



BERNSTEIN

CRYPTOASSETS

**DISCRETION IS THE
BETTER PART OF VALOR**

BERNSTEIN PRIVATE WEALTH MANAGEMENT

BERNSTEIN PRIVATE WEALTH MANAGEMENT INVESTMENT STRATEGY GROUP

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“The enormous rally in bitcoin and other cryptoassets has been impossible to miss. Since last March’s coronavirus-induced low of around \$5,000, the bitcoin price has risen 12x to around \$60,000 just one year later. From its creation in 2009, it’s been the best-performing asset in the world. With a value of \$1.1 trillion, bitcoin alone is roughly as large as the venture capital asset class, has one-third the value of all gold held by investors, and has 6% of the total US money supply. The computer network supporting it consumes as much energy as Argentina.

If all the news over the past year had been about the price action, we might dismiss the move in bitcoin and other cryptoassets as pure speculation. But there’s been real, fundamental progress over the past several years—not just for bitcoin, but for the entire blockchain and cryptoasset space. Given that progress and the controversy around these assets, we think it’s time for investors to take a closer look at recent developments, what they could mean for existing portfolios, and the opportunities they might create for the future.

Progress on several fundamental fronts—including security, regulation, and infrastructure—means these assets may finally be accessible to a broad range of investors. Even global central banks such as the US Federal Reserve are researching and testing their own digital currencies based on this technology. But accessibility does not equal investability. Investors interested in blockchain technologies and cryptoassets must rely on a fundamental framework when approaching the space and dimension its unique risks, including valuation.

Overall, we believe that cryptoassets and the ecosystem supporting them have a foundation on which to continue growing over the coming decades. Even if investors don’t buy cryptoassets directly, they’ll need to consider what their growth means from a portfolio standpoint. Part of that involves the opportunities and threats created for companies and industries with which investors are familiar. Part involves figuring out where the value from this new technology is likely to accrue and how to take advantage of it.

There’s still no holy grail when valuing cryptoassets. Different valuation approaches have drawbacks, yet overall, they help shed light on how investors may approach the space in the future. We highlight four in particular: The Platform Value Approach, the Portfolio Theory Approach, the Cost of Production Approach, and the Quant Approach.

With valuation difficulties remaining and these assets subject both to significant price volatility and genuine fundamental risk and uncertainty, investors need to proceed cautiously. Risk management is critical. Investors should be prepared for any given cryptoasset to rapidly lose the majority or entirety of its value. As a result, we recommend limiting the overall size of investments in the space, diversifying across various

OVERVIEW

- Cryptoassets and blockchain technologies have made substantial fundamental progress in the past several years and the foundation is now in place for them to flourish. Even major central banks like the US Federal Reserve are considering digital versions of existing currencies that operate using blockchain technology.
- As with any new technology, the market price may significantly diverge from fundamental developments, either too positively or too negatively, so investors need to tread carefully.
- Valuing cryptoassets isn’t impossible, but it is harder than valuing traditional assets. There’s still little agreement on the best approach or the right assumptions for many assets. That wide margin of error leads to more volatility and necessitates caution.
- Investors should approach the space with a venture capital mindset—while the potential rewards may be large, these assets and projects could rapidly lose the majority or entirety of their market value. Diversification and due diligence will be critical, as will a balance of optimism and skepticism.

cryptoassets and strategies, and ensuring that investors or their portfolio managers are conducting careful due diligence to understand the fundamentals of their crypto investments. Furthermore, these investments should be funded with long-duration capital—perhaps capital earmarked for future generations—that won’t be affected by high volatility.

While the fundamental foundation for cryptoassets is now stronger than ever, further caution is still required, as this concept remains in its infancy. Today, the cryptoasset markets are once again subject to a high degree of speculative fervor. A balance of optimism and skepticism will be critical to differentiate between attractive opportunities and promotional hype.

THE TWO KEY QUESTIONS

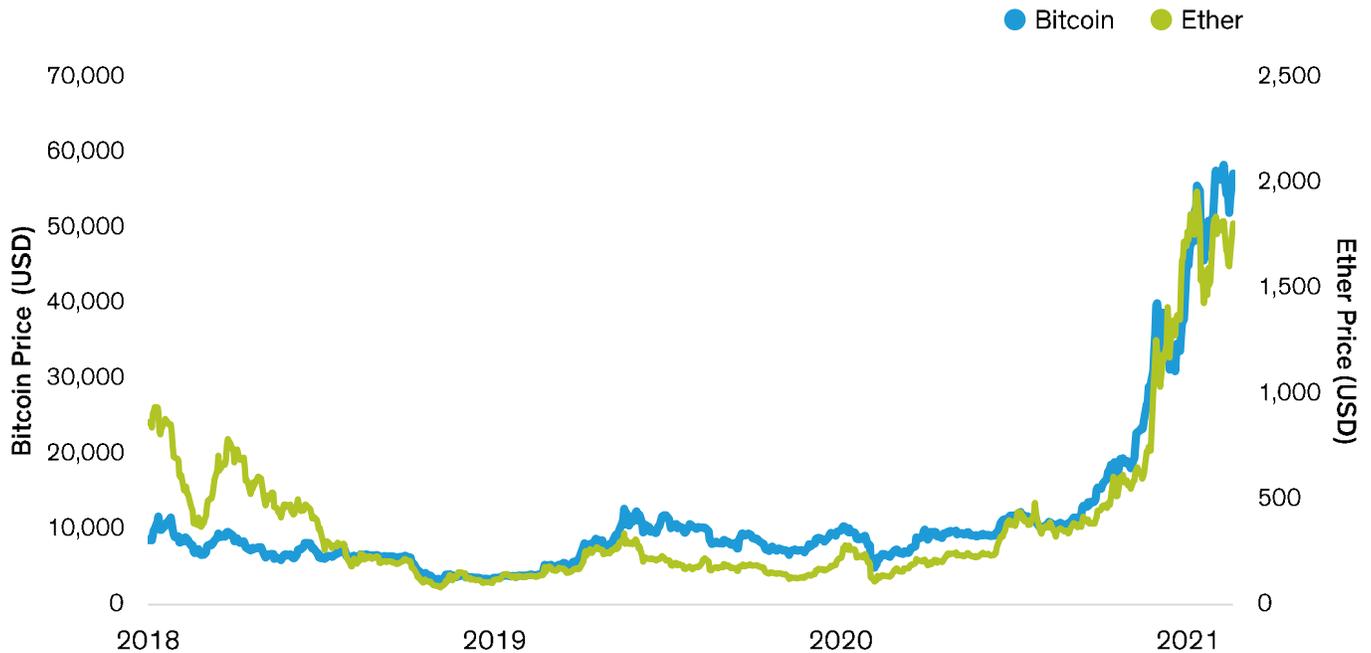
With the dramatic surge in the prices of bitcoin and other cryptoassets recently,¹ it's no surprise that we've fielded many questions asking whether clients should buy into this boom. Is it a bubble, an emerging asset class, or both? (**Display 1**)

We've continued to monitor the evolution of blockchain technologies and the development of the crypto markets for several years. To date, our view

has primarily emphasized the conclusions of our April 2018 white paper, "[Will Blockchain Change Everything?](#)"

As it stands today, we're as excited as ever by the possibilities that blockchain technology holds—either through public blockchains or private versions. Projects developed using this technology have the potential to make everyday tasks even more efficient, while unlocking things we've never been able to do before and developing a range of governance structures and organizations that weren't previously possible.

