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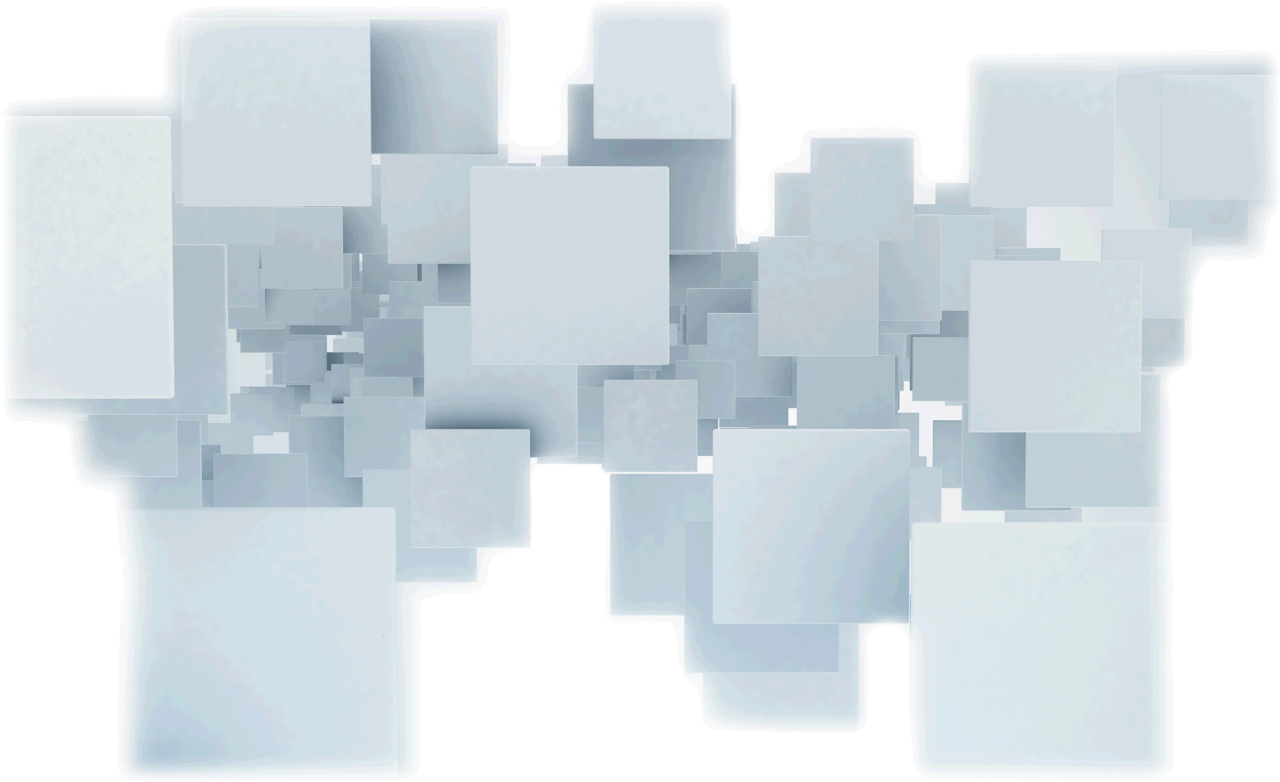
J.P. Morgan Perspectives

Decrypting Cryptocurrencies: Technology, Applications and Challenges



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See page 69 for analyst certification and important disclosures.

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With this special report on Cryptocurrencies, we launch a new quarterly series, *J.P. Morgan Perspectives*, which brings together views and analysis from across the broad scope of J.P. Morgan's Global Research franchise. This new series will feature in-depth analysis of critical global issues impacting economies and markets across all disciplines. We hope this series will both inform and foster public debate on evolving economic, investment and social trends.

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Executive Summary

Introduction

- J.P. Morgan researchers from across a wide range of expertise analyze various aspects of Cryptocurrency (CC) to gain insight on this market and its potential evolution in this report. CCs' extremely rapid growth, and then fall, both in terms of number of CCs and prices and their challenge to the current financial infrastructure, are forcing all market participants to closely monitor and understand this new market.
- Cryptocurrencies are virtual currencies that are created, stored and governed electronically by an open, decentralized, cryptography system. CCs can be used to exchange money, to buy certain goods/services or as an investment. There are over 1,500 cryptocurrencies with a market cap of some $400bn as of February 8, 2018, with Bitcoin being the largest representing a third of the market according to CoinMarketCap.
- Launched in early 2009, Bitcoin (BTC) is the dominant cryptocurrency with a market cap of $140 billion (representing one-third of the CC market) and nearly 17 million BTC units in circulation (capped at 21 million). Bitcoin was the first major cryptocurrency and has spawned many competing CCs and technologies, many of which still fall back to Bitcoin as a support currency. Bitcoin itself has split into two cryptocurrencies, Bitcoin and Bitcoin Cash, to improve liquidity.

Technology

- **Cryptocurrencies** are the face of the **innovative maelstrom** around the Blockchain technology that is bringing both massive price volatility and a constant trial-and-error of new product try-outs and failures.
- CCs are **unlikely to disappear** completely and could easily survive in varying forms and shapes among players who desire greater decentralization, peer-to-peer networks and anonymity, even as the latter is under threat. The underlying technology for CCs could have the greatest application in areas where current payments systems are slow, such as **across borders**, as **payment, reward tokens** or **funding systems for other Blockchain innovations** and the Internet of Things, as well as parts of the underground economy.

Applications

- There are over **1,500 CCs** with a market cap of $400bn. Transactions in the three largest CCs average $550bn per month and come mostly from individuals. Ownership is highly concentrated. The opportunity set around direct CC trading appears relatively limited for banks, while the two Bitcoin futures recently launched are seeing only $140mn in daily trading.
- **Blockchain** saw its first expression through **Bitcoin** – the first CC – but is more likely to ultimately see its greatest application outside of CCs across other financial and non-financial transactions, even as Blockchain itself looks set to **evolve fast** as the market learns about what works best.
- There is the **potential** for increased usage of **Blockchain** in cross-border payments, settlement/clearing/collateral management as well as the broader world of TMT, Transportation and Healthcare but only where any cost efficiencies offset regulatory, technical and security hurdles.
- Hedge funds have been moving into this market making up most of the **175 CC funds** but AUM remains only a few billion dollars. Asset managers are experiencing limited success in bringing products to market and have not been able to launch CC funds or ETFs without support from the SEC or major distributors.
- While about half of the early CC transactions happened in the **underground** economy, the share of this is declining, with investing and speculation now taking a much larger share.

Challenges

- It will be extremely **hard for CCs to displace and compete with government-issued currencies,** as dollars to euros and yuan are virtual natural monopolies in their regions and will not easily give up their seigniorage profits.
- CCs are experiencing **heightened volatility and will face challenges** from both technology (such as rising mining costs and hacking) and regulators who are concerned about anti-money laundering and investor protection, as CC payments are irreversible and there is no recourse.
- **Security concerns** have mounted in Bitcoin exchanges as hackers have infiltrated a number of CC exchanges generating large losses, while regulators are challenging anonymity.

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Cryptocurrencies: overview

Cryptocurrencies (CC) are virtual currencies that are created, stored and governed electronically by an open, decentralized, cryptography system. CCs can be used to exchange money, to buy certain goods/services or as an investment. There are over 1,500 cryptocurrencies with a market cap of some $400 billion, with Bitcoin being the largest, representing a third of the market according to CoinMarketCap (*Huang*[1]).

CCs' extremely rapid growth, and then fall, both in terms of number of CCs and prices, and their challenge to the current financial infrastructure are forcing all market participants to closely monitor and understand this new market. In response, J.P. Morgan researchers from across a wide range of expertise analyze various aspects of Cryptocurrency to gain insight on this market and its potential evolution in this report.

Where are we now?

Launched in early 2009, Bitcoin (BTC) is the dominant cryptocurrency with a market cap of $140 billion (representing one third of the CC market) and nearly 17 million BTC units in circulation (capped at 21 million). Bitcoins are created or "mined" by individuals (miners) when they complete the computational task of solving (processing) a Bitcoin transaction, unlocking new Bitcoins for that individual's effort as a reward. Bitcoin was the first major cryptocurrency and has spawned many competing CCs and technologies, many of which still fall back to Bitcoin as a support currency. Bitcoin itself has split into two cryptocurrencies, Bitcoin and Bitcoin Cash, to improve liquidity (*Huang*).

Acceptance of Bitcoin at the enterprise level is still in its infancy. Thousands of **businesses**, including major companies, now allow the use of CCs in exchange for goods and services (*Inkinen*, *Allen*). Surveys suggest, though, that less than 10% of Bitcoin holders plan to use their CC to pay for goods and services. Most use CCs for investing or speculating. Transactions are dominated by **individuals,** with the average transaction size currently around 1 Bitcoin.

The anonymous nature of CC **transactions** makes it hard, if not impossible, to determine where the users are. We know the majority of miners and exchanges are in Asia, but ¾ of the ATMs that allow users to buy and sell CCs for cash are in North America. Early on, there was a strong suspicion that much of CCs were used in the illicit economy, largely because of the way CCs were set up as anonymous and off-the-official-grid. But recent surveys, and the small size of Bitcoin transactions, suggest that the **share of illegal transactions had fallen** to 20% in 2016 and has continued to fall since. Part of this is due to authorities clamping down on dark web sites and tax authorities starting to demand tax information from companies that support the CC world (*Inkinen*).

Although **Banks** across the globe have had limited direct involvement in Bitcoin or other CCs, the industry has been very active in pursuing initiatives around the Blockchain technology that underpins Bitcoin. The opportunity set around direct CC trading seems relatively limited, due in large part to anti-money laundering (AML) and know your customer (KYC) concerns, but in the near- to medium term, business models will likely need to evolve around the cost benefits of technology, including distributed ledgers (*Sinha*).

Asset managers are in the early stages of cryptocurrency product development. There has been limited success in bringing products to market thus far. A leading issue is acceptance of the underlying cryptocurrency products, which yet appear to have the support of either the SEC or major distributors. While the recent launch of futures trading on the CBOE and CME would seem to help the fund industry with both improved Bitcoin price transparency and trading liquidity concerns highlighted by the SEC, we have yet to see product approvals and a growing number of funds are withdrawing applications. Security concerns have mounted in Bitcoin exchanges as hackers have infiltrated a number of cryptocurrency exchanges, generating large losses. Thus, while there has been a lot of talk about cryptocurrency funds, at this point in time there is little assets under management invested globally in such products (*Worthington*).

The surge in CCs has attracted the attention **of central banks and regulators**. The Fed, the ECB, and other macroprudential regulators view CC markets to be in only nascent stages, with minimal implications for systemic risk, and thus have not yet taken a stance on the regulation of the asset class. Meanwhile, global securities regulators have begun to lay down ground rules, in many cases subjecting CC-related businesses and initial coin offerings (ICOs) to existing securities laws, requiring registration or authorization, and promoting investor protection. To date, these have been piecemeal efforts, with various nations staking independent regulatory positions, and there has been little global coordination on cryptocurrency regulation. The anonymity among the exchange of

[1] Names in *italic* refer to the lead authors of the sections following

cryptocurrencies presents a challenge for regulators attempting to limit money laundering and terrorist-financing activities. We review the actions that regulators in various jurisdictions have taken to limit the risks associated with cryptocurrencies (*Roever*).

What does the future bring?

In the **early stages of innovation**, usually set off by new technology — in this case Blockchain (*Kambo*) — the market experiments with many different approaches to see what shape and form will stick and end up offering the most economic value-added. We would note that it is not pre-ordained that cryptocurrencies will succeed as there are valid concerns about what economic value they really contribute. But in a time of rapid innovation, many new products will are often-and-errored. We believe the potential disruption from Blockchain cannot be ignored.

The excitement of innovation typically also leads to **price booms and then crashes** among the early movers, before more realistic prices emerge among the eventual survivors. Much of this is what we see today with exponential price gains and losses, growth and diversity among cryptocurrencies. Given the amount of speculation in these markets, **technical signals** can be very useful in gauging market direction and they have been sending the right signals in recent months (*O'Connor*). Fundamentals are a lot less informative here, although it can be useful to look at the cost of mining CCs, even as one must also account for the elasticity of supply (*Kaneva*).

Cryptocurrencies are both a new technology — Blockchain — and a new currency (many new ones). The new shape and form of the CC market in the future will likely ultimately depend on **what economic value they are perceived to add**. We would expect the marketplace and regulators to ultimately weed out what are perceived the negative, less useful characteristics of CCs and retain the positive elements that add economic value.

As discussed more in detail below in *Kambo*, *Huang*, *Allen*, and *Sinha*, the Blockchain technology driving CCs offers transparency to transactions and allows them to be virtual and peer-to-peer. Distributed ledger technology has the potential to offer regulators greater degrees of transparency, higher levels of resiliency and shorter settlement times, reducing counterparty and market risk. See for example, the discussion by *Sinha* of banks' effort to use Ripple to create more efficient cross-border payments.

Allen similarly discusses various efforts under way with, for example, a number of payment processing firms increasingly partnering with technology firms/Blockchain providers to offer an alternative settlement engine to various payment participants. We expect various Blockchain-based ecosystems to coexist and compete with each other (similar to Payments networks in the current environment), with success predicating on technology capabilities (such as API features), number of participants on the network and ease of adoption. Given the hurdles, CCs are more likely to be used as ancillary payment methods rather than gaining traction as a primary source of exchange.

While seeing a potential for the deployment of the underlying Blockchain technology in payments, we do not see cryptocurrencies competing with central bank-issued money for lawful transactions. We note that CCs have not attained the relative stability of value to make them useful as money for everyday transactions. As discussed in *Feroli* and *Aziz*, the current set of government-issued fiat currencies — such as the dollar and the euro — provide efficient media of exchange, stores of value and units of account. Some of the early buyers of CC were clearly dismayed by ballooning balance sheets of the major central banks in the aftermath of the global financial crisis (GFC), but the lack of any meaningful inflation since, in both developed markets (DM) and emerging markets (EM), has surely reduced concerns about fiat (legal tender issued by a central bank) money.

In addition, we find that local legal tender money tends to be a natural monopoly with only extreme hyperinflation leading people to seek out a monetary alternative. To add, *Feroli* and *Aziz* do not find that CCs are currently meeting the standards of what constitutes money as the huge volatility of CC has made use of it as a unit of account impractical. Finally, given the huge returns from running a central bank (seigniorage), governments will be quite possessive of their legal tender role and will likely put up a fight if CCs were to gain broader traction domestically (see *Roever* and *Lei* on how regulations on CCs are steadily tightening).

Some EMs, such as Venezuela and Russia, appear to be considering issuing CCs as a way to improve international funding and evade US **sanctions**. *Aziz* is quite dubious about whether any of this will work as CCs face regulatory headwinds and are neither better than fiat money in establishing policy credibility nor in providing liquidity during crises.

Several central banks, as discussed in *Feroli*, are investigating whether they should issue CCs in their own

currency, but are very far from actually doing so, as any increased efficiency in payments technology does not appear to be that obvious. In addition, the issuance of **crypto dollars**, for example, would give non-banks access to the Fed balance sheet, and thus could endanger the economically and socially important financial intermediation function of commercial banks.

In market economies, commercial banks manage the largest part of what we call money through their deposit base that they in turn lend out to the economy, after holding back a fraction as reserves at the central bank. If cryptocurrencies were seen as superior to bank deposits, prompting a wholesale shift into cryptocurrencies, then a much larger share of savings would go to the central bank's assets (government debt) and less to commercial banks loans, thus potentially dramatically increasing private credit risk premia and reducing the flow of credit to the private sector. Fractional reserve banking was a tremendous innovation that surely contributed greatly to global growth over the last two centuries, and we would expect that central banks would think twice before disturbing this source of capital to the private sector.

Normand examines the potential role of CCs in terms of offering **diversification** in a global portfolio, given both their high returns over the past several years and their low correlation with the major asset classes, offsetting some of the cost of high volatility. If past returns, volatilities and correlations persist, CCs could potentially have a role in diversifying one's global bond and equity portfolio. But in our view, that is a big if given the astronomic returns and volatilities of the past few years. If CCs survive the next few years and remain part of the global market, then they will likely have exited their current speculative phase and would then have more normal returns, volatilities (both much lower) and correlations (more like that of other zero-return assets such as gold and JPY). Based on its historical performance, CCs can be 10 times more volatile than core assets like stocks, or than portfolio hedges, like commodities. Liquidity is also well below most other potential hedges. Extraordinary returns can be generated in the price discovery phase, only to be followed by several years of mean-reversion toward the eventual, long-term average level. In the current market conditions, we do not believe that an allocation to Cryptocurrencies as insurance should be a portfolio's main or only hedge. Note that even though CCs have improved risk-adjusted returns over the past several years, they have not prevented portfolio drawdown during periods of acute market stress, like the equity flash crashes of August 2015 and February 2018.

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Blockchain – the technology behind cryptocurrencies

- **Blockchain (often referred to as distributed ledger technology) is a secure transaction ledger database shared by all parties in a distributed network that records and stores every transaction that occurs in the network, creating an irrevocable and auditable transaction history.**
- **Blockchain can be considered a superior database where the data and access to the data are encrypted. The distributed nature of the Blockchain means the master record is shared or mutualized.**
- **Blockchain is the core technology underlying Bitcoin, but we see the potential for Blockchain to span several industries. In our view, the biggest appeal of Blockchain will be in the ability to deliver efficiency gains across the value chain.**
- **We note collaboration will be key in bridging the gap between the technology and the practical applications for Blockchain to be widely adopted. There are already a number of consortiums that have emerged and endorsement from regulators would also be important. There are a number of proof-of-concepts being tested, and whilst the full impact may not be seen for several years, we believe the potential disruption from Blockchain cannot be ignored.**

In this section, we provide a background on Blockchain, the technology forming the underlying infrastructure behind cryptocurrencies such as Bitcoin. Blockchain is still an emerging technology, but momentum has been gathering pace over the past few years as the use of the technology extends across several industries with potentially disruptive implications.

Summary of Blockchain
Blockchain (often referred to as distributed ledger technology) is a secure transaction ledger database shared by all parties in a distributed network, which records and stores every transaction that occurs in the network, creating an irrevocable and auditable transaction history. Blockchain can be considered a superior database where the data and access to the data are encrypted. The distributed nature of the Blockchain means it has a built-in redundancy and can survive the loss of one node because the master record is shared or mutualized.

Innovative Way of Using Existing Technology

The cleverness of Blockchain is not that it is a totally new technology, but rather it is an innovative use of three long-standing existing technologies. Basically, Blockchain is a combination of a peer-to-peer (P2P) network plus public key infrastructure (PKI) encryption technologies plus the use of a cryptographic hash (encryption).

Blockchain = P2P Network + PKI + Cryptographic Hash

Each of these technologies has been around for as long as 30 years. The P2P network was popularized by Napster in June 1999; PKI, which gives the ability to secure transactions between two untrusted parties and provides other key elements like time stamping, has been in use since the 1990s. In fact, in a 1991 Journal of Cryptology article, Stuart Haber and W. Scott Stornetta described the process for digital time-stamping and a secured chain of blocks, while in 1992 Bayer, Haber and Stornetta incorporated Merkle (or hash) trees as a necessary means to compress the size of a historical Blockchain. Finally, the cryptographic hash used for the consensus algorithm that solves conflicts in a Blockchain is typically based on ECC (elliptic curve cryptography), which was created in 1985, but became popular for security use in areas like mobile devices around the turn of the century.

What is Blockchain and how does it work?

Blockchain: A secure transaction ledger database that is shared by all parties in a distributed network. Every transaction is recorded and stored to create an unchangeable and auditable transaction log.

The terms Blockchain, distributed ledger or share ledger are interchangeable.

