-year battle with the Securities and Exchange Commission (SEC) and entrenched market authorities before the SPDR S&P 500 (SPY) ETF debuted in January 1993.<sup>1</sup>

The delay in listing spot bitcoin ETFs in the US is even more striking. Despite ample evidence that bitcoin can be a useful diversifier in a long-term investment portfolio,<sup>2</sup> spot bitcoin ETFs were approved only after more than a decade of regulatory obstacles. Meanwhile, the SEC chose to approve a futures-based bitcoin ETF in the interim, raising questions about regulatory consistency.

Spot bitcoin ETFs debuted on 11 January 2024; a full year of data now exists with which to assess their performance. The results are remarkable. In their first year, these ETFs amassed \$75 billion in new assets under management (AUM)—an unprecedented figure in ETF history. Equally unprecedented was the simultaneous launch of 10 spot bitcoin ETFs, sparking fierce competition among issuers. So far, IBIT and FBTC

have led in asset growth, while GBTC has delivered the highest returns despite its relatively high fees. This article examines the first-year performance of spot bitcoin ETFs.

## The Struggle to List Spot Bitcoin ETFs

Spot bitcoin ETFs were launched in the US in January 2024 after a protracted regulatory battle spanning more than a decade. The first application for a spot bitcoin ETF was filed in July 2013 by the Winklevoss Bitcoin Trust under the ticker COIN. However, in March 2017, the SEC rejected the application, citing concerns about fraud and manipulation in the underlying bitcoin market, which lacked the regulation seen in US securities and commodity futures exchanges. Figure 1 summarizes key milestones in the history of bitcoin ETF applications and rejections.

On 20 January 2017, Grayscale filed an S1 with the SEC to convert its Grayscale Investment Trust (launched in September 2013) into an ETF. Initially available to accredited investors, the trust became publicly traded in May 2015 as a closed-end fund under the ticker GBTC, giving retail investors access to bitcoin. The ETF conversion would have enabled authorized participants to perform arbitrage between the ETF and the spot bitcoin market,

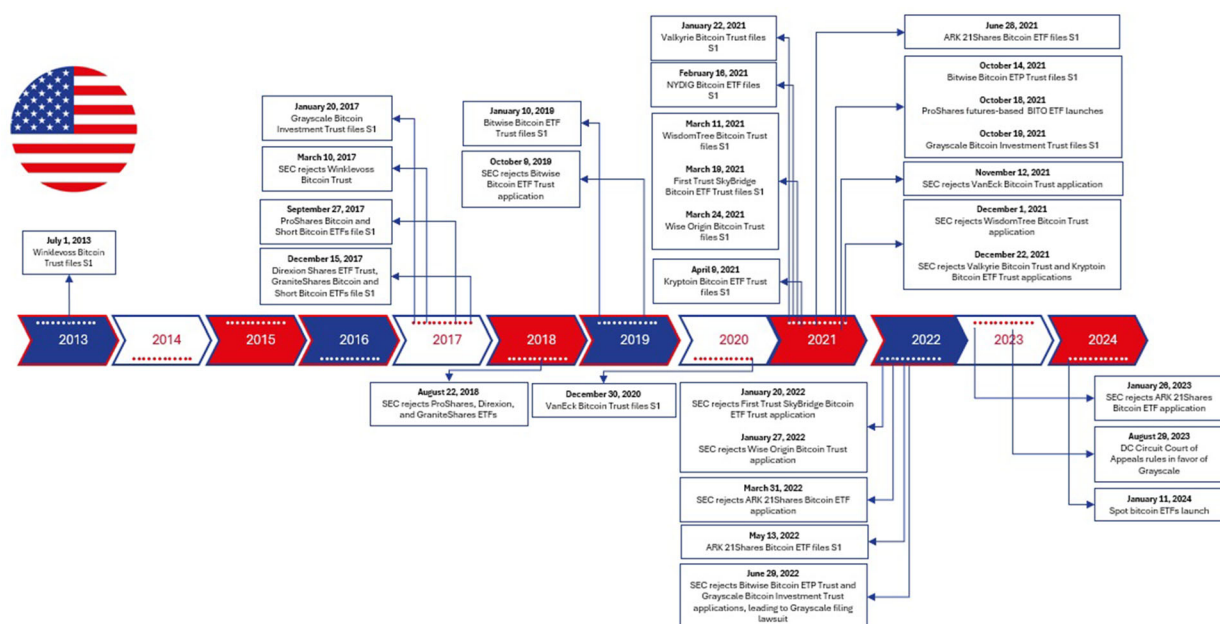
aligning the ETF's market price with its intraday intrinsic value. However, Grayscale withdrew the application after a few months, citing an unfavorable regulatory environment.<sup>3</sup>

Another significant milestone was ProShares' September 2017 filing for futures-based bitcoin ETFs, including both long (1x) and inverse (-1x) products. The SEC rejected both applications in August 2018. ProShares later reapplied with only the long futures-based ETF, which the SEC approved. The ProShares Bitcoin Strategy ETF (BITO) was launched on 19 October 2021. A fully collateralized futures position should theoretically track spot bitcoin performance if arbitrage is active between spot and futures markets.

The SEC's inconsistent approach to spot and futures-based bitcoin ETFs is puzzling. It rejected spot ETFs over concerns about bitcoin's vulnerability to fraud and manipulation in unregulated markets. Yet, it approved futures-based ETFs, arguing that Chicago Mercantile Exchange (CME) bitcoin futures trade in a regulated market. However, these futures derive their prices from a spot bitcoin index that relies on the same unregulated markets the SEC deemed problematic for spot ETFs.

