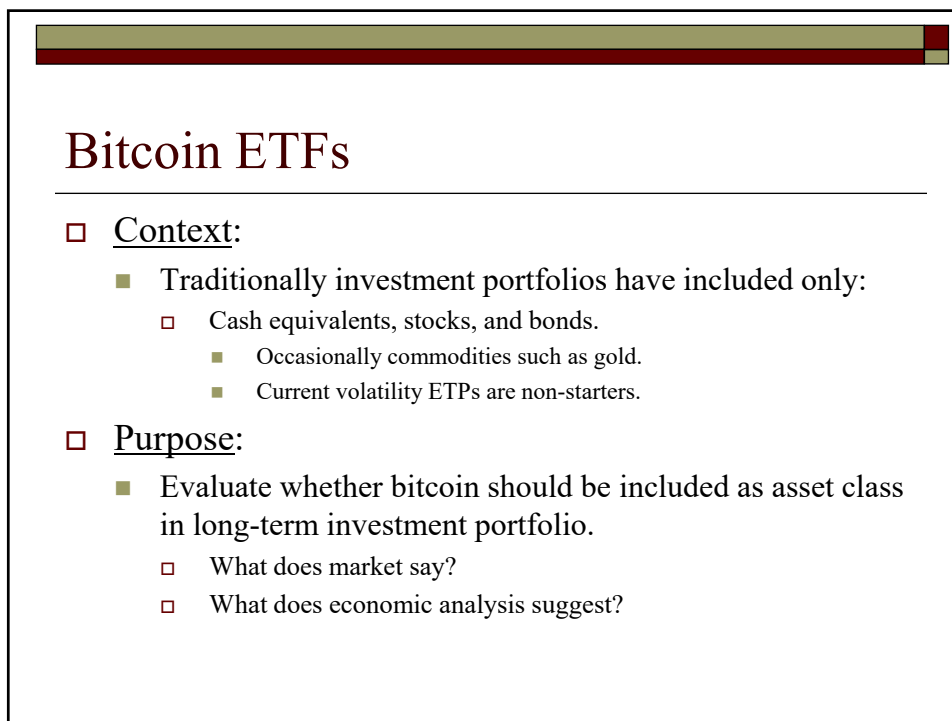


1



2

Bitcoin ETFs

- Outline:
 - What is bitcoin?
 - Why consider it as asset class?
 - History of bitcoin
 - Futures-based bitcoin ETPs
 - Spot-based bitcoin ETPs
 - Cash-and-carry trade
 - Should bitcoin be included in long-term investment portfolio?

3

What is bitcoin?

- Bitcoin is digital asset or cryptocurrency.
- Digital assets:
 - Have intrinsic value of 0.
 - Will never produce earnings so cannot discount cash flows.
 - Worth what people are willing to pay for it.
 - Value is arbitrary.
 - Determined by supply/demand.
 - Analogous to GameStop.

4

What is bitcoin?

- Bitcoin has unique properties.
 - Originally established as way to transfer money.
 - No one can create more of it (e.g., 21 million bitcoins).
 - Can never be censored (only accessed using internet).
 - Hard to confiscate.