DISPLAY 1: BITCOIN, ETHER, AND OTHER CRYPTOASSETS HAVE SURGED IN RECENT MONTHS

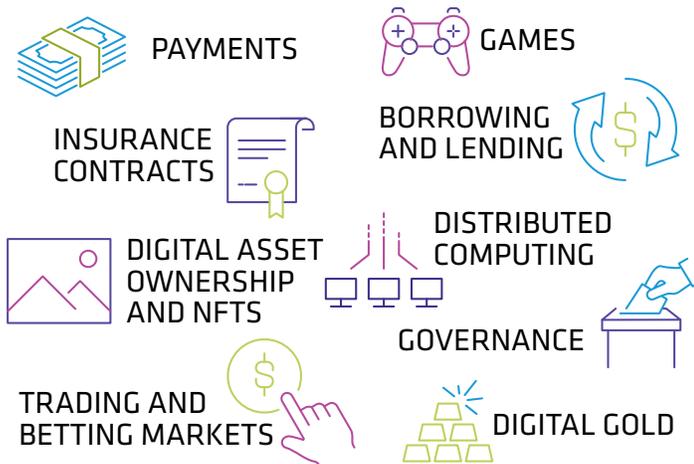


Past performance does not guarantee future results.

Source: Bloomberg and Bernstein analysis

1. While commonly called cryptocurrencies, we think it's more useful to think of them as cryptoassets. Some are designed with money-like attributes in mind and may mature into more of a currency-like asset over time. Others are not very well designed to serve as money but could still serve as assets for individuals and firms.

Trusted third parties have been essential to organizing life for most of human history—yet technology could now weaken the case for middlemen in a range of industries. In some ways, the situation resembles the early stages of the internet revolution. In the coming decades, many new entities are likely to emerge and experiment with different applications of the technology, with an inevitably diverse array of outcomes from their efforts.



There are many questions surrounding cryptoassets and blockchain technology, including ones from legal, environmental, political, and economic perspectives. For investors, two critical questions rise above the others:

First, at what point in the development and maturation of cryptoassets will it make sense for investors to include them in their investment universe?² Put simply, when will crypto be ready for prime time?

Second, once these assets have matured to the point where they should be considered for investment, how should we think about when to buy, when to sell, and how to size positions?

WHEN WILL CRYPTO BE READY FOR PRIME TIME?

This question echoes those faced by investors considering investing in a frontier stock market. Before deciding to buy or sell any individual stock in a given country, you'd first want to get a sense of the economic fundamentals and the degree to which the rule of law prevails. Only once

you're comfortable with the country itself would you begin to think about which stocks to buy.

Bitcoin,³ the oldest cryptoasset, was launched in January 2009 and only in recent years has it become more mainstream. Because cryptoassets have primarily come from outside the existing financial system, they've faced a number of challenges in terms of security, regulation, and integration. These have been real obstacles and, while significant progress has been made for the entire space—especially for some of the more mature coins like bitcoin—there's still heightened risk in these areas compared to other assets.

We'll break down each of these hurdles, discuss what progress has been made in recent years, and see where things stand for crypto investors today.

Cryptoassets have primarily come from outside the existing financial system.

Security for Cryptoassets

Unlike dollars in a bank or brokerage account, cryptoassets lack government-mandated insurance, meaning holders can be exposed to theft and fraud.⁴ There have also been some notable incidents of hacking or theft in recent years—including the Mt. Gox loss of 650,000 bitcoin, which today would be worth around \$39 billion, and the Bitfinex hack of 120,000 bitcoin. Hackers still attempt a range of strategies to separate people from their cryptoassets. Exchanges and investors have made substantial strides in foiling these attempts, but risks remain.

In addition, part of a crypto network's security comes from its decentralized nature. Since it's not controlled by any individual party, you don't have to worry about trusting that person or group. But if an attacker can muster more than half of the network's computing power, they can overwhelm the system and effectively spend the same coins twice while wielding that control. This is called a 51% attack. While it would be difficult to achieve in as large a network as Bitcoin, such attacks have happened to other cryptoassets, including Bitcoin Gold, which at the time was the 26th largest cryptoasset.

2. In this case, we're thinking about investors broadly. Venture investors can, should, and have invested in this space for a number of years already and will continue to do so. But we're focused on mainstream institutional investors and their end clients, who are frequently individuals.
 3. By convention, Bitcoin (with a capital "B") is the network/protocol and bitcoin (with a lowercase "b") is the cryptoasset used in its system.
 4. Some private insurance offerings are emerging, but they have yet to be tested.

Cryptoassets are tied to protocols, which you can think of as a set of rules coded into software. You tell the computer to generate or transfer a digital coin when something happens and when that occurs, the coin is created or transferred. Since blockchain protocols and cryptoassets are fueled by software, they're also susceptible to bugs. Some of these can be highly consequential—for instance, a bug which was discovered and fixed for Bitcoin in 2018. A key component of bitcoin's investment rationale is that only 21 million coins can ever be produced. This bug could have increased that number and diluted all bitcoin holders. Thankfully, that didn't happen, but it's a reminder of the risk which bugs pose to cryptoassets.

To some extent, hacking and bugs have become a part of modern life. Companies and governments are hacked, data is leaked. Usually that's not an existential issue for the firm or nation. But for cryptoassets still earning users' trust and growing their networks, that can be debilitating. Returning to the Bitcoin Gold example, for almost four years after that attack and lasting up until a stunning surge in the past month, its price remained down 75% from its pre-attack level.⁵

Finally, if you deposit money in a bank or buy a stock and forget about it, you're unlikely to misplace it. But for investors in cryptoassets, losing your private key (the code which allows you to access your assets) can render your assets inaccessible. As a result, the most attractive security and privacy features of cryptoassets are in some ways their most perilous. Estimates of lost bitcoin add up to around 20% of the total in existence, according to crypto data firm Chainalysis.⁶

Regulating Uncharted Waters

Regulation represents another risk. However, the trend in the past few years has been encouraging as governments have worked to establish reasonable protections for investors while creating a foundation for cryptoassets to flourish. One of the first important clarifications came from the IRS, stating that cryptoassets are capital assets similar to stocks or bonds—rather than commodities or currencies—conferring more favorable tax treatment.