After BITO's launch, Grayscale renewed its efforts to convert GBTC into an ETF, filing again with the SEC on 19 October 2021. The SEC denied the

Figure 1. Milestones in the Struggle to List Spot Bitcoin Exchange-Traded Funds (ETFs) in the US



application in June 2022, prompting Grayscale to file a lawsuit in the DC Circuit Court of Appeals. In August 2023, the court ruled unanimously in Grayscale's favor, vacating the SEC's denial. The court noted the clear financial relationship between spot bitcoin and bitcoin futures markets, calling the SEC's rationale "arbitrary and capricious." When the SEC declined to appeal the decision in October 2023, the path was cleared for GBTC's conversion and other spot bitcoin ETF to launch.

On 11 January 2024, GBTC was uplisted as an ETF and nine new spot bitcoin ETFs debuted. The effects of these events were immediate. **Figure 2** tracks the percentage premium/discount of GBTC's market price (MP) compared to its net asset value (NAV) before and after the ETF conversion. As a closed-end fund, GBTC's MP often deviated from its NAV due to a lack of active arbitrage. For example, GBTC traded at a 43% premium in July 2019 but at a 49% discount in December 2022.

When Grayscale argued its case in March 2023, the discount was 36%. It narrowed to 18% by August 2023, following the court's ruling, and to 16% after the SEC announced it would not appeal. By the 11

January 2024 launch date, the discount had shrunk to 1.6%. Since then, the premium/discount has stabilized near zero, with an average of  $-0.03\%$  and a median of  $-0.01\%$ , as illustrated by the flatline in the figure's right-hand section.

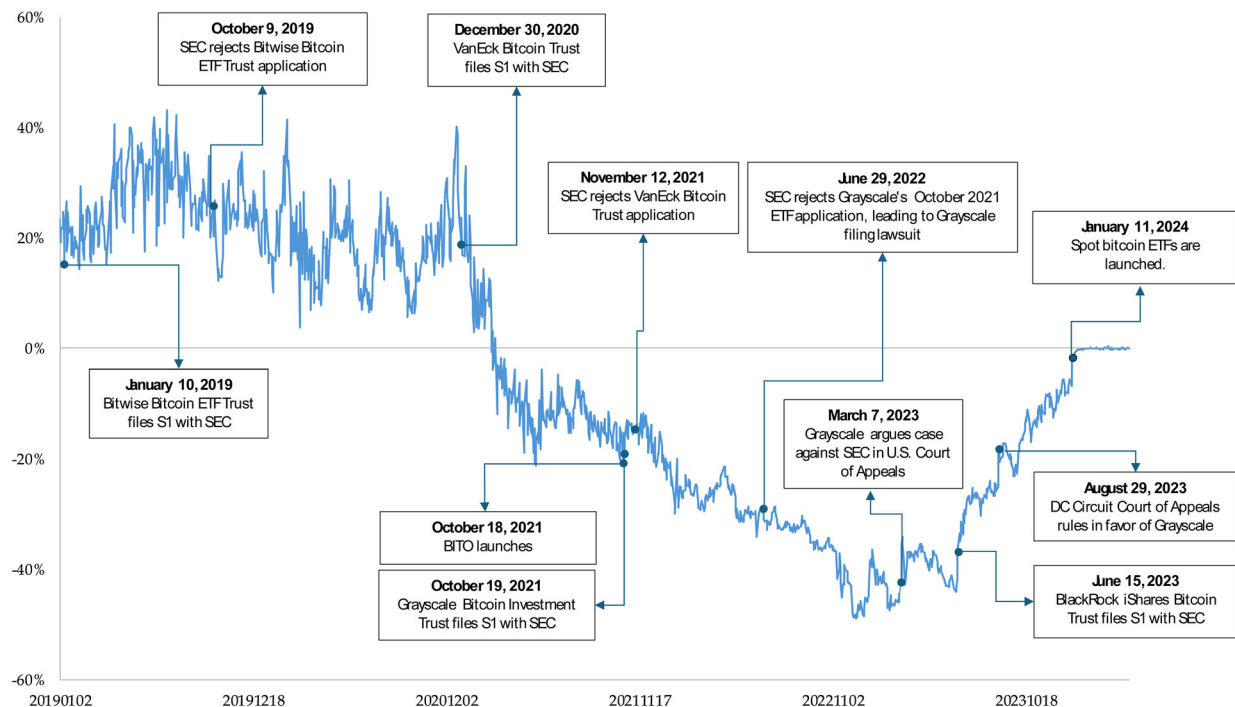
## Market Reaction to Spot Bitcoin ETFs

The US Court of Appeals' ruling went unchallenged, ending Grayscale's long regulatory battle. In the following months, regulators swiftly finalized the details for new spot bitcoin ETFs. On 11 January 2024, Grayscale and nine other issuers launched their spot bitcoin ETFs, marking a historic moment in the ETF industry: the first time multiple ETFs based on the same asset debuted simultaneously.<sup>4</sup>

## The New Products

An ETF has two key attributes: its expense ratio and its benchmark index. The benchmark index defines the ETF's expected performance before fees, while the expense ratio indicates how much of

**Figure 2.** Premium/Discount (%) of Grayscale Bitcoin Trust (GBTC) in the Years Preceding Its Conversion to an ETF Structure on 11 January 2024



Notes: The premium/discount is  $MP/NAV - 1$ , where MP is the market price per share and NAV is the net asset value per share.

