Demystifying Crypto in Asset Allocation

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Genesis

Extending the Efficient Frontier with Crypto

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Summary

→ Using data from from 2010 to 2022, we find that bitcoin improves the risk-reward potential of an investment universe for portfolios across the risk spectrum.

→ Optimal portfolios that maximized risk-adjusted returns would have included allocations to bitcoin in every calendar year.

→ The high volatility of bitcoin relative to other asset classes enables unlevered investors to construct portfolios across a wider spectrum of risk objectives.

→ We argue that forecasting future returns is difficult for all assets and is no easier for traditional asset classes even if there is more historical data available than for bitcoin.

→ Reducing the volatility of bitcoin via volatility scaling has also improved its risk-reward and can enable investors with a lower risk tolerance to gain exposure.

→ The correlation of bitcoin to traditional asset classes and hedge fund strategies has varied through time and has been low on average.

→ The beta of bitcoin to traditional asset classes has only been significant on days it has been down.

→ When measuring excess returns that cannot be explained by other assets, bitcoin's is significantly higher than for any traditional asset class or hedge fund strategy.

(Note: we use uppercase Bitcoin to denote the network, and lowercase bitcoin or BTC to denote the asset; for Ethereum, we use uppercase to denote the network, and ether or ETH to denote the asset. "Merge" is capitalized when referring to Ethereum's upcoming consensus shift. All $ are USD unless otherwise specified.)

Extending the Efficient Frontier

Optimal portfolios, as defined by modern portfolio theory, include an allocation to bitcoin

Modern portfolio theory (MPT) is not so modern, with Harry Markowitz's seminal work celebrating its 70th birthday this year. But despite its well-documented limitations and the many innovations developed since, the elegance and simplicity of MPT's implementation in practice still make it the foundational starting point for portfolio construction. It is with this in mind that it serves as a useful illustration to explore BTC's merits from an asset allocation perspective.

Mean variance optimization is a process of finding the optimal allocation to a set of assets such that the investor is maximizing their risk-adjusted return. The process is most heavily influenced by three main factors:

→   the expected returns of each asset

→   the risk of each asset as measured by volatility

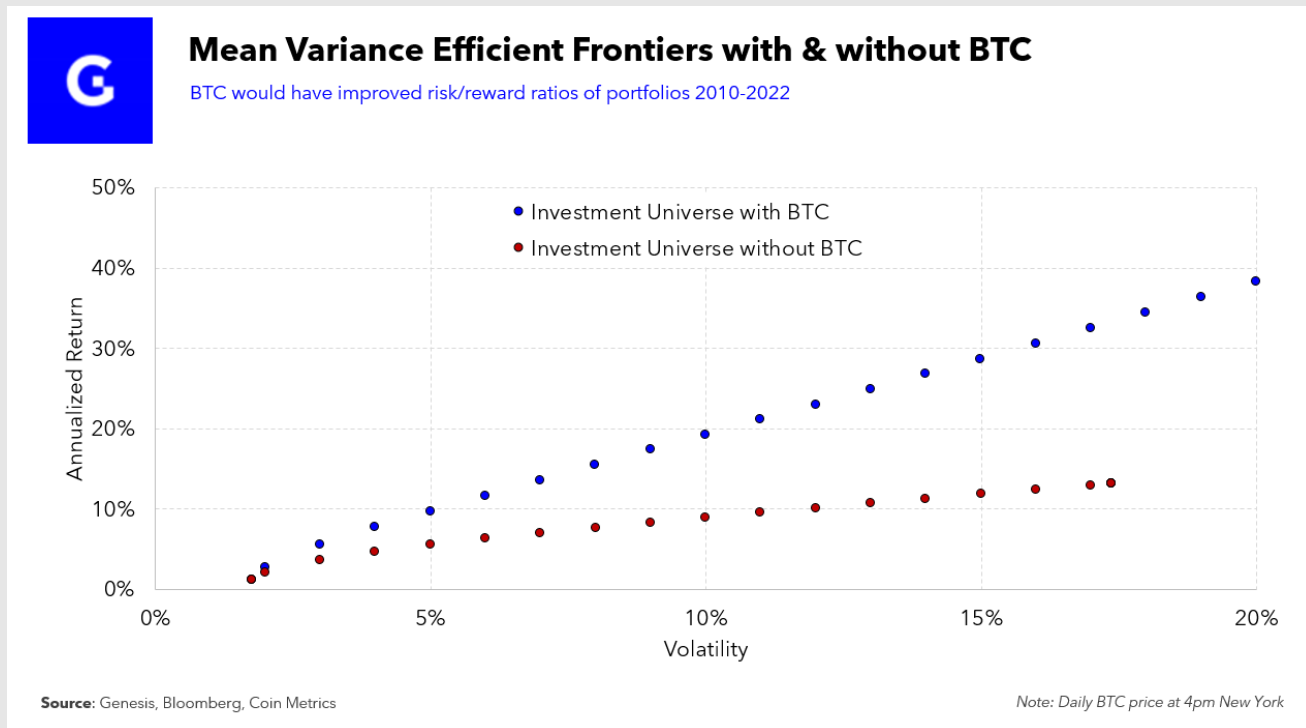→   the relationship between the assets, as measured by covariance

These inputs for an investment universe are fed into an optimization algorithm which solves for the optimal weights There are a vast number of considerations that go into measuring each of these three components on a forward-looking basis for any given asset, so as a starting point we (naively) proxy the expectation of each component[1] with their observed historical quantities using data from 2010 to 2022. We compare two investment universes. The first universe includes common long-only asset classes such as equities, bonds and commodities, as well as popular hedge fund indices from HFRX to represent alternative investment strategies (details in Appendix I). The second universe includes all of the above and also includes BTC[2] in the investable universe.

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1 For example, in place of the expected daily return we use the average historic daily return.
2 All BTC prices in this note are as of 4pm New York time so they are contemporaneous with asset class data for correlation calculations.