Simply put, Blockchain is widely recognized as a superior database.
The simplest way to define Blockchain is as a superior database where:

1. data that is stored is encrypted;
2. access to the data is encrypted;

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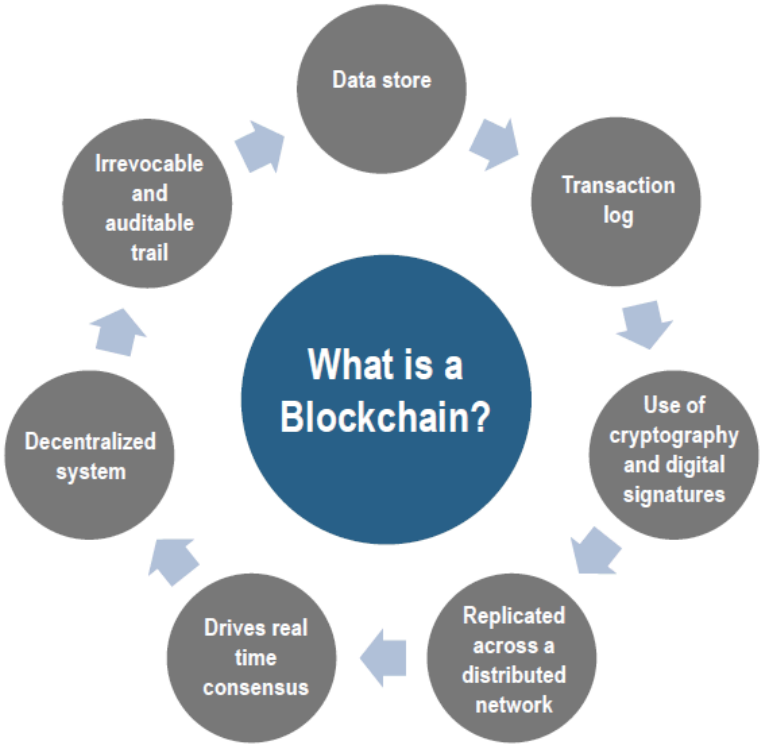
3. the distributed nature of the Blockchain means that it has a built-in redundancy and can survive the loss of one node because the master record is shared;
4. transactions are immutable, in that it is impossible to alter historical records, thus creating a credible audit trail.

In the diagram below, we summarize the main components of the Blockchain or distributed ledger as it is often referred to. Ultimately, we see Blockchain improving efficiency, which, through the mutualization of processes, should lower costs.

Figure 1: The key components of Blockchain



Source: J.P. Morgan

Wikipedia definition of Blockchain

"A block chain, or Blockchain, is a distributed database that maintains a continuously-growing list of data records hardened against tampering and revision. It consists of data structure blocks – which hold exclusively data in initial Blockchain implementations, and both data and programs in some (for example, Ethereum) of the more recent implementations – with each block holding batches of individual transactions and the results of any Blockchain executables. Each block contains a timestamp and information linking it to a previous block."

Distributed ledgers – A type of database architecture whereby all nodes within a system cooperate to reach a consensus on the accurate state of a shared data resource.

Decentralized – Eliminates the need for a central authority to process, validate or authorize transactions.

Centralized – Control under a single entity, which leaves the system exposed to a single point of failure.

Benefits of distributed ledgers

Secure and consistent – The database is an irrevocable and irreversible record of all transactions. Data stored cannot be tampered with or revised. This creates an auditable transaction history.

Trusted – Computer servers within the network must reach a consensus, which in turn allows for transactions to take place between otherwise unknown parties.

Real-time data store – All nodes within the system store an identical copy of the ledger, which is updated almost automatically.

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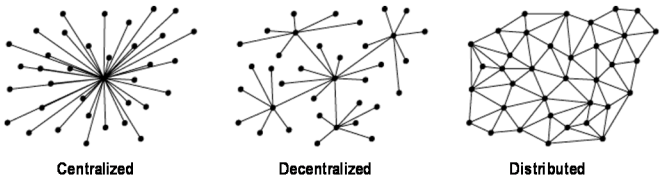
What is a distributed ledger?

The Blockchain, as previously mentioned, is a digital, distributed ledger. Each block within the system is generated once multiple nodes reach a consensus and validate the transactions. This is where the distributed nature of the Blockchain stems from, a concept that we illustrate below based on a study into the benefits of adopting a digital data communications system integrated with a distributed network framework.

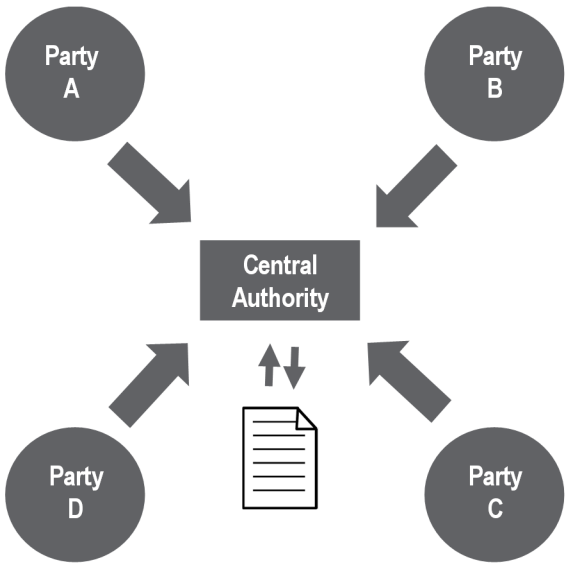
Figure 2: Distributed network infographic



Source: "On Distributed Communications Networks", Paul Baran, 1964.

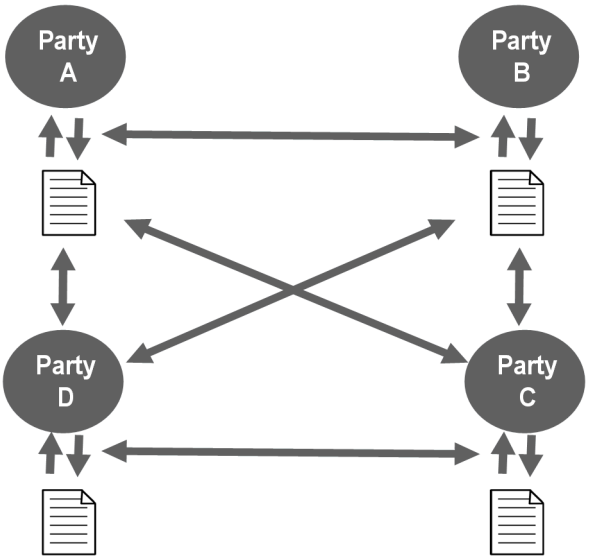
As a distributed database, multiple copies of data exist across multiple computers, which together create a peer-to-peer network. Hence, rather than a single centralized server or database, the Blockchain captures an entire decentralized network of machines, with each one acting as a node within that specific network. This ultimately serves to reduce the need for central authorities to clear transactions and certify ownership.

Figure 3: Centralized ledger approach



Source: J.P. Morgan. For illustrative purposes only.

Figure 4: Distributed ledger approach



Source: J.P. Morgan. For illustrative purposes only.

Shortcomings of the centralized ledger driving interest in the distributed ledger

Existing practices of data management, particularly of personal data, encompass vast legacy IT systems typically located within a single institution. An array of networking systems are then layered over to facilitate external communications, resulting in added cost and complexity. Such a centralized system thus presents a high-cost single point of failure, with data that are often outdated and out of sync, which may be exposed to cyber crime.

Given the distributed ledger platform comprises multiple shared copies of the data, the ledger is inherently harder to attack, as an attack would have to simultaneously target all copies in order to be successful. In addition, the technology is resistant to any suspected malicious tampering or unauthorized database changes as network participants will notice any change to an isolated part of the ledger. However, we should note that Blockchain is not completely immune to cyber crime: collusion among users could result in modifications to all copies of the ledger at the same time.

In our view, completely moving away from the established centralized model may be viewed as too risky, and therefore, a solution could be for the existing centralized authorities (central securities depositories or custodians) to support the implementation of distributed ledgers. In such a scenario, there could be a period over which existing infrastructure would need to coexist and

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connect with distributed ledger platforms, which is why we are seeing a collaborative approach emerging in the financial services industry.

How does a Blockchain transaction work?

Public Blockchain – Provides users with read access and the ability to transact with others. Users are able to transfer value without the consent of the Blockchain operator.

Private Blockchain – Provides restricted read access to the predesignated list of Blockchain operators and auditors. Users must rely on interfaces offered by operators in order to submit or read transactions.

Permissioned Blockchain – Building of the Blockchain is limited to a known set of entities, who are able to restrict use by specified end users.

Unpermissioned Blockchain – Anyone is allowed to participate in creating the Blockchain. Users are hence freely able to enter or exit.

Public keys – An identifier that may be freely shared with other users.

Private keys – Essentially a password that must be retained in confidentiality.

Blockchain uses public key cryptography to validate access to private networks, as well as sign validated blocks and individual transactions.

Every "block" within the Blockchain consists of a list of transactions and a block header as illustrated below. This header will in turn detail:

1. structured data relating to transactions in the block;
2. a timestamp relating to the proof-of-work algorithm;
3. reference the previous block or parent block through use of a "hash."

The result is the "chain" element of the Blockchain, with each block identifiable via the hash of its respective header. New blocks are generated using the "consensus" process (referred to as "mining" under Bitcoin), which authorizes new transactions and links them to the chain. If participants in that process are preselected, the ledger is referred to as permissioned, which may consist of one or more owners and can assume a level of trust. On the other hand, a ledger open to all participants (e.g. Bitcoin) is un-permissioned that allows access to anonymous connections and typically assumes zero trust between participants.

Cryptography and consensus

To digitally sign transactions, Blockchain technology relies on public key cryptography (PKI), which uses two keys making it more difficult to crack. The two keys – the public and private – are related mathematically, with the public key used to sign and encrypt data when sent, and the private key then used to decrypt the data when opened by the designated recipient. Aside from encrypting data, public key cryptography is also used to verify identity, digitally time stamp a transaction and ensure that the specific transaction on the Blockchain has not been tampered with or corrupted.

Given the distributed element of the Blockchain, data on all new transactions must be disseminated to every node on the network, thereby enabling the database to remain in sync and ensure globally consistent data. Hence, the simultaneous dissemination of data reduces the need for reconciliations and reduces errors. Blockchain technology facilitates this via one of its key innovations, the consensus process, whereby the majority of nodes in the network must coincide with one another. The process is computed instantaneously as each new transaction and subsequent block is verified.

Tokenization

Tokenization is the process of embedding data related to a real-world asset on a digital token stored on a Blockchain. Such tokens are easily transferable and provide a secure and clear trace of ownership history. Bitcoin is just one example of a tokenized representation of value; it is possible to replace collateral, cash, gold and other securities with a unique token.

Tokens are easy to transfer between two parties digitally, and, we note, benefit from the Blockchain's unique properties, including:

1. clear evidence and history of ownership,
2. prevention of double spending,
3. transparent status tracking.

The underlying asset, which the token is representing, can continue to be stored with a trusted third party, such as a custodian.

Smart contracts – Repeatable and modular scripts run on the Blockchain, to facilitate autonomous transactions between parties once certain criteria have been met.

Smart contracts

A growing aspect of Blockchain's attractions is the use of smart contracts, whereby business instructions implied by a contract are programmed in the Blockchain and executed along with a transaction. Smart contracts are one example of distributed applications (DApps) that can be built on a Blockchain. Terms are implemented and encoded in programming language, which can then execute automatically once particular conditions are satisfied. The programmed code serves to copy

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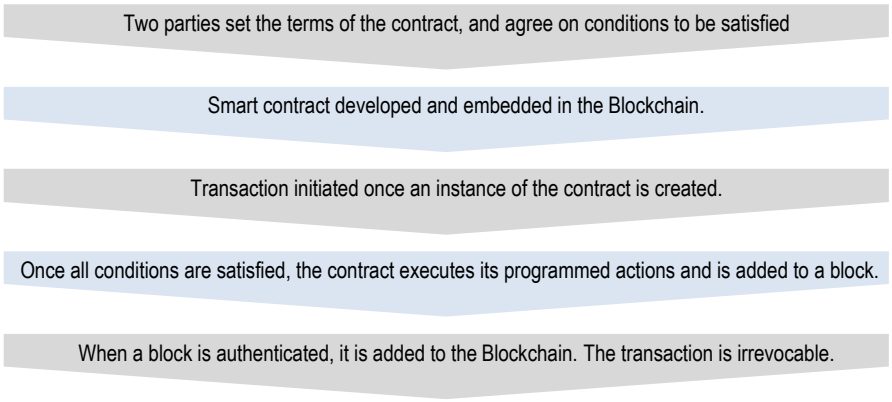
conventional commercial agreements by digitizing transactions within the system and authenticating them through a Blockchain. Like any passive data, smart contracts become irrevocable once added to the ledger.

Examples of smart contract use could include the conditions under which the transfer of a bond might occur or a bilateral CDS settlement. In the figure below, we set out a typical smart contract process.

Figure 5: Smart contract process



Source: J.P. Morgan. For illustrative purposes only.

Blockchain Security

There is a tremendous amount of security built into Blockchain that gives the technology the ability to bring trust to transactions between previously untrusted parties. But we would note that there are still areas that users need to be aware that are unsecured and present risk.

Security lies in the transaction process and the actual Blockchain

The use of PKI ensures the identity of the parties entering into a transaction is the one that holds those particular private keys. The process also ensures that the information stored in a block has not been tampered with over time. These are two very important elements.

There is a lack of inherent security on the individual user/party

While the actual transaction process and information stored on a Blockchain are secure, what is not covered is the security of the users' individual assets. We have seen this a number of times where individuals' digital wallets have been stolen and even larger coin exchanges lose users' coins (or have them stolen) as was the case with Mt. Gox in February 2014, and Coincheck last month. Below we note three primary areas that individual user/parties should be conscientious of securing:

- secure/backup all private keys;
- secure the digital wallet; and
- protect ownership by willing assets to heirs.

The private key is the digital asset that proves identity and ownership. These are typically found inside the digital wallet, but the actual keys can be both visible and hidden. All digital keys should be secured and backed up. If lost the digital assets like Bitcoins are lost with it. Many experts recommend securing the digital wallet by backing up or even keeping a copy off-line in what is called cold storage. Lastly, we note crypto currency is like any other asset and should be considered when deciding how to transfer assets to another party upon death.

Potential uses cover a spectrum of industries

Blockchain technology was originally developed as a way to record transactions in a transparent, secure, immutable and efficient way, which was used for digital currencies such as Bitcoin. However, we note the technology has the potential to transform how businesses and governments operate in a variety of aspects. We expect the 'use cases' for Blockchain technology to continue to grow across many industries. To determine where Blockchain might be useful there tends to be four common denominators in the use cases:

1. transactional nature;
2. intermediaries exist;
3. need for trust; and
4. need for verification.

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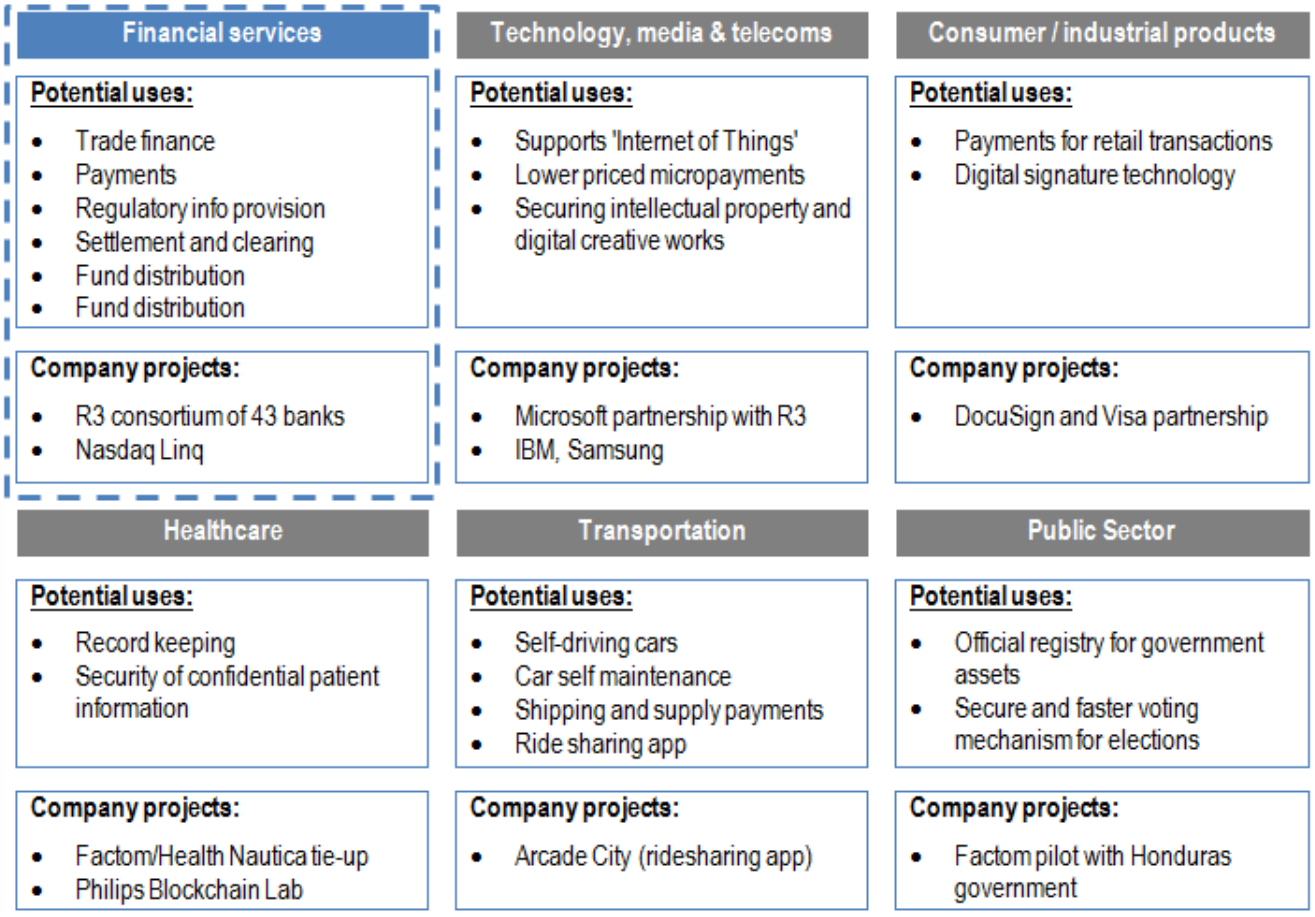
While financial services are often cited as a key industry for potential application of the Blockchain technology, we also see scope in TMT, healthcare, transport, consumer and industrial products, as well as in the public sector. Though mass adoption of the technology is likely a long way off, companies nonetheless acknowledge the potential of Blockchain and are investing time and effort in understanding its capabilities in order to remain in the debate and avoid missing opportunities or worse, disruptive surprises.

Financial institutions are the main investors, given the technology is perceived as likely to have its greatest potential impact on financial services. However, we have seen Blockchain concepts and prototypes across several sectors.

Figure 6: Reach of Blockchain technology application in various industries



Source: Based on Deloitte University Press report.

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Figure 7: Summary of potential uses of Blockchain in the financial services industry

Trade finance	• Traditionally a paper-intensive process, which Blockchain can serve to digitize and validate records. • Potential for secure transactions with digital records of related data, which is accessible to all participants involved in the trade.
Payments	• Transparency of transactions allows all participants involved to view the entire lifecycle and provides a auditable transaction log. • Scope for potential savings in cross border payments.
Regulatory information Provision	• Reduction of costs and improvement of efficiencies associated with AML and KYC processes. • Accuracy of data maintained as all nodes within the system must reach a consensus.
Settlement / Clearing / Collateral Management	• Typical settlement of T+3 could be potentially reduced to T+0. • Secure and consistent data relating to ownership, and accurate store of information for asset custody purposes.
Fund administration	• Transparency of AML and KYC processes can be enhanced, with scope for cost and time efficiencies. • Assist in fund valuations and fund administration.