Table 1. Attributes and Summary Statistics for Bitcoin ETFs as of 27 December 2024

Ticker	Name	Issuer information		Holding period in days				
		Expense ratio	Benchmark index	In millions		Market share	Average of ratios	Ratio of averages
				\$AUM	\$TVOL			
IBIT	iShares Bitcoin Trust Registered	0.25%	BRRNY	52,148	1,931	50.6%	18.7	15.5
GBTC	Grayscale Bitcoin Trust	1.50%	XBX	19,538	305	19.0%	64.9	41.8
FBTC	Fidelity Wise Origin Bitcoin Fund	0.25%	FBRR	19,138	388	18.6%	33.7	25.2
ARKB	ARK 21Shares Bitcoin ETF	0.21%	BRRNY	4,437	162	4.3%	29.1	22.2
BITB	Bitwise Bitcoin ETF	0.20%	BRRNY	3,825	118	3.7%	32.9	27.0
HODL	VanEck Bitcoin Trust	0.00%	BRRNY	1,295	20	1.3%	49.9	31.2
BRRR	Valkyrie Bitcoin Fund	0.25%	BRRNY	846	4	0.8%	133.6	74.9
BTCO	Invesco Galaxy Bitcoin ETF	0.25%	LPRR	736	18	0.7%	41.8	21.7
EZBC	Franklin Bitcoin ETF	0.19%	BRRNY	719	8	0.7%	57.6	38.5
BTCW	WisdomTree Bitcoin Fund	0.25%	BRRNY	365	5	0.4%	31.4	11.9
Total spot-based ETFs				103,046				
BITO	ProShares Bitcoin Strategy ETF	0.95%	None	2,306	473.4		9.6	6.8
Total bitcoin ETFs				105,352				

Notes: \$AUM = assets under management in US Dollar terms; \$TVOL = average daily trading volume in US Dollar terms; BRRNY = CME CF Bitcoin Reference Rate–New York Variant; ETF = exchange-traded fund; FBRR = Fidelity Bitcoin Reference Rate; LPRR = Lukka Prime Reference Rate; XBX = CoinDesk Bitcoin Price Index.

Source: Compiled from most recent information on issuer websites.

the return will be reduced by management fees. Table 1 presents the expense ratios and benchmark indexes for 10 spot-based bitcoin ETFs and the futures-based bitcoin ETF (BITO), which launched more than two years earlier.

As of 27 December 2024, the expense ratios of spot bitcoin ETFs ranged from 0.0% for HODL to 1.5% for GBTC. Most ETFs have settled at a standard expense ratio of 0.25%, including IBIT, FBTC, BRRR, and BTCO. ARKB's expense ratio is slightly lower, at 0.21%, but its market share for spot bitcoin ETFs is just 4.3%. BITB and EZBC have even lower expense ratios, but they also hold smaller market shares.

HODL recently reduced its expense ratio to 0.0%, a strategic move to increase its market share. In contrast, BITO, the futures-based ETF, has an expense ratio of 0.95%, which is significantly higher than all spot-based ETFs except GBTC.

Table 1 also includes additional summary statistics for bitcoin ETFs during their first year of trading, from 11 January 2024 to 27 December 2024. These statistics highlight key trends and dynamics. First, the competition among bitcoin ETF issuers has been fierce, with clear winners and losers. The biggest successes are IBIT and FBTC, both of which have captured significant market share. As

of 27 December 2024, IBIT held \$52.1 billion in AUM, representing 50.6% of the market, while FBTC followed with \$19.1 billion (18.6%). GBTC—despite experiencing a substantial decline in \$AUM—remains a major player with \$19.5 billion, making it the second-largest ETF. Interestingly, these differences in market share appear unrelated to expense ratios.

Second, IBIT leads as the most actively traded ETF, as measured by the average daily trading volume in dollar terms (\$TVOL). It is followed by FBTC and GBTC. These three ETFs are not only the largest in terms of \$AUM but are also the most actively traded. The market has spoken.

Third, \$AUM and \$TVOL also shed light on how investors use these ETFs. Dividing daily \$AUM by \$TVOL provides an estimate of the average holding period (AHP), expressed in days. To reduce daily noise, AHP can be calculated over the sample period either as the average of daily ratios or as the ratio of daily averages, both yielding qualitatively similar insights. IBIT's short holding period indicates that it is primarily used for speculative purposes rather than long-term investing. BITO, the futures-based ETF, is even more extreme, with an average holding period of fewer than 10 days. On the other hand, BRRR's longer holding period suggests that it appeals to long-term investors. As more long-term



investors grow comfortable with spot bitcoin as an asset class, the AHP for many ETFs can be expected to increase.

The bitcoin ETFs have different benchmark indexes to track bitcoin performance. Seven of the ten spot-based ETFs, including IBIT, use the CME CF Bitcoin Reference Rate–New York variant (BRRNY). GBTC relies on the CoinDesk Bitcoin Price Index (XBX), notable for having the longest historical data series. Fidelity and Invesco have developed proprietary benchmarks for their funds. BITO, the futures-based ETF, does not use a benchmark index but states that it seeks “results, before fees and expenses, that correspond to the performance of bitcoin.”<sup>5</sup> The construction and selection of benchmark indexes have proven to be valuable takeaways from the first year of bitcoin ETF trading. These choices influence performance comparisons and investor perceptions, underscoring the importance of thoughtful index design in a competitive market.