5

Asset class performance

Bitcoin performance compared to major asset classes

Bitcoin has had periods of high performance and significant drawdowns
2013-2023

| 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | Cumulative | Annualized |
|----------------------|--------------------|---------------------|--------------------|----------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|------------------------|--------------------|
| BTC 5,516% | SPX 12% | BTC 37% | BTC 119% | BTC 1,300% | AGG 0% | BTC 92% | BTC 302% | BTC 58% | CMT 20% | BTC 156% | BTC 315,678% | BTC 124% |
| SPX 26% | AGG 5% | AGG 0% | HY 17% | EM 35% | HY -2% | SPX 29% | Gold 24% | CMT 30% | Gold 1% | SPX 25% | SPX 226% | SPX 13% |
| HY 6% | HY 2% | SPX -1% | EM 15% | SPX 18% | Gold -3% | EM 21% | SPX 15% | SPX 29% | HY -11% | HY 12% | HY 64% | HY 5% |
| AGG -1% | EM 1% | HY -4% | CMT 14% | Gold 12% | SPX -7% | Gold 18% | EM 14% | HY 5% | AGG -12% | Gold 12% | EM 35% | EM 3% |
| EM -3% | Gold -3% | Gold -11% | SPX 11% | HY 7% | CMT -9% | HY 14% | AGG 7% | EM 0% | EM -18% | EM 9% | Gold 18% | Gold 2% |
| CMT -9% | CMT -18% | EM -14% | Gold 7% | CMT 6% | EM -15% | CMT 10% | HY 7% | AGG -1% | SPX -20% | AGG 5% | AGG 17% | AGG 2% |
| Gold -29% | BTC -58% | CMT -25% | AGG 2% | AGG 3% | BTC -73% | AGG 8% | CMT -3% | Gold -6% | BTC -65% | CMT -2% | CMT -4% | CMT 0% |

6

History of bitcoin ETFs

- May 22, 2010: First bitcoin trade
 - Now thousands of unregulated cryptocurrency markets trading 24/7.
- July 13, 2013: Winklevoss Bitcoin Trust filed application with SEC to launch first Bitcoin ETF (COIN).
 - SEC rejected application under rule BZK Rule 14.11(e)(4).
 - For an exchange to list and trade shares of an ETF, the exchange:
 - Must have surveillance-sharing agreements with significant markets for trading the underlying commodity or derivatives on that commodity; and,
 - The markets must be regulated.

7

History of bitcoin ETFs

- September 27, 2017: ProShares filed an S-1 registration statement for two Bitcoin ETFs.
 - SEC rejected on Aug 22, 2018, based on Exchange Act Section 6(b)(5)—the requirement that a national securities exchange's rules be designed to prevent fraudulent and manipulative acts and practices.
 - □ SEC also noted that the CBOE had offered no record evidence to demonstrate that the futures markets on which the ETFs would be based were of significant size, which could lead to fraudulent and manipulative acts.
- CBOE futures contract was delisted, and CME futures was launched.

8

History of bitcoin ETFs

- ❑ October 19, 2021: SEC approved ProShares Bitcoin Strategy ETF.
 - Second generation ETF:
 - ❑ Assumes active arbitrage between spot and futures markets.
 - ❑ Spot return equals sum of risk-free return and futures return.
- ❑ Futures settlement
 - CME CF Bitcoin Reference Index (BRRNY)
 - ❑ Underlies CME bitcoin futures.
 - ❑ Transparent.

<https://www.cmegroup.com/markets/cryptocurrencies/bitcoin/bitcoin.html>

9



10

BITO (ProShares)

BITO **FACT SHEET** **As of 11/19/2021**
BITCOIN STRATEGY ETF

- The fund offers investors a convenient way to incorporate a rapidly growing digital asset into their portfolios as:
 - a complement to stocks and bonds
 - a hedge against inflation
 - an alternative to traditional currency investments
 - a replacement for "real assets" like gold and commodities

Original fact sheet

11

BITO (ProShares)

ProShares **Fact Sheet As of 9/30/24**
BITO ProShares Bitcoin ETF

Why BITO ?

- First U.S. bitcoin-linked ETF.
- Familiarity, liquidity and transparency of an ETF.
- Available through a brokerage account—no need for a cryptocurrency exchange account or wallet.

Current fact sheet

12

BITO (ProShares)

Fund Details

| | |
|-----------------------|---------------|
| Inception Date | 10/18/21 |
| Trading Symbol | BITO |
| Intraday Symbol | BITO.IV |
| CUSIP | 74347G440 |
| Exchange | NYSE Arca |
| Net Assets | \$184 billion |
| Expense Ratio | 0.95% |
| Distribution Schedule | Monthly |

No specified benchmark.
Bitcoin futures benchmark is BRRNY.