The chart below shows the efficient frontiers[3] the set of portfolios that offer the highest expected return for each given level of risk up to 20% volatility - for unlevered long-only portfolios across the two investment universes. Optimal portfolios constructed from the universe that includes BTC dominate those built from the universe that excludes it.
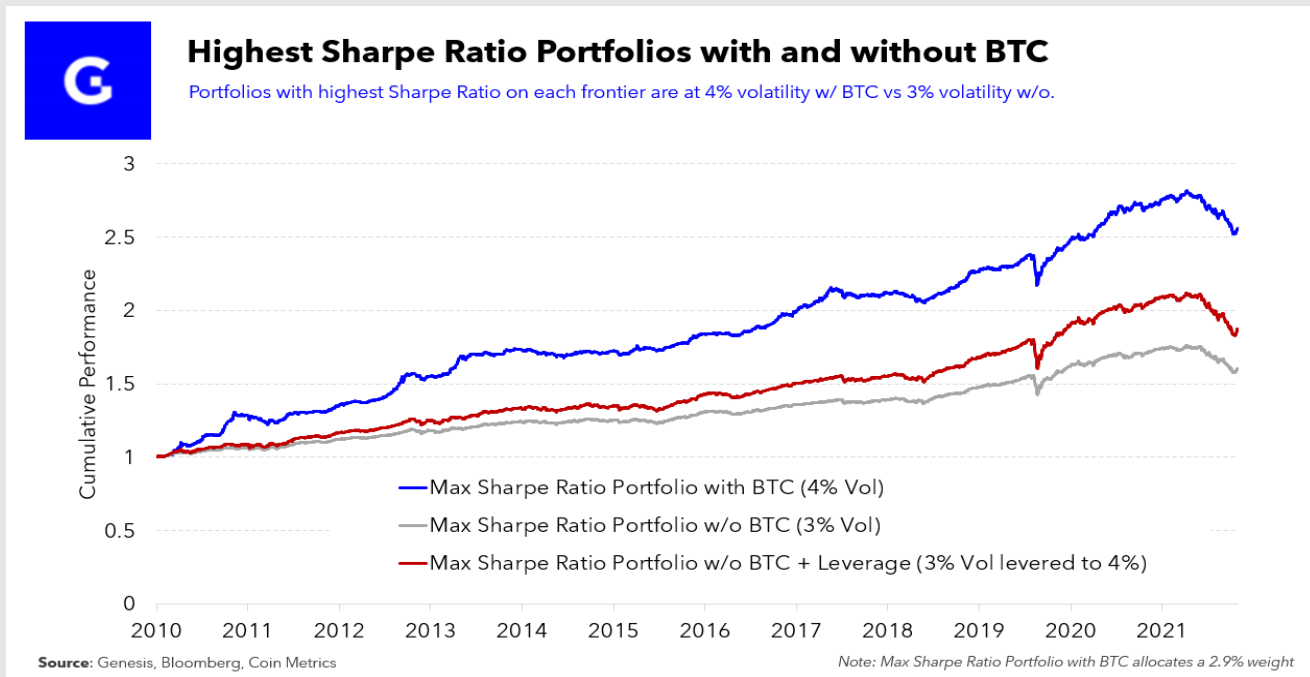
Mean Variance Efficient Frontiers with & without BTC

BTC would have improved risk/reward ratios of portfolios 2010-2022

- Investment Universe with BTC
- Investment Universe without BTC

(Chart: Annualized Return vs Volatility, x-axis 0% to 20%, y-axis 0% to 50%)

Source: Genesis, Bloomberg, Coin Metrics

Note: Daily BTC price at 4pm New York

The high volatility of BTC relative to other asset classes enables unlevered investors to achieve a wider spectrum of portfolio risk.

The analysis across the full data sample paints an intuitive picture - at lower levels of volatility, there is little difference between the two frontiers, since mean variance optimization allocates zero or small amounts to BTC when constrained by low levels of portfolio risk. However, as the portfolio risk budget (defined as the level of portfolio volatility targeted by the investor) increases, the difference widens since the optimizer allocates an increasing weight to BTC, which, as is well known, has had high risk-adjusted returns over the period 2010-2022.

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3 The efficient frontiers are calculated using a standard optimization algorithm with constraints that weights are between 0 and 1 (long only, no leverage), and portfolio volatility is equal to the risk budget, which is set for each integer percentage between 1% and 20%.

It is worth noting that the traditional portfolios in this setting are generally unable to reach levels of risk higher than 17%, since they are unable to allocate more than 100% to the highest-volatility asset in the investment universe, which is equities. This highlights the capital efficiency of BTC, which has had a high innate volatility that makes it a useful tool for boosting the volatility of portfolios for unlevered investors with a high risk tolerance.

Highest Sharpe Ratio Portfolios with and without BTC
Portfolios with highest Sharpe Ratio on each frontier are at 4% volatility w/ BTC vs 3% volatility w/o.

Legend:
— Max Sharpe Ratio Portfolio with BTC (4% Vol)
— Max Sharpe Ratio Portfolio w/o BTC (3% Vol)
— Max Sharpe Ratio Portfolio w/o BTC + Leverage (3% Vol levered to 4%)

Source: Genesis, Bloomberg, Coin Metrics   *Note: Max Sharpe Ratio Portfolio with BTC allocates a 2.9% weight*

As an additional illustration, consider the portfolios with the highest Sharpe ratios[4] (the highest risk-adjusted return) on each of the two frontiers. For the set of portfolios constructed from the investment universe including BTC, the maximum Sharpe ratio is at the 4% volatility level (which allocates 2.9% of the portfolio to BTC), whereas for the universe excluding BTC, the best risk-reward is at 3% volatility. An investor who had allocated to the optimal portfolio with BTC realized over 2.5x their initial outlay over the period, whereas the optimal portfolio without BTC only ended the period with just over 1.5x. Since these two portfolios target different levels of risk, for an apples-to-apples comparison the chart above also includes the performance of the maximum Sharpe ratio portfolio without BTC levered to the equivalent level of risk (from 3% volatility to 4%) and shows that it would only have ended the period up ~1.75x.

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4 Sharpe Ratio = (Average Return - Risk-free Rate) / Volatility

Optimal BTC Weight By Portfolio Volatility and Calendar Year

BTC is included in portfolios with higher risk capacity in each calendar year

Portfolio Volatility	Optimal Bitcoin Portfolio Weight											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2%	0%	0%	2%	1%	0%	1%	3%	1%	0%	1%	0%	0%
3%	1%	1%	3%	1%	0%	3%	5%	2%	0%	2%	0%	0%
4%	1%	1%	5%	2%	0%	5%	7%	3%	0%	3%	2%	0%
5%	2%	2%	6%	3%	0%	7%	9%	4%	0%	4%	4%	1%
6%	2%	3%	7%	3%	0%	9%	11%	5%	0%	5%	6%	1%
7%	3%	3%	8%	4%	0%	10%	13%	7%	0%	6%	8%	1%
8%	3%	4%	10%	5%	0%	12%	15%	8%	0%	7%	9%	1%
9%	4%	4%	11%	5%	0%	13%	18%	9%	0%	8%	11%	2%
10%	4%	5%	12%	6%	0%	15%	20%	10%	0%	9%	13%	2%
11%	4%	6%	14%	7%	0%	17%	22%	11%	0%	10%	14%	3%
12%	5%	6%	15%	7%	10%	18%	24%	12%	0%	10%	16%	3%
13%	5%	7%	16%	8%	13%	20%	27%	13%	0%	11%	17%	6%
14%	6%	7%	18%	9%	16%	21%	29%	14%	0%	13%	19%	8%
15%	6%	8%	19%	9%	18%	23%	31%	15%	0%	15%	20%	10%
16%	7%	8%	20%	10%	20%	24%	34%	16%	0%	17%	22%	12%
17%	7%	9%	22%	11%	22%	26%	36%	17%	7%	19%	24%	14%
18%	7%	10%	23%	11%	24%	27%	38%	19%	12%	21%	25%	15%
19%	8%	10%	24%	12%	25%	29%	41%	20%	15%	23%	27%	17%
20%	8%	11%	26%	12%	27%	30%	43%	21%	17%	24%	29%	18%