## Assets Under Management

Since the launch of spot bitcoin ETFs, three dominant players—IBIT, GBTC, and FBTC—now control 88.2% of total \$AUM. Table 2 and Figure 3 illustrate the strong investor demand for these products and how competition has shaped the market over time.

Before spot bitcoin ETFs debuted, GBTC held \$28.6 billion in AUM, while BITO, a futures-based ETF, managed \$2.2 billion, totaling \$30.7 billion. By 27 December 2024, total bitcoin ETF investments had soared to \$105.4 billion—more than a 240%

increase. No ETF launch in history has generated such extraordinary interest.

The growth in IBIT’s \$AUM has been remarkable, rising from \$0 on 11 January 2024 to \$52.1 billion by 27 December 2024. With a 49.5% market share, IBIT’s rapid ascent reflects BlackRock’s dominance as the largest ETF provider in the US, bolstered by its powerful marketing capabilities. GBTC experienced a decline in \$AUM, which was anticipated given its significantly higher expense ratio compared to other ETFs. Despite this, it remains a major player, holding \$19.5 billion. FBTC has also performed well, accumulating \$19.1 billion in AUM and capturing an 18.2% market share. The remaining seven spot-based bitcoin ETFs collectively attracted \$12.2 billion, representing 11.6% of the market. While this figure is smaller in scale, it reveals broader investor interest in bitcoin ETFs

Figure 3. Bitcoin ETF Assets Under Management in Millions of US Dollars from 11 January 2024 to 27 December 2024

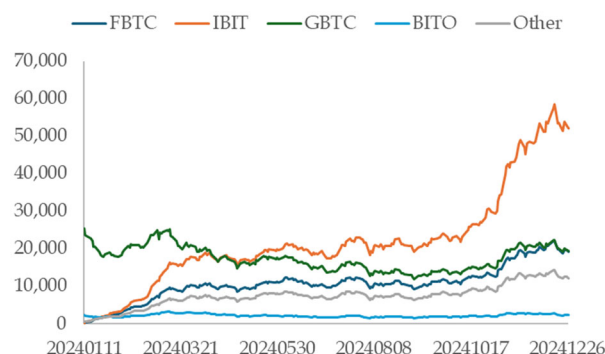


Table 2. Assets Under Management in Millions of US Dollars for the Three Largest Spot-Based Bitcoin ETFs (IBIT, GBTC, and FBTC) and the Largest Futures-Based ETF (BITO) on 11 January 2024 and 27 December 2024

Ticker	20240111		20241227		Percentage growth
	\$AUM	Percentage	\$AUM	Percentage	
IBIT			52,148	49.5%	
GBTC	28,581	92.9%	19,538	18.5%	–31.6%
FBTC			19,138	18.2%	
Other spot ETFs			12,222	11.6%	
BITO	2,187	7.1%	2,306	2.2%	5.5%
Total	30,768		105,352	100.0%	242.4%

Notes: \$AUM = assets under management in US Dollar terms; ETF = exchange-traded fund.

beyond the top three. The dramatic increase in bitcoin ETF investments underscores the unparalleled interest in these products. This growth outpaces any other ETF introduction in history, reflecting both the novelty of the asset class and the market's readiness for such offerings. Finally, [Figure 3](#) illustrates these trends, showing the rapid accumulation of \$AUM by IBIT and FBTC, the decline in GBTC, and the modest growth among other ETFs since 11 January 2024.

GBTC experienced a 31.6% decline in its \$AUM. While this loss might initially seem entirely attributable to its higher expense ratio of 150 bps compared to IBIT's 25 bps, this assumption overlooks a key factor. A substantial portion of the decline was due to GBTC shares being tied up in bankruptcy estates before its uplisting. Once GBTC transitioned to an ETF, these shares were sold—not because of its higher fees, but because GBTC's market price had recovered from a deep pre-uplisting discount to fair value, enabling the bankruptcy estates to repay creditors at fair value.

However, an offsetting factor for GBTC's market share is the potential capital gains tax liability faced by its long-term investors. Many early investors in the Grayscale Bitcoin Trust acquired their shares at much lower prices. Selling those shares to switch to a lower-cost provider would trigger significant capital gains taxes, providing an incentive to remain invested despite GBTC's higher fees.

The long-term trajectory of GBTC's market share relative to major competitors like IBIT and FBTC remains uncertain. Expected annual revenue can be measured by multiplying \$AUM by the expense ratio. At current \$AUM levels, GBTC generates approximately \$293.1 million in annual revenue (\$19,538 million  $\times$  0.015), compared with IBIT's \$130.4 million. This significant revenue advantage emphasizes the financial impact of GBTC's higher expense ratio, even as competitive pressures reshape the market.

Despite its relatively high 0.95% expense ratio, BITO has managed to slightly grow its AUM. This may seem surprising, but its first-mover advantage, granted by the SEC, plays a key role. As [Table 1](#) suggests, BITO is primarily used for speculative trading rather than long-term investment.

Whether BITO's AUM will decline over time remains uncertain, but significant outflows seem likely. IBIT, for instance, has an average daily

trading volume more than four times higher than BITO's and an expense ratio nearly one-quarter of BITO's, making it a more attractive choice for many investors. However, BITO's established presence and specialized use case may help sustain its market share.

## Bitcoin ETF Performance

To assess the performance of the bitcoin ETFs, we download daily total return index data for both spot and futures-based bitcoin ETFs, along with their respective benchmarks, covering the period from 11 January 2024 to 27 December 2024. These data are sourced from Bloomberg. We conduct five related analyses to evaluate performance.