Another regulatory focus came in the areas of "Know Your Client" (KYC) and anti-money laundering (AML). Given the anonymity of cryptoassets, much of their original usage was in illicit trade. To prevent such nefarious activities while opening the technology for more legitimate users, major governments have bolstered KYC and AML standards.

Though innocuously named, the US Office of the Comptroller of the Currency's Interpretive Letters 1170 and 1174 stand out as two recent and particularly positive regulations. The first allows federally chartered banks and thrifts to provide custodial services for cryptoassets. Custody has proven to be a major obstacle for greater institutional involvement—if you're going to invest in assets on a client's behalf, both of you need to have confidence that the assets are in secure hands. A whole infrastructure exists to safeguard stocks and bonds, but it's only begun to be built for cryptoassets. Some of the security solutions offered by cryptoasset custodians are even more demanding than those of bank or brokerage accounts.

5. Bitcoin Gold had already fallen by 90% from its December 2017 peak to around \$40 in April 2018, before the attack in May.

6. Bullish investors point to this as further constraining the supply and supporting the price.

The second Interpretive Letter allows banks to contribute their computing capacity to blockchain networks and to conduct payments using stablecoins—cryptoassets designed to have lower volatility based on a peg to an underlying asset (like the US dollar) or group of assets (such as a basket of leading currencies). When people speak of the institutionalization of cryptoassets, regulations are pivotal in protecting Main Street investors and allowing cryptoassets to be integrated into the rest of the financial system.

In addition to these regulations, governments are still determining how to classify different cryptoassets. Are they securities, currencies, commodities, or something else? Their treatment, especially by securities regulators like the US's SEC and UK's FCA, may be particularly important as crypto firms and protocols attempt to expand to more traditional areas of finance. After the 2017 bubble in cryptoassets, regulators cracked down on new cryptoassets and initial coin offerings (ICOs), eliminating some of the more speculative—and in some cases, outright fraudulent—activity. If cryptoassets are to become digital claims to real world assets in the future ("tokenization"), that could begin to look increasingly like the assets regulated by the SEC and their global counterparts.

Ongoing legal decisions on this front will also be critical to the future—in December 2020, the SEC sued Ripple Labs and two of its executives for the unregistered offering of \$1.3 billion in securities starting in 2013. The security in question is XRP, a cryptoasset whose price dropped by half after the announcement of the suit, and yet remains the fourth largest, with a total value of \$80 billion.

If done well, these ongoing regulatory decisions and experiments will protect susceptible investors while providing a foundation for innovation in the crypto space.

Finally, because of the potential value of these technologies and their implications for economic policymaking, major central banks including the Federal Reserve and European Central Bank are researching and testing their own digital currencies (central bank digital currencies, or CBDCs). Between 2012 and 2020, the percentage of people in Sweden using cash in the past month fell from 93% to 50%. The country is testing an e-krona issued by the central bank and distributed by approved participants. In China, several pilot programs are underway for a CBDC which could function as digital cash—integrating with Alipay, WeChat Pay, and other technologies—eventually allowing the country to bypass the existing US-led international transfer system. Perhaps surprisingly, the Bahamas are at the forefront of CBDCs, launching their digital Sand Dollar in October 2020. Issued by the central bank, the Sand Dollar supply remains quite low. It also pays no interest and can only be held domestically.

If done well, these ongoing regulatory decisions and experiments will protect susceptible investors while providing a foundation for innovation in the crypto space. They will determine how different categories of people can interact with certain assets and define what they can do with them.

Can Cryptoassets Play a Role in Investment Portfolios?

The last major hurdle in considering whether cryptoassets are an investable asset class is whether investors can even make reasonable estimates of their expected return characteristics in order to judge cryptoassets' relative merits. **If we can't expect to make a reasonable judgment about the potential returns and risks of these assets, then the question of when to buy or sell and how much to invest is moot.**

In some ways, all assets have both investment and speculative attributes—stocks tend to be more tied to fundamentals, currencies and commodities have a fundamental foundation but can be more speculative, and assets like art and collectibles are dominated by speculation. But even for fundamentally grounded assets like stocks, at certain points in time like the dot-com bubble, speculation can still reign supreme.

Where do cryptoassets sit on this spectrum? Are they more like Microsoft shares, Mexican pesos, Monet paintings, or Beanie Babies? We believe the answer is all of the above—some cryptoassets are more like stocks or currencies, others are more like art or collectibles.

Are they more like Microsoft shares, Mexican pesos, Monet paintings, or Beanie Babies?

For the cryptoassets that are more Microsoft than Monet, how can investors get comfortable owning them in their portfolios? To do that, you have to believe the rewards of including them outweigh the risks.

In the investment industry, this trade-off is commonly modeled using an optimization technique. Yet optimization depends enormously on the assumptions you make about returns, volatility, and correlation. Cryptoassets (with the exception of stablecoins) are generally quite volatile, as their supply tends to be inflexible while demand fluctuates significantly. Their correlation with other assets has also been low to date, as asset-specific circumstances disconnected from the rest of the economy have largely driven their moves. And then there's the big assumption—expected returns, which have a disproportionate impact on your optimal weighting.

Our Bernstein Research colleagues ran a simplified optimization to see how much long-term investors might want to invest in bitcoin. Using data from January 2016 through October 2020, they estimated that bitcoin could merit a 1% position in portfolios if you assume a monthly return of 3%. That works out to over a 40% annual return, far exceeding that which we'd expect from any other asset class. If that seems like a small position given such outsized expected returns, it's because bitcoin's volatility is so high. To justify a 5% allocation, you'd need to assume that bitcoin will more than triple each year. At that rate, bitcoin would have the same value as all US stocks in around three years. This begs the question—are those reasonable expectations? How do you estimate the expected returns for cryptoassets?

This is hard. These are new assets. Blockchain protocols which spawn cryptoassets are being created for a variety of different purposes, much the same way we use some software to write, different programs for graphic design, some to watch videos, and still others for data analysis. But in the world of blockchain, these applications may include the creation of digital alternatives to gold, payment networks, smart contracts, or the tokenization of (the creation of a digital claim on) real-world assets.⁷ And the rules by which the coins themselves are generated can also differ across those protocols. Just as you value a bank differently than a manufacturer or a dollar or a bar of gold, different valuation methods will be better suited to some cryptoassets than others. Over time, these valuations should connect to some form of economic fundamentals, just as they do in other asset classes, but for now the territory remains unfamiliar to most investors.

Importantly, we believe that valuation approaches are becoming increasingly relevant in the cryptoasset space and that there are rational ways to approach the market. There's a lot of noise in the space, so caution

There's no holy grail when valuing cryptoassets. Many approaches have been suggested. Part of the challenge is finding approaches that make sense.

is warranted, but there is more there than pure unbridled speculation. Yet we would not be surprised to see the speculation overwhelm the fundamentals from time to time—and more so than in other asset classes.