Source: Genesis, Bloomberg, Coin Metrics

Rather than use the data over the entire sample to determine optimal weights, we can create efficient frontiers using returns, volatilities, and correlations over shorter time periods. The chart above shows the weights in BTC of optimal portfolios at each level of volatility from 1% to 20% on a calendar year basis[5]. The mean variance optimal portfolios have non-zero allocations to BTC in every calendar year, including years of crypto bear markets. Note that in calendar years where BTC returns were negative (such as 2014 and 2018), it was only included in the optimal portfolio for higher levels of risk - for example, in 2018 only portfolios that targeted 17% volatility or above had a positive weight to BTC. The role bitcoin played in these instances was to enable them to achieve the desired level of portfolio risk. It is important to re-emphasize the practical issue with mean variance optimization - the portfolios are only optimal if your inputs for risk, correlation, and returns are accurate. Having accurate inputs for the expected returns of BTC is difficult in practice, and simply using historical returns is unlikely to produce good estimates. However, this is also the case with any asset in the investment universe.
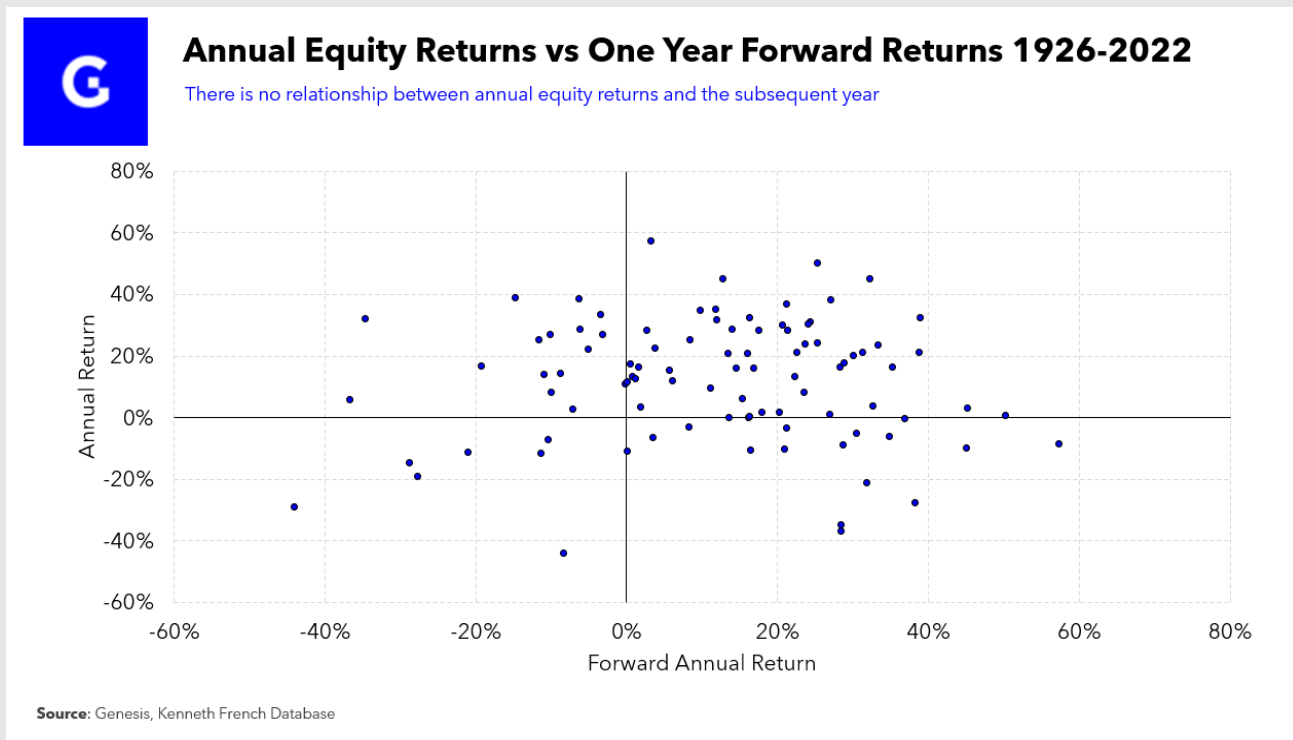
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5 The returns, volatility, and correlations across the investment universe for each calendar year are input into an optimization algorithm to solve for the optimal weights.

What to Expect, If You're Expecting

More historical data available for traditional asset classes doesn't make forecasting their expected returns any easier than for BTC.

Most will be quick to point out that BTC has had a short history and as it matures it is unlikely to be able to repeat the stellar returns it has experienced thus far. On the other hand, academics have gathered data on equities, bonds, and bills going back centuries. The evidence is clear - as the most famous and also the most often forgotten saying goes in investing, past performance is not a guarantee of future results. Though there is some nuance at shorter time frames, there is no statistical relationship between equity market returns from one year to the next.
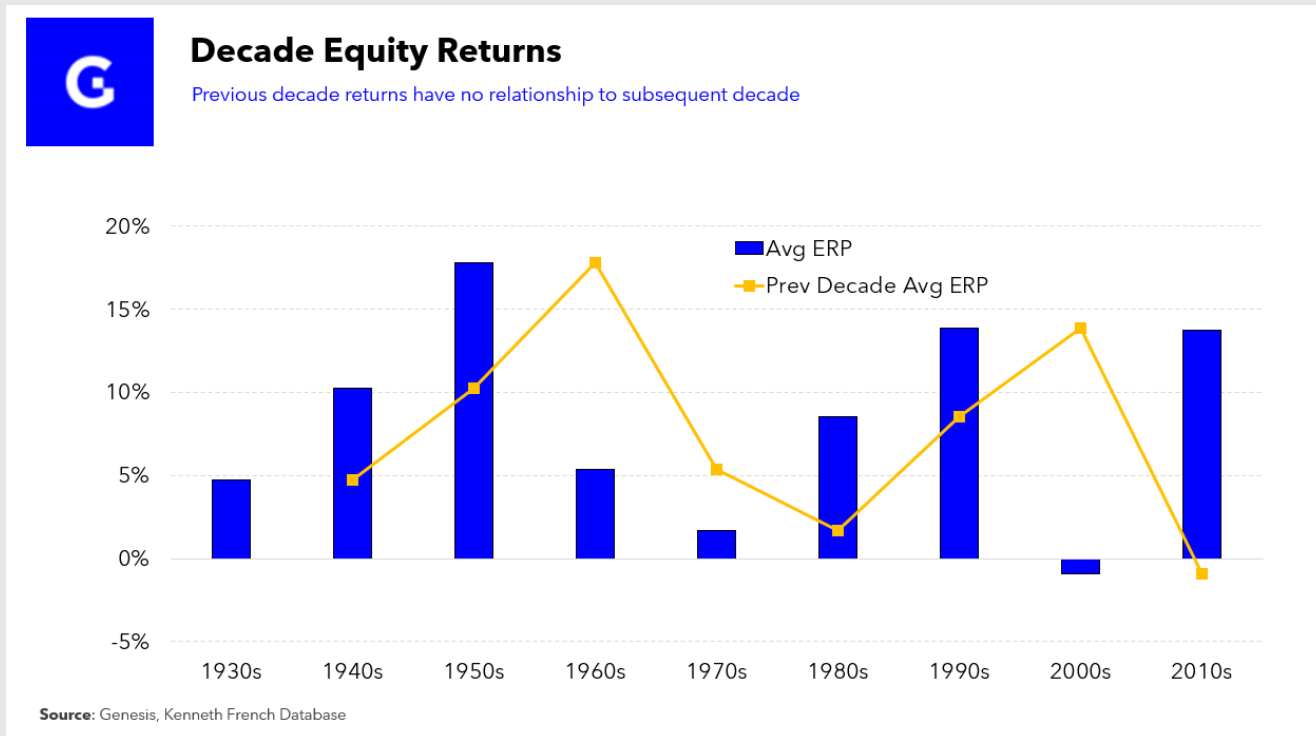
"To bankrupt a fool, give them information" - Nassim Taleb

Annual Equity Returns vs One Year Forward Returns 1926-2022

There is no relationship between annual equity returns and the subsequent year

Source: Genesis, Kenneth French Database

Whilst longer-term data in other asset classes might add comfort about the longevity of an asset class, it still does not help with prediction. The chart below shows the equity risk premium (equity returns above cash) in each of the last nine decades - though it has been positive for the majority, even 10 years of data is not a useful indicator for what the average returns were for the subsequent decade.