13

Bitcoin ETF (BITO)

- ProShares dominates CME Bitcoin futures market.
 - More long hedgers than short hedgers.
 - Speculators must step in.

Percent of open interest

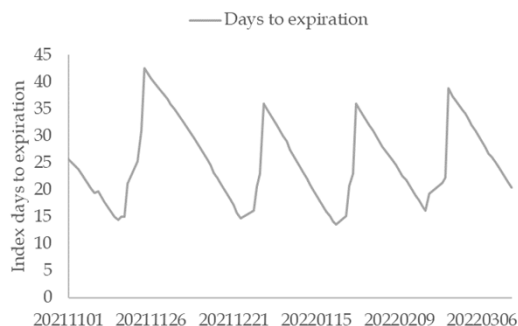
20211101 20211126 20211221 20220115 20220209 20220306

Recall SEC’s rejection of ProShares application on Sept. 27, 2017, on grounds that Cboe bitcoin futures market “did not have significant size.”

14

Bitcoin ETF (BITO)

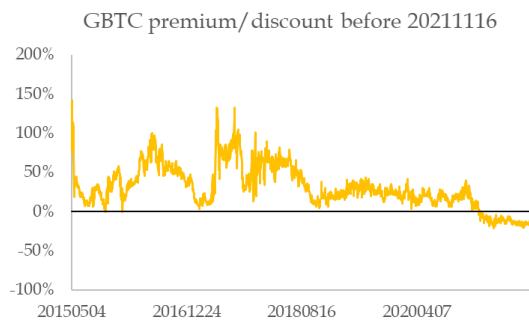
- BITO does not have defined benchmark.
 - BITO rolls between bitcoin futures in cavalier fashion.
 - No constant maturity index like VIX short-term futures index (30 days)



15

Grayscale closed-end trust (spot-based)

- May 4, 2015: Grayscale GBTC began trading on exchange as closed-end end fund.
 - Premium/discount (%) = $(MV - NAV) / NAV$
 - Support file: GBTC premium-discount.xlsx



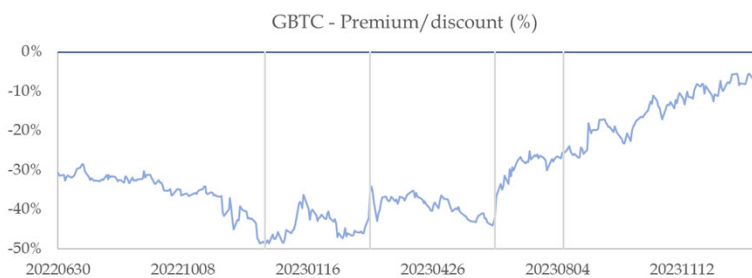
16

Let races begin...

- November 16, 2021: Grayscale announced application to convert its Bitcoin Investment Trust into ETF.
 - SEC rejected application.
 - Grayscale sued SEC and won.
- January 11, 2024: GBTC as well as 9 new spot-based bitcoin ETFs (free riders) are launched.

17

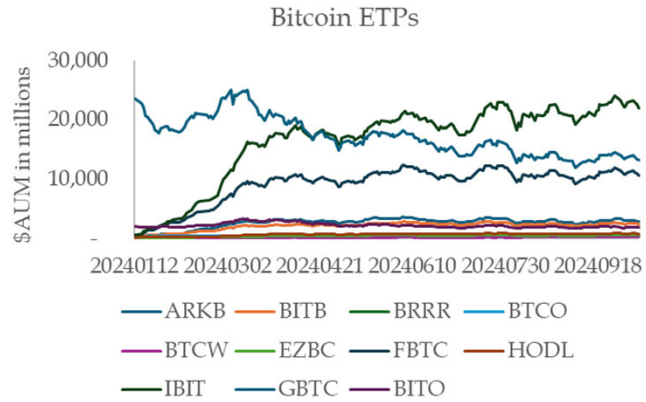
Let races begin...