Overall, while there are still significant risks to any given cryptoasset, we believe enough progress has been made in security, regulation, and market maturation that the asset class deserves to be considered inside a portfolio. In addition, investors should pay attention to the threats or

7. For those interested in the ongoing move toward a digital world, tokenization can create non-fungible digital assets inside games or virtual worlds. This creates "digital scarcity" and allows people to buy or sell unique digital assets without worrying about there being multiple copies. Non-fungible tokens (NFTs), which have recently been used to digitally "own" art, music, and even basketball highlights, are another major application.

opportunities which these technologies create for existing companies and industries. At present, we'd still operate under the assumption that an investment in any given cryptoasset could rapidly lose the majority, if not the entirety, of its value. As such, we proceed extremely cautiously to the next question—how can investors make reasonable decisions about buying, selling, and holding cryptoassets?

HOW DO YOU VALUE A CRYPTOASSET?

This is the billion-dollar question. How can an intelligent, long-term investor approach such seemingly speculative assets as crypto? Do they even have a value?

There's no holy grail when valuing cryptoassets. Many approaches have been suggested. Part of the challenge is finding approaches that make sense—the other part is applying those methods using reasonable assumptions. For instance, estimates of the fair value for bitcoin have ranged from Jeremy Grantham's \$0 to Scott Miner's \$400,000. At least one bitcoin promoter has gone further and estimated a value of \$1,000,000 per bitcoin, which would put the value of all bitcoin on par with the current \$19 trillion supply of US dollars. Somewhere in there lies the truth—but where?

To demonstrate potential valuation metrics, we'll mostly focus on bitcoin, as it's the oldest cryptoasset, represents close to two-thirds of total crypto value, and draws the most attention and speculation. Yet today there are over 9,000 cryptoassets listed on CoinMarketCap.com and, as mentioned above, certain valuation methods may be better suited for some of these assets than others.

Our goal here is not to put a target price on any cryptoassets, but rather to map out how investors may approach the problem. These methods are designed to highlight key aspects of these assets and how investors can put them in context to make more rational decisions. They're not perfect—we'll also highlight their drawbacks so investors can form their own opinions.

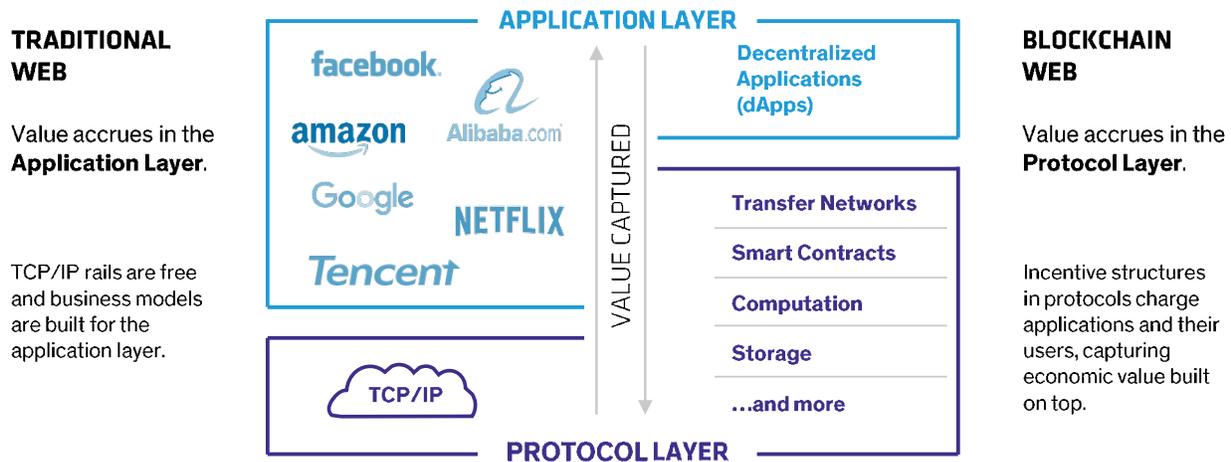
The Platform Value Approach

Before turning to bitcoin, though, there's an approach that's worth mentioning. We'll only touch on it here, as it's more useful for other cryptoassets such as ether (ETH, the second most highly valued cryptoasset today, with a market cap of \$270 billion) than it is for bitcoin. This is the Protocol, or Platform Value Approach. **(Display 2)**

A key difference between the blockchain protocols and previous ones—such as those underpinning the internet—is their ability to capture the value occurring on their platform. When you go to a website such as www.Bernstein.com, you're connecting via digital rails using a software

DISPLAY 2: THE FAT PROTOCOL THESIS

Suggests Crypto Protocols Can Capture More Value Than Applications



Source: Joel Monegro, Union Square Ventures, and Bernstein analysis

protocol called TCP/IP. Initially built by the US Department of Defense, the software ultimately became a public good, a technology that we all use freely today. Yet it enables immense value creation—from the daily work we do to the value of application companies like Google, Facebook, and Amazon. These companies have built business models on top of it in such a way that the value accrues to them and their shareholders. Blockchain is different because value can be captured by the protocol itself. Imagine if that internet protocol had a toll system built into it and every time you used the internet for something, it charged you a tiny fee. That’s effectively what public blockchains can do with their coins.

We singled out ether here because the Ethereum network is designed to be a building block which developers can use as the foundation for their own projects, enabling blockchains that can serve as smart contracts, lending markets, trading markets, betting markets, games, and more. But to build and operate your project using Ethereum’s network, you must compensate the network for processing and verifying what you’re doing, which means paying it with ether, the network’s currency.

There are two ways to accomplish this—you either “mine” ether by investing in computer hardware and electricity to process the data running on the network⁸ or you buy it by exchanging another asset, such as dollars. In either case, the more developers and end users tap into the Ethereum network, the more value it can potentially capture. This is one of the primary reasons for the excitement surrounding cryptoassets—while applications have captured the economics of the world built on the internet, protocols may capture the economics of the world built on the blockchain.⁹

As with software companies, we believe that each “sector” of the crypto space—payments, smart contracts, gaming, digital gold, and so on—is likely to be dominated by one or more protocols. It’s quite possible to go astray here—think about how things looked for Netscape, AOL, or Myspace at past points in time—they were new, exciting, and promising businesses that eventually faded away. Yet from that emerged today’s dominant companies like Facebook, Google, and Amazon.

Hence, one way to think about the value of a cryptoasset is to think about the value of all those potential projects that can be built from its protocol, how much value the developers and miners will capture, and how much value will be passed onto the network itself. At the same time, investors must account for the fact that the future is uncertain—similar to venture or early-stage investments, we can’t know whether those endeavors will succeed. In addition, the structures are still evolving—Ethereum’s system is likely to transform in meaningful ways over the next year or so and the value that it’s able to create and capture will change as a result. That makes it difficult to forecast what its long-term economics will look like. Because this way of thinking is based on the value that the protocol can create and capture as a platform for its users, we call it the “Platform Value Approach.”¹⁰

And yet, for each valuation approach we discuss, including the Platform Value Approach, there are arguments against its applicability/appropriateness. To that end, we’ll include a critical counterpoint for each to allow readers to assess the full argument.