First, we calculate the return performance of each ETF to establish a baseline. Next, we analyze the returns of the underlying bitcoin benchmark indices to understand how the ETFs would have performed without management fees. We show that the choice of benchmark index complicates the performance comparison.

The remaining three analyses focus on tracking differences and risk-adjusted performance. For simplicity, we concentrate on the daily returns of the three largest spot bitcoin ETFs (GBTC, IBIT, and FBTC) and the futures-based BITO ETF. All results are summarized in [Table 3](#).

## Bitcoin ETF Returns

Panel A of [Table 3](#) provides a summary of the daily returns for the four ETFs. The "holding period return" represents the total return from 11 January to 27 December 2024 (242 trading days), and "annualized volatility" is the annualized standard deviation of the logarithmic returns. The "return/risk ratio" is calculated by dividing the return by the risk (volatility).

The return results are surprising. If all ETFs tracked the same spot bitcoin index before fees, their after-fee returns should follow a predictable order: IBIT and FBTC (both with 0.25% expense ratios) tied for first, followed by BITO (0.95%) and then GBTC (1.50%). Despite GBTC's expense ratio being six times higher than IBIT's and FBTC's, it delivered a 104.5% return: nearly 500 bps higher than IBIT and FBTC. Even more unexpectedly, BITO's return lagged

**Table 3. Return Analysis of Bitcoin ETFs and Underlying Benchmarks from 11 January 2024 to 27 December 2024**

*Panel A: ETF return summary*

Description	GBTC	IBIT	FBTC	BITO
Holding period return	104.47%	101.58%	101.86%	90.80%
Annualized volatility	56.92%	57.18%	57.24%	57.61%
Return/risk ratio	1.836	1.776	1.779	1.576

*Panel B: Index return summary*

Description	XBX	BRRNY	FIDBCRP	SPBTCFUT	SPBTFDUT	EFFR
Holding period return	104.34%	102.27%	101.83%	92.64%	93.27%	5.15%
Annualized volatility	56.28%	55.04%	55.55%	57.63%	57.74%	0.20%
Return/risk ratio	1.854	1.858	1.833	1.607	1.615	25.986
Correlation	1.000	0.990	0.992	0.998	0.998	0.038

*Panel C: Tracking performance summary—specified benchmark*

Description	GBTC	IBIT	FBTC	BITO <sup>a</sup>	BITO <sup>b</sup>
Tracking difference	0.13%	−0.69%	0.03%	−1.84%	−2.47%
Tracking volatility	3.77%	8.92%	7.64%	3.10%	3.12%

*Panel D: Tracking performance summary—XBX benchmark*

Description	GBTC	IBIT	FBTC	BITO
Tracking difference	0.13%	−2.77%	−2.48%	−13.55%
Tracking volatility	3.77%	3.85%	3.91%	4.41%

*Panel E: Risk-adjusted performance summary—XBX benchmark*

Description	GBTC	IBIT	FBTC	BITO
Relative volatility	1.011	1.016	1.017	1.024
Beta	1.008	1.014	1.015	1.021
Total risk adjustment	−0.99%	−4.35%	−4.17%	−15.89%
Systematic risk adjustment	−0.77%	−4.13%	−3.94%	−15.61%

Notes: ETF = exchange-traded fund.

Total number of trading days is 243, and the total number of daily returns is 242.

<sup>a</sup>Tracking difference of BITO using SPBTCFUT benchmark.

<sup>b</sup>Tracking difference of BITO using SPBTFDUT benchmark.

behind those of IBIT and FBTC by more than 1,000 bps. We explore these anomalies later in this section.

The return volatilities of the four ETFs hover around 57%, with GBTC being the lowest at 56.9%. The return/risk ratios mirror the order of the holding period returns: GBTC has the highest ratio at 1.84, and BITO has the lowest at 1.58.

## Bitcoin Index Returns

One possible reason for the return differences in Panel A of Table 3 is that the ETFs track different benchmark indexes. Panel B of Table 3 details five such indexes, with GBTC's benchmark, XBX, showing the highest holding period return at 104.3%.

XBX is based on 4:00 PM ET bitcoin prices from major cryptocurrency exchanges, including Coinbase, Bitstamp, itBit, Kraken, Gemini, and LMAX Digital. This makes it well suited for performance evaluation, as all bitcoin ETFs use 4:00 PM ET closing prices. In contrast, the BRRNY and FIDBCRP benchmarks have returns more than 200 bps lower. Although they also use prices from the same exchanges, their calculation methods differ. BRRNY averages the volume-weighted median trade prices during each five-minute interval in the last hour before 4:00 PM ET, while FIDBCRP is based on a single volume-weighted median price over that period.

Because BRRNY and FIDBCRP reflect prices closer to 3:30 PM ET, their lower returns likely result from



bitcoin prices rising in the final 30 minutes of trading. If prices had fallen instead, the inverse would be true. This 3:30 PM ET pricing also makes them less reliable for performance comparisons. Additionally, XBX has higher return volatility (56.3%) than BRRNY (55.0%) and FIDBCRP (55.6%) due to differences in index construction. While all spot-based indexes diversify across exchanges, BRRNY and FIDBCRP also diversify across time.

BITO's benchmark is more ambiguous. According to its 30 September 2024 Fact Sheet, ProShares states:

BITO seeks results, before fees and expenses, that correspond to the performance of bitcoin.