Source: J.P. Morgan estimates.

Financial services

There are many potential applications for Blockchain in the broad financial services sector, and we believe it is important for players to implement pilot initiatives and explore how the technology could impact their business. We detail some of these potential applications above.

- **Trade finance** - In trade finance, for example letters of credit, Blockchain can help reduce the associated extensive documentation and complex document flows. The transparent nature of Blockchain could help mitigate the potential risk of document fraud and potentially lower the cost of transaction reconciliation between and within financial institutions. Further, the creation of an auditable transaction log should provide assurance and validate products in the supply chain.
- **Payments** - Bitcoin was the initial use of Blockchain within the payments space. The payments process is increasingly moving towards instant payments on a national, regional and global basis. Blockchain potentially allows everybody involved in a transaction to see the entire transaction lifecycle and provide auditability of messages within the process. The use of a distributed ledger could be adopted for cross currency payments globally, to improve costs and make the process more transparent and continuous.
- **Regulatory information provision** - The rising burden of providing regulators with increasing data globally is a time-consuming task for the companies but also for the regulators who have to consume such vast amounts of information. Blockchain could reduce the costs associated with anti-money laundering (AML) and know your client (KYC) processes as the regulator could track the source of funds and use data to identify clients on the Blockchain. However, the regulatory reporting process remains complicated and we could expect issues with permissionless Blockchain for financial institutions. Consequently, Blockchain is unlikely to replace the existing processes, but it could improve efficiency, and we would expect permissioned or private Blockchains to be more widely considered.
- **Settlement/Clearing/Collateral Management** - Settlement within the exchanges space is typically T+3 days, but the delay is principally due to market practices, financial industry laws and regulatory requirements and not necessarily to current technological infrastructure. The industry has already been discussing the potential to reduce settlement to T+2 (already common in Australia) and the implementation of Blockchain could act as a catalyst to drive down the settlement period further towards T+0. The use of Blockchain/ distributed ledger for settlements could provide a secure, consistent source of proof of the current ownership and provide the origin of assets to custodians, agents and beneficial owners. We note the constraint will clearly be on developments in the regulatory and legal framework to facilitate a shorter settlement period. Blockchain could also have the potential to be implemented in the collateral management process, given the benefits of Blockchain to assess origin of assets, track transactions and determine ongoing ownership.

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- **Fund administration** - The asset management sector has lagged the banking and market infrastructure sectors in exploring Blockchain; however, there are signs of early adopters emerging who want to join the debate and understand the potential for their industry. It appears that the initial focus will be on collaborating with other financial services players within the post-trade processes, such as settlement and custody. However, we also see scope for Blockchain to be adopted to improve processes with client onboarding (AML/KYC), fund valuations (NAV calculations) and fund administration (reconciliations, corporate actions). As regulators seek to assess whether clients are getting value for money, any opportunities for costs to be reduced for clients would be welcomed, in our view.

Technology, media and telecommunications (TMT)

Interest within in the technology space is illustrated by Microsoft's high-profile partnership with the R3 consortium to leverage the merits of Blockchain and take a lead over key competitors Amazon and Alphabet's Google. Both IBM and Samsung have produced a proof of concept to demonstrate how Blockchain could support applications in the 'Internet of Things' (IoT, a network of physical objects embedded with electronics, and network connectivity that enables these objects to collect and exchange data). This is made possible by the distributed element of the ledger, which can facilitate greater coordination between a vast number of devices. The security challenge facing IoT applications could also be mitigated by cryptographic security.

Potential applications for the media sector could include support for lower priced micropayments, processed without fees enforced by prevailing payment networks, which may be used by a magazine vendor for example to charge their readers per article rather than per month. Some companies are also exploring the use of Blockchain to safeguard intellectual property and digital creative works, namely images or music.

Consumer and industrial products

The most likely application of Blockchain in the consumer and industrial products industry, in our view, is as an alternative payment platform for retail transactions.

Healthcare

The healthcare sector is focusing its attention on Blockchain as a way of securing digital assets. Factom, for example, the Blockchain-based record-keeping system provider, has partnered with US medical records and services solutions provider, HealthNautica, which aims to integrate Blockchain technology to help protect the integrity of highly sensitive documents such as medical bills and records, and surgery schedules. By securing medical records via a Blockchain, patients would more readily be able to share their medical history with multiple providers, while still being able to retain control over those records. Healthcare giant Philips Healthcare has recently launched 'Philips Blockchain Lab,' a research and development center, which is investigating further applications of Blockchain, but has yet to disclose what exactly these could entail.

Transportation

Proposed uses in the transportation sector focus on self-driving cars, which could identify drivers using a retina scan and check this against personal details on the Blockchain. It is also possible for cars to carry out their own self-maintenance by ordering parts and repairs when necessary, or updating annual insurance via the use of smart contracts, which could further be implemented to process automatic payments. Within the shipment and supply segment of the sector, Blockchain may be used to facilitate instantaneous payments as soon as merchandise is delivered. Ridesharing start-up Arcade City has recently launched a mobile application consisting of an open marketplace where riders are able to connect directly with drivers via Blockchain technology. Their platform was launched in a bid to take market share from the likes of Uber and Lyft.

Public sector

Blockchain may be used to tackle inefficiencies in current systems and improve the effectiveness of public services. For example, the technology could be used as an official registry for government assets or intellectual property owned by businesses and citizens, such as vehicles, houses and patents. Factom, for example, has partnered with the Honduras government to trial a Blockchain-based initiative to keep records of land ownership. The main motive for such a system is to mitigate corruption and fraud related to a centralized registry under government control by replacing it with a transparent distributed ledger. Blockchain could also facilitate voting in elections, ensuring the integrity of results and ultimately speeding up the vote counting process.

Benefits and obstacles of Blockchain adoption

The figure below summarizes the potential benefits from the use of Blockchain and the obstacles to the implementation of the technology. Overall, we would expect further benefits from Blockchain to evolve as new uses of the technology emerge.

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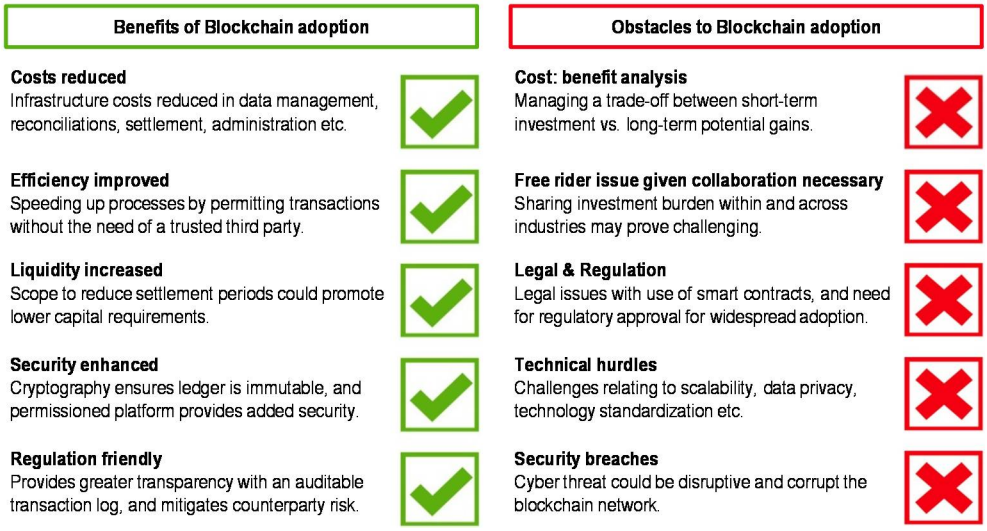
Figure 8: Blockchain adoption – Key benefits and obstacles



Source: J.P. Morgan

Benefits of Blockchain adoption

From the perspective of the financial services industry, we note Blockchain has the potential to fundamentally transform the business models of banks, exchanges and asset managers. We would highlight the below potential benefits that we foresee for the financial services sector.

- **Costs reduced** - The concept of mutualization should allow the financial services industry to share the costs of building and maintaining infrastructure. Ultimately, this should help to reduce the overall teams of employees involved in data management, reconciliations and dealing with errors. For the exchanges sector, we see the most obvious areas to reduce costs being in the post-trade area and, in particular, settlement processes, as settlement times are reduced and manual processes are streamlined.
- In the asset management sector, we see scope for costs savings in administration, which includes services such as KYC/AML processes, record-keeping, fund valuations and asset safe keeping. We believe these savings can be passed on to customers in the form of lower total expense ratios.
- **Efficiency improved** - The use of Blockchain should have an overriding benefit in terms of increasing efficiency, enabling, for example, faster transfer of transactions, value and assets without the need for a trusted third-party, the simultaneous recording of single data on the same ledger, reducing the need for reconciliations and ensuring information can be accessed by those with permission on a more real-time basis.
- **Liquidity increased** - The potential for settlement periods to be reduced has the impact of reducing the capital that is tied up in the system and increases liquidity. The customers of the exchanges can benefit from lower capital requirements as counterparty risk is potentially reduced.
- **Security enhanced** - The use of cryptography means that information recorded on the distributed ledger can be immutable or not able to be altered. In addition, there is an automated conflict resolution that ensures conflicting transactions never become part of the confirmed data set (or Blockchain).

  While Bitcoin was established around a permissionless platform, we expect uses of Blockchain in the financial services sector will be permissioned. Consequently, access will only be available to those users that have access via the private keys to the encrypted data. Blockchain can also improve the security around asset ownership and transfer of ownership through the use of tokenization, which provides a digital record for the underlying assets.
- **Regulation friendly** - While regulators seemed to express concerns over the use of Bitcoin, we believe that this principally reflected Bitcoin being based on a permissionless structure. The proposed uses of a distributed ledger in the financial sector are likely to be based on known participants defined in advance, with appropriate KYC/AML documentation with tightly authorized access. Consequently, we believe that distributed ledger technology has the potential to offer regulators greater degrees of transparency,

higher levels of resiliency and shorter settlement times, reducing counterparty and market risk. The auditable trail is also a key benefit from a regulatory perspective, in our view.

Obstacles to Blockchain adoption

The level of interest in Blockchain is clearly generating momentum across the financial services industry, but widespread adoption is still expected to take several years. We discuss below the obstacles that we see to the progression of Blockchain from concept to reality.

- **Cost-benefit analysis -** Appetite to invest in new technology may be limited at a time where financial service companies have had to invest significant amounts on capital adequacy and regulatory requirements. Carrying out a cost-benefit analysis is unlikely to be straightforward due to the level of uncertainty. That said, new entrants, with no legacy constraints, could utilize Blockchain to create cheaper, more efficient platforms; hence, ignoring Blockchain may not be an option.
- **Free rider issue given collaboration necessary -** Our understanding of Blockchain is that success requires collaboration between the various parties to build processes and infrastructure. Consequently, sharing the costs of investment across the industry could prove to be a challenge depending on financial ability and willingness to share such costs. This gives rise to the potential free rider problem with certain participants relying on others to contribute to a greater extent.
- **Legal -** Legal issues will have to be addressed as there is no precedent for the use of smart digital documents. Consequently, the legal implications of errors around the production of smart contracts and how to deal with different jurisdictions globally are issues that we believe will need to be addressed.
- **Regulation -** Regulators will need to give the green light for the application of the technology and this will be important to gain widespread adoption, in our view. Given the global nature of financial services, the approval will be required across different jurisdictions. We see greater issues for permissionless open-distributed ledger, while permissioned platforms could gain more support.
- **Technical hurdles -** As with any new technology, there is the risk for untested technical hurdles, which include issues around scalability, data privacy, performance, identity management and technology standardization. In addition, individual Blockchains operate separately and there is no cross Blockchain integration. We could see a situation potentially develop where two companies operate their own private Blockchain, but find the need for the two Blockchains to interoperate.
- **Security breaches -** There is the risk of intentional security breaches that could have unknown consequences. The distributed nature of Blockchain does provide some protection, as to hack the system would require collusion across the network (or ownership of 50%+ of the nodes in most cases) and, in the event information is corrupted, there is a record on the distributed ledger.

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Cryptocurrency 101

- **Cryptocurrency (CC) is a virtual currency that is created, stored and governed electronically by an open, decentralized, cryptography system. There are currently over 1,500 cryptocurrencies with a market cap of $400 billion**
- **Bitcoin (BTC) is the dominant cryptocurrency with a market cap of ~$140 billion, representing one third of the cryptocurrency market, and nearly 17 million BTC units in circulation, capped at 21 million**
- **In order for a cryptocurrency ecosystem to thrive, CCs must be created, stored, exchanged and processed. We divide these four tasks into four sub-sectors; (1) Miners that create cryptocurrencies; (2) Wallets that store CCs; (3) Exchanges that serve to trade CCs for other CCs or national currencies; and (4) Processors that enable merchants to accept CCs as a payment tender**

What is cryptocurrency?

Cryptocurrency (CC) is a virtual currency that is created, stored and governed electronically by an open, decentralized, cryptography system. CCs can be used to exchange money, to buy goods/services or as an investment. There are currently over 1,500 cryptocurrencies with a market cap of $400 billion with Bitcoin being the largest representing a third of the market according to CoinMarketCap.

The foundation for cryptocurrencies, notably Bitcoin, is that there is no centralized monetary authority, relying instead on a Blockchain or a distributed public ledger that is open and shared by a network of connected computers that are incentivized to validate and record transactions (and ultimately drive liquidity). The public ledger is a running list of completed transactions, time-stamped and recorded in blocks, making it transparent for anyone on the network to check the validity of past transactions. True to its name, cryptocurrencies leverage cryptographic techniques requiring hefty mathematical and computational processing power to ensure nonrepudiation of a transaction between two parties.

What is Bitcoin?

Launched in early 2009, Bitcoin (BTC) is the dominant cryptocurrency with a market cap of ~$140 billion (representing one-third of cryptocurrency market) and nearly 17mn BTC units in circulation (capped at 21mn). Bitcoins are created or "mined" by individuals (miners) when they complete the computational task of solving (processing) a Bitcoin transaction, unlocking new Bitcoins for that individual's effort as a reward. Bitcoin was the first major cryptocurrency and has spawned many competing CCs and technologies, many of which still fall back to Bitcoin as a support currency. **Bitcoin itself has split into two cryptocurrencies, Bitcoin and Bitcoin Cash, to improve liquidity.**

Acceptance of Bitcoin at the enterprise level is still in its infancy, but some notable companies are embracing it including Fidelity (mining cryptocurrencies and has partnered with Coinbase to integrate cryptocurrency wallets), Overstock.com, Subway (certain franchises testing), Zynga, Rakutan and KFC Canada.

How does it work? What does a transaction look like?

In Figure 9, we illustrate how cryptocurrencies work in the real world via a simple example of how Bitcoins are exchanged from one party to another.

Who are the key players in the cryptocurrency ecosystem?

In order for a cryptocurrency ecosystem to thrive, CCs must be created, stored, exchanged and processed. We divide these four tasks into four sub-sectors. (1) Miners that create cryptocurrencies; (2) Wallets that store CCs; (3) Exchanges that serve to trade CCs for other CCs or national currencies; and (4) Processors that enable merchants to accept CCs as a payment tender.

1. **Miners or mining**. Like mining for gold, CCs are mined by individuals using computers to process transactions and earn a CC reward. Specifically, mining is the act of recording transactions to the public ledger or Blockchain to unlock a reward (e.g. Bitcoins). It is a very resource-intensive process, requiring heavy computer power to satisfy security conditions (rooted in cryptography) and ensure that all network participants agree the Blockchain is accurate. The Blockchain grows more complex as more lists of transactions (blocks) get added to the chain, necessitating increasing computer power to sustain it. The mining label is clever, because miners must invest resources (hardware, energy, computer power) to position themselves to be the first to successfully process the transaction to earn the CC coin. Mining has spawned many sub-industries including mining pools (miners pooling together resources and sharing in the rewards), hardware equipment manufacturers and mining cloud services.

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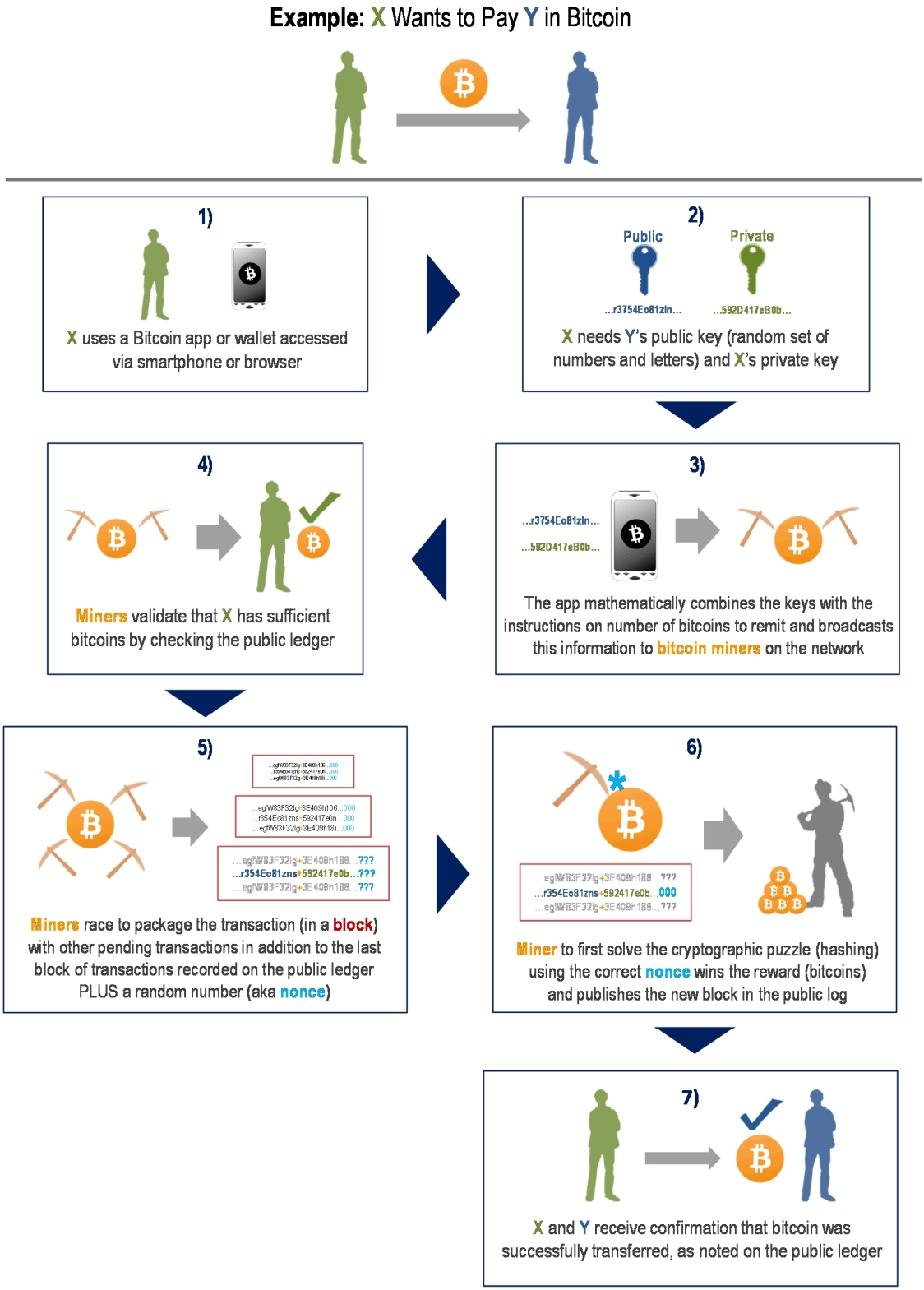
Figure 9: Bitcoin Transaction Flow



Source: J.P. Morgan

2. **Wallets**. Wallets store cryptocurrencies, and can come in many forms including hot (online) wallets in an app or browser, and cold (offline) hardware options. Cryptocurrency wallets are analogous to leather or digital wallets that hold cash or credit/debit card credentials. Examples of wallets include BitPay, Coinbase, Blockchain.info, Electrum, Exodus.
3. **Exchanges**. Cryptocurrencies can be bought or sold on exchanges. Most exchanges allow trading for CCs for fiat currencies. See "Asset manager participation limited in cryptocurrency funds. Credibility an issue" for more details.
4. **Processors**. No different than merchant acquirers, cryptocurrency processors provide services and tools for merchants to accept cryptocurrencies as a form of payment. Many of these tools are integrated into the checkout flow of a transaction. Example processors include Braintree, Shopify, and until recently Stripe, which is currently phasing out bitcoin acceptance at its merchants given currency volatility.

