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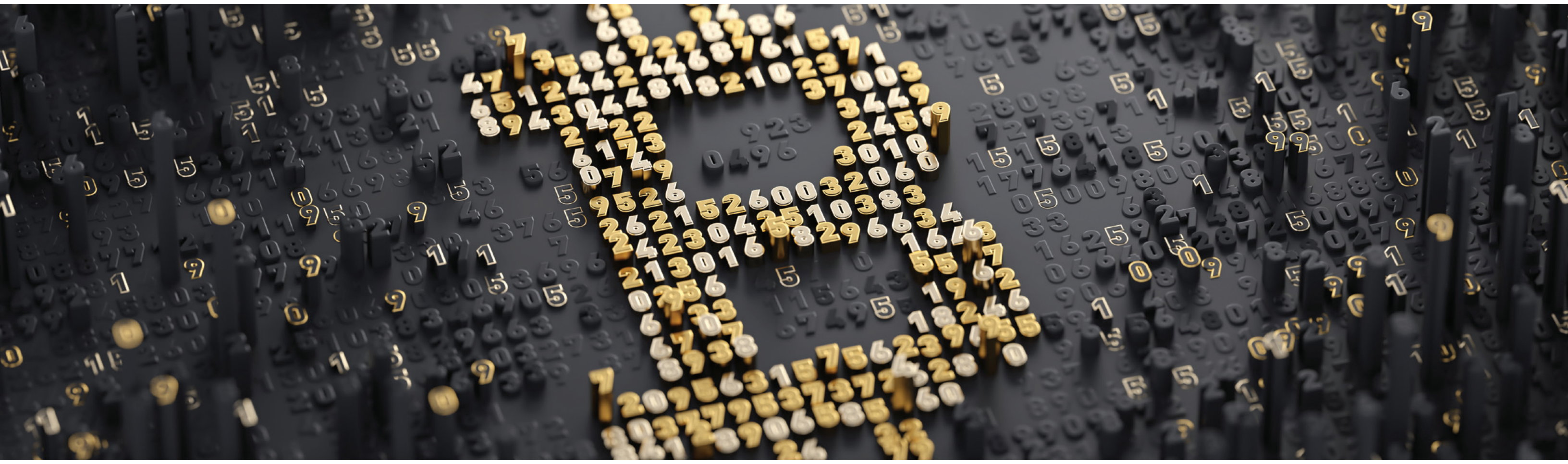
NEUBERGER | BERMAN



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Taking the "Byte" Out of Bitcoin

In our view, cryptocurrency investing is sprinting toward institutional adoption. Yet, to date, investor focus has been on "beta/delta one" strategies dominated by high-profile, self-proclaimed Bitcoin trading experts. Our experience suggests that many of these crypto-traders are simply offering access to Bitcoin (a custody solution) while competing for the honor of having named the highest price target. We do not believe it is possible to know what Bitcoin's price is going to do month to month, and our skepticism tells us that any investor claiming knowledge is likely just marketing their wares. However, this very uncertainty is exactly why we propose to explore options on Bitcoin as a route into a more risk-efficient approach to the asset, one that seeks to benefit from one of Bitcoin's most notable qualities—its volatility.

In the name of brevity, we will skip an introduction to Bitcoin[1] and assume for the purposes of this paper that our readers are already down the road of considering Bitcoin exposure for their investment portfolios.

At present, most investors appear to be holding/trading Bitcoin to "get rich", to the tune of ~$1 trillion in market capitalization. We certainly have no qualms with those pursuing great reward at the assumption of great risk. However, we prefer to pursue strategies that seek to compound capital efficiently over longer periods of time in what we call "stay rich" strategies.

Setting aside any fundamental and/or technical analysis, we believe the combination of Bitcoin's volatility and its seemingly uncorrelated return profile (Figure 1 below), offers a potentially attractive investment opportunity for investors to generate a unique return stream by attempting to harvest volatility as part of a diversified portfolio.