On the surface, this suggests that BITO's benchmark is spot bitcoin. However, because BITO holds a fully collateralized position in bitcoin futures, a more appropriate benchmark would be a futures-based bitcoin index. S&P offers two such indexes. SPBTCFUT represents a fully collateralized investment in nearby bitcoin futures and Treasury bills, rolled each month from the nearest contract to the second-nearest starting six days before expiration. SPBTDFUT, on the other hand, rolls futures contracts daily to maintain a constant maturity of about 30 days. Whaley (2022) analyzes BITO's futures holdings and concludes that ProShares typically holds as much of the nearby contract as allowed, supplementing the second-nearest contract as needed. Given this, SPBTCFUT seems to be the most appropriate benchmark for BITO.

Panel B of Table 3 reports summary statistics for both futures-based indexes. The holding period return for SPBTCFUT is 92.6%, while SPBTDFUT returned 93.3%. These returns are more than 1,000 bps below XBX, and their return volatilities are more than 100 bps higher. This highlights a key distinction: futures-based indexes behave differently than spot-based indexes.

## Bitcoin Futures Are a Drag

From the inception of the US ETF industry in 1993 until early 2006, all ETF offerings were physical replication products. In these ETFs, issuers directly held the securities or assets of the underlying benchmark index. For example, State Street launched the first ETF, SPY, on 22 January 1993, which tracked the S&P 500 index by holding its constituent stocks. BlackRock followed with the first

four bond ETFs in 2002: SHY, IEF, and TLT, which held US Treasury bonds with different maturities, and LQD, which held investment-grade corporate bonds. On 18 November 2004, State Street also launched GLD, the first commodity ETF that physically held gold.

By 2006, innovation in the physically replicated ETF market had slowed. While there was investor demand to hold other asset classes such as commodities and volatility, physical replication became challenging due to the high cost or impracticality of holding the spot assets. The solution was to create new ETFs using fully collateralized futures strategies. In early 2006, DBC—a commodity futures index ETF—and USO—a crude oil futures ETF—were introduced. DBC allowed for synthetic exposure to diversified commodities, and USO enabled trading in crude oil futures. In 2009, Barclays launched VXX, a volatility-focused ETF based on a futures index. These products held cash and futures contracts, rather than physical assets. Interestingly, when the first bitcoin ETF was launched on 18 October 2021, it was also a fully collateralized futures-based product, despite the availability of direct spot bitcoin investment.

To understand how futures-based ETFs work, we need to explore the relationship between the price of bitcoin futures and the spot bitcoin price. According to basic economic principles, if two investments offer identical outcomes at a future time  $T$ , they must have the same price today, or else arbitrage opportunities would exist. To demonstrate this, imagine an individual who wants to hold spot bitcoin at a future time  $T$  for a known price today. There are two alternatives:

1. Buy a bitcoin futures contract today. Upon expiration at time  $T$ , the individual pays the futures price,  $F$ , and receives the spot bitcoin.
2. Buy spot bitcoin today at the current price  $B$ , finance the entire purchase at an interest rate,  $r$ , and hold the bitcoin until time  $T$ . This might involve incurring storage costs,  $s$  (although the costs of holding bitcoin are trivial).

Because both alternatives lead to the same future outcome, their prices must be identical today, establishing the link between spot bitcoin and bitcoin futures prices. Thus,

$$Be^{(r+s)T} = Be^{cT} \quad \text{or} \quad F = Be^{cT} \quad (1)$$

Where  $F$  and  $B$  are the bitcoin futures and spot prices,  $T$  is the time to futures contract expiration,

and  $c$  is the “bitcoin carry rate.” The “implied” bitcoin carry rate can be determined for each contract futures contract expiration using:

$$c = \frac{\ln(F/B)}{T} \quad (2)$$

For certain assets, futures arbitrage is hindered by trading costs or other constraints. In the VIX futures market, for instance, the cost-of-carry relationship does not hold because trading the spot VIX is too expensive. The spot VIX is a portfolio of hundreds of S&P 500 index options, which must be rebalanced daily. This makes it impractical to trade the spot VIX on an intraday basis. Without a tradable spot VIX, arbitrage opportunities are not possible. VIX futures prices are determined by supply and demand at each contract maturity, meaning that the shape of the futures curve can vary.<sup>6</sup>

This issue is not limited to the VIX futures market; it applies to most commodity futures markets as well. Like the VIX, commodities such as crude oil, natural gas, grains, and livestock are considered “non-carry markets.” In these markets, futures prices are set by supply and demand at each contract maturity, and the cost-of-carry relationship does not necessarily apply.

In contrast, the bitcoin futures market does have an “anchor.” The spot bitcoin market is deep and liquid, whereas the bitcoin futures market is smaller, with less than 1% of the dollar value outstanding and about 5% of the trading volume. Despite the smaller size, there are no clear barriers to arbitrage in the bitcoin futures market, so the futures relationship should theoretically hold. However, it does not.