What are the major cryptocurrencies?

There are currently over 1,500 cryptocurrencies with a market cap of nearly $400 billion, with Bitcoin being the largest representing over a third of the market according to CoinMarketCap.

Table 1: Top 10 Cryptocurrencies by Market Capitalization

Rank	CC Name	Market Cap ($B)	% of Total Market Cap
1	Bitcoin	142.010	36%
2	Ethereum	80.511	20%
3	Ripple	30.224	8%
4	Bitcoin Cash	20.811	5%
5	Cardano	9.175	2%
6	Litecoin	8.109	2%
7	NEO	7.309	2%
8	Stellar	6.695	2%
9	EOS	5.477	1%
10	IOTA	5.084	1%
	Total Market Cap	396.980	100%

Source: CoinMarketCap
Note: As of midday 2/8/2018

How do new cryptocurrencies form?

Most cryptocurrencies are derived from the open source code of Bitcoin. Anyone can code a new cryptocurrency, but the challenge is creating a community willing to use and mine the new coin. There are many case studies of cryptocurrencies developed to support a closed ecosystem, analogous to a loyalty or frequent flyer program.

Initial Coin Offerings (ICOs) have gained momentum as a mechanism to raise funds in exchange for cryptocurrencies. ICOs raised nearly $4 billion in 2017, which in turn has garnered increased regulatory scrutiny given inherent fraud risks, with the U.S. SEC issuing a warning against ICOs, and China and Korea banning ICOs outright.

How is Ethereum different from Bitcoin?

As shown in Table 1, Ethereum is the second largest cryptocurrency in the market behind Bitcoin. However, unlike Bitcoin's foundation as a currency Blockchain, Ethereum (native currency is Ether) is a Blockchain platform for transacting anything. As such, Ethereum is considered a decentralized platform for applications, enforced by *smart contracts* that run exactly as programmed. This is why many developers are building applications (e.g. many ICOs leverage the platform) on Ethereum.

The key difference versus Bitcoin is that the Ethereum framework includes "smart contracts" (code) embedded in the Blockchain that get executed once certain transaction conditions are met. In other words, a smart contract automatically records a transaction on the Blockchain once agreed upon instructions (e.g. an "if x, then y" statement) are satisfied, creating a host of opportunities to automate any transaction without the need for an intermediary. These contracts are what miners execute in exchange for a reward of Ether (Ethereum's native currency).

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The economics of cryptocurrencies

- **As currently structured, cryptocurrencies do not meet the standard economic definition of money**
- **Because of this, we don't see cryptocurrencies competing with central bank-issued money for lawful transactions**
- **Some central banks have expressed interest in issuing their own cryptocurrencies**
- **While technically feasible, developed market central banks could face some thorny design issues, such as whether to maintain anonymity**
- **Even so, distributed ledger technologies are likely to be employed by payment systems, often with central bank involvement**

The economic issues raised by cryptocurrencies mainly relate to how they will interact with existing monetary regimes and the central banks that administer them. The **first** issue is **whether cryptocurrencies can become a legitimate competitor to existing national currencies.** With a few exceptions, we see this outcome as **highly unlikely**. Cryptocurrencies have not attained the relative stability of value to make them useful as money for everyday transactions. Even if this hurdle is overcome, well-functioning money is a natural monopoly and is very hard to displace by challengers.

The **second** issue is **whether central banks will co-opt distributed ledger technology to create their own central bank-issued cryptocurrencies.** Several developed market central banks are studying this notion, but so far it is still in the discussion stage. We note that two issues have prevented faster adoption. First, central banks generally already operate highly efficient interbank payment systems, so the added advantage has not been obvious. Second, creation of a central bank-issued cryptocurrency could create thorny design issues that touch on public policy areas that are broader than merely monetary policy. For example, it is debatable as to whether the public sector should create a financial vehicle that provides the anonymity craved by black market operators.

In most countries, the central bank sits at the center of a web of privately, or semi-privately, owned payment systems. It seems more feasible that some of these participants would be able to employ distributed ledger technology, even if payments are still ultimately denominated in traditional currencies.

From barter to money…

If cryptocurrencies attain their ambition to be considered currencies, then the economics of cryptocurrencies should begin more generally with the economics of money. The macroeconomics of money, in turn, is best studied after considering the microeconomics of money. A standard definition of money is an asset that serves as a medium of exchange. Historically, it arose as a technological advance that overcame some of the shortfalls of bartering. Chief among these is the so-called "double coincidence of wants": barter only works when you want some of what I am selling and I want some of what you are selling. This will be an exceedingly rare occurrence in economies that produce many specialized goods. Money solves this problem.

Cueing off of William Stanley Jevons' work from the late 19th century, modern monetary theory generally lists three functions of money: (i) a unit of account, (ii) a medium of exchange, (iii) a store of value. This tripartite enumeration informed the modern theory of money demand, which was formulated by Milton Friedman in the middle of the 20th century. Since money's principal use is for exchange, money demand should quite clearly positively co-vary with the volume of purchases in the economy. However, because money serves as a store of value, two temporal dimensions are also involved. Money does not pay interest in most forms (paper currency, cryptocurrency), but not all forms (reserves in most countries). Thus, when considering a portfolio of money and other non-monetary assets, a higher interest rate should lower the amount of money demanded. Moreover, inflation is nothing more than the rate at which money's purchasing power declines. So inflation lowers money demand, deflation increases money demand.

…and money to cryptocurrency?

With these preliminaries in mind, the first obvious economic question raised is whether cryptocurrencies function as money. We note the answer to this question is equally obvious: thus far, **cryptocurrencies generally do not function as money**. The huge volatility of the price of cryptocurrencies—with respect to either traditional currencies or to a basket of goods and services—has made use of cryptocurrencies as a unit of account impractical. Only hobbyists are using cryptocurrencies as a medium of exchange, at least for conventional transactions for goods and services. And while cryptocurrencies can serve as a store of value, it is not a stable store of value—a condition that is also often attached to the functional definition of money. The fundamental problem seems to be that the supply of

cryptocurrencies is not nimbly adjusted to offset fluctuations in demand. As a result, the values of cryptocurrencies tend to gyrate massively, frustrating any attempt to price and transact in them. Some cryptocurrencies are being developed which seek to attain price stability with adjustments in supply (Tether, MakerDAO, Basecoin, etc.), though it remains to be seen whether they will be successful.[2]

If, hypothetically, some cryptocurrencies would rise to meet the functional definition of money, then a second question is **whether they could compete** with traditional currencies. Here we should note two senses of "compete." The dollar currently competes with the euro, yen, etc. as a currency for invoicing international transactions, for raising funds in international capital markets, etc. There is no a priori reason to think a cryptocurrency couldn't also compete in this sense if it were to attain a modicum of price stability (granted, a big "if"). One area where it is reasonable to expect cryptocurrencies to compete quite well is in **black market** activity. This might matter for the dollar, in particular, as most of the growth in dollar currency circulation is in $100 bills, and much of this is believed to be used for illicit purposes. So far this hasn't seemed to have impacted demand for the greenback; even in recent months, **dollar currency growth has been accelerating** well above the pace of US nominal GDP growth.

At any rate, even a hypothetically stable-value cryptocurrency is unlikely to compete with the dollar for transactions in goods and services in, say, Chicago, or to compete with the euro in Stuttgart. Economists have long viewed successful, i.e. relatively price-stable, currencies as **natural monopolies** in a given geographic area. This particular natural monopoly arises as a result of the inherent network externalities: pricing a New York meal in yen makes little sense as almost all customers will be holding dollars, and thus, it makes little sense to carry yen around New York as almost everything will be priced in dollars. This isn't a result of a heavy-handed government—businesses in New York are free to price in Kenyan shilling if they want—rather it is a simple matter of rational choice. If the Fed (ECB) sets policy reasonably well, we believe it will be extremely hard for cryptocurrencies to edge out the dollar (euro) for ordinary domestic transactions.

[2] According to the fiscal theory of the price level, the value of a fiat currency is determined by the real fiscal resources that ultimately back that currency (such as a stream of tax revenue). Experiments in stable price cryptocurrency mostly have been backed up by other nominal, not real, resources.

The rise of robo-central bankers?

Existing cryptocurrencies are unlikely to compete with established conventional currencies, but a second issue that arises (and one we devote more discussion to) is whether central banks choose to co-opt the distributed ledger technology underlying cryptocurrencies to create their own, central bank-issued cryptocurrency. Recently a number of developed economy central bankers, including those in Canada and Sweden, have begun investigating the practicalities of issuing central bank cryptocurrency (CBCC). Unlike existing cryptocurrencies, a potential CBCC (sometimes also called central bank digital currency) would be issued and backed by the central bank and trade 1:1 with the existing currency, thus having a much more stable value than existing cryptocurrencies. A number of commentators (including a few from within the Federal Reserve System) have mused on the possibility of a "Fedcoin" for the US. Below we look at some of the controversial design issues involved in creating a CBCC (for concreteness, most of the discussion below considers the case of the Fed).

Our analysis looks at the creation of **Fedcoin** as conceptually equivalent to two steps. First, allowing non-banks (businesses and households) to have the ability to directly hold reserve account balances at the Fed, giving them a claim on the Fed's balance sheet (Fedcoins). Second, allowing transactions on these claims to clear and settle on a peer-to-peer basis, utilizing the distributed ledger technology that serves as the back-bone of Bitcoin. Both steps would be controversial and require the assent of Congress. The first step could serve as a back-door route to a **narrow-banking system**, with large and controversial implications for financial intermediation. The second step raises questions about whether Fedcoin should be structured to preserve the **anonymity** of cash (or bitcoin). Moreover, it is not apparent whether the second step is even necessary, as the Fed can (and does) efficiently serve as a trusted third-party clearing and settling agent.

Note, however, that the Fed is only one node, albeit an important one, in the US payment infrastructure. Other private sector participants in that infrastructure already employ distributed ledger technology and we believe will almost certainly expand its use. In fact, some of this is occurring with the Fed's involvement in industry "fast payments" initiatives. Even if Fedcoin remains a distant reality, we believe the US payments system will still benefit from distributed ledger and other financial technologies.

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Why bother with CBCCs

The white paper that introduced Bitcoin in 2008 described it as "a peer-to-peer electronic cash system." The supply of Bitcoins follows a predetermined path and does not adjust in response to fluctuations in the money demand curve. As mentioned earlier, this has resulted in huge fluctuations in value—relative to traditional currencies or to a basket of goods and services. Because of these value fluctuations, most economists are quite skeptical that Bitcoin will ever be useful as a medium of exchange or unit of account (for example, see the survey linked here). If instead cryptocurrency supply were controlled by a central bank to trade 1:1 with the existing, conventional, currency then it would have a more stable value relative to a basket of goods and services, thereby making it more usable for everyday transactions, in our view.

Virtually every central bank around the world today is an institution in the service of the public. If they were to issue CBCCs, we would expect that there must be a compelling policy rationale. One such rationale is to keep up with the times: payment systems are increasingly cashless, and it would seem natural that central bank-provided payment services should move in that direction. (Whether cashless need imply crypto is a question we address below). In fact, one reason impelling Sweden's Riksbank to study the issuance of a so-called "e-krona" is that physical krona are actually contracting in quantity, underscoring that country's rapid move to a cashless society. Some economists, most notably former IMF Chief Economist Ken Rogoff, argue that central banks should actively encourage a cashless future. With an entirely digital (or crypto) currency, it becomes much simpler to implement deeply negative rates, as the option to hold zero interest cash would no longer limit how far interest rates can go into negative territory. It almost goes without saying that the Rogoff argument is controversial.

A potential CBCC would be a third form of monetary base, alongside currency and reserves. Just as a dollar of currency trades 1:1 with a dollar of reserves, so too would a dollar of Fedcoin trade 1:1 with either of the other two dollar forms. From a central bank balance sheet perspective all that changes is the introduction of another form of liability for the central bank. This would not necessarily have any implications for monetary policy, and all three forms of monetary base would continue to be backed by assets on the Fed's balance sheet.

Bank reserves arguably are a form of electronic cash, like Bitcoin. Unlike Bitcoin, their issuance is controlled by the Fed's monetary policy, which, as mentioned earlier, most economists see as a desirable property. Reserves still differ from Fedcoin in two respects. First, only a limited number of entities, primarily depository institutions, are allowed to hold reserves. Second, reserve payments are settled by a trusted third party, the Fed, rather than on a peer-to-peer basis.

A banker's bank, or a people's bank?

The Fed's interaction with businesses and households is generally mediated through the banking sector, as is common for central banks. Fedcoin would give businesses and individuals direct access to this claim on the Fed's balance sheet. Depending on how it is structured, this could create a strong incentive to shift transaction deposits from the commercial banking system to Fedcoin: claims on the Fed balance sheet are even safer than FDIC-insured claims. If Fedcoin paid interest, as is currently the case with reserves, this incentive would be even stronger. If this migration from deposits to Fedcoin were to occur, the Fed effectively would be using its balance sheet to create a "**narrow bank**." (In brief, narrow banks take deposits and invest them solely in safe, liquid securities—often only government securities. The idea is to separate deposit creation and payment services from the financial intermediation involved in screening and lending to risky borrowers.) Narrow banking proposals have a long history, with advocates both for and against the idea. In any case, the move toward such a system could be quite disruptive to the financial sector, and Congress would almost certainly want to weigh in on a vast restructuring of such a large sector of the economy.

P2P or Fed in the middle?

A digital claim on the Fed balance sheet held by non-banks is still one step removed from being considered a CBCC. For cryptocurrencies like Bitcoin, and hypothetically like Fedcoin, payments between two parties are cleared and settled in a decentralized, peer-to-peer setting, facilitated by distributed ledger technology. This is in contrast to, for example, Fedwire, which is used for large-value, time-critical payments executed between banks. In that scheme the Fed sits at the center of the network, acting as a centralized, trusted third party in clearing and settlement. For Bitcoin and other cryptocurrencies there is no such trusted third party, which is the motivating rationale for a distributed ledger. Transactions occur on a peer-to-peer basis and are validated by the network of users.

Over the past few years the Bank of Canada has experimented with a peer-to-peer payment system known

as Project Jasper. As is the case with traditional bank reserves, Project Jasper involved the exchange of central bank-created money (CADcoin) among a limited, permissioned, group of financial institutions. Unlike reserves, however, CADcoin achieved clearing and settlement through a distributed ledger shared among participating institutions. While CADcoin could point the way forward for CBCCs, one caution is that not even the BoC is currently thinking of deploying this on anything other than a trial basis. While it was a successful proof of concept, we note there are **no obvious efficiency or resiliency benefits**. Part of the issue is that the interbank payment systems already perform quite well, as evidenced by the fact that even in the depths of the financial crisis the system (both in Canada and the US) functioned largely without a hitch.

Given all this, it's not obvious to us that peer-to-peer transacting and distributed ledger technology would be optimal. If the Fed is a trusted third party, then it may be the case, as the Bank of Canada seems to have concluded, that clearing and settlement can be conducted more efficiently on a centralized basis. And if you don't trust the Fed then you probably shouldn't be using the dollar in the first place. In fact, a number of proposals have called for broad, digital access to balances at the Fed while still using centralized clearing and settlement. For example, researchers at the NY Fed recently floated a proposal called Segregated Balance Accounts (SBAs), which effectively would allow non-bank access to the Fed's balance sheet. And as we noted here, James Tobin proposed a similar "Deposited Currency Accounts" scheme at the 1987 Jackson Hole Conference.

If, for whatever reason, it is decided to construct Fedcoin as a distributed ledger payment system, then another design choice is whether it should share one important attribute of both Bitcoin and cash: **anonymity**. This is in contrast to the other principal means of payment available to individuals—bank deposits—where the government encourages banks to know their clients. It seems that Fedcoin could be structured to preserve anonymity, but the question is: should it? On the one hand, privacy has come to be seen as an implicit constitutional right, and that may extend to monetary transactions. On the other hand, there are several laws on the books intended to prevent the financial system from being used to launder money or finance terrorism and other activities. As with other potential Fedcoin design issues, it is almost certain that these are broad enough public policy issues that common notions of central bank independence don't apply and the public's representatives would want to have the last word.

Fast times at FRB

Because of political and institutional impediments, we are doubtful we will see Fedcoin anytime soon. That doesn't necessarily mean the Fed wouldn't be involved in an ongoing way with distributed ledger technologies. As a stakeholder in the broader payments system, the Fed has encouraged private sector participants to consider ways the US can catch up in delivering faster payments, particularly at the retail level. One possibility we can see is a decentralized approach that relies on private payment platforms utilizing distributed ledger technologies. Even if Fedcoin is never realized, faster payments may deliver some of the benefits that motivate consideration of CBCCs.

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EM: troubled by the anonymity of cryptocurrency

- **We expect digital currencies will expand, as elsewhere, with the support of authorities**
- **But cryptocurrencies have already and continue to run into regulatory headwinds**
- **Much of this has to do with the troubling anonymity of cryptocurrencies**
- **Ironically, some countries are hoping to exploit this anonymity to bypass cross-border constraints**
- **The success of such efforts is likely to be limited**

Debates over the merits and dangers of cryptocurrency (CC) have surfaced in public fora with varying degrees of urgency across EM. The reactions of policymakers and regulators have also differed widely, as have the use and development of CC.

Some of the divergence in the reaction stems from the lack of distinction drawn between digital currencies (DCs) in general and CC is particular. Given that DC can potentially be more efficient and secure than existing systems of payments and settlement, its use will likely expand, perhaps more rapidly than currently anticipated as elsewhere.

However, all virtual currencies are not CCs. A CC differs in a fundamental way: CC transactions are necessarily anonymous, while the more general DC transactions are not. Almost all EM authorities have, in principle, accepted (and many have encouraged) the issuance of both private and official DCs given their greater efficiency and better security. However, the anonymity of CC has troubled many EM authorities, although we note that some are planning to issue CCs, ironically (it would appear) to exploit the same anonymity to circumvent sanctions on cross-border transactions.

The troubling anonymity of CC

We begin by discussing the challenges that anonymity of CC transactions would encounter before turning to the advantages that make them attractive. Some of these challenges are obvious. For example, in a world of heightened scrutiny over money laundering and terrorism funding, it is hard to imagine any authority allowing anonymous transactions given domestic laws and international commitments. (e.g., the FATF sponsored AMLCFT Act). More generally, anonymous transactions would test civil and criminal laws that require establishing the identities of those involved in a transaction, the end use of the underlying commodity or service being transacted, and the sources of funds used in financing it. For example, it would make it very difficult to curb tax evasion even if the tax authority was part of the CC system, i.e., had full access to the distributed ledger underlying the CC, since it would still not be able to identify those involved in the transactions.

India: against even the anonymity of cash

This concern over anonymity led India to undertake a massive and painful demonetization of its currency in 2016 to minimize tax evasion and money laundering through cash transactions. And cash transactions are far less anonymous than those under a CC. Since then the Indian government has been advocating and encouraging digital financial transactions in order to better track the identities of the entities involved and the sources of funding to clamp down on tax evasion and the growth of the black economy.