20221213 - Discount to NAV reaches all-time low. Discount = 49%.
 20230307 - Grayscale and SEC to court case ensues. Discount = 36%.
 20230615 - BlackRock files for Bitcoin ETF. Discount = 42%.
 20230829 - SEC declines to appeal the Grayscale case. Discount = 18%.
 20230111 - GBTC launches after SEC approval on 20230110. Discount = 1.6%.

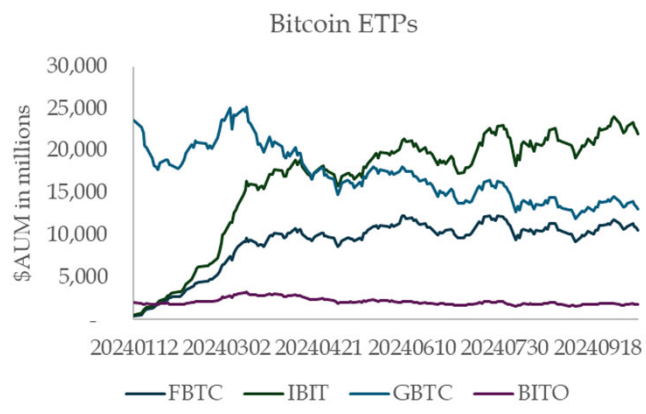
18

Let races begin...



19

Let races begin...



20

Let races begin...

Support file: Currency report generator 20231229 vs 20241014.xlsx

Increase driven largely by bitcoin ETPs. Unprecedented in ETF history.

| Asset category | ETFdb.com 20241014 | | | ETFdb.com 20231229 | | |
|-----------------|--------------------|-------------------|---------|--------------------|-------------------|---------|
| | # of funds | \$AUM | Percent | # of funds | \$AUM | Percent |
| Equity | 2,599 | 7,891,575,010,300 | 79.2% | 2,324 | 6,364,316,220,700 | 78.3% |
| Bond | 515 | 1,691,188,622,300 | 17.0% | 516 | 1,485,595,931,000 | 18.3% |
| Commodity | 84 | 162,817,284,600 | 1.6% | 86 | 133,380,665,200 | 1.6% |
| Real Estate | 43 | 81,278,526,300 | 0.8% | 45 | 72,629,222,500 | 0.9% |
| Currency | 41 | 60,475,959,900 | 0.6% | 25 | 3,596,111,400 | 0.0% |
| Multi-Asset | 156 | 36,274,399,800 | 0.4% | 152 | 31,788,522,700 | 0.4% |
| Preferred Stock | 17 | 34,965,048,300 | 0.4% | 17 | 31,353,552,700 | 0.4% |
| Alternatives | 31 | 6,399,742,800 | 0.1% | 32 | 4,854,795,900 | 0.1% |
| Volatility | 12 | 2,851,907,100 | 0.0% | 18 | 3,768,152,400 | 0.0% |
| | | 9,967,826,501,400 | | | 8,131,283,174,500 | |

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GBTC (Grayscale)

As of 09/30/24

Fund Details

Inception Date: 9/25/2013

NYSE Listing Date: 1/11/2024

Benchmark Index: CoinDesk Bitcoin Price Index²

Assets Under Management: \$14,030,278,653

Shares Outstanding: 277,810,100

Net Asset Value (NAV): \$50.50

Bitcoin per Share: 0.00079620³

Total Bitcoin in Trust: 221,191.33

Fund Expense Ratio: 1.50%

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IBIT (BlackRock)

iShares Bitcoin Trust ETF

IBIT

Sponsor fee: 0.25%, waived to 0.12% for 12 months up to \$5bn in assets.³

Inception Date: 1/5/2024

Investment objective: The Trust seeks to reflect generally the performance of the price of bitcoin.