**Figure 4.** Prices of Spot Bitcoin and Bitcoin Futures at the Close on Tuesday, 28 May 2024

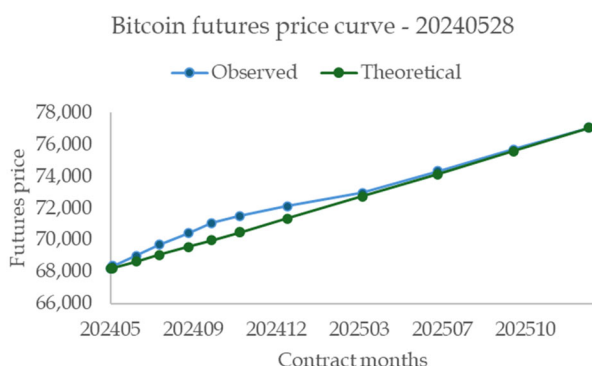


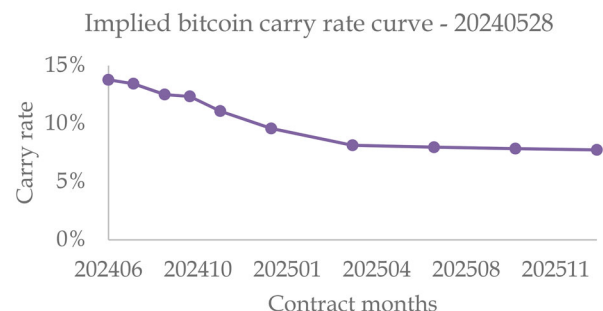
Figure 4 illustrates the bitcoin futures price curve as of 28 May 2024. The observed prices are shown in the blue line, while the theoretical futures prices—based on the implied carry rate of the December 2025 futures contract (7.7%)—are represented by the dark green line. The use of this implied carry rate ensures that the theoretical curve matches the observed curve at its starting point vertical axis (i.e., the spot bitcoin price) and ends at the price of the most distant futures contract traded on that day (the December 2025 futures contract). As expected, the bitcoin futures market is in contango, where futures prices are higher than the spot price.

The observed term structure of bitcoin futures prices can be converted into contract-specific carry rates using Equation (2). If the bitcoin futures market were a “carry market,” the carry rates would be relatively flat, indicating that the price difference between contracts is consistent across time. However, this is not the case.

Figure 5 shows the implied carry rates for different bitcoin futures contracts. For instance, the June 2024 futures contract has an implied carry rate of 13.8%, followed by 13.4% for July 2024 and 12.5% for August 2024. The most distant contract, December 2025, has a carry rate of 7.7%, as mentioned earlier.

These varying carry rates indicate that the bitcoin futures market behaves more like a “non-carry market,” where prices are influenced by other factors, such as supply and demand at each contract maturity, rather than the typical relationship between spot and futures prices seen in carry markets. The question remains: why does the bitcoin market behave this way?

**Figure 5.** Bitcoin Carry Rates at the Close on Tuesday, 28 May 2024



The answer may be “limits to arbitrage.” To drive the futures price back into a carry relation, the arbitrageur must buy spot bitcoin and sell the futures in two separate markets.<sup>7</sup> Selling just a single bitcoin future exposes the liquidity provider to substantial risk. The market price of a single contract is about \$500K, and bitcoin prices are highly volatile. A spike upward in the bitcoin futures price would force the arbitrageur to add cash to their position because the futures are marked-to-market daily. The contango observed in the bitcoin futures market reflects a risk premium demanded on the short futures position. The implied carry rate of the June 2024 bitcoin futures in Figure 4 is 13.8%, well above the bitcoin carry cost rate (i.e., interest plus storage).

## Tracking Performance

The unusual bitcoin futures price curve is reflected in the tracking performance of the ETFs. Panel C of Table 3 shows how each of the four funds performed relative to its benchmark. The “tracking difference” is the holding period return of the ETF over the 243-day sample period minus the holding period return of its benchmark. “Tracking volatility” represents the annualized volatility of the difference in the daily return of the ETF compared to its benchmark.

Of the spot bitcoin ETFs, only GBTC and FBTC outperformed their benchmarks. Their tracking differences were small, at 0.13% and 0.03% respectively. However, it is interesting to note that Grayscale was able to overcome its 150 bps management fee. In contrast, FBTC’s fee was only 25 bps. At the other extreme, BITO underperformed both of its assumed benchmarks by around 200 bps, which is much more than its expense ratio of 95 bps. This suggests that BITO’s undefined replication strategy performed worse than the more transparent and tradable S&P 500 bitcoin futures indexes.

The tracking differences for IBIT and FBTC are not very meaningful because they do not have contemporaneous prices. This is reflected in their higher tracking volatilities compared to the other ETFs.

Because all ETFs use different benchmarks, making direct comparisons is challenging. One approach is to compute tracking errors based on the 4:00 PM ET prices of the ETFs relative to the price of spot bitcoin at the same time. XBX is the only spot-based benchmark that does this. While SPBTCFUT

and SPBTDFUT are also based on 4:00 PM ET prices, they are futures-based indexes that perform much worse than XBX.

The results in Panel D of Table 3 show the same GBTC performance as in Panel C, but with some new findings. First, IBIT and FBTC underperformed spot bitcoin by more than 200 bps, significantly more than their expense ratios of 25 bps. The remaining underperformance may be due to slippage in the replication strategy. Second, BITO lost 13.6% compared to spot bitcoin, making it an inferior choice for long-term investors. Third, the tracking volatilities for GBTC, IBIT, and FBTC are similar, while BITO has higher tracking volatility, reflecting the greater liquidity and depth of the bitcoin spot market compared to the futures market.