Venezuela: taking steps to benefit from the anonymity of CC

At the other end of the spectrum, in more recent months, the Venezuelan government has announced plans to introduce its own CC called *petro*. The currency would be backed by the country's natural resources, namely oil, gold, and diamonds. Their hope is that transactions in the CC can bypass the sanctions on cross-border transactions. The details of the payments system are being worked out and the lack of specifics makes it difficult to assess the success of the new currency.

However, any payment system works through mutually reinforcing confidence, e.g., entity A will accept *petro* as payment from B only if it has faith that some other entity C will be willing to transact in *petro*, so on and so forth. While it is conceivable that entities in other countries facing similar sanctions might be willing to transact in *petro*, it is hard to imagine those in non-sanctioned countries doing so as such transactions would be deemed illegal by their governments. Taking such a risk would necessarily limit the use of the currency. Press reports also suggest that Russia may be warming up to the idea of launching "crypto ruble," a CC backed by the country's oil reserves, again to circumvent sanctions,

although the central bank has publicly voiced its concerns over the use of CCs. [3]

CC could create a multiple FX regime

It is understandable why the anonymity of the *petro* (or any other CC) could make it an attractive vehicle to sidestep sanctions. That said, we would note that the general concerns over anonymity would also arise in Venezuela if domestic transactions are allowed to be settled in *petro*. Thus, if and when the *petro* is introduced, it would likely be limited to foreign transactions. Such restrictions are not new. Until the late 1990s, history was replete with examples of such dual-or multiple-currency regimes. And this is because such arrangements ended up creating distortions and inefficiencies that inflicted long-lasting economic wounds. China unified its exchange rate regime in 1995, which is often cited as a key reform that spurred the phenomenal expansion of the economy for the next two decades. Today, countries such as Iran and Zimbabwe are among the handful that continues with such FX regimes.

Commodity-based CC demands greater tolerance for volatility

We believe the success of the system will also depend on the ability of all participants to be able to verify the authenticity of the value and size of the backing resources. This, in turn, in the case of Venezuela would require the government to open its oil reserves to continuous external scrutiny. In addition, while backing a currency with a commodity is not new (e.g., the extensive use of the gold standard in the last century), linking the *petro* to global oil prices would make its value volatile and unrelated to the domestic business cycle forcing the economy to undergo unwarranted and painful output and price adjustments.

CC is neither better than fiat money in establishing policy credibility …

It is also argued that a CC could act as an alternative to fiat money, i.e., legal tender issued by a central bank, especially in countries where the lack of credibility of policymakers and policymaking has heightened macroeconomic instability. The logic is that since a CC is a self-contained and self-governing system, it cannot be influenced by discretionary policies and therefore will not be affected by the lack of policy credibility. Consequently, in countries lacking such credibility, CC can help to restore stability.

While we believe a carefully designed CC could potentially do so, there already exist several such mechanisms that are much better understood through years of experience. For example, it was quite common in the 1980s and 90s for countries undergoing hyperinflation to devalue, remonetize, and fix their exchange rate to a stable hard currency such as the USD. In more extreme circumstances, a fixed-exchange rate regime was converted to a currency board or the country dollarized fully (e.g., Ecuador as recently as 2000 in the aftermath of a sovereign debt crisis). By choosing the appropriate currency to peg, these mechanisms allowed a country to "import" the policy credibility of another country quite effectively.

Fixed-exchange regimes have become rare with the widespread adoption of inflation-targeting by EM central banks since the early 2000s. But these FX arrangements have been extensively studied and their workings and effects well understood. So it is unclear why it would be necessary to adopt an arrangement, such as a CC that is still at an experimental stage and does not necessarily provide any more credibility than the traditional FX-based stabilization programs. Again, using Venezuela as an example, the government has designated the oil from Ayacucho oil field No.1, whose reserves are estimated at over 5 billion barrels, to back the proposed *petro*. This is equivalent to a forward sale of the oil reserves except that the *petro-based* transaction would be anonymous. The key question remains who will transact in *petro* because (i) it is illegal to do so and while the financial transaction is anonymous, clearing the purchased oil through the importing country's customs isn't and (ii) the country's ailing oil infrastructure risks further decline in production, thereby raising doubts about the government's ability to adequately supply *petro* as needed for liquidity.

… nor in providing liquidity during crisis

The ability to provide adequate liquidity is a hallmark of a well-functioning market, but more so during times of crisis. One benefit of fiat money (legal tender issued by a central bank), is that it can be used to provide emergency liquidity from the outside. This is the role central banks play as the lender-of-last resort. Closed systems, such as a CC arrangement, have natural limits to the amount of liquidity they can generate. For example, in the proposed *petro* arrangement the total liquidity is limited by the

[3] Source: https://www.nytimes.com/2018/01/03/technology/russia-venezuela-virtual-currencies.html and https://www.bloomberg.com/news/articles/2017-12-15/what-the-world-s-central-banks-are-saying-about-cryptocurrencies.

number of barrels of oil backing the currency at any point in time. When a global shock hits the system, it can run out of liquidity. One can argue that more oil can be drilled to create more *petros*, but that too has natural limits as discussed earlier. Private systems have generated additional liquidity to meet emergency situations but it is not intrinsic to the arrangement (for example, in the 1907 US financial crisis, J.P. Morgan pledged large sums of his personal funds and convinced other bankers to do the same to shore up public confidence in the banking system.)

Economic theory has shown that private provisioning of liquidity is inadequate during a global shock, while experience suggests that public provisioning of liquidity plays a critical role in mitigating crises (the 2008 crisis being the most recent example). Such public provisioning of liquidity is not possible in a CC system without changing its structure fundamentally.

China: typifying EM response to CC

Given these apprehensions, most EM authorities remain cautious about CC, although, they have welcomed DC as a potentially more efficient and secure payments arrangement, and many central banks are researching into the modalities of issuing their own DC.

A case in point is China, where, on the one hand, the PBOC is reportedly studying the possibility of issuing its own DC, while, on the other hand, it has made it clear that CC is not a legal tender and that financial services related to CC are banned across all financial institutions and payment providers, including the issuance of any wealth-management product (WMP) related to a CC.

Nonetheless, CCs have gained popularity and regulators could easily find themselves behind the curve. For example, instead of directly providing financial services or issuing products denominated in CC, funds have invested in initial coin offerings (ICOs), which in 1H17 reportedly raised RMB2.6bn. In addition, it is estimated that around 60% of the world's CC mining pools are located in China, followed by the US at around 15%. This has forced regulators to tighten rules, intensify inspection of CC trading platforms, and eventually place a ban on ICOs last September. Such reactions are likely to become a template for other EM regulators.

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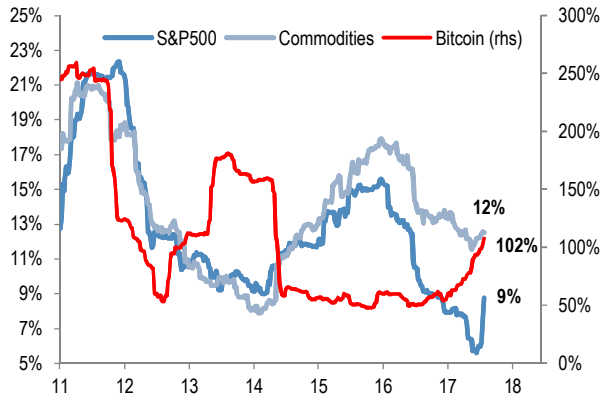
Cryptocurrencies as portfolio diversification: Questionable, despite low correlations

- **Cryptocurrency detractors often cite these instruments' extreme volatility as a reason to avoid the most-watched market since dot-com stocks of the 1990s**
- **But for those focused on diversification or portfolio insurance, we note what matters more is how these instruments' volatility plus their correlation with core markets impacts a portfolio's risk-return characteristics over the long term or during periods of extreme cyclical or political stress. Such extremes could include recessions, inflation surges, currency crises or collapse of the payments system.**
- **Cryptocurrencies haven't existed long enough to examine their contribution to portfolio efficiency over several business cycles, but their performance over the past few years suggests the following: some improvement in risk-adjusted returns over the medium term, but no ability to mitigate portfolio drawdown during periods of acute market stress like equity flash crashes of August 2015 and February 2018.**
- **Hedgers should hold two other reservations. One is cryptocurrencies' limited liquidity relative to traditional hedges like commodities, inflation-linked bonds or the yen, a feature endemic to any currency that is not legal tender. Another is unstable risk-return characteristics typical in the early phases of market development (similar to gold's behavior after the collapse of the Bretton Woods system), which cautions against extrapolation for risk-management purposes.**

Investors should always look for better insurance

Cryptocurrency detractors often cite these instruments' extreme volatility — Bitcoin's realized volatility over the past year has been about 10 times that of equities — as a reason to avoid the most-watched market since dot-com stocks of the 1990s (Figure 10).

Figure 10: Cryptocurrencies can be 10 times more volatile than core markets like Equities or hedges such as Commodities
1Y realized volatility on BTC, S&P500 and JPM Commodity Curve Index



Source: J.P. Morgan, Bloomberg

This argument is eminently sensible, in our view: any consumer, business or investor who prioritizes stability in their medium of exchange or store of value should probably avoid the majority of the world's government-issued/fiat currencies (i.e. most emerging market ones plus G10 commodity ones), much less the crypto aspirants. Hence, the view expressed a few years ago that cryptocurrencies were an innovation worth limiting one's exposure to (see *The audacity of bitcoin: Risks and opportunities for corporates and investors* by Normand from February 11, 2014).

But for those focused on **diversification or portfolio insurance**, what matters more is how these instruments' volatility plus their correlation with core market assets impacts a portfolio's risk-return characteristics over the long term or during periods of extreme macroeconomic or market stress. Recessions and inflation surges are such events against which investors tend to insure by raising their allocation to cash, government bonds (both for recessions), inflation-linked bonds and commodities (for inflation surges and stagflation). Crises of confidence around government-issued (fiat) currencies or the payments system are two other scenarios against which cryptocurrencies could insure, with the first occurring due to a hyperinflation and the second in a failed nation-state (think Arab Spring or EMU Crisis). Even though cryptocurrencies haven't existed for long enough to test their usefulness during recessions, inflationary upturns or regime failures, hedgers might hope that a low/inverse correlations with traditional asset classes over the past several years could improve portfolio efficiency (raise returns for a target level of risk) more than customary hedges such as commodities, the yen or inflation-linked bonds.

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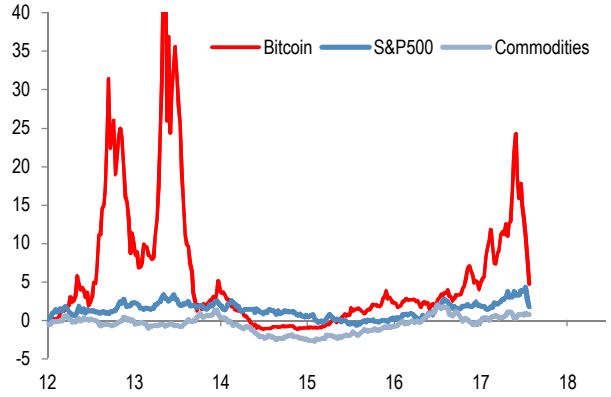
Using Bitcoin's returns and volatility as representative of all crypto assets, it seems that these instruments could carry some diversification value over the medium term, subject to a few caveats. One is that **liquidity** is well below most other potential hedges. The other is that **risk-return characteristics could change significantly** as this market evolves (similar to the fate of other quasi-currencies such as gold), thus invalidating any tentative conclusions based on only a few years of data. Cryptocurrencies have also failed to offset equity market **drawdowns** during periods of acute market stress like in August 2015 and in February 2018, unlike the yen's consistent outperformance during such high-volatility events.

Cryptocurrencies less correlated with core markets than typical hedges

Most commentary on cryptocurrencies focuses on their outsized returns or their extraordinary volatility but rarely on both, or on their correlation with core markets. Figure 10 and Figure 11 plus Table 2 provide a few statistics for discussing these assets in a portfolio context. Despite volatility which is some 10 times that of stocks, 12 times that of the yen and 8 times that of commodities, cryptocurrencies have delivered higher risk-adjusted returns (measured as rolling 12-mo returns divided by 12-mo realized volatility) in four of the past five years (Figure 11). Their boom-and-bust cycles have not diminished, however, since their launch several years ago. These markets have also demonstrated a near-zero average correlation with other asset classes over the past five years, compared to the mildly positive average correlation that some other traditional hedges like inflation-linked bonds, commodity indices, gold and the yen often exhibit with other capital market assets (Table 2). For investors focused mainly on equities, however, the yen and Treasuries move the most inversely, with correlations of about -0.3 to the S&P500 over the past few years compared to bitcoin's zero correlation.

Figure 11: Cryptocurrencies' risk-adjust returns have been higher than those of core asset classes, but boom-and-bust tendencies have not diminished since their launch

Rolling 12-mo returns divided by rolling 1Y realized volatility



Source: J.P. Morgan

Table 2: For hedging purposes, what matters also is cryptocurrencies' correlation with other assets

Correlation of weekly returns over past five years and past year

Past five years	S&P 500	USTs	US HG Credit	EM Local	TIPS	Commodities	Gold	Yen cash	Bitcoin
S&P 500	1	-0.28	-0.08	0.36	-0.05	0.32	-0.14	-0.34	0.04
USTs		1	0.91	0.29	0.84	-0.19	0.44	0.54	0.06
US HG Credit			1	0.43	0.87	-0.05	0.37	0.44	0.07
EM Local				1	0.46	0.36	0.32	0.19	-0.07
TIPS					1	0.04	0.38	0.40	0.07
Commodities						1	0.22	-0.01	-0.06
Gold							1	0.54	-0.03
Yen cash								1	-0.06
Bitcoin									1

Past year	S&P 500	USTs	US HG Credit	EM Local	TIPS	Commodities	Gold	Yen cash	Bitcoin
S&P 500	1	-0.10	0.04	0.22	-0.03	0.08	-0.01	-0.09	0.29
USTs		1	0.94	0.36	0.88	0.08	0.62	0.62	0.21
US HG Credit			1	0.36	0.83	0.15	0.54	0.54	0.23
EM Local				1	0.36	0.15	0.52	0.53	-0.10
TIPS					1	0.27	0.69	0.54	0.17
Commodities						1	0.46	0.19	-0.07
Gold							1	0.73	0.01
Yen cash								1	-0.04
Bitcoin									1

Source: J.P. Morgan, Bloomberg

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Given high absolute returns over the medium term and low co-movement with other markets, it is unsurprising that a modest allocation to bitcoin over the past several years would have improved portfolio efficiency on average for a hypothetical multi-asset portfolio. Figure 12 plots the risk-adjusted returns for a standard 60% equities/40% fixed income portfolio (red line) in which the fixed income portion is further allocated 20% to Treasuries, 15% to US high-grade credit and 5% to EM local currency debt. That portfolio generated a positive return-to-risk in the majority of quarters, with a ratio of 1.4 over the past five years and 2.4 over the past year. The portfolio's period of greatest drawdown was mid-2015 to early 2016, when a combination of China-related shocks (CNY devaluation), oil oversupply and an EM credit slowdown weakened US corporate profits growth, thus generating negative returns on the US equity, high-grade credit and EM local markets allocations of this portfolio (Figure 12).

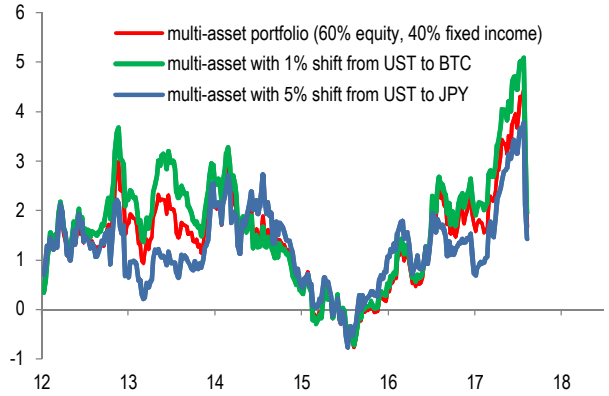
Replacing 1% of the Treasury allocation with Bitcoin generates only somewhat-encouraging results. The good news is that a modest 1% switch (so in notional terms, $10,000 for a millionaire hedging an individual portfolio or $1bn for a portfolio manager overseeing a $100bn institutional fund) would have raised risk-adjusted returns over the medium-term. Compared to the baseline portfolio, return-to-risk rises from 1.4 to 1.7 over the past five years, and from 2.4 to 2.8 over the past year. By comparison, a similar 1% allocation to any of the more traditional hedge instruments (gold, commodities, TIPS) would not have altered portfolio efficiency materially. The results are similar for 5% or even 10% switches from Treasuries to traditional hedges: none of these strategies improve portfolio efficiency significantly compared to a 1% allocation to a cryptocurrency.

There's usually a catch

The bad news is two-fold. First, including Bitcoin in a multi-asset portfolio did not prevent portfolio drawdown from mid-2015 to early 2016 when US stocks and EM local markets were falling, since Bitcoin itself was mostly range-bound over this period. Nor did cryptocurrencies offset portfolio losses during periods of acute market stress like the equity flash crashes of August 2015 (S&P500 -11% in a week, BTC -12%) and February 2018 (S&P500 -8% in a week, BTC -45%). A modest allocation to yen (moving 5% from Treasuries into yen cash) did outperform the benchmark portfolio, however, given that currency's more consistently negative correlation with equities and positive correlation with equity volatility.

Figure 12: On average, a 1% switch from Treasuries to BTC improves portfolio efficiency over a multi-year horizon, but it has not mitigated drawdown during major equity market declines like summer 2015 and early 2018

Rolling return-to-risk on a hypothetical portfolio comprising 60% US stocks (S&P500), 20% US Treasuries, 15% US high-grade credit and 5% EM local market bonds, vs two hypothetical portfolios that replace 1% of Treasuries with bitcoin and 5% of Treasuries with yen.



Source: J.P. Morgan

Second, even a 1% allocation into cryptocurrencies may prove difficult for large, institutional investors attempting to operate in relatively small markets like cryptocurrencies, where lack of government sponsorship for any of these as legal tender – the currency which all market participants must accept to settle debts – may always limit scale (see *The audacity of bitcoin* for a fuller discussion of how this legal tender issue should always render non-government currencies like gold or cryptocurrencies inferior as money, even if they might serve other transactional or investment purposes). Even after their meteoric rise in value over the past year, the total market capitalization of cryptocurrencies of around $400bn currently (and a $150bn average over the past year) is quite modest compared to that of more traditional hedges in fixed income, commodities or government-issued currencies like the yen (Figure 13).

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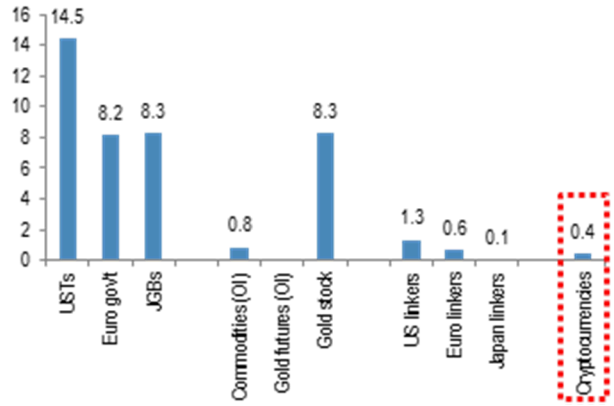
The longer-term issue around asset allocation is whether the risk-return characteristics exhibited over the past five years will be of any relevance as and when cryptocurrency markets evolve. One lesson from both major regime changes (think the collapse of the Bretton Woods system of fixed exchange rates in the 1970s) and technological change (think the dot-com era of the 1990s), is that the first few years of the brave new world often deliver extraordinary returns as part of the price-discovery process (Figure 14). But those first four to five years are often followed by several years of mean-reversion towards the eventual, long-term average level. So even if cryptocurrencies represent as much the future of finance as they could represent a financial market bubble (like technology stocks 20 years ago), the possibility of mean reversion in coming years could detract from portfolio efficiency through the return angle. Thus, based on the above, investors are probably best served by hedging their bets — we believe that any allocation to cryptocurrencies as insurance should not be a portfolio's only hedge.