Similarly for bonds, expected returns are driven by prevailing yields rather than historic realized bond returns. Though this highlights that BTC's short history should not make its future returns any less forecastable than other asset classes, it is also ill-advised to simply extrapolate its stellar historic returns over the last 12 years when making expectations.

Decade Equity Returns
Previous decade returns have no relationship to subsequent decade

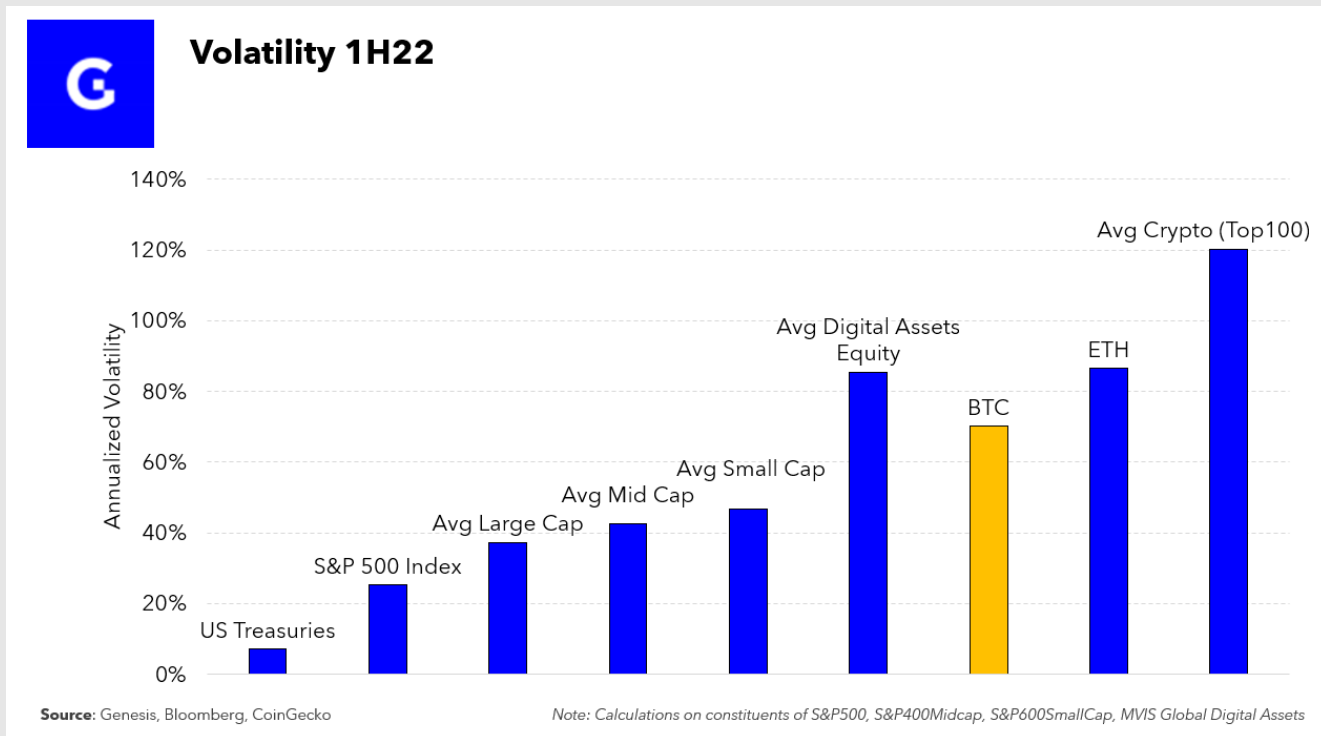**Source**: Genesis, Kenneth French Database

A robust investment process should not be overly reliant on an investor's ability to perfectly forecast expected returns. However, as previously mentioned, expected returns are just one input into portfolio construction. And fortunately for market participants, the other two elements, volatility and correlation, are less unstable. First, let's consider the volatility of BTC.

Your Size is not Size

Reducing the volatility of BTC via volatility scaling has shown merit historically and can enable an allocation for investors with lower risk tolerance.
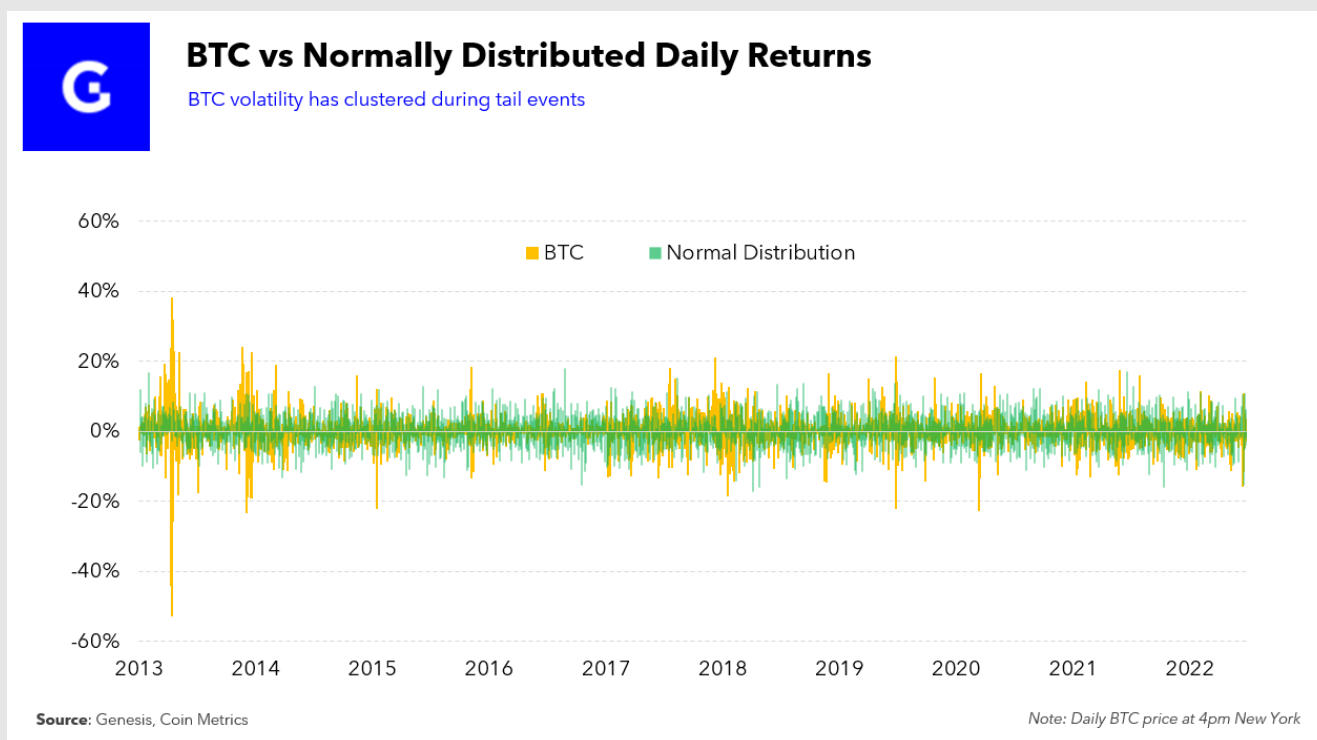
The high volatility of BTC relative to other asset classes is often given as a barrier to entry for traditional investors looking to make their first allocation. Although realized volatility has come down for BTC over the last decade, as shown in the chart below, in the first half of 2022 it was still over 2.5x that of the S&P 500 index, 1.8x that of the average large cap stock[6], 1.65x the average mid-cap stock, and 1.5x the average small-cap. And although blockchain-related equities have in fact been more volatile than BTC itself over the first half of 2022, crypto more broadly (represented by the volatility of the average token within the largest 100 by market cap) is the more volatile asset class.