FIGURE 1. NOTHING COMPARES

Correlation to Bitcoin Total Return
Jul. 19, 2010 – Jun. 30, 2021

S&P 500	0.15
Russell 2000	0.17
MSCI Emerging Markets	0.07
BBG Barc. U.S. Aggregate	0.01
BBG. Barc. U.S. Corp. High Yield	0.07
BofA ML Long-term U.S. Treasury	0.00
HFRI Equity Hedged Total (net)	0.10
S&P GSCI	0.11
Gold Price (USD)	0.11
U.S. Dollar Futures	-0.01

Source: Bloomberg LP. For illustrative purposes only. Nothing herein constitutes a prediction or projection of future events or future market behavior. Due to a variety of factors, actual events or market behavior may differ significantly from any views expressed or any historical results. Indexes are unmanaged and are not available for direct investment. Investing entails risks, including possible loss of principal. **Past performance is no guarantee of future results**.

The explicit catalyst for our thinking was the introduction of Bitcoin futures (at five Bitcoins per contract or ~$275,000) and options by CME Group in 2020; more recently, on May 3, 2021, CME Group launched Micro Bitcoin futures, which trade in units of 1/10th of a Bitcoin (roughly $5,400 per contract). While overall volumes and open interest levels vary, Bitcoin futures have found reasonable flow, and option markets appear to be well quoted despite limited activity. We believe, with a functioning futures market supporting it, the Bitcoin option market is accessible to investors. And, to adopt the old Gold Rush wisdom, if Bitcoin is the gold, Bitcoin derivatives could be the pickaxes and shovels.

Bitcoin Pickaxes and Shovels

Most daily Bitcoin transactions occur "off-blockchain" ("off-chain"), meaning they are never verified and posted to Bitcoin's public distributed ledger ("on-chain"). Off-chain cryptocurrency transactions reduce/eliminate the latency and expense of verifying "on-chain" transactions, a process that takes about 10 minutes on average and currently costs about $30[2] per verified transaction regardless of the dollar value of the transaction for Bitcoin. While off-chain transactions may diminish Bitcoin's coveted platform-independent status, they allow transaction volumes to be potentially unlimited.

Persistent buying and selling of a new asset class, i.e. proven liquidity, is typically required to build institutional investor confidence before they will adopt futures and options markets and enable them to supplement the established cash market.

We believe cryptocurrency may have a lower hurdle to clear than most new asset classes for investor adoption of futures and options. Given the relative complexity of Bitcoin custody and trade verification on its blockchain, derivatives markets may grow rapidly as more efficient sources of exposures. We anticipate that many investors will appreciate standardized, exchange-traded, centrally cleared derivatives, such as CME Group products, held at secure, crypto-friendly custodians/prime brokers, as their off-chain access to Bitcoin. At present, Bitcoin futures have a relatively high roll cost, but we expect the cost to fall as exposure demand grows and additional Bitcoin products proliferate.