COUNTERPOINT

For some cryptoassets, it’s unclear whether the value created by the platform will accrue to the holders of the asset itself or to those who put in the work and are paid in rewards and transaction fees for processing transactions. In some cases, holding coins may be what allows someone to profit from processing transactions or from increased usage and adoption. In others, that value might be captured by entities outside the network.

What About Bitcoin?

As the first cryptoasset (and with a current value of over half of the entire crypto market), Bitcoin is the 800-pound gorilla in the crypto world.

But what do people do with the Bitcoin network?

It doesn’t have all the flexibility built into Ethereum, so it’s primarily useful for basic transactions. Originally conceived as a payments network, it does function that way to some degree. However, due to the volatility of the bitcoin price, it’s not an ideal asset to fund near-term spending.

Think about it this way—if you’re operating in an illicit market which makes it difficult or impossible to use US dollars or other major currencies and where anonymity is a major selling point, then transacting in bitcoin makes a lot of sense.

But if you’re a grocery store that operates with thin profit margins and has to pay rent, wages, and—most importantly—taxes in US dollars, even if somebody did pay you with bitcoin, how long would you hold onto it before converting it to dollars? One day’s move could easily double your profit margin or wipe it out entirely. Why introduce that risk?

In addition, Bitcoin’s network can only process a small fraction of the transactions that companies like Visa or Mastercard handle in a day. So, as a payment network, it has serious shortcomings. Some of these have been adjusted by tweaking the software, some would require overhauling it from square one, and others can be patched up by building additional software on top of it.

And yet, we still think asking whether investors should be willing to own bitcoin has merit. Why? Because bitcoin is a long-lived option on the asset it may someday become.

8. This type of mining is called “proof-of-work” and is how bitcoin and ether have been generated from their inception. However, starting in December 2020, Ethereum is migrating to a “proof-of-stake” system. Proof-of-work is based on miners’ computing power and all else equal, is more energy intensive. Proof-of-stake is based on miners’ holdings of the currency and is designed to be more scalable and less energy intensive.
9. For more on this, check out Joel Monegro’s [Fat Protocols](#) thesis from 2016, among other resources.
10. This is similar to the Total Addressable Market Approach laid out by Matt Hougan and David Lawant in a wonderful recent [primer on cryptoassets](#) published by the CFA Institute; however, that approach appears to be a mix of what we think of as the Platform Value Approach and the Portfolio Theory Approach.

It's become common to compare bitcoin to gold. And it's not unreasonable. Both have shortcomings as currencies and payment mechanisms, which we won't delve into here. And yet, according to the World Gold Council, 42,600 metric tons of gold are held for private investment, totaling \$2.6 trillion at today's prices.

Admittedly, gold is also notoriously hard to value. What does that mean for valuing bitcoin and similar cryptoassets?

The Portfolio Theory Approach

One of the most fundamental concepts in finance and economics states that in free markets with transparent information, two equivalent assets have the same value. If not (perhaps because the information isn't transparent after all), then savvy investors will try to buy the cheaper one while selling the more expensive one. Formulated another way, if two assets are equivalent, when you aggregate all investors' portfolios into one global portfolio, those two assets should have equal weights and any individual investor should be indifferent between them.

So, if bitcoin eventually does become "digital gold" and is equally valuable in the eyes of investors, then one would expect the total value of bitcoin

to match the total value of gold. Here's where the assumptions begin to matter—what component of the gold supply? The \$2.6 trillion of gold held by private investors? The additional \$2.1 trillion of gold held by governments? All \$12 trillion of gold that's above ground, jewelry and all?

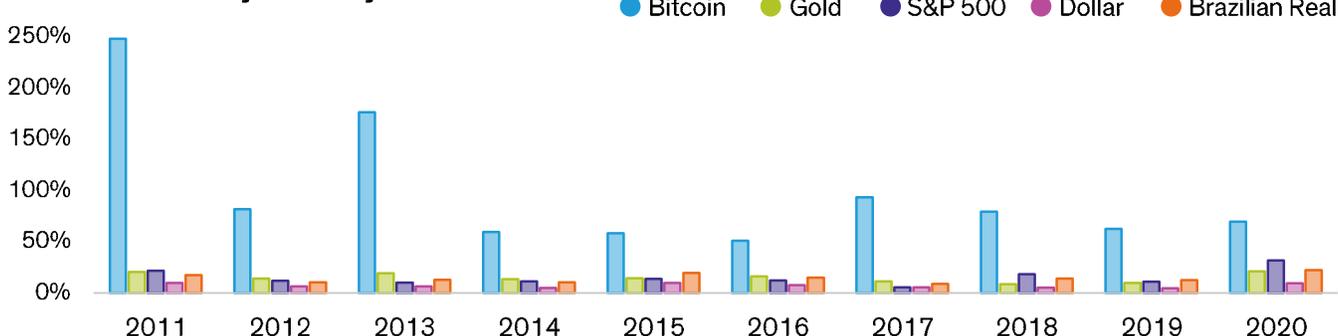
Further, how similar to gold can bitcoin become? One is physical, the other digital. From an asset allocation perspective, will bitcoin take on gold's return attributes? Bitcoin is still several times more volatile than gold and it's unclear whether its correlation to assets like stocks will match gold's. In fact, one important nuance emerges as the critical reason why Bernstein and other investors are drawn to a [certain allocation](#) to gold in a portfolio—more than just about any other asset, gold has historically been a great disaster hedge.¹¹ When the markets become topsy-turvy, gold has historically offered remarkable protection. Bitcoin, on the other hand, has appeared correlated with risk assets like stocks in times of both market exuberance and despair.

Will bitcoin's volatility settle down, and if so, when? And will its correlation to other assets parallel gold's? (**Display 3**)

There are also the matters of timing and uncertainty. Bitcoin is not equivalent to or more desirable than gold today—so its value must be lower. But how quickly can it close that gap? Will it ever?

DISPLAY 3: BITCOIN'S RETURNS ARE FAR MORE VOLATILE THAN ANY OTHER MAJOR ASSET

Annualized Volatility of Weekly Returns



Correlation of Bitcoin to Other Assets



Past performance does not guarantee future results.

Source: Bloomberg and Bernstein analysis

11. Note that we don't call gold a great inflation hedge, but rather a disaster hedge. Over its history, it has served better as the latter than the former.

Some investors invoke other assets for equivalence or other markets to increase the size of Bitcoin's total addressable market. This is an approach that startup management teams and investors often take with new companies. Other oft-cited benchmarks include the US or global money supply, the global payment settlement market, unseizable assets, or assets outside the control of questionable government regimes.