Volatility 1H22

Annualized Volatility

Avg Crypto (Top100)
Avg Digital Assets Equity
ETH
BTC
Avg Small Cap
Avg Mid Cap
Avg Large Cap
S&P 500 Index
US Treasuries

Source: Genesis, Bloomberg, CoinGecko

Note: Calculations on constituents of S&P500, S&P400Midcap, S&P600SmallCap, MVIS Global Digital Assets

6 The S&P 500 has lower volatility than the average stock within the index due to the effects of diversification
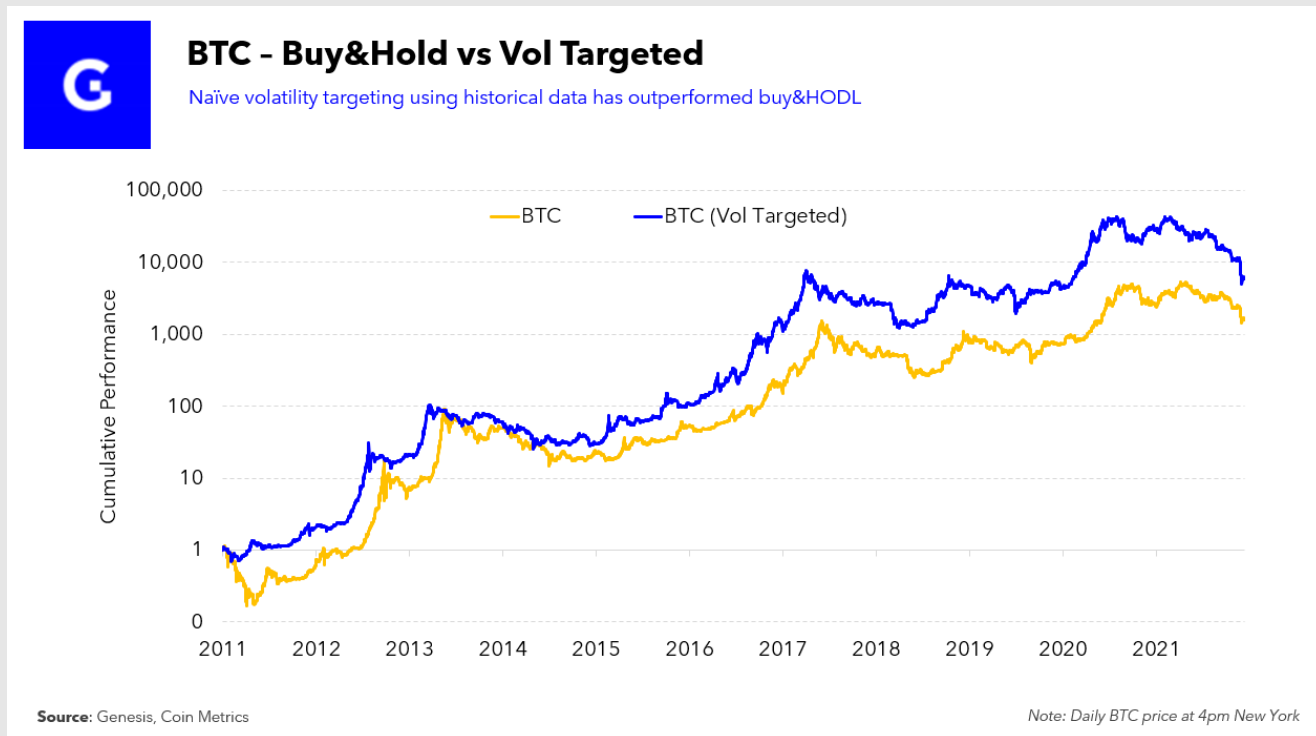
However, when viewing a portfolio through its risk weights (portfolio weight scaled by volatility of the asset), the volatility of the underlying asset is less relevant for portfolio construction, since the investor can simply dial their dollar exposure up or down to achieve the level of risk weighting they desire from that asset - for instance, an investor who wants BTC exposure but with half the volatility can simply combine a 50% BTC position with 50% in cash and rebalance frequently. As highlighted previously, the relatively high volatility of crypto in the context of risk weights comes with the advantage that an investor can achieve high risk targets without needing to leverage their position (unlike for lower volatility asset classes such as fixed income) - to bring risk weights more in line with other asset classes, an investor could mix their BTC allocation with cash.

BTC vs Normally Distributed Daily Returns

BTC volatility has clustered during tail events

Legend: ■ BTC ■ Normal Distribution

Source: Genesis, Coin Metrics

Note: Daily BTC price at 4pm New York

A complication in allocating a fixed risk weight to an asset is that volatilities change with time. The above chart shows daily BTC returns from 2013 to 2022 compared to hypothetical returns drawn from a normal distribution with the same average return and volatility. As with many risk assets, it is clear that BTC's returns breach the traditional statistical assumption of normality - namely that its volatility is not stable through time.

Thus, an investor must actively rebalance portfolio allocations to maintain a fixed risk target, reducing their position size if they forecast an increase in volatility, and increasing their position size if they expect volatility to decline. What is also visible from the above chart is that periods of high BTC volatility are persistent - thus, investors who reduced positions during these periods of heightened volatility since they were looking to keep a constant risk weight had broadly achieved the desired result. This serves as an intuitive counterpoint to high volatility being a barrier for an investor to allocate to crypto.

BTC – Buy&Hold vs Vol Targeted

Naïve volatility targeting using historical data has outperformed buy&HODL

Source: Genesis, Coin Metrics

Note: Daily BTC price at 4pm New York

Also worthy of note is that these historic periods of persistent heightened volatility often coincided with the largest drawdowns in BTC. The chart below compares the performance of BTC to a portfolio that was designed to maintain a constant level of portfolio risk equal to the long term volatility of BTC by rebalancing between a mix of BTC and cash (e.g. volatility targeting[7]).