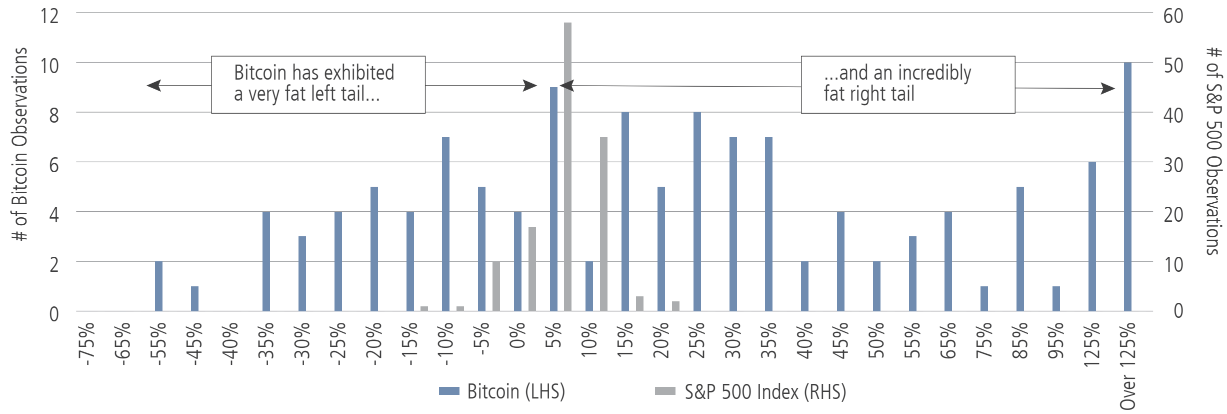
[1] For an introduction to Bitcoin, please see *The Bitcoin Experiment* by Hakan Kaya, PhD, Seth Yerk, CFA, & Suzanne Peck.
[2] Sum of daily Bitcoin Blockchain transaction fees divided by the number of transactions verified.

Surveying the Opportunity

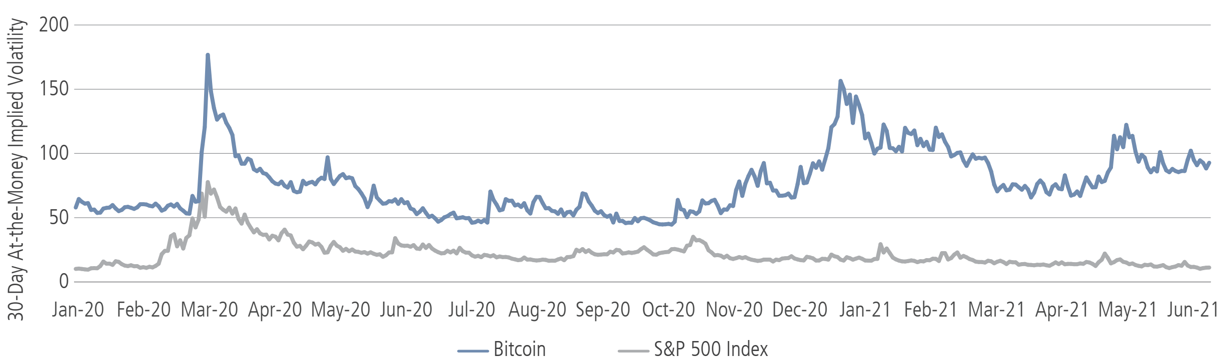
Given our decade of experience developing systematic options strategies on a variety of volatile index exposures, we believe that similar success may be found in developing such strategies with Bitcoin. Consider the 10 years of return history in figure 2.

FIGURE 2. FAT TAILS AND HIGH FEAR LEVELS

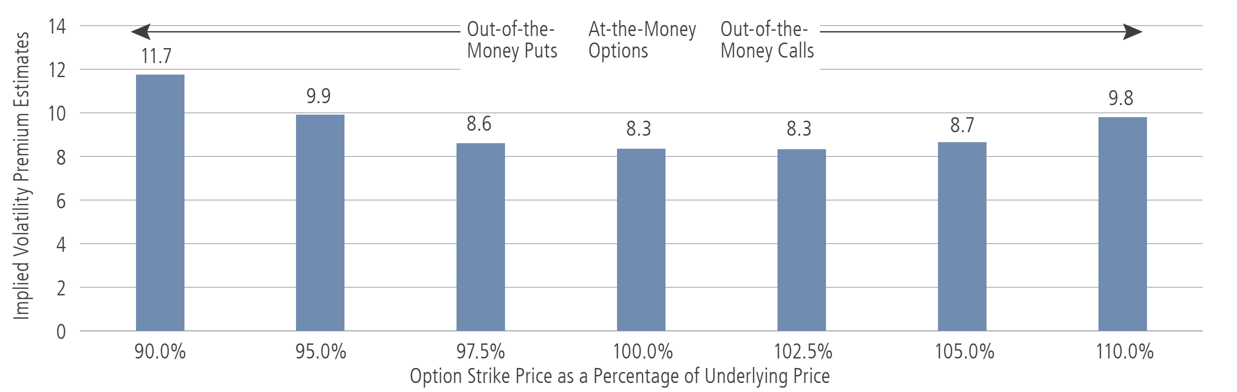
Bitcoin and S&P 500 two-month return distributions, November 2010 – June 2021