Reference benchmark: CME CF Bitcoin Reference Rate – New York Variant (BRRNY)

Bitcoin custodian: Coinbase

23

FBTC (Fidelity)

- January 11, 2024: GBTC as well as 9 new spot-based bitcoin ETFs are launched.

KEY FACTS

Sponsor: FD Funds Management LLC

Inception Date: 1/10/24

Investment Objective: FBTC seeks to track the performance of bitcoin.

Benchmark: Fidelity Bitcoin Reference Rate

Instrument Type: Exchange-traded product

Contractual Expense Ratio: 0.25%

NAV Pricing: Daily, 4:00 p.m. ET (weekdays)

Bitcoin Custodian: Fidelity Digital Asset Services, LLC

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“Traders swoop on cash and carry trade...”

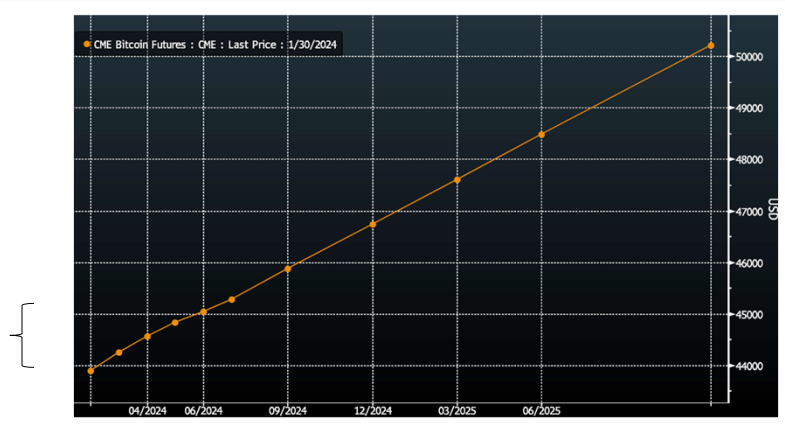
Traders swoop on bitcoin 'cash and carry' trade after ETF launches
Activity in futures contracts linked to cryptocurrency surges to record levels in January



Traders say volumes have been boosted by applying to bitcoin a tried and tested strategy in other markets © Reuters
Jennifer Hughes in Chicago and Philip Stafford in London JANUARY 27 2024

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Futures price curve



Futures prices appear above cost of carry relation for short maturities.

26

“Traders swoop on cash and carry trade...”

- Recall cost of carry relation implies:

| <i>Position 1</i> | = | <i>Position 2</i> |
|--|---|-------------------------------|
| Buy asset/sell futures | = | Buy risk-free bonds (lend) |
| Buy risk-free bonds (lend)/buy futures | = | Buy asset |
| Buy asset/sell risk-free bonds (borrow) | = | Buy futures |
| Sell asset/buy futures | = | Sell risk-free bonds (borrow) |
| Sell risk-free bonds (borrow)/sell futures | = | Sell asset |
| Sell asset/buy risk-free bonds (lend) | = | Sell futures |

27

“Traders swoop on cash and carry trade...”

- Recall cost of carry relation implies:

| <i>Position 1</i> | = | <i>Position 2</i> |
|--|---|-------------------------------|
| Buy asset/sell futures | = | Buy risk-free bonds (lend) |
| Buy risk-free bonds (lend)/buy futures | = | Buy asset |
| Buy asset/sell risk-free bonds (borrow) | = | Buy futures |
| Sell asset/buy futures | = | Sell risk-free bonds (borrow) |
| Sell risk-free bonds (borrow)/sell futures | = | Sell asset |
| Sell asset/buy risk-free bonds (lend) | = | Sell futures |

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Cash and carry bitcoin trade

- Sell futures and buy bitcoin.

| Action | Investment ₀ | Value _T |
|----------------------|-------------------------|----------------------|
| Sell bitcoin futures | 0 | $-(\tilde{B}_T - F)$ |
| Buy bitcoin | $-B$ | \tilde{B}_T |
| Total | $-B$ | F |
| | | $= Be^{rT}$ |

Cash and carry trade is riskless. If futures are overpriced, can earn abnormal return.