Given its limitations as a payment technology, its volatility and shortcomings as a store of value, the incentives for countries to maintain or enhance their monetary sovereignty to the extent possible, and the ease with which a government with a falling currency could forcibly disconnect their banks from the crypto markets, we're more skeptical of these comparisons. We also note that in many cases, the hypotheticals are posed as, "What if Bitcoin gets 1% of this multitrillion-dollar base of assets or transactions?" As venture capital pitches go, those types of cases are typically weak, especially when they're mustered for businesses which are supposed to benefit from network effects.¹²

One final element deserves a mention. It's common to hear opinions along the lines of "bitcoin is going to be worth as much as this or that asset." Sticking with our benchmark of the total gold being held by private investors, that's currently \$2.6 trillion. You may hear people use that as their target value for bitcoin, up from around \$1.1 trillion today. Combined, though, they have a value today of around \$3.7 trillion. If that's the right value for both and they're equivalent, they'd each be worth \$1.9 trillion.

That's much more than today's \$1.1 trillion for bitcoin, but if you assume it takes time to achieve parity—and that there's likely to be a lot of volatility along the way—the case for bitcoin becomes less attractive. If it reaches that point in 5–10 years, your annual returns of around 7% may not compensate for the volatility. If it takes 10–15 years, the roughly 4% rate of return is unlikely to be worth the risk along the way.

COUNTERPOINT

People have a special and unusual relationship with gold, dating back thousands of years. It's unclear that any new asset deserves to stand on equal footing with it. There are many characteristics which bitcoin and gold share, but even giving bitcoin the benefit of the doubt, its trading history to date suggests it's more of a risk-on asset than a disaster hedge.

The Cost of Production Approach

How else might one value bitcoin and other cryptoassets? They're similar to commodities, so what if we think of them that way? In commodity markets, prices tend to gravitate to the intersection of the cost of producing the marginal unit and the value of that marginal unit to customers.

One advantage of the cost of production approach is that it allows us to better appreciate the fundamental drivers behind bitcoin and the economics of different participants in the ecosystem. How profitable are miners at different prices? How much value can chipmakers capture? And how does the future that people envision for bitcoin comport with reality?

While there are limits to the cost of production method in general, in many commodity markets it frequently acts as a governor. When the price falls below a certain level, higher-cost producers leave the market, reducing the quantity created. And as prices rise, more production comes online, increasing the quantity created.

Yet the cost of production only represents half the equation.¹³ One could assemble a car by hand and it would cost thousands of dollars in parts and machinery plus many hours of time—but if nobody wanted to drive it, it would only be worth its scrap cost.

On top of that, bitcoin has two additional characteristics that make it unique relative to other commodities, resulting in serious flaws for this approach.

First, and most importantly, as producers supply more capacity to the market (in the form of computing power), that does not change the rate at which bitcoin is produced. Regardless of the computing capacity, one block of data is added to the chain roughly every 10 minutes. Right now, the compensation for being the first to process and verify that block is 6.25 bitcoin. So, until around May 2024, 6.25 bitcoin will be created every 10 minutes, no matter how many miners want to produce them. To make this possible, the system offsets the changes in computing power by changing the difficulty of the calculations roughly every two weeks. That "difficulty adjustment" differs markedly from other commodities where the quantity produced increases as suppliers join the market. This adjustment mechanism has significant implications for Bitcoin's economics.

Second, every 210,000 blocks, the reward for processing and verifying blocks goes down. This is called a "halving." That happened in May 2020, as the reward fell from 12.5 bitcoin/block to 6.25 and it's expected to happen again around May 2024, at which point it will fall to 3.125 bitcoin/block. Those step changes in bitcoin-denominated revenue impact miners' economic prospects.

12. Rather than calling this the Portfolio Theory approach and connecting it to an asset such as gold, we thought about calling this the Total Addressable Market approach, similar to Hougan and Lawant, especially since it's by taking creative liberties with the appropriate addressable market that many blue-sky narratives are crafted. However, we think there's a distinction between taking a business or industry analyst's approach to the economics enabled and captured by a blockchain protocol (as in our Platform Value Approach) and the approach of comparing assets in a portfolio based on their return attributes and desirability (which we've deemed the Portfolio Theory approach).

13. Alfred Marshall, one of the leading economists of his time, likened supply and demand to the two blades of a pair of scissors. Neither the top blade nor the bottom blade does the cutting. It's done by both simultaneously.

So how much does it cost to produce a bitcoin? The answer depends primarily on the computing power of your equipment and your electricity cost. With the most modern equipment available today and some of the world's lowest electricity prices, variable costs in China, Mongolia, and other countries could be as low as \$4,000/bitcoin. If you're running the latest equipment in a part of the US with relatively low electricity prices, your variable costs could be around \$7,000/bitcoin. On the other hand, if you're set up at home with equipment from a couple years ago, it could very well cost you \$30,000–\$40,000 to produce one bitcoin today.¹⁴

The Cost of Mining a Bitcoin Varies Widely

CHINA,
Mongolia,
other
countries



HOME SETUP
with equipment from
a couple years ago



Source: US Department of Energy, Bitmain, online mining rig sale listings, press reports, and Bernstein analysis

COUNTERPOINT

The unique nature of Bitcoin's difficulty adjustment introduces a circular logic that doesn't exist in the production of physical goods. Normally, price floors are really demand floors—if the quantity demanded falls as low as it conceivably can, higher-cost production facilities shut down and the price settles to the highest remaining cost of production. Because of the difficulty adjustment and the disconnect between computing power (production) and the network's usage, that doesn't happen for Bitcoin. As the price falls, some miners are forced out, but the remaining miners become *more* profitable. In a normal commodity market, the remaining miners are still profitable but *less* so at lower prices. At the most extreme, the bitcoin price could collapse but the network could still operate normally by relying on the most efficient miners. That means there's no binding price floor. The reverse also holds true. No matter how high the price reaches, additional miners joining the system don't increase the number of bitcoin produced, they just take a higher percentage of the rewards for mining.

This seems intuitive considering how Bitcoin was designed—unlike commodities where price increases are a signal to produce more, Bitcoin's production rate is preset. That requires disconnecting its price from its production.

The Quant Approaches

While they may vary slightly, the approaches we dub "Quant" are united by fitting lines to a set of datapoints. The challenge is deciding which data to include and how to tweak it in order to make the line fit well,¹⁵ and how to connect that result to some theoretical underpinning.

The computing power of the crypto network and its number of active users are two simple variables which you might expect to have an impact on its value. There's a clear relationship in the data as well (**Display 4, next page**).¹⁶ This makes sense—connecting the price of bitcoin to the network's computing power or user base effectively follows a high-level application of a Cost of Production Approach or Platform Value Approach. In addition, computing power can be thought of as a proxy for the security of the network, making it harder for hackers to overwhelm the system.