## Risk-Adjusted Performance

A potential criticism of the tracking performance presented in Panel D of Table 3 is that it does not account for the different risk levels of the ETFs. Panel E aims to address this by adjusting for these differences. It provides four key pieces of information. “Relative volatility” is the ratio of the estimated standard deviation of the excess return of the ETF (i.e., the daily ETF return less the daily Fed funds return) to the standard deviation of the XBX excess return. “Beta” is estimated from an ordinary least squares regression of the excess return on the ETF on the XBX excess return. The two risk-adjusted performance measures, denoted  $RA_{ETF}$ , are based on the “total risk adjustment” provided by the relative volatility (row 1) and the “systematic risk adjustment” provided by beta (row 2). The abnormal returns are defined by:

$$AR_{ETF} = (R_{ETF} - r) - (R_{XBX} - r) \times RA_{ETF} \quad (3)$$

Where  $AR_{ETF}$  is the abnormal return of the ETF,  $R_{ETF}$  ( $R_{XBX}$ ) is the holding period return of the ETF (XBX), and  $r$  is the risk-free return. The results reported in Panel E have the same rank ordering of performance as those of Panel D because the relative volatility and beta risk measures are near one.

## A Trading Game

The first-year performance of bitcoin ETFs naturally raises the question: “Could you have made an arbitrage profit?” Panel A in Table 3 suggests it was possible. Suppose you invested \$100 in GBTC and simultaneously short-sold \$100 of BITO on 11

January 2024. By 27 December 2024, your GBTC investment would have grown to \$204.47, while your BITO short position would be worth \$190.80, resulting in a net gain of 13.67.<sup>8</sup>

Statistical analysis shows that GBTC's daily returns are significantly higher than BITO's at the 0.0013 probability level. Additionally, the annualized volatility of the daily return differential between the two ETFs is relatively low, at 2.46% (compared with GBTC's 56.92% and BITO's 57.61%). While this long/short strategy may seem appealing, caution is warranted. The sample size is limited to 242 daily return observations, and competition among ETF issuers remains intense. Market dynamics could shift rapidly.

## Conclusions

The launch of spot bitcoin ETFs has been the most successful in ETF industry history, attracting \$75 billion in AUM in its first year. The market's preference is clear: investors favor spot-based ETFs over futures-based alternatives. This preference is logical—when the underlying benchmark is tradable, spot-based products are more efficient for investors. Futures-based ETFs impose additional rollover trading costs and risks for long-term investors. By

approving futures-based ETFs first, the SEC inadvertently saddled investors with a suboptimal product, resulting in millions of dollars in opportunity costs.

An analysis of bitcoin ETF performance in the first year reveals several key findings. First, GBTC and FBTC outperformed their benchmarks indexes, although only marginally. GBTC's performance is more spectacular in the sense that it overcame its 150 bps management fee compared to FBTC's 25 bps. In contrast, BITO significantly underperformed its assumed benchmarks, highlighting inefficiencies in its replication strategy. Second, IBIT's and FBTC's tracking performance was difficult to interpret relative to their defined benchmarks due to a lack of contemporaneous price data. However, when compared to the price of spot bitcoin, both underperformed by more than 200 bps. Third, some spot-based benchmark indexes rely on average prices from the last hour of trading, making it difficult to accurately measure tracking differences. Fourth, after adjusting for risk, GBTC, IBIT, and FBTC exhibited similar tracking volatilities. However, BITO's volatility was higher, reflecting the greater liquidity and lower volatility of the spot bitcoin market compared to the futures market. While these findings are compelling, they are based on just one year of data. As a result, their implications for future performance remain highly uncertain.

### Editor's Note

Submitted 7 August 2024

Accepted 21 January 2025 by William N. Goetzmann

## Notes

1. The Canadian regulatory approach differs from that of the US. In the US, the issuer and listing exchange must prove to the SEC that the ETF is consistent with the Securities Exchange Act of 1934 (e.g., supports investor protection, fosters fair, orderly, and efficient markets, and is not susceptible to fraud and manipulation). In Canada, it is flipped. The OSC must show that the ETF does not follow its regulations. See OSC (2019, page 4, paragraphs 26 and 27).
2. Portfolio selection mechanics were developed by Markowitz (1952). Applying the mechanics to see whether bitcoin should be included in a long-term investment portfolio is a matter of developing reasonable estimates of expected return and volatility as well as the pairwise correlations with other assets. Some recent work includes Brière, Ooster, and Szafarz (2015), Smales (2019), Hougan and Lawant (2021), and Liu and Tsyvinski (2021).
3. See Casey Wagner, Grayscale files to convert GBTC to ETF, Blockworks (April 5, 2021).
4. The struggle for market share was so intense among issuers that the competition began *before* the product launch. Indeed, some funds waived their entire expense ratios. Interestingly, Vanguard, the second-largest ETF provider, chose not to offer a spot bitcoin ETF. See "Vanguard has no plans to join spot bitcoin ETF fray," *Financial Times* (January 17, 2024). The company says, "Our perspective is that these products do not align with our offer focused on asset classes such as equities, bonds, and cash, which Vanguard views as the building blocks of a well-balanced, long-term investment portfolio."
5. See BITO: ProShares Bitcoin Strategy ETF (September 30, 2024).

6. Keynes (1930) was the first to argue this point and label the market conditions. With more short than long hedgers, futures prices will fall until speculators are satisfied with the risk premium and step up to absorb the imbalance. He called the result of the downward-sloping futures price curve "normal backwardation." By the same logic, when more long than short hedgers exist, the futures price curve will slope upward, a condition he called "contango."
7. The profit from this arbitrage opportunity has not gone unnoticed by the financial press. See "Traders swoop on bitcoin 'cash and carry' trade after ETF launches." *Financial Times* (January 24, 2024).
8. Of course, the net gain would need to be adjusted by the fact that BITO is sometimes "hard-to-borrow." Absent a reliable source of daily borrowing rates for BITO, our example should be viewed as illustrative.

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