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7 Rebalancing compares the current volatility (as measured over the previous 365 days with an exponentially weighted moving average) to the target volatility (the long term realized volatility of BTC)

A reason for outperformance of the volatility-targeted portfolio over a simple buy-and-hold strategy is that it reduced its BTC exposure during episodes of higher volatility, which dampened the impact of negative periods. This additional benefit could be a potential bonus for investors with a low risk budget who may utilize volatility targeting to allocate to crypto.

The persistence of volatility, the lack of need for leverage, and the additional transparency of digital assets (unlike for traditional assets, an investor can measure and manage risk in real time, 24 hours a day, 7 days a week) make them as well suited, if not better, for risk management purposes than other asset classes.

A Curious Correlation

BTC's correlation to traditional asset classes and hedge fund strategies has varied through time and has been lower than other assets on average.

"A theorist can explain any correlation, and its inverse" - Thomas Gold

The chart below shows the average pairwise correlation (ie, the average correlation between each asset and all the others in the universe) between asset classes and strategies in our previously defined investment universe per calendar year. Over the period 2010 to 2022, BTC's average pairwise correlation between other asset classes in our previously defined universe has been the lowest, providing evidence that it provides diversification benefit independent of whether it can repeat the high level of returns it achieved historically, and especially when compared to the ability of other asset classes to diversify a portfolio.

BTC – Average Pairwise Correlation* by Calendar Year

BTC has had low correlation to traditional asset classes and hedge fund strategies
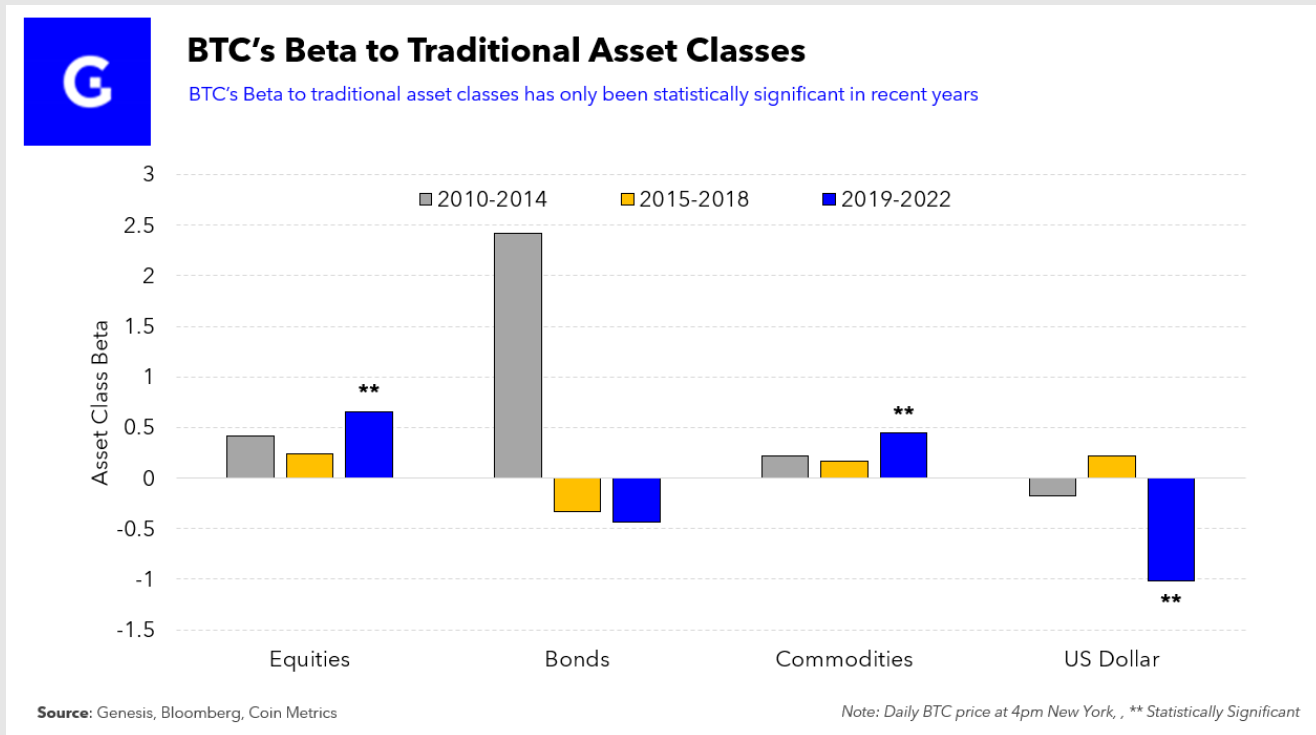
	2010 to 2022	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	1H 2022
BTC	**0.12**	0.17	0.13	0.11	0.14	0.13	0.13	0.12	0.12	0.13	0.13	0.32	0.26	0.30
S&P 500	**0.40**	0.41	0.47	0.39	0.33	0.41	0.42	0.42	0.38	0.36	0.32	0.47	0.43	0.40
US Bonds	**0.17**	0.22	0.30	0.30	0.14	0.25	0.24	0.21	0.22	0.18	0.25	0.19	0.22	0.22
Commodities	**0.27**	0.37	0.39	0.26	0.17	0.14	0.28	0.27	0.17	0.25	0.21	0.46	0.32	0.14
Equity Hedge	**0.43**	0.39	0.52	0.41	0.37	0.44	0.47	0.43	0.44	0.37	0.33	0.53	0.53	0.47
Macro/CTA	**0.19**	0.25	0.22	0.19	0.25	0.32	0.23	0.20	0.30	0.19	0.18	0.22	0.49	0.27
Relative Value Fixed Income Convertible Arbitrage	**0.23**	0.17	0.16	0.16	0.17	0.19	0.18	0.20	0.20	0.22	0.20	0.52	0.49	0.46
EH Equity Market Neutral	**0.25**	0.22	0.34	0.21	0.25	0.21	0.23	0.22	0.29	0.27	0.19	0.32	0.19	0.17
ED Merger Arbitrage	**0.34**	0.36	0.48	0.26	0.16	0.24	0.27	0.25	0.24	0.23	0.18	0.49	0.27	0.38
Event Driven	**0.40**	0.27	0.50	0.42	0.33	0.44	0.43	0.40	0.33	0.32	0.22	0.51	0.44	0.38
Absolute Return	**0.41**	0.39	0.44	0.28	0.29	0.43	0.41	0.31	0.36	0.33	0.32	0.56	0.47	0.36
Relative Value Arbitrage	**0.35**	0.22	0.36	0.25	0.22	0.36	0.41	0.28	0.33	0.35	0.26	0.51	0.46	0.39

Source: Genesis, Bloomberg, Coin Metrics, HFRX

*Note: *the average correlation of the asset to each of the others*

Taking a closer look at BTC's relationship with other asset classes and strategies, the regression analysis in the chart below considers BTC's [betas](#) to long-only asset classes and also the US Dollar, across three time periods (chosen to broadly represent the last three bitcoin price cycles) - we have excluded hedge fund strategies in this part of the analysis since their betas are less intuitive to interpret. Whilst BTC has had a positive beta to equities during all of the last three cycles, its relationship has only been statistically significant (ie. reliably different from zero after accounting for measurement noise) during the most recent three-year period - though it had a high beta coefficient to bonds in the early years between 2010-2014, the relationship was extremely noisy to the extent that it was not significant from a statistical perspective. Since 2019, BTC also realized a positive beta to commodities and a larger negative exposure to the US Dollar.