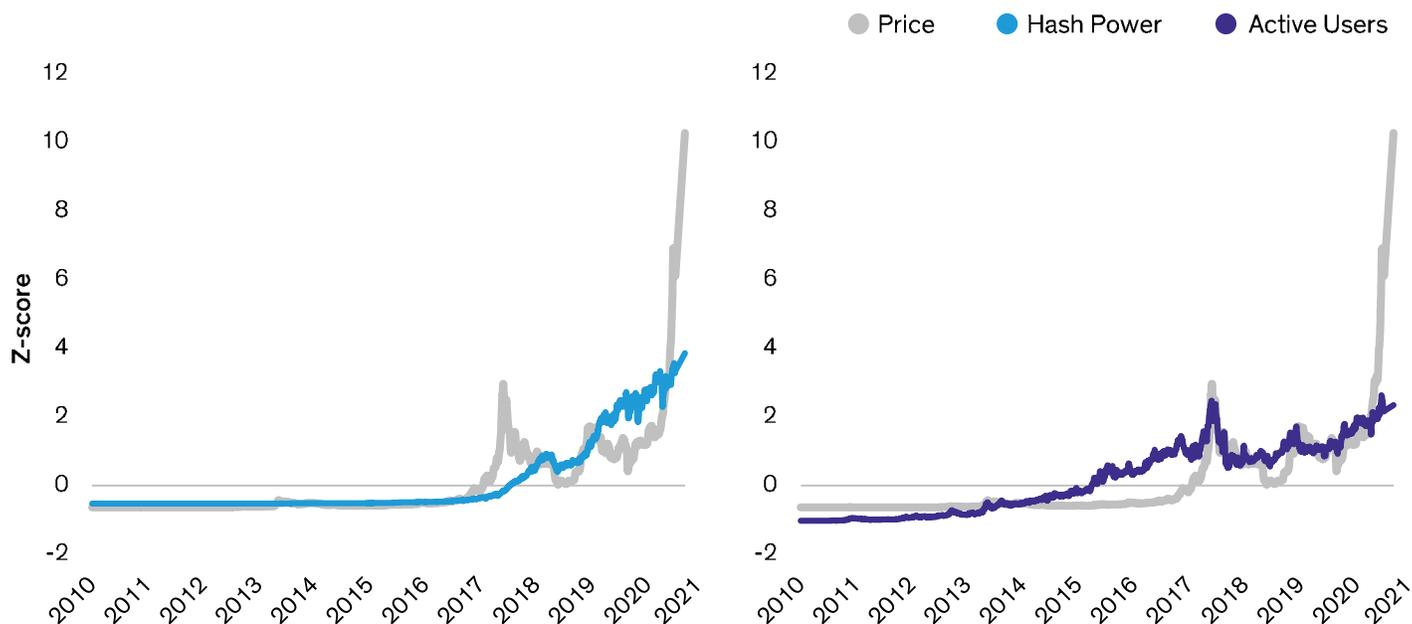
There are lots of ways to combine or transform different variables in an effort to explain bitcoin's prices or their changes over time. Between hobbyists, Wall Street quants, and machine learning programs, we're sure many versions will be tested in the coming years. We've run the data several different ways and believe a rather simple model to be fairly informative, theoretically reasonable, and consistent with the data.

14. We focus on variable costs in this section as it relates to running or shutting down computing capacity. However, fixed costs are also critical to the decision to invest in mining operations in the first place and hardware costs in particular drive miners' return on investment and the pricing power of their suppliers. This is important to the addition of capacity over time.

15. The goal is to fit the data well but not too well, which is called overfitting and effectively mistakes noise in the data for signal, making for unreliable predictions when new data come in.

16. The relationships for bitcoin are shown here; however, the relationship holds for a large number of other cryptoassets. See [Bhambhwani et al., 2019](#).

DISPLAY 4: BITCOIN'S PRICE IS STRONGLY CORRELATED TO COMPUTING POWER AND ACTIVE USERS



All variables converted to seven-day moving averages for smoothness and Z-scores for comparability.
Source: CoinMetrics and Bernstein analysis

One heuristic which you may hear in discussions about Bitcoin or other networks is called Metcalfe's Law.¹⁷ It states that the value of a network is proportional to the square of its size (n^2). This law was used (and abused) during the dot-com bubble, but it's come back in vogue in recent years to explain the value of companies and cryptoassets which benefit from network effects. The idea is that the value of a network doesn't increase linearly as more users are added, but rather exponentially.

The framework suffers from two key problems: Some members of a network can add more value than others and, at some point, the effect must plateau. Otherwise, at a large network size, the marginal value of adding one more user would drive the overall value to become a stunningly large portion of global assets. Similarly, combining two equally sized networks would somehow make the combined version worth four times as much as each was worth on its own. We think that likely overestimates the value of network size and opt instead for a more conservative but still nonlinear multiplier: $n \times \log(n)$.¹⁸

17. It's interesting that another analogy for valuing bitcoin is the value of diamonds, which also have a large and durable existing stockpile, a limited annual production, and are thought to hold their value over time. A rule of thumb for their value is Tavernier's Law, that the price is proportional to the number of carats squared—thus a diamond that is twice as large is four times as valuable. This is actually identical to Metcalfe's Law. The ability of diamonds to act as a store of value is questionable in its own right—we'd recommend this [fascinating account of the value of diamonds](#) from The Atlantic in 1982. (Thanks to Bernstein Research's Bob Brackett for highlighting it to us.)