Figure 13: Lack of legal tender status may always constrain cryptocurrency liquidity compared to traditional portfolio hedges

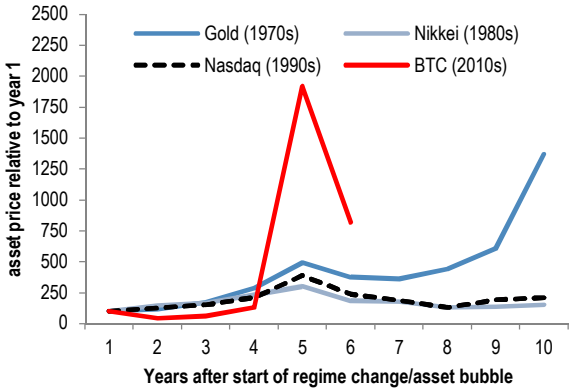
Value of outstandings in traditional portfolio hedges in $ trillions. Measures used are: for bonds, outstanding nominal and inflation-linked bonds for US, Euro area and Japan; for commodities, open interest across commodities futures curve for a commodity index (JPMCCI) and gold, and value of aboveground gold stock; and for cryptocurrencies, market capitalization of Bitcoin, Ripple and Ethereum.



Source: J.P. Morgan

Figure 14: Bubble or the future of finance?

Asset values indexed to 100 in year one of regime change, chosen as 1971 for gold, 1986 for Nikkei, 1995 for Nasdaq and 2013 for Bitcoin.



Source: J.P. Morgan

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The regulation of cryptocurrencies

- **The Fed, the ECB, and other macroprudential regulators view cryptocurrency (CC) markets to be in only nascent stages, with minimal implications for systemic risk, and thus have not yet taken a stance on the regulation of the asset class**
- **Meanwhile, global securities regulators have begun to lay ground rules, in many cases subjecting CC-related businesses and initial coin offerings (ICOs) to existing securities laws, requiring registration or authorization, and promoting investor protection**
- **To date, these have been piecemeal efforts, with various nations staking independent regulatory positions, and there has been little global coordination on cryptocurrency regulation. We review the actions that regulators in various jurisdictions have taken to limit the risks associated with cryptocurrencies**
- **The anonymity among the exchange of cryptocurrencies presents a challenge for regulators attempting to limit money laundering and terrorist-financing activities. To comply with existing law, while also taking advantage of the benefits that Blockchain-based technology present for modern payment systems, some financial institutions have created private Blockchain networks…**
- **…further, the EU has recently amended its Anti-Money Laundering Directive to extend its scope to providers of exchange services between fiat (legal tender issued by a central bank) currencies and virtual currencies as well as to custodian wallet providers. We could see other global regulators take a similar approach in the future**

Historically, there has been a natural delay between the emergence of new financial technologies, the broad adoption among market participants, and ultimately, the regulation of those technologies. This was the case a decade ago with the global financial crisis (GFC) with securitization and other maturity and credit transformation methods. Some of these technologies had been successfully used across markets for over a decade before the GFC, and their use became systemic in part due to their inclusion in Basel II risk-based capital standards for banks. Importantly, while prudential regulators understood there were risks before the GFC, their oversight failed to evolve ahead of, or along with the risks.

As cryptocurrencies evolve, we believe there are lessons to be learned from the GFC experience about regulation of emerging financial technologies and avoiding the development of systemic risks. Relative to the problems that led to the GFC, the adoption of cryptocurrencies is nascent and their use is far from systemic. The US Financial Stability Oversight Council (FSOC), through which 10 US regulatory agencies, as well as US Treasury collaborate to identify emerging financial stability risks, acknowledged Bitcoin and distributed ledger technologies in their 2016 and 2017 annual reports but generally found that risks were low, since "virtual currencies are only used by a very small number of consumers."[4] Similarly, Fed Chair Jerome Powell, testified during his confirmation hearing before the Senate Banking Committee that cryptocurrencies "don't really matter today; they're just not big enough." The **ECB's** Mario Draghi has made similar statements regarding the current level of risks.[5] However, this may not be the case in five to ten years if cryptocurrency use continues to expand at a rapid pace. Because of the GFC, the power and market presence of prudential regulators across developed markets have grown, and their approach to risk is far more proactive. As a consequence, it seems unlikely risk posed by cryptocurrencies will be permitted to rise to a systemic level.

Despite the early stage of cryptocurrency adoption, **regulators** globally have begun to set ground rules. Early responses by regulators have largely focused on avoiding criminal behavior, limiting the use in money laundering, and promoting investor protection. However, these are piecemeal efforts, with various nations staking independent regulatory positions in anticipation of or response to particular developments. So far, there is little global coordination on cybercurrency regulation. While some countries have banned the use of cryptocurrencies, many others permit transactions for goods and services between private parties, and have moved to collect taxes on such transactions. Still, even in countries where private transactions are allowed, banks and financial institutions may be restricted from trading. In nations open to cryptocurrency use, scrutiny of trading has been escalating, and the recent launch of US-based futures contracts tied to Bitcoin has elevated the regulatory

[4] https://www.treasury.gov/initiatives/fsoc/studies-reports/Documents/FSOC_2017_Annual_Report.pdf
[5] https://www.cnbc.com/2017/10/19/cryptocurrencies-are-not-mature-enough-ecb-chief-mario-draghi.html

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focus. Finally, in most cases, the regulatory response to the evolution of Blockchain and related technologies use in payments has been constructive in part because the adoption of these technologies has been championed by established financial institutions.

A survey of regulation so far

The US experience with regulation of cryptocurrencies demonstrates many of the issues facing regulators globally. The first challenge is defining the asset class, given the broad number of regulators and the different markets that their mandates cover. To date, the SEC and CFTC have issued Regulatory Orders on the basis that the assets fall into the categories of *securities* and *commodities*, respectively, and thus subjecting various cryptocurrency-related activities to existing securities and commodities regulations. While cryptocurrencies remain largely unregulated in the US, we note these actions represent steps toward investor protection and market oversight (Table 3).

Table 3: While cryptocurrencies remain largely unregulated in the US, a number of agencies have taken action to protect investors, and other jurisdictions have gone as far as banning the trading of cryptocurrencies

Summary of various regulatory actions and statements regarding cryptocurrencies

Agency	Date	Action
CFTC	9/17/15	CFTC issues settlement order against trading platforms listing Bitcoin options, clarifying the CEA's definition of "commodity"
SEC	7/25/17	SEC releases investigative report declaring that the tokens issued by the DAO are securities under the Securities Exchange Act
	9/11/17	SEC states that issuers of an ICO must demonstrate that the product is not a security or comply with applicable securities laws
FINRA	12/21/17	FINRA warns investors to be aware of stock scams when considering the purchase of shares of companies that tout high returns associated with cryptocurrencies
Federal Reserve	11/30/17	Quarles speaks on innovation in the payment system and acknowledges challenges around the treatment and definition of cryptocurrencies as well as the benefits from innovation for the future of the payment system
FinCEN	3/18/13	FinCEN issues guidance considering the use of virtual currencies from the perspective of categories within the definition of money service businesses, MSBs
NY State DFS	6/24/15	NY DFS issues final rules which require a license from the superintendent in order to engage in any virtual currency business activity
EP/ European Council	12/20/17	EP/EC release compromise text amending 4th AMLD to incorporate virtual currency exchanges and custodian wallet providers
ESMA	11/13/17	ESMA alerts investors of the risks of ICOs and alerts firms involved in ICOs to the need to meet regulatory requirements
BaFin	4/28/16	BaFin states virtual currencies qualify as financial instruments and thus, a commercial handling may trigger authorization requirements
	11/15/17	BaFin warns consumers of risks around ICOs and states that it decides on a case-by-case basis whether the offeror is required to obtain authorization under KWG
Swiss FINMA	9/29/17	FINMA issues Guidance 04/2017 that states, depending on how an ICO is structured, some parts may be covered by existing regulations; States it will investigate a number of ICO cases to determine whether provisions were breached
French AMF	11/19/17	AMF launches public consultation on ICOs; regulations expected following analysis of information gathered from consultation
UK FCA	4/1/17	The FCA issues a consultation on distributed ledger technology
	12/1/17	The FCA issues consumer warning about the risks of investing in cryptocurrencies
Canadian CSA	8/24/17	CSA issues statement that businesses should consider if prospectus, registration and/or marketplace requirements apply to their cryptocurrency offerings
Japan	8/25/16	Payment Services Act recognizes CC as a means of payment that is not a legal currency. Banking Act prohibits banks and securities companies from dealing in CC.
China PBOC	12/5/13	Private party transactions permitted, but financial institutions are prohibited from transacting
Taiwan	11/13/15	Financial Supervisory Commission indicates its stance on Bitcoin remains neutral
South Korea	9/29/17	Financial Services Commission bans ICOs
	1/23/18	The FSC says existing anonymous virtual accounts will be banned; cryptocurrency exchanges must provide customers' information
Singapore	10/2/17	MAS states that virtual currencies are not legal tender; MAS is working on a new payment services regulatory framework that will address money-laundering risks; states that ICOs must comply with existing securities laws
Indonesia	1/13/18	Bank Indonesia states cryptocurrencies are not a legitimate instrument of payment and prohibits payment system operators from making CC transactions

Source: CFTC, SEC, FINRA, Federal Reserve, FinCEN, NY State DFS, European Council, ESMA, BaFIN, FINMA, AMF, FCA, CSA, MAS, BI, Coindesk

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The hack of the **DAO**, or Distributed Autonomous Organization, in June 2016, exposed a flaw in the trading of CCs using Blockchain technology, as the attacker was able to exploit a bug in the code and steal coins valued at $55mn and prompted securities regulators to focus their attention on these new technologies and the associated cybersecurity risks. In response, the **SEC** issued a report in July 2017, which stated that tokens offered and sold by the DAO were securities, and therefore, subject to the federal securities laws since they fit the definition of an investment contract. "An investment contract is an investment of money in a common enterprise with a reasonable expectation of profits to be derived from the entrepreneurial or managerial efforts of others."[6] Thus, issuers of distributed ledger or Blockchain-based securities must register offers and sales of such securities unless a valid exemption applies. Since then, the SEC has halted certain ICOs, or initial coin offerings, from companies that have failed to register, citing concerns over investor protection.[7] Similarly, FINRA issued an investor alert in December, warning investors against "cryptocurrency-related stock scams."[8]

The **CFTC**, with oversight over futures, options, and derivatives contracts, has also taken action to bring the trading of CCs under its regulatory scope. In 2015, it declared that three companies engaged in the trading of Bitcoin futures and options had violated the Commodity Exchange Act, since they were not registered with the Commission. Early January, after facing criticism around the Agency's oversight of CCs and the recent launch of Bitcoin futures, CFTC Chairman Christopher Giancarlo released a statement on virtual currencies, outlining the approach the agency has taken and advising investors of the various risks associated with virtual currencies.[9] The chairmen of the CFTC and SEC are scheduled to testify in front of the Senate Banking Committee later this month.

The chairmen of the CFTC and SEC testified in front of the Senate Banking Committee on February 6.[10] Both the CFTC and SEC, along with other agencies, are participating in an interagency working group of financial regulators, led by Treasury Secretary Steven Mnuchin that is looking at virtual currencies. However, it's not clear whether the group has enough regulatory authority to handle issues within the sector, and further legislation may be needed to adequately regulate CCs. While CFTC Chairman Giancarlo recommended a "do no harm" approach for distributed ledger technology, he said that virtual currencies "likely require more attentive regulatory oversight in key areas, especially to the extent that retail investors are attracted to this space."

Outside the US, **European** market regulators have taken actions similar to their US counterparts. The **European Securities and Markets Authority** (ESMA) issued a statement in November alerting investors of the risks of ICOs and alerting firms involved in ICOs to the need to meet regulatory requirements. Among EU member states, various authorities have also taken specific action (Table 3). In Germany, **BaFin** has classified all virtual currencies (VC) as financial instruments, and thus, "a commercial handling of the VCs may trigger the authorization requirement" under the Banking Act, Kreditwesengesetz (KWG).[11] **Switzerland** has been a hub for cryptocurrency activity and ICO issuance, and its regulator **FINMA** released a statement in September stating that, depending on how an ICO is structured, some parts may be covered by existing regulations. In **France**, the financial regulator AMP released a public consultation in November and stated that it expects to release regulations on ICOs after analysis of the information gathered from consultation is complete. While the **UK FCA** has not stated whether existing securities and/or banking regulations apply to the cryptocurrency activities, it issued a consultation on distributed ledger technology last April, and more recently released a warning to investors about the risks around CCs.

In Asia, there has been strong interest in CC and in some cases active markets have developed. In several countries, Bitcoin and other CCs are approved as a means of payment for goods and services, but existing regulations restrict banks from trading or dealing. For example, the People's Republic of China (PBOC) has been active in CC regulation for several years. The PBOC has made it clear that CC is only a virtual commodity and not legal tender. This was highlighted in a "Notice on Risk Prevention related to Bitcoin" released by the PBOC back in December 2013. Importantly, all financial institutions and payment providers are forbidden to provide services for or products denominated in Bitcoin. The Notice was mainly regarding regulation on Bitcoin, but in our view, what PBOC actually referred to is not only limited to Bitcoin,

[6] https://www.sec.gov/litigation/investreport/34-81207.pdf
[7] https://www.sec.gov/news/public-statement/statement-clayton-2017-12-11
[8] http://www.finra.org/newsroom/2017/finra-warns-investors-dont-fall-cryptocurrency-related-stock-scams
[9] http://www.cftc.gov/idc/groups/public/@newsroom/documents/file/backgrounder_virtualcurrency01.pdf
[10] https://www.banking.senate.gov/public/index.cfm/hearings?ID=D8EC44B1-F141-4778-A042-584E0F3B9D39
[11] https://www.bafin.de/EN/Aufsicht/FinTech/VirtualCurrency/virtual_currency_node_en.html

but all CC. With such a clear stance, we believe China's financial institutions' involvement in CC will be very limited (see "Cryptos in China" in this report).

While most CC regulation to date has been driven by national regulators, international regulatory bodies appear to be increasing their involvement. CFTC Chair Giancarlo noted in his Senate testimony that the Commission is in communication with overseas regulatory counterparts through bilateral discussions and in meetings of the Financial Stability Board (FSB) and the International Organization of Securities Commissions (IOSCO).

Additionally, the Bank for International Settlements (BIS) may be preparing to advance coordination of regulatory efforts by central banks globally. In a recent speech, Agustín Carstens, BIS General Manager, urged central banks and financial authorities to pay particular attention to the ties linking CCs to real currencies and ensure that they do not undermine the institutional infrastructure of the wider financial system. To ensure a level playing field for all participants in financial markets, access to legitimate banking and payment services should be limited to those exchanges and products that meet accepted high standards globally. "This means 'same risk, same regulation'. And no exceptions allowed," said Carstens.[12]

Other regulatory considerations

What are the regulatory challenges faced by institutions that prevent the broad adoption of CCs and their underlying technologies? On the one hand, Bitcoin and other similar tokens trade using a decentralized, distributed ledger known as the Blockchain, in which the identity of a participant is not known to the rest of the network, therefore, making it challenging for banks to comply with anti-money laundering requirements. However, many US banking firms, including J.P. Morgan, have been working toward building Blockchain-based applications for use among their businesses, adapted in a way such that access is permissioned and there is sufficient transparency on users and counterparties. For example, in October 2017, J.P. Morgan launched Quorum, an interbank payments platform, in partnership with two other banks. Quorum is an implementation of the Ethereum codebase, which allows for the use of smart contracts, in an institutional setting. Importantly, the system preserves confidentiality, while also allowing regulators and accountants the ability to audit the transactions. Further, as its website states, "Quorum supports Blockchain transactions among a permissioned group of known participants."[13] (For other examples, see "Banks: Involvement in Blockchain & CCs" in this report.)[14] Still, as banking institutions attempt to transition legacy systems onto Blockchain technology, they must do so in accordance with existing regulatory and legal frameworks.

The **challenge of anonymity** among the exchange of CCs on public Blockchains is something that the EU recently has tried to address. On December 20, the European Parliament and European Council agreed to an amendment to its 4th Anti-Money Laundering Directive that extends its scope to providers of exchange services between fiat currencies and virtual currencies as well as to custodian wallet providers. Still, the compromise text acknowledges that this change still will not address the issue of anonymity attached to virtual currency transactions. "To combat the risks related to the anonymity, national Financial Intelligence Units (FIUs) should be able to obtain information allowing them to associate virtual currency addresses to the identity of the owner of virtual currencies." More recently, the Financial Services Commission of South Korea said that existing anonymous virtual accounts would be banned and that cryptocurrency exchanges must be able to verify customers' identification. Should these steps prove successful at increasing the transparency around the cryptocurrency marketplace, we could see US regulators take a similar approach in the future.

With respect to emerging risks, it is worth considering how the concentration of CC activity could migrate as various jurisdictions increase their regulatory scrutiny. We have primarily focused on the regulatory actions taken by DM authorities. Just as the growth of shadow banking emerged as prudential regulators have limited the ability of banks to compete in various markets, EM economies may see increased growth in the use of CCs as a cheaper, more secure form of monetary transactions compared to central-bank issued fiat currencies (see "EM: troubled by the anonymity of cryptocurrency" in this report). To the extent that global trading of CCs is performed out of businesses based in jurisdictions with a lighter regulatory touch, this could potentially present a destabilizing source of systemic risk.

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[12] https://www.bis.org/press/p180206.htm

[13] https://www.jpmorgan.com/country/US/en/Quorum#close

[14] Some regulators are encouraging the adoption of Blockchain technologies. The UK FCA launched a regulatory "sandbox" in 2015, allowing businesses to test innovative products and services. https://www.fca.org.uk/firms/regulatory-sandbox

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Who uses cryptocurrencies and what for?

- **The market capitalization of cryptocurrencies has increased significantly over the past year, to around $400bn currently, or around one-quarter of the amount of gold held as a store of wealth**
- **The market remains dominated by individual investors, though recent developments such as the listing of Bitcoin futures have aimed to broaden its appeal among institutional investors even if volumes remain modest thus far**
- **Geographical dispersion of activity has been broadening, and acceptance among businesses has gradually risen**
- **The use of Bitcoin for illicit purposes has likely declined amid an increased awareness of limitations to the anonymity it provides, greater scrutiny by government agencies, the development of Blockchain analysis tools, and their growing use for investment and speculative purposes**

Ownership is highly concentrated

The ownership of the cryptocurrency market is very concentrated as early miners typically hold the majority of the outstanding stock. Estimating the total number of cryptocurrency holders, however, is difficult given the pseudonymous[15] nature of transactions and the fact that each individual can use a number of wallet and exchange accounts, and thus multiple addresses. That said, the concentration is clearly evident in the distribution of Bitcoin addresses as shown in Table 4, with addresses holding a balance of more than one Bitcoin accounting for just 2.5% of total addresses, but more than 95% of Bitcoin in circulation. A concentrated ownership structure is not unusual or surprising, however. In fact it is typical for a new asset class such as cryptocurrencies.

Activity is dominated by individual investors

The trading in cryptocurrencies has been dominated by individual investors who have flocked into Bitcoin and other cryptocurrencies over the past years mostly for speculative purposes. Indeed, estimates by a 2016 report by ARK Invest and Coinbase suggested that in 2013-2016 more than half of Coinbase users used Bitcoin strictly as an investment rather than for transactional purposes[16]. Similarly, a survey by LendEDU[17] suggested just over half of respondents invested in Bitcoin as a store of value or speculative purposes, around 40% because they believed it was a world changing technology, and less than 10% planned on using it for transactions or to make purchases.