BTC's Beta to Traditional Asset Classes

BTC's Beta to traditional asset classes has only been statistically significant in recent years

Legend: 2010-2014, 2015-2018, 2019-2022

Y-axis: Asset Class Beta (from -1.5 to 3)

X-axis categories: Equities, Bonds, Commodities, US Dollar

Source: Genesis, Bloomberg, Coin Metrics

*Note: Daily BTC price at 4pm New York, , ** Statistically Significant*

A more nuanced picture emerges when running separate regressions for positive and negative days for BTC. These relationships varied by cycle - whilst there were no significant relationships between 2010-2014, the chart below shows BTC's beta to asset classes during the 2015-2018 cycle on days it was up and days it was down.

Even though exposures were not statistically significant during the 2015-2018 sample as whole, BTC had meaningful positive beta to equities and the US Dollar when only considering down days. Namely, on days it was down BTC had a strong relationship with equities and an even stronger one with the dollar. On the contrary, BTC had no significant beta to traditional asset classes on up days over the 2015-2018 cycle.

BTC moves have been more related to other asset classes on days it was down than on days when it increased in price.


BTC's Beta on Up vs Down Days (2015-2018)

BTC had statistically significant exposure to US Equities (+) and the US Dollar (+) on down days in the previous cycle
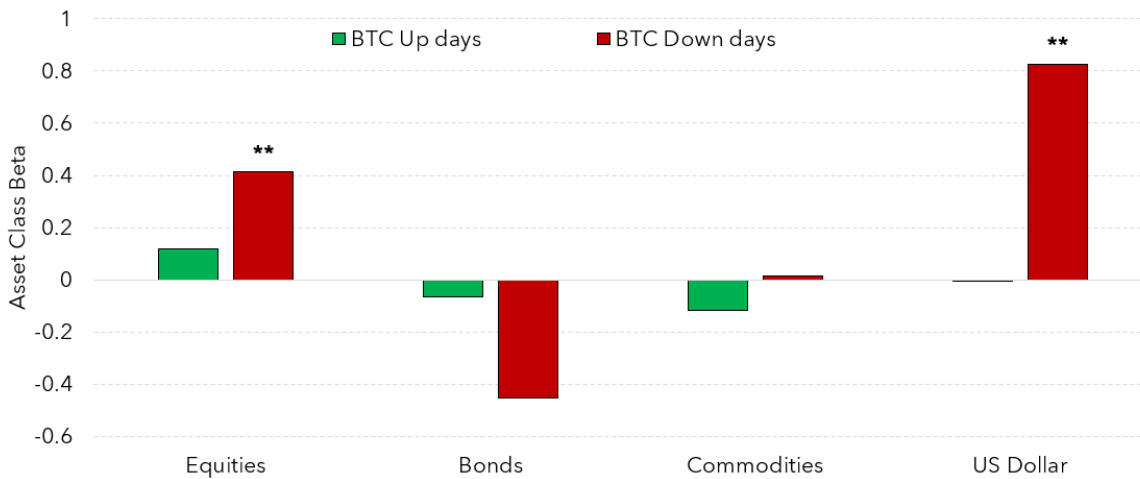
Source: Genesis, Bloomberg, Coin Metrics

*Note: Daily BTC price at 4pm New York, **Statistically Significant*

Similarly, the chart below considers the most recent cycle so far (2019-2022), BTC has only seen significant relationships during down days, when it has had a positive beta to both equities and commodities, whilst its largest beta was a negative relationship with the US Dollar. None of its betas to traditional asset classes have been statistically significant on days BTC had a positive return.

BTC's Beta on Up vs Down Days (2019-2022)

BTC had statistically significant exposure to US Equities (+), Commodities (+), and USD (-) on down days in recent years