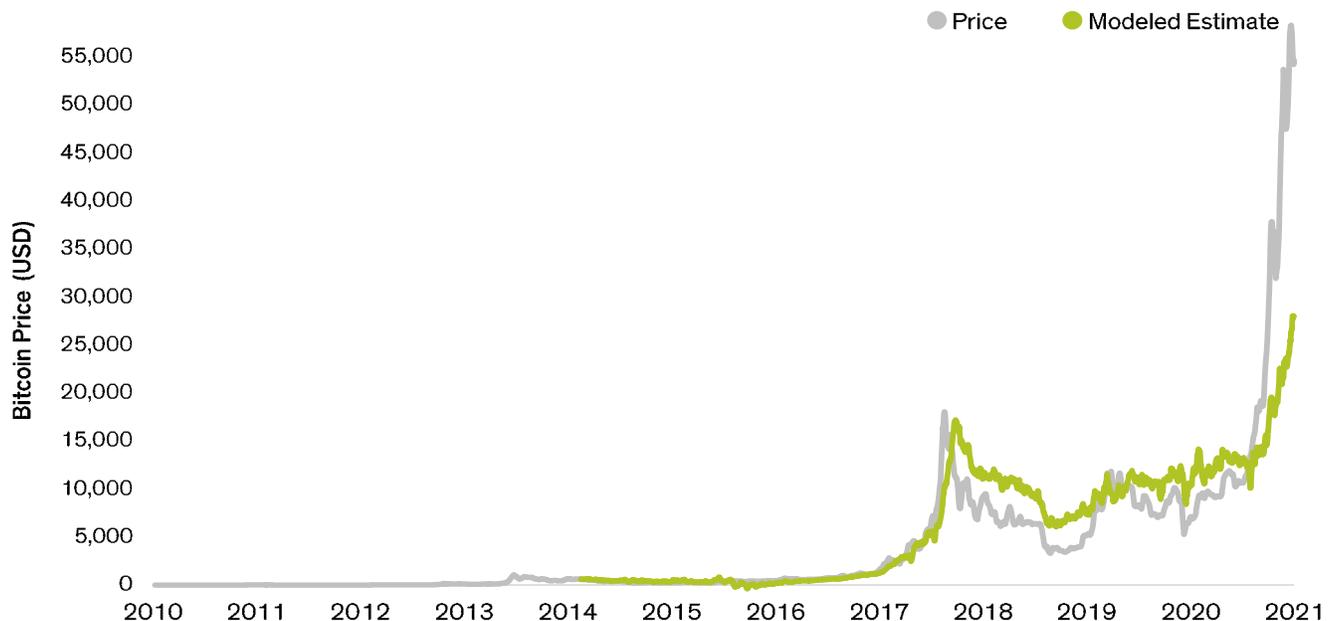
18. As it turns out, regressions based on Metcalfe's Law have a slight statistical edge in explaining bitcoin's historical prices. However, for theoretical and forward-looking reasons, we prefer the $n \times \log(n)$ formulation. We won't get into the math here but an approachable and interesting argument for this was made in [IEEE Spectrum](#) in 2006.

19. This calculation is based on rolling calculations using data from the previous four years, removing the potential for lookahead bias. However, during a prolonged bubble, the incorporation of an increasing share of extreme data into the estimate will eventually bias it upward.

Applying that approach to Bitcoin's historical data,¹⁹ we're able to create a market-derived estimate for Bitcoin's value over time based on the total computing power and user base in its network (**Display 5, next page**).

This approach has a few benefits. You can apply it at any given point in time to estimate the degree of "bubbliness" (or "anti-bubbliness"). Also, if you can estimate the network's computing power and user base at some point in the future, you can roughly estimate a price for the asset at that point in time. Finally, it creates a way to think about what's implied by the current price relative to the asset's own history and fundamentals. For instance, based on this model, to support a price of around \$60,000, Bitcoin's hash rate and user base would each need to grow by around 60% from where they stand today.

DISPLAY 5: WE CAN ESTIMATE BITCOIN'S "VALUE" OVER TIME BASED ON ITS FUNDAMENTALS



Current analysis and estimates do not guarantee future results.

Source: CoinMetrics and Bernstein analysis

COUNTERPOINT

While these estimates are a tool, they shouldn't be mistaken for a fundamental value. They'll change as the network grows or shrinks and as investor preferences evolve. They also can't distinguish between temporary and lasting effects.

To call this "value" may be misleading. It's an estimate of what the market may be willing to pay based on what it's paid recently.²⁰

The Vagaries of Valuation

Valuation in general is part science, part dark art. For stocks—which will generate somewhat predictable cash flows in the future—it's prone to error and bias. It's even more difficult for cryptoassets. Even the best analysis can only take you so far. **Risk management is critical.** For assets like cryptoassets, we'd urge investors to have a large dose

of humility in their valuation estimates and trading signals, to consider whether they have enough of a margin of safety, to be prepared for any given cryptoasset to lose the majority of its value, and to make sure they're diversified across and within asset classes.

DISCRETION IS THE BETTER PART OF VALOR

Cryptoassets have come a long way in a short while. Their total market value now stands at around \$2 trillion. For comparison, total venture capital assets are around \$1 trillion²¹ and global high-yield bonds weigh in at \$3 trillion. But for investors, the recent progress on regulatory and operational fronts matters even more. While cryptoassets are still highly speculative, there's a more robust fundamental foundation for them now than in the past.

20. If you're looking to buy a house, you may try a similar analysis to estimate how much to pay based on what people have paid for similar houses in the area recently. You might find selling prices to be positively related to asking prices, negatively related to property taxes, and positively related to the number of beds and baths. But that can just tell you that the price is right relative to the area's recent history, not relative to all the other assets in the world or what the market might look like next year.

21. Preqin and McKinsey.

We've been impressed from the start with the potential for blockchain technology, but we've been uncertain about the prospects for cryptoassets themselves and how investors should think through them. Some are further along in their maturity and development and more worthy of consideration than others. Overall, with more of a regulatory framework, more security, and more digital infrastructure in place, they've advanced to the point where investors should contemplate how they might allocate to cryptoassets going forward. However, significant risks remain and additional caution is required.

Even before considering valuation, be prepared for large temporary or permanent impairments of capital in any given cryptoasset.

Blockchain technology has the potential to add substantial value in the future. Much like the software revolution, blockchain's value is likely to be distributed unevenly, with a small number of large winners in each "sector." Unlike the software revolution, the entities in the ecosystem that capture it may be different.

Determining the value of a cryptoasset is a new challenge. It's analogous in some ways to other assets, though investors still need to figure out the best approaches. Even then, we'll likely see a wide range of estimates based on disparate assumptions. These assets will be fundamentally

volatile—their futures could chart many different courses and views may quickly move from one extreme to another.

As investors begin to allocate in the space, they should remember there are unique downside risks. Even before considering valuation, be prepared for large temporary or permanent impairments of capital in any given cryptoasset. With the exception of venture investments or highly leveraged stocks, that's a risk to which few investors are accustomed. We see three ways to address it:

- Limit the size of your investment in the space
- Diversify your investments across multiple cryptoassets
- Ensure that you or your investment manager conducts rigorous diligence on the risks and rewards of each individual cryptoasset in the portfolio

In addition, any investments in the space should be funded with capital that can be allocated for the long term and is impervious to high volatility. Avoid putting capital at risk that may be needed in the near future or to meet one's spending needs.

There are logical ways to approach the crypto market, but caution is required. On top of the fundamental risks, much of what we've seen in recent months appears quite speculative. As with any new technology, we'd anticipate periods of exuberance and disillusionment as adoption unfolds, winners emerge, and losers vanish. Those signs of speculation should be a reminder of the need for caution, but at the same time, they shouldn't distract or detract from the fundamental progress being made in the cryptoasset space.

Bitcoin and other cryptocurrencies are a very speculative investment and involves a high degree of risk. Investors must have the financial ability, sophistication/experience, and willingness to bear the risks of an investment, and a potential total loss of their investment. Information provided by Bernstein is not intended to be, nor should it be construed or used as investment, tax or legal advice, a recommendation, or an offer to sell, or a solicitation of an offer to buy, an interest in cryptocurrency. Bernstein does not offer cryptocurrency products and investments in cryptocurrency are not suitable for all investors.

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