Table 4: Proportion of addresses and of total Bitcoin held by Bitcoin balance

%

Balance (Bitcoins)	% of total addresses	% of total coins
0 - 0.001	55.3%	0.0%
0.001 - 0.01	20.4%	0.1%
0.01 - 0.1	15.6%	0.8%
0.1 - 1	6.2%	3.3%
1-10	2.0%	8.6%
10 - 100	0.5%	26.0%
100 - 1,000	0.1%	21.9%
1,000 - 10,000	0.0%	19.9%
10,000 - 100,000	0.0%	16.7%
100,000 - 1,000,000	0.0%	2.7%

Source: BitInfoCharts

Moreover, transaction sizes remain relatively modest. Data from Bitinfocharts suggest that median daily transaction sizes have typically been well below $500 before 2H17, only rising to a peak of just over $5,000 in mid-December and early January following marked price appreciation, before declining back to around $1,000 in recent days. At the same time, the number of active addresses on the Bitcoin Blockchain rose steadily from 100K at the beginning of 2014 to 500K-700K for much of 2017.

Geographical dispersion is broadening

Estimating the geographical dispersion of where cryptocurrencies are used and where usage is highest is challenging. Data compiled by CoinATMRadar on the location of cryptocurrency ATMs machines—which allow users to buy and sell cryptocurrencies for cash—suggest that at the time of writing this note some three-quarters of ATMs are located in North America, followed by 20% in Europe and just over 2% in Asia.

Another way to look at geographical dispersion is to look at the proportion of trading by currency. Data from BitCoinity suggest that when looking at volumes of trading Bitcoin versus traditional fiat currencies, the US

[15] Transaction details are displayed on a public ledger, but users' identities are hidden behind their bitcoin addresses.

[16] https://research.ark-invest.com/bitcoin-asset-class
[17] https://lendedu.com/blog/investing-in-bitcoin

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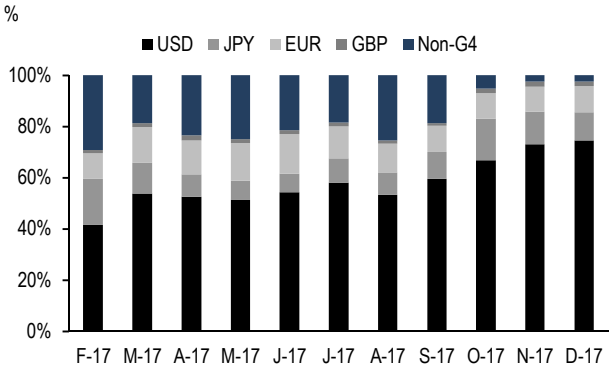
dollar appears to account for the largest share currently, followed by JPY and EUR (Figure 15). But the currency of trading does not necessarily conform to the location of trading. Indeed, the dollar appears to be the dominant currency throughout the day, while the peaks suggest activity tends to concentrate around Asian trading hours and the overlap of European and US hours (Figure 16).

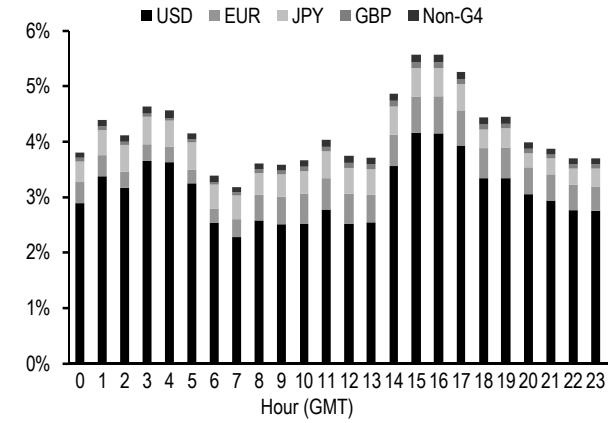
What about liquidity across different currencies? Looking at the average bid-ask spreads to buy Bitcoin across a large number of exchanges, it appears that JPY has offered the tightest bid-offer spreads over the past month (Figure 17) followed by USD. By contrast, EUR appears to offer a wider spread, and while the bid-offer spreads in JPY and USD have declined steadily over the past year they have widened in EUR.

Figure 15: Share of monthly volume across all exchanges by currency pair (in units of BTC)



Source: Bitcoinity.org

Figure 16: Share of hourly volume over the past 30d by pair (in units of Bitcoin)

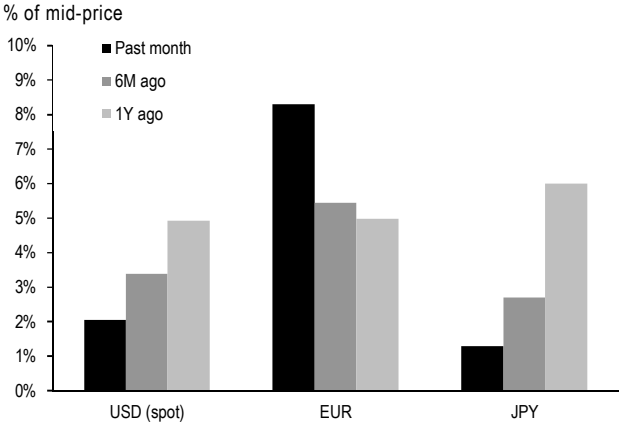


Source: Bitcoinity.org

This would seem to suggest that the degree of activity in Asia is somewhat underrepresented in the above figures. Indeed, volume of activity by exchange quoted on coinmarketcap.com regularly lists Asian exchanges such as Binance, Bithumb and Upbit among largest by total volumes over the previous 24 hours, though the former does not include trading cryptocurrencies vs. traditional currencies. That said, individuals can use different exchanges around the world, meaning that the location of the exchange does not necessarily correspond with the locations of those executing trades.

The number of businesses accepting Bitcoin or other cryptocurrencies in exchange for goods or services is also growing. Data from coinmap.org and usebitcoins.info show that thousands of businesses, including major companies, allow the use of cryptocurrencies in exchange for goods or services. Coinmap.org, which shows the location of more than 11,700 known venues that accept cryptocurrencies around the world, suggests a significant concentration of venues in North America and Europe, along with some countries in the Asia Pacific (particularly Japan and South Korea) and South American regions.

Figure 17: 1M average bid/ask spread to buy 10 BTC



Source: Bitcoinity.org

Participation by financial institutions remains modest

As mentioned above, a significant portion of individual investors hold cryptocurrencies as a store of wealth. The total market cap of cryptocurrencies was around $400bn (Figure 18), around a quarter of that of gold as store of wealth (gold bars, coins and physical gold ETFs all together amount to $1.5tr). And monthly trading volumes of the three largest cryptocurrencies by market capitalization (Bitcoin, Ethereum and Ripple) have increased sharply in recent months, from around $5bn in early 2017 to $550bn in December. This represents around half of the monthly trading volume of gold futures of $1.1trn as of January18 aggregate volumes were higher, reaching around $680bn.

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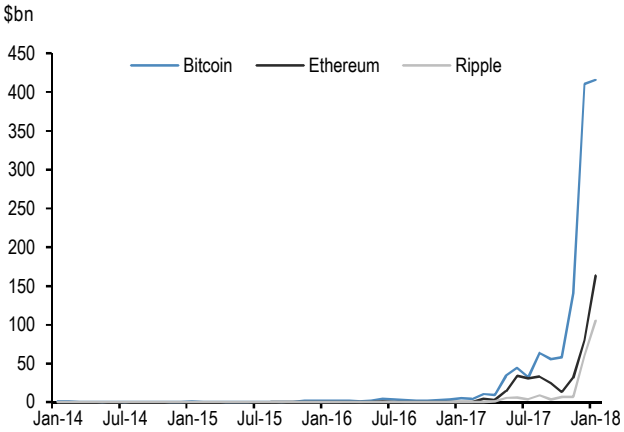
Figure 18: Monthly trading volumes in the three largest cryptocurrencies by market capitalization



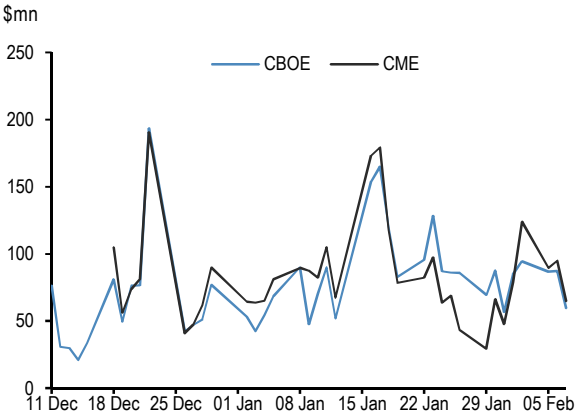
Source: Coinmarketcap

Few institutional investors, mostly hedge funds, have entered cryptocurrency markets, however. Almost 100 funds focused on digital assets like Bitcoin were launched last year, bringing the total number of such "crypto-funds" to 175, according to financial research firm Autonomous Next. Total assets under management by "crypto-funds" now stand at $3bn-$4bn, again according to Autonomous Next.

These hedge funds are not necessarily long CCs and are more keen to exploit price differences and arbitrage opportunities across various cryptocurrencies. In fact hedge funds used the newly launched Bitcoin futures by CME and CBOE to go short Bitcoin. CFTC data confirm that speculative or non-commercial category in Bitcoin futures has maintained short positions of more than 30% of open interest since the CBOE futures were launched.

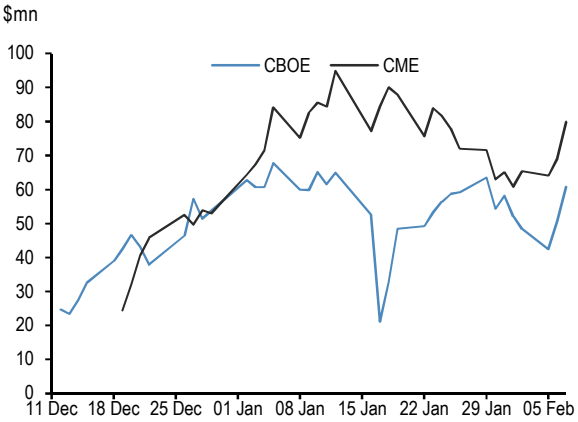
Since the futures contracts were listed by the CBOE and CME (on December 10 and 17, respectively), daily trading volumes on both exchanges initially spiked to nearly $200mn on December 22 when Bitcoin prices experienced sharp swings (Figure 19). Similarly, Jan 16 saw significant price swings following the closure of cryptocurrency lending and exchange platform BitConnect with volumes again rising sharply to around $175mn. Between these two peaks of activity, and again after the more recent one, volumes settled around an average of around $70mn per day on each exchange. Futures trading volumes thus remain very modest compared to average Bitcoin trading volumes of around $13bn per day since the futures contracts were listed. While open interest in both the CBOE and CME contracts has risen steadily, it too remains rather modest at around $60mn and $70mn respectively (Figure 20). The sharp decline in open interest on the CBOE in mid-January is more likely to be related to the expiry of the front contract on January 17th rather than the sell-off in cryptocurrencies on the previous day.

Figure 19: Aggregate daily volumes across Bitcoin futures contracts



Source: Bloomberg, J.P. Morgan

Figure 20: Aggregate open interest across Bitcoin futures contracts



Source: Bloomberg, J.P. Morgan

Relative use of Bitcoin for illicit purposes has likely declined

Given the apparently anonymous nature of Bitcoin transactions, there has been a popular perception that its use has been biased towards so called 'dark markets'. However, the privacy afforded by Bitcoin is not absolute, as transaction details are displayed on a public ledger even if the identities are hidden behind Bitcoin addresses.

It is this link between Bitcoin addresses and individuals that various government agencies have sought to establish. For example, in late 2017 a California Federal court ordered Coinbase, a major provider of cryptocurrency wallet accounts, to hand over to the US

Internal Revenue Service the identifying records of individuals who have transacted more than $20,000 through their accounts in a single year between 2013 and 2015. In mid-2017 law enforcement agencies in the US and EU closed two of the largest "dark web" markets, AlphaBay and Hansa. Separately, a group of academics from Princeton have also showed that third-party web trackers used on most shopping websites can be used to de-anonymize users of cryptocurrencies[18].

Partly as a result of developments such as the above, an increased awareness of limitations to anonymity afforded by Bitcoin, and the development of Blockchain analysis tools such as BlockSci[19] mean that the use of Bitcoin for illicit purposes has likely declined. For example, the co-founder Blockchain Intelligence Group provided estimates to CNBC suggesting that the share of illicit transactions have declined significantly in 2017, down from a 20% share in 2016 and from around 50% in earlier years. Similarly, a recent academic paper argued that around half of bitcoin transactions over time have been associated with illegal activities, but that this share has declined to around 20% by end 2016/early 2017[20].

Competition between cryptocurrencies looks set to intensify

The cryptocurrency space encompasses well over a thousand different cryptocurrencies, each with different characteristics and serving different functions. Given the number of cryptocurrencies, varying designs and rapid pace of innovation, competition among them looks set to intensify. Those that survive are likely to enjoy a competitive advantage, e.g. a first-mover advantage in gaining broad acceptance, a niche role that serves a function better than alternatives, or a broader ecosystem that maintains a balance between adaptability to different tasks and efficiency in performing them.

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[18] https://arxiv.org/pdf/1708.04748.pdf
[19] https://arxiv.org/pdf/1709.02489.pdf
[20] *Sex, Drugs and Bitcoin: How much illegal activity is financed through cryptocurrencies?*, S. Foley et al, Jan 2018, Figure 5.B, p. 55

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Banks' involvement in Blockchain and CCs

- **Opportunities for Banks to utilize Blockchain technologies for conducting business could have far-reaching implications for the sector in our view. On the other hand, we view the opportunity set around direct crypto-currency trading as relatively limited for banks**
- **Areas where banks are identifying potentially transformational change include payments, clearing, settlement, KYC and AML processes and Trade Finance amongst others**
- **We look at a growing list of new Blockchain based systems including Ripple, which aims to facilitate cross border payments between Global banks in seconds compared to days for traditional systems, at lower cost**

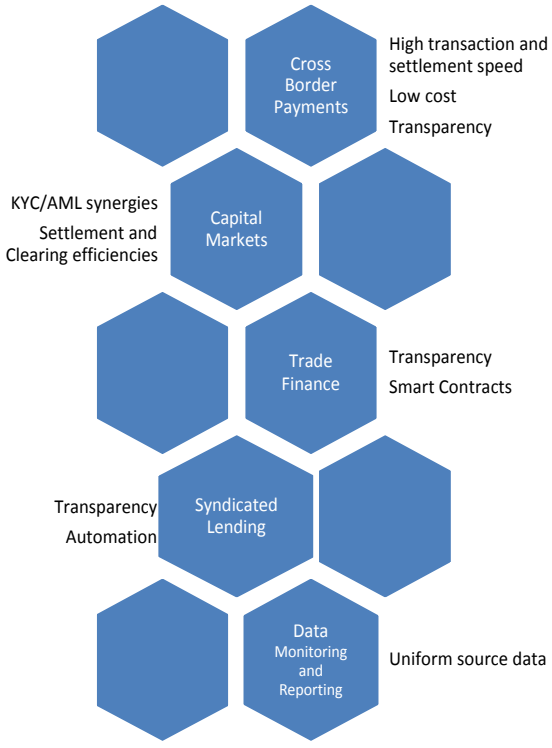
Although banks across the globe have had limited direct involvement in Bitcoin or other Crypto currencies, the industry has been very active in pursuing initiatives around Blockchain technology that underpins Bitcoin. The opportunities for Banks to utilize evolving Blockchain technologies as a cost efficient means of conducting business could have far-reaching implications in our view, over the long term. On the other hand, we view the opportunity set around direct crypto-currency trading as relatively limited, not least due to regulatory concerns around Anti-Money laundering and "Know Your Customer" (KYC) regulation. In this section, we discuss areas within Banking that could see significant change as a result of initiatives around Blockchain applications and look at the case of Ripple, which has the potential to disrupt cross border payments processing across the industry globally.

Banking on the Blockchain

In our view, if widespread adoption of Blockchain technology were to ensue (encouraged by regulators), bank costs have the potential to fall materially in certain back and middle office processes which could result in large cost efficiency gains for early-adopters. This type of cost reduction also has the potential to crystallize market share gains if reflected in competitive asset pricing by early adopters. In the medium to long term, business models are likely to need to evolve around the cost benefits of technology, including distributed ledgers in order to keep up with competition from existing banks and fintech pioneers. *A 2017 Accenture report 'Banking on Blockchain' based on detailed McLagen data for Investment Bank costs estimated a c.30% potential annual saving in costs for the largest investment banks, which includes a 70% reduction on central financial reporting, a 50% reduction on centralized processes such as client on-boarding, and a 50% reduction on business operations such as trade support.*

Regulatory support for Blockchain: Importantly, there is also support from regulatory authorities for such technological progress which should encourage investment and participation from banks. We highlight Mark Carney's (Chair of the Financial Stability Board and Governor of the Bank of England) comments around Blockchain: "*New technologies could transform wholesale payments, clearing and settlement. In particular, distributed ledger technology could yield significant gains in the accuracy, efficiency and security of such processes, saving tens of billions of pounds of bank capital and significantly improving the resilience of the system.*" Similar conclusions have been made by the European Central Bank, Bank of Japan and U.S. Federal Reserve.

Figure 21: Areas for transformation



Source: J.P. Morgan

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Areas of potential application: We have identified the following business areas within Banking that in our view would see significant change from the adoption of Blockchain technology:

Cross Border Payments

Global payments account for a significant proportion of banking revenues that pass through incumbent banks and long-established networks. At present, large payments or remittances are affected by three main accounts which are interlinked:

High transaction and settlement speed: The average time taken to complete a cross-border payment is around 5 days, with some payments taking multiple weeks to settle. The complex path of cross-border payments through multiple intermediaries can produce cumulative knock on delays at each stage. This results in institutions including banks, holding unnecessary capital while waiting for transfers to settle which could otherwise be invested elsewhere.

Blockchain technology can allow for an almost real-time transfer of funds through a decentralized network, thereby removing the need to go through any intermediary at all. Ripple is one example of such an enabler. The settlement times for Blockchain based systems can be as quick as 4 seconds compared to traditional banking systems of 3 to 5 days.

Low cost: Cross-border payments incur fees of approximately 3% but can vary depending on the size and currency of the transaction. Further, foreign exchange fees are often non-fixated until the settlement of funds, leaving parties exposed to unintended FX risks. Blockchain and digital assets remove the need for intermediaries and therefore reduce a large proportion of fees due and allow for more FX certainty due to the speed of transaction.

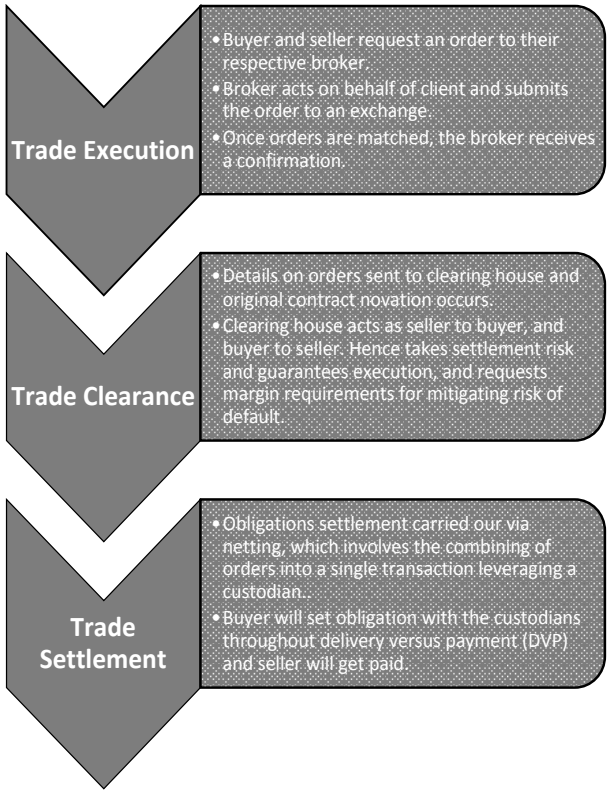
Transparency: Traditional cross-border payment processes pass through multiple intermediaries, often to the detriment of transacting parties who lack the clarity on timelines and costs of settlement. These systems use a one-way messaging system in comparison to some Blockchain technologies that use a two-way messaging system—allowing for relevant information (such as KYC and fees) to be transferred and reconciled before payments are made. This reduces the likelihood of failure and allows transactions to be monitored while in transit. The transparency of Blockchain technologies allows for transactions to occur tamper-free with a reduced fraud risk.