Bitcoin and S&P 500 30-day at-the-money option implied volatility, January 13 – June 30, 2021



Estimated Bitcoin option implied volatility premium, January 13 – June 30, 2021



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We can see that Bitcoin has exhibited fat tails on both the left and the right of its returns distribution—and that the right tail is exceptionally fat relative to what we have seen from equity markets. That high level of realized volatility is reflected in even higher levels of implied volatility priced into at-the-money options: market participants looking to hedge their exposure to Bitcoin have evidently been willing to pay a high premium to do so.

Moreover, there is significant skew in out-of-the-money options on both sides of the Bitcoin implied volatility "smile," which suggests that there is currently plenty of "fear" of both tails of the Bitcoin returns distribution priced into Bitcoin option markets.

While Bitcoin's volatility may decline as it becomes more liquid and institutionalized, the same development is likely to require more warehousing of Bitcoin risk by market participants, and therefore more demand for hedges against both the upside and downside risk. For that reason, we believe that Bitcoin options are likely to continue to carry a relatively high implied volatility premium for the foreseeable future.

Ultimately, we see three higher probability scenarios for Bitcoin in the coming years. One, Bitcoin continues its meteoric rise and remains extremely volatile. Two, Bitcoin's price suffers a collapse, driving volatility to new extremes. Three, Bitcoin's growth rate slows and volatility declines (but remains attractive). In all cases, we believe utilizing option strategies may provide advantages to or complement a Buy & Hold Bitcoin strategy. Using the average implied volatility since Bitcoin options went live in 2020, the average monthly yield on an at-the-money Bitcoin put option has been approximately 9%, or well over 100% annualized—a reduction from here would be merely a shift from something extreme to something very substantial.

There are a number of ways an investor could approach a Bitcoin implied volatility strategy, by selling put options or calls, or a mix of both. Given the extremely fat tails of its historical returns distribution, investors looking to take some of the "byte" out of Bitcoin may find a hedged approach attractive. For example, selling out-of-the-money put options with an aim of gathering downside implied volatility premiums, while simultaneously buying them as hedges, could potentially generate a return stream close to the long-term average for Bitcoin itself, while giving up some of the more extreme upside outcomes realized in exchange for cutting exposure to some of the more extreme downside realized volatility outcomes.

A New Asset Class: Crypto Implied Volatility

For the last 10 years we have researched, recommended and implemented options-based strategies for institutional and high net worth investors. Several times we have refrained from pursuing volatility/option strategies that we believed to be too speculative or merely "faddish." In Bitcoin, we believe we have found a new and potentially worthy application of our discipline for those looking to acquire Bitcoin exposure.

Thus far, Bitcoin has proven to provide both an opportunity to diversify investment portfolios and to potentially earn substantial profits. However, those benefits are not offered on a risk-free basis. Rather, they have come with extraordinary levels of volatility and unique operational risks—we consider "lose your password and lose all your money" to be a material risk no matter how small the probability of it occurring. Succinctly, the evolution and growth of Bitcoin (and other cryptocurrencies) may offer new sources of portfolio return and volatility premium for investors to harvest. We expect these risk premiums will likely persist. Hence, we believe options-based, implied-volatility strategies are a potentially unique solution for investors looking to participate in Bitcoin's future with a potentially greater degree of risk control and operational efficiency, and, down the road, we expect additional cryptocurrencies will likely present similar opportunities.

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