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Cash and carry bitcoin trade

- Assume no access to futures markets.
- Solution: Buy IBIT and short sell BITO.
 - Ignoring lending fees, portfolio has no investment and no risk.
 - Costless arbitrage portfolio.

30

Cash and carry bitcoin trade

□ Buy IBIT and short sell BITO.

- Support file: IBIT vs BITO.xlsx
- Examine summary statistics.
- Volatilities nearly identical.
- Correlation near perfect.
- IBIT HPR higher than BITO.

| Summary | | |
|-----------------|----------|----------|
| Description | IBIT | BITO |
| No. of obs. | 189 | 189 |
| Mean (daily) | 0.158% | 0.136% |
| StDev (daily) | 3.593% | 3.619% |
| Skewness | -0.14 | -0.14 |
| Kurtosis | 1.60 | 1.54 |
| Autocorrelation | -0.13 | -0.14 |
| Minimum | -15.556% | -15.604% |
| Median | -0.102% | 0.000% |
| Maximum | 10.769% | 10.783% |
| Mean (annual) | 39.85% | 34.25% |
| StDev (annual) | 57.04% | 57.45% |
| CAGR | 48.95% | 40.85% |
| HPR | 34.83% | 29.29% |

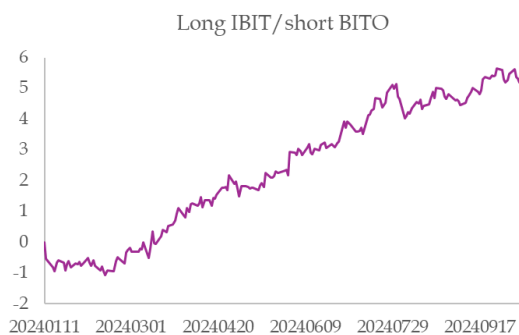
| Correlations | | |
|--------------|-------|-------|
| | IBIT | BITO |
| IBIT | 1 | 0.999 |
| BITO | 0.999 | 1 |

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Cash and carry bitcoin trade

□ Buy IBIT and short sell BITO.

- Missing variable in analysis: Borrowing fee for BITO.



32

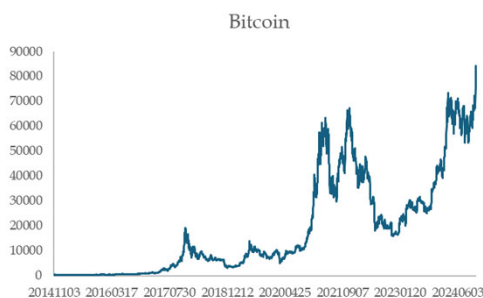
Is bitcoin long-term investment?

- Downloaded data series beginning 20141103.
 - First date Bloomberg reports BRRNY.
 - Computed summary statistics.
 - Support files: XBX history 20141103 – 20241111.xlsx
Bitcoin ETP evaluation.xlsx.

33

What is bitcoin's expected return?

- History of bitcoin since 20141103:



Little to base prediction of expected return. Pure speculation.

- Up over 20% since election.

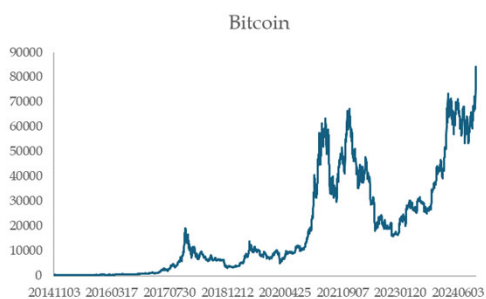
| Summary | |
|-----------------|-----------|
| Description | XBX |
| No. of obs. | 3661 |
| Mean (daily) | 0.152% |
| StDev (daily) | 3.611% |
| Skewness | -0.370 |
| Kurtosis | 5.295 |
| Autocorrelation | -0.019 |
| Minimum | -26.257% |
| Median | 0.134% |
| Maximum | 19.698% |
| Mean (annual) | 38.23% |
| StDev (annual) | 57.32% |
| CAGR | 46.56% |
| HPR | 25714.33% |

| Correlations | |
|--------------|-----|
| | XBX |
| XBX | 1 |

34

What is bitcoin's expected return?