Source: Genesis, Bloomberg, Coin Metrics

Note: Daily BTC price at 4pm New York, **/* Statistically Significant at 5%/10%
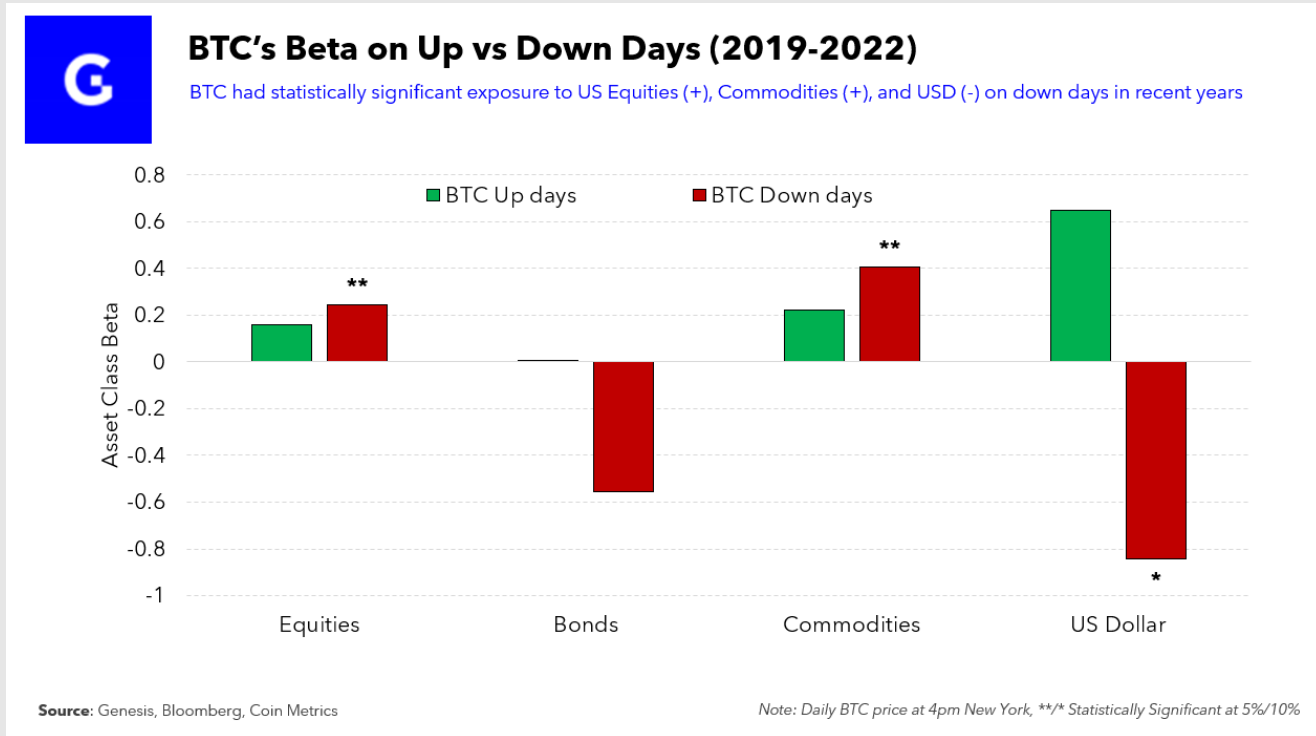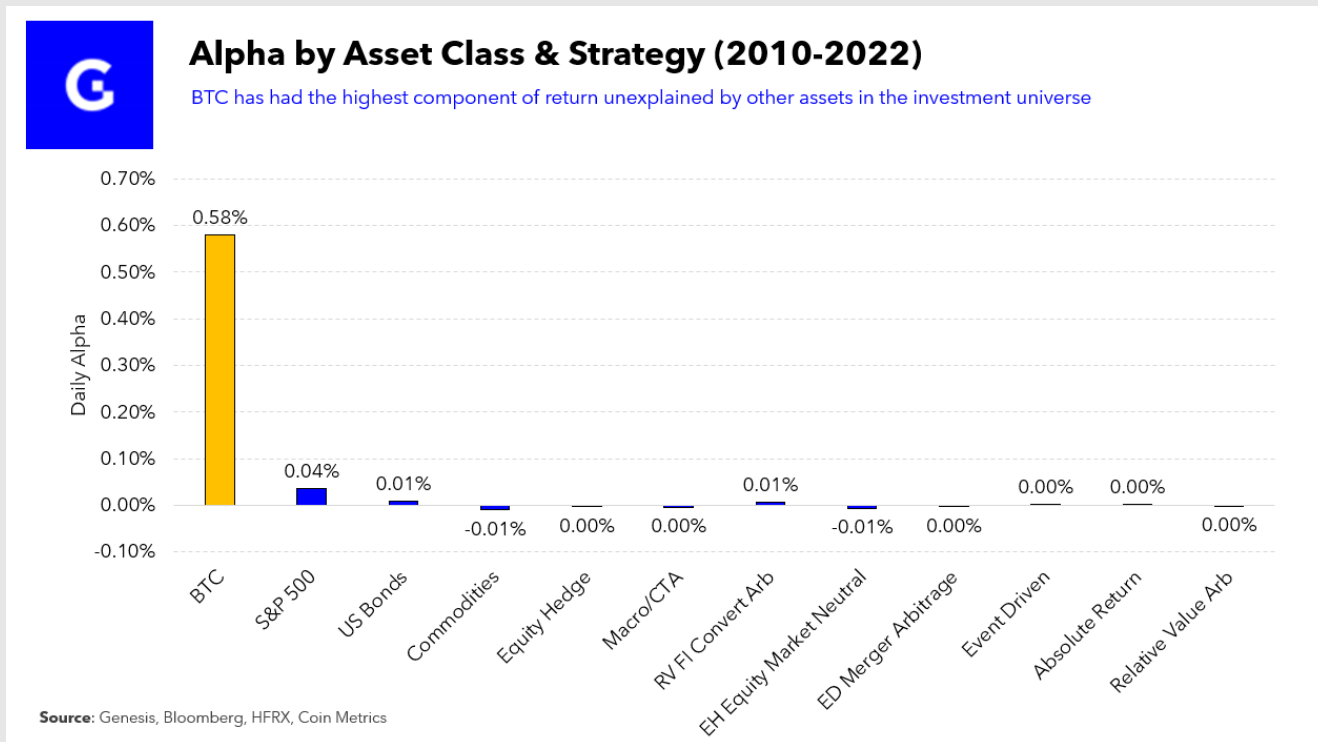
On this evidence, BTC's increased correlation to traditional asset classes in recent years has occurred mostly during periods of decline, and dollar strength has had a larger impact than declines in stocks or commodities. The jury is still out on the extent to which the recent increase in BTC's correlation to traditional assets is structural and this is an important portfolio construction consideration going forward. Though it is evident, particularly when using higher frequency data over shorter timeframes, that the correlation has continued to vary even during this recent cycle - and given the unique macro backdrop in 2022 thus far, it is also prudent not to assume that this year will be a reflection of long term relationships going forward[8].

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8 As a side note, periods of high correlation tend to contain the most noise. In practice, statistical methods that are used to make correlation estimates more robust tend to reduce the impact of data points with the highest correlation.

One last consideration is the [alpha](#) of BTC - the component of its return that is not explained by the remainder of the asset class universe.The chart below shows the alpha when regressing each asset against all the other assets in the investment universe between August 2010 and June 2022. BTC has had a daily excess return of 0.58% after controlling for all the other asset classes and hedge fund strategies in the investment universe. The only other alphas which were statistically significant during the period were the S&P500 and US bonds, and BTC's was higher by an order of magnitude (0.58% per day, versus 0.04% and 0.01% respectively). The caveats of past performance not guaranteeing future results notwithstanding, this is food for thought for any allocator who uses alpha as an input into their investment decision making process.

Alpha by Asset Class & Strategy (2010-2022)

BTC has had the highest component of return unexplained by other assets in the investment universe

Daily Alpha

- BTC: 0.58%
- S&P 500: 0.04%
- US Bonds: 0.01%
- Commodities: -0.01%
- Equity Hedge: 0.00%
- Macro/CTA: 0.00%
- RV FI Convert Arb: 0.01%
- EH Equity Market Neutral: -0.01%
- ED Merger Arbitrage: 0.00%
- Event Driven: 0.00%
- Absolute Return: 0.00%
- Relative Value Arb: 0.00%

Source: Genesis, Bloomberg, HFRX, Coin Metrics

Conclusion

"All truth passes through three stages. First, it is ridiculed. Second, it is violently opposed. Third, it is accepted as being self-evident."
- Arthur Schopenhauer

The extent to which we can make data-driven conclusions about the long-term expected returns of BTC are limited. However, this is also true of most other asset classes, and even though BTC's history may be short when compared to traditional broad asset classes, it is significant when compared to most hedge fund and VC track records that institutional investors base their manager allocations on. From a risk perspective, BTC and crypto more broadly have many properties that make them favorable tools to include in a toolbox alongside traditional assets, including their relatively high volatility, and potential diversification benefits. As institutional adoption continues at a rapid pace, the available data suggests that having a zero weight in crypto is a big bet for a diversified investor to be making.

Demystifying Crypto in Asset Allocation

APPENDIX

Investment Universe	Data Source (31Jul2010 to 30Jun22)
Bitcoin	Coin Metrics (BTC New York 4pm Close)
S&P 500	Bloomberg (SPXT Index)
Bloomberg Barclays US Aggregate Bond Index	Bloomberg (LBUSTRUU Index)
Bloomberg Commodities Index	Bloomberg (BCOMTR Index)
HFRX Equity Hedge Index	Bloomberg (HFRXEH Index)
HFRX Macro/CTA Index	Bloomberg (HFRXM Index)
HFRX Relative Value Fixed Income Convertible Arbitrage Index	Bloomberg (HFRXCA Index)
HFRX EH Equity Market Neutral Index	Bloomberg (HFRXEMN Index)
HFRX ED Merger Arbitrage Index	Bloomberg (HFRXMA Index)
HFRX Event Driven Index	Bloomberg (HFRXED Index)
HFRX Absolute Return Index	Bloomberg (HFRXAR Index)
HFRX Relative Value Arbitrage Index	Bloomberg (HFRXRVA Index)

Other Data	Source
Risk-free Rate	Kenneth French Database
Equity Risk Premium	Kenneth French Database
US Dollar Index	Bloomberg (DXY Curncy)

Contact

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