- History of bitcoin since 20141103:



Economic reasoning:
 What is expected return on asset that requires investment and has no market price risks?

35

Is bitcoin long-term investment?

Expected returns and expected volatility

| Description | EFFR | BND | VTI | IAU | XBX |
|----------------|-------|-------|--------|--------|--------|
| Mean (annual) | 1.71% | 1.75% | 11.88% | 7.98% | 53.26% |
| StDev (annual) | 0.15% | 5.43% | 18.07% | 14.25% | 67.89% |

Expected correlations

| | EFFR | BND | VTI | IAU | XBX |
|------|--------|--------|--------|-------|-------|
| EFFR | 1 | -0.038 | -0.006 | 0.007 | 0.018 |
| BND | -0.038 | 1 | 0.113 | 0.362 | 0.050 |
| VTI | -0.006 | 0.113 | 1 | 0.047 | 0.213 |
| IAU | 0.007 | 0.362 | 0.047 | 1 | 0.074 |
| XBX | 0.018 | 0.050 | 0.213 | 0.074 | 1 |

Expected returns

| | EFFR | BND | VTI | IAU | XBX |
|--------------|-------|-------|-------|-------|-------|
| Nominal rate | 4.83% | 4.61% | 6.44% | 5.02% | |
| E(ln return) | 4.72% | 4.51% | 6.24% | 4.90% | 0.00% |

36

Vary risk tolerance

| Portfolio allocations at different risk tolerances | | | | | | |
|--|---------------------|---------------------------|--------|--------|-----|-----|
| Expected return | Expected volatility | Optimal portfolio weights | | | | |
| | | EFFR | BND | VTI | IAU | XBX |
| 4.76% | 0.50% | 0.9736 | 0.0000 | 0.0264 | | |
| 4.80% | 1.00% | 0.9452 | 0.0000 | 0.0548 | | |
| 4.97% | 3.00% | 0.8341 | 0.0000 | 0.1659 | | |
| 5.14% | 5.00% | 0.7234 | 0.0000 | 0.2766 | | |
| 5.35% | 7.50% | 0.5850 | 0.0000 | 0.4150 | | |
| 5.56% | 10.00% | 0.4467 | 0.0000 | 0.5533 | | |
| 5.77% | 12.50% | 0.3083 | 0.0000 | 0.6917 | | |
| 5.98% | 15.00% | 0.1700 | 0.0000 | 0.8300 | | |
| 6.24% | 18.07% | 0.0000 | 0.0000 | 1.0000 | | |

Constrain allocations to IAU and XBX to 0.

37

Vary risk tolerance

| Portfolio allocations at different risk tolerances | | | | | | |
|--|---------------------|---------------------------|--------|--------|--------|-----|
| Expected return | Expected volatility | Optimal portfolio weights | | | | |
| | | EFFR | BND | VTI | IAU | XBX |
| 4.76% | 0.50% | 0.9702 | 0.0000 | 0.0262 | 0.0037 | |
| 4.80% | 1.00% | 0.9381 | 0.0000 | 0.0542 | 0.0078 | |
| 4.97% | 3.00% | 0.8138 | 0.0000 | 0.1641 | 0.0221 | |
| 5.14% | 5.00% | 0.6874 | 0.0000 | 0.2735 | 0.0392 | |
| 5.35% | 7.50% | 0.5371 | 0.0000 | 0.4110 | 0.0519 | |
| 5.56% | 10.00% | 0.3820 | 0.0000 | 0.5480 | 0.0701 | |
| 5.78% | 12.50% | 0.2245 | 0.0000 | 0.6845 | 0.0910 | |
| 5.99% | 15.00% | 0.0675 | 0.0000 | 0.8212 | 0.1114 | |
| 6.24% | 18.07% | 0.0000 | 0.0000 | 1.0000 | 0.0000 | |

Constrain allocation to XBX to 0.

38

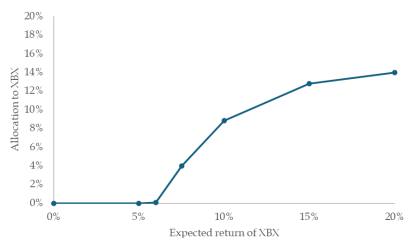
Vary risk tolerance

| Portfolio allocations at different risk tolerances | | | | | | |
|--|---------------------|---------------------------|--------|--------|--------|--------|
| Expected return | Expected volatility | Optimal portfolio weights | | | | |
| | | EFFR | BND | VTI | IAU | XBX |
| 4.76% | 0.50% | 0.9701 | 0.0000 | 0.0262 | 0.0037 | 0.0000 |
| 4.80% | 1.00% | 0.9390 | 0.0000 | 0.0543 | 0.0067 | 0.0000 |
| 4.97% | 3.00% | 0.8138 | 0.0000 | 0.1641 | 0.0220 | 0.0000 |
| 5.14% | 5.00% | 0.6938 | 0.0000 | 0.2743 | 0.0319 | 0.0000 |
| 5.35% | 7.50% | 0.5369 | 0.0000 | 0.4110 | 0.0521 | 0.0000 |
| 5.56% | 10.00% | 0.3802 | 0.0000 | 0.5477 | 0.0721 | 0.0000 |
| 5.78% | 12.50% | 0.2268 | 0.0000 | 0.6848 | 0.0884 | 0.0000 |
| 5.99% | 15.00% | 0.0690 | 0.0000 | 0.8214 | 0.1096 | 0.0000 |
| 6.24% | 18.07% | 0.0000 | 0.0000 | 1.0000 | 0.0000 | 0.0000 |

Allow investment in XBX.
Will not hold at any reasonable risk tolerance.

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Vary XBX expected return



| Portfolio allocations at assumptions regarding E(R) of XBX | | | | | | |
|--|-------------|---------------------------|--------|--------|--------|--------|
| Expected return | E(R) of XBX | Optimal portfolio weights | | | | |
| | | EFFR | BND | VTI | IAU | XBX |
| 5.56% | 0.00% | 0.3837 | 0.0000 | 0.5482 | 0.0681 | 0.0000 |
| 5.56% | 5.00% | 0.3837 | 0.0000 | 0.5482 | 0.0681 | 0.0000 |
| 5.56% | 6.00% | 0.3788 | 0.0000 | 0.5468 | 0.0735 | 0.0009 |
| 5.60% | 7.50% | 0.3957 | 0.0000 | 0.4952 | 0.0691 | 0.0400 |
| 5.76% | 10.00% | 0.5068 | 0.0000 | 0.3745 | 0.0303 | 0.0884 |
| 6.32% | 15.00% | 0.6810 | 0.0000 | 0.1900 | 0.0010 | 0.1280 |
| 7.00% | 20.00% | 0.7641 | 0.0000 | 0.0962 | 0.0000 | 0.1397 |
| 7.71% | 25.00% | 0.8183 | 0.0000 | 0.0368 | 0.0000 | 0.1449 |

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Lesson summary

- Bitcoin ETFs have created new asset class.
- Spot-based ETFs outperform futures-based ETFs because of contango in bitcoin futures market.
- For moderate risk tolerance, small investment appears warranted.
 - Sensitive to assumption regarding expected return on bitcoin.

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