As well as the fintech pioneers such as Ripple, Ethereum, and Hyperledger, commercial banks are developing their own payment settlement solutions such as UBS' Utility Settlement Coin, which is collateralized by fiat funds in a central bank.

Capital Markets

Within the Capital Markets space, we note there could be a number of potential benefits stemming from Blockchain application. For the exchanges sector for example, Blockchain appears to have the greatest potential to transform the post-trade ecosystem as pre-trade processes have already seen efficiency improvements over the past decade. Proponents believe Blockchain has scope to tackle certain limitations of the current post-trade system by streamlining, simplifying and ultimately improving the process. Hence, Blockchain could help reduce the time, cost and counterparty risk associated with clearing and settlement. Consequently, clients could benefit from lower capital requirements, while liquidity across the system could be increased. Accenture's Banking on Blockchain report have estimated a $10bn saving for the largest investment banks from the application of Blockchain to their businesses.

Figure 22: Simplified trading lifecycle



Source: J.P. Morgan estimates, Company reports. For illustrative purposes only.

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During the Trade process, real-time transaction matching alongside settlement has the ability to reduce transaction times. Further, automated reporting allows for transparency for market participants including regulators. Post-trade efficiencies include reduced margin and collateral requirements, and the ability for smart contracts to perform automated tasks upon specific conditions being met, such as netting and custody transfers.

KYC/AML synergies: Prior to any business activity performed by a bank, KYC activities, that could take up to one month (and in many cases, longer), must be performed in accordance with AML regulations. During this period, the client is unable to make transactions with the bank. Further, this is a labor-intensive process; for example RBS has indicated that c2,000 employees are involved with customer on-boarding—an inefficient, costly process that can be transformed by technology.

Blockchain has the ability to create a database that stores client information across the industry. Proponents believe that this removes the duplicative efforts by individual banks and allows for a transparent trusted source database to be available for regulators and banks alike. Likewise, they believe the ability to leverage from the industry's network for KYC information minimizes delays to the client for transactions. There is further potential for digital passports to be created whereby a client's transaction history can be tracked and new transactions can be verified and signed with ease.

This is already taking place in the banking industry such as through the internal divisions at Credit Mutual Arkea and through cooperative efforts with MUFG, OCBC Bank, HSBC and Singapore's Info-communications Media Development Authority.

Settlement and Clearing efficiencies: A typical trade lifecycle from execution to settlement lasts 3 days (T+3) with some asset classes such as syndicated loans taking 20 days (as described by Finextra). A longer settlement cycle increases back office costs due to the potential for human error in reconciliations and reviews and a risk of a chain of settlement failures as further trades may depend on failed trades.

Blockchain could allow for near real-time settlement (T+0) which could reduce the risks of delays within the settlement cycle and therefore reduce associated costs such as the hold up of capital. The transparency of the review and approval process through Blockchain could also give clarity to transacting parties, and reduces the need for manual reconciliations, which are prone to human error.

Similarly, we note the role of the central counterparty for clearing and netting trades could be more efficient with Blockchain technologies. Smart contracts with pre-defined rules can automatically net trades and trigger other such events to better manage initial and variation margin, freeing up capital for clients.

Trade Finance

The traditional Trade Finance lifecycle involves numerous parties, physical checks of delivered goods at each checkpoint and paper-based administration. Other hurdles such as a manual contract creation and a risk of delayed payment or delivery could potentially give Blockchain an opportunity to transform this process with regards to complexity, speed and cost.

Transparency: Operating a private Blockchain with importers, exporters, banks, couriers, storage operators and other involved parties can allow for a trusted source of undisputed contract data, making the process less complex immediately. This can reduce administration costs through the removal of duplicative efforts, and reduce the likelihood of fraud. The contract, transaction and ownership history can be tracked by all parties and updated real-time throughout the delivery of the goods.

Smart contracts: The Blockchain process allows for a paperless end-to-end transaction process with information symmetry between parties. However, going one step further, by introducing smart contracts, payments and receipts to various parties can be automated when products reach specific checkpoints or other terms in the contract are met.

Real-world trials have already been performed for cotton, cheese and tuna shipments (and are outlined in the section below) that have reduced the number of steps in the cycle and the process duration from several days to hours.

Syndicated Lending

Settlement cycles for syndicated loans are often 20 days or more due to the quantity of information exchanged, lengthy reviews and the paper forms of communication between parties, despite a recommended 7 day settlement cycle from the Loan Syndications & Trading Association.

Transparency: Each party can have the ability to enter contract information directly into the Blockchain ledger,

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which updates in real-time for all other parties to see. This removes the need for paper communications and multiple contract reviews as contract changes through the Blockchain are transparent. Further, loan data are stored cryptographically and can only be accessed with proper permissions, maintaining the confidentiality of parties. By utilizing this technology, a shorter settlement cycle is possible and allows banks to hold less regulatory capital for unsettled trades.

Automation: Smart contracts can be applied to digitize the syndicated loan to reconcile trades against credit agreements, automatically debit interest payments from the borrower's account and adjust the loan liability within the Blockchain. This reduces the need for manual reconciliations and processing which can result in time and cost savings. The Blockchain also has the ability to provide personalized views of the transaction for each party, such as their loan balance, payment schedule and position information, as well as a holistic view of syndicated transaction.

Data Monitoring and Reporting

In an increasingly data driven world, access to relevant, high quality data gives banks the ability to make better decisions and compete effectively.

Uniform source data: Blockchain allows for data to be input accurately with the requirement for verification before acceptance. Any updates can be monitored through the availability of a complete audit history of changes. The Blockchain can then act as a golden source of data, available for use for internal departments within a bank or by external parties by the use of permissions. Systems can be interlinked and smart contracts created such that reporting can be event-triggered, automated and accurate.

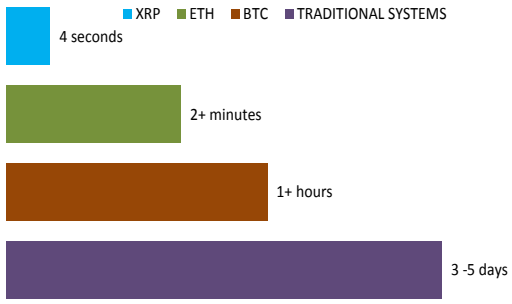
Examples include trade data for the use of compliance monitoring, risk management and financial and regulatory reporting, or KYC information as discussed above.

Below, we discuss a prominent fin-tech company, Ripple, that is at the forefront of the cross border payments industry using its own digital currency asset.

Case Study: Ripple – efficient, cross border payments

Ripple aims to use Blockchain to conduct cross-border transactions between Global banks by stitching together bank ledgers through its proprietary tool. Ripple has made some progress in getting user acceptance with a client base of +100 financial institutions and an active investor base. Its primary benefits against traditional systems and other digital assets are its speed per transaction and cost per transaction, with clear implications for the global payments industry that could be ripe for transformation if Ripple is able to gain share. We note that RippleNet does not require the use of the digital currency Ripple (XRP) for transactions, which may not appeal to users due to its volatility and regulatory status. Ripple's initiatives have led to more innovation in existing payment systems as well, as SWIFT released a new platform (Global Payments Innovation) that reduces transaction times and aims to explore distributed ledger technology for faster cross-border payments.

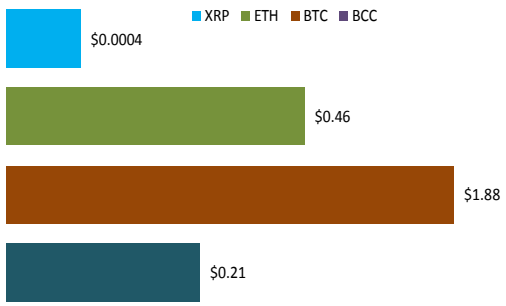
Figure 23: Speed per transaction



Source: Ripple website, CoinCentral

At present, we note that the speed, cost and liquidity characteristics of Ripple have made it the most appealing digital asset for financial institutions for application at scale. Ripple has already received acceptance within the financial community and has also partnered with the Bank of England in the FinTech Accelerator program to demonstrate real-time settlements using the Ripple Interledger Protocol.

Figure 24: Cost per transaction



Source: Ripple website

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Ripple's enterprise solution is xCurrent, a software that can fit within a bank's existing infrastructure of ledgers and is the first to offer global real-time gross settlement. The process has four components outlined below:

- Messenger: This enables Ripple-connected banks to exchange KYC/AML and other risk information, fees, FX rates, payment details and delivery details. This is a two-way messaging system unlike SWIFT which is a one-way system.
- Interledger Protocol Ledger (IPL): This sub-ledger to the bank's ledger tracks the debits, credits and liquidity across the parties and allows transferred funds to settle instantly.
- FX Ticker: This provides the FX rates between ledgers and keeps track of the configuration of ledgers.
- Validator: This cryptographically confirms the status of funds to be transferred and triggers the simultaneous transfer and settlement of funds.

Whereas we believe Ripple's creation has the potential to create competitive disruption for an existing service (Cross border payments between banks via SWIFT), there are other Blockchain-based technologies that can be applied more widely across the financial services sector.

Ethereum is an important example which is designed for targeting applications that are for mass consumption, visible to all and distributable. A 'proof-of-work' concept is used whereby all participants on the Blockchain are required to reach of consensus over the order of all transactions that have taken place. The ability for users to deploy personalized smart contracts and decentralized applications makes this one of the more likely to be used Blockchain platforms across applications.

A long list of Bank initiatives is already underway

In Table 5, we highlight an extensive list of some of the ventures based on Blockchain and distributed ledger technology by banks and consortiums. We note that the majority of these projects are in the proof-of-concept stage.

- UBS' Utility Settlement Coin; a digital cash instrument backed by central bank funds that allows for payments to bypass clearing houses to be directly transferred to parties.
- Wells Fargo, CBA, Barclays, BBVA; various platforms have been used in practice for trade finance transactions whereby cotton, cheese and tuna shipments have been transported using smart contracts and automated payments.
- Barclays' Corda; a platform that allows for smart derivative trading contracts to be standardized across parties and transparent to participants.
- IBM and Hyperledger platforms; KYC platforms have been developed for various banks that allow for the collection, validation and storage of KYC information.
- Commonwealth Bank of Australia and Ethereum; a platform that allows for DCM investors to bid for gov. bonds and uses smart contracts to transfer bond ownership and automate payments for successful bids.

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Table 5: Various initiatives by banks and consortiums by area

Business Area	Blockchain Platforms	Participating Banks' Initiatives
KYC	IBM and Hyperledger Fabric; Primechain Technologies patent pending technology	Credit Mutuel Arkea, IBM; MUFG, OCBC Bank, HSBC Singapore, Info-communications Media Development Authority; Deutsche Bank, HSBC, MUFG, IBM; State Bank of India (and the BankChain consortium)
DCM	Ethereum	Commonwealth Bank of Australia
Derivatives	Corda	Barclays
Fixed Income Trading	Chain, Eris Industries, Ethereum, IBM and Intel	R3
Payments	Ripple; IBM and Hyperledger Fabric; Utility Settlement Coin, Ethereum, Deloitte Technology, Quorum	Axis Bank, Rak Bank, Standard Chartered; MUFG; UBS, IBM, car parts manufacturer ZF; UBS, Clearmatics, Bank of New York Mellon, Deutsche Bank, Santander and others; Singapore Central Bank, R3; Standard Bank, DBS Bank, Infocomm Development Authority or Singapore; China Life, Guangfa Bank; SWIFT and member banks; JP Morgan
Oil Settlement	IBM and Hyperledger Fabric	Natixis, Trafigura, IBM
Securities	FundDLT	BNP Paribas, SmartAngels; Natixis
Syndicated Loans	Fusion LenderComm	R3, Finastra; R3, Synaps Loans, Symbiont, Ipreo
Trade Finance	Skuchain Brackets platform; Blockchain platform set up by Wave; Microsoft Azure blockchain; IBM and Hyperledger Fabric; Infosys blockchain	Wells Fargo, Commonwealth Bank of Australia; Barclays, Wave; BBVA, Wave; UBS, IBM, Bank of Montreal, Caixa Bank, Commerzbank, Erste Group; Bank of America Merrill Lynch, Microsoft; Kasikorn Bank, IBM; Bank of Tokyo-Mitsubishi UFJ, NTT Data Corporation; ICICI Bank, Emirates NBD

Source: Company websites

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Asset manager participation limited in cryptocurrency funds. Credibility an issue

- **State of the asset management industry for CCs still nascent. Both the SEC and many major distributors have expressed concerns about CCs, and the launch of a Cryptocurrency ETF has yet to make it through the U.S. approval process**
- **Migration to futures exchange trading could help drive fund approvals, as Bitcoin futures add more credibility and legitimacy for funds to build products, but developments are still early here**

State of the asset management Industry for cryptocurrencies – nascent

Asset managers have a tiny presence in Cryptocurrencies. There are only a handful of funds offering exposure and these limited offerings have come largely from outside the US. Here, both the SEC and many major distributors have expressed concerns about Cryptocurrencies, and the launch of a Cryptocurrency ETF has yet to make it through the U.S. approval process.

Cryptocurrency ETF – Holy Grail for Owners and Investors, Without Success Thus Far

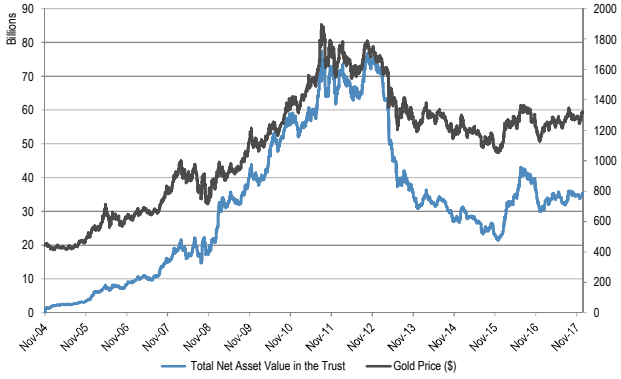
A number of asset managers have sought to launch Bitcoin ETFs, but with no success thus far. We note the ETF structure has a number of advantages. It offers 1) **Easier access**: Investors need wallets to trade the physical Bitcoins today, making it hard to access. ETFs are frequently traded and highly accessible via investors' brokerage accounts. **2) Liquid market:** ETFs are actively traded and highly transparent. Here, derivatives, such as futures, readily track underlying assets and are regularly used by ETFs to support access to the underlying investments. **3) High Integrity:** ETFs are traded through brokerage accounts that carry with them insurance via the SIPC. Bitcoin 'exchanges' have no such insurance and expose holders to potential fraud and theft.

We see ETFs as a significant leap forward for new asset management products such as Bitcoin. In terms of what an ETF could potentially do for Bitcoin and cryptocurrencies, we look at the launch of the Gold ETF below.

Gold ETF Helped to Gradually Transform the Gold Market

Launched in 2004, SPDR Gold Shares ETF was the first gold ETF approved in the US by the SEC. It provided investors with easy access to the spot gold market in equity form at low transaction costs. Since its launch, retail access to gold has skyrocketed as new investors more easily turn to the gold market as a portfolio diversifier and as a foundational asset. This enhanced access to the physical market coincided with a meaningful increase in the price of gold, which jumped from $443 in November 2004 to ~$1900 at its peak in 2011 and to ~$1300 today. Today, the SPDR Gold Shares ETF is one of the biggest ETFs in the market with over $35bn under management.

Figure 25: Gold ETF Has Helped Boosted Gold Prices



Source: Bloomberg

Select Asset Managers Are Trying to Develop Cryptocurrency Products; Most Are Watching/Waiting

Given heightened market interest in cryptocurrencies from investors, we have seen a number of asset managers developing Bitcoin and Blockchain fund products. A number of US asset managers have filed applications for Bitcoin-based ETFs, including Van Eck, Proshares and Direxion. However, the SEC has yet to approve these products, citing concerns on lack of regulation and liquidity of the underlying products. As such, we see the development of cryptocurrency asset management products at a standstill currently in the U.S.

Current Filers for Cryptocurrency-based Products – Not the Major Asset Managers

The largest asset managers continue to be on the sidelines with regards to Bitcoin and Cryptocurrencies Funds. The largest publicly traded asset managers, which we sampled, BlackRock, Invesco (Powershares), Franklin and T. Rowe, all confirmed that they have yet to launch any products involving Cryptocurrencies.

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Nonetheless, we think they are watching closely to see how trading and interest evolves, particularly with regard to Cryptocurrency ETFs.

Wirehouses Ban Cryptocurrency Trading for Retail while Other Brokers Support Trading

Brokers at Merrill Lynch, Wells Fargo, RBC, and Morgan Stanley are not allowing their advisors to offer Bitcoin related investments or derivatives to retail wealth management clients, according to a Financial Advisor article published on Jan 8th[21]. The main issues the wirehouses are citing include 1) suitability of cryptocurrency for clients; 2) liquidity issues; 3) high trading fees; and 4) high volatility. While many of the large wealth managers and private banks are showing significant caution towards the trading of/investing in Cryptocurrencies, some are supporting trading activities in CC. TD Ameritrade, for example, is allowing clients to trade Bitcoin futures and Goldman Sachs is also offering its customers access to CME's bitcoin futures through its futures brokerage arm.

US Cryptocurrency Fund Applications Have Been Rejected by the SEC – Others in US Have Withdrawn

The SEC has yet to approve a Cryptocurrency ETF. Despite numerous applications, the SEC has indicated concern with the lack of transparency and the potential for manipulation.

Winklevoss Bitcoin Trust Received SEC Denial in March 2017, Now Appealing

Winklevoss Bitcoin Trust was the first Bitcoin-based ETF proposed back in mid-2013. Its pricing is based off its proprietary index, WinkDex, which represents a blended average price across different Bitcoin exchanges.

In early March 2017, SEC had initially denied Winklevoss Bitcoin Trust (although the fund is appealing the SEC's decision) due primarily to lack of regulation and surveillance. In its review, SEC pointed out that a commodity-based ETP product must satisfy two requirements 1) Exchange must have surveillance-sharing agreements with significant markets for trading the underlying commodity or its derivatives. 2) Those markets must be regulated. Here, the SEC ruled against the Winklevoss Bitcoin Trust ETF, citing the lack of adequate regulation of the underlying market and the potential for "fraud and manipulation".[22]

Growing Numbers of Funds are Withdrawing Applications

A number of Bitcoin funds have withdrawn their applications to the SEC to launch Bitcoin funds—bitcoin Investment Trust ETF, VanEck Vectors Bitcoin Strategy ETF, ProShares Bitcoin ETF, ProShares Short Bitcoin ETFs, First Trust Bitcoin ETF, Rex Bitcoin Strategy ETF, Rex Short Bitcoin Strategy ETF and Direxion Bitcoin ETF all have withdrawn applications, some as recently as 01/18.According to the withdrawal letters filed to SEC[23], fund companies were requested by the SEC to pull their applications until concerns regarding liquidity and valuation of the funds' underlying instruments are resolved

The sponsors filed through post-effective amendments to registration statements, which gave the SEC just 75 days to review their filings and if no disapproval or objection are issued, the funds can be listed. We think the 75 days' timeframe is probably too short for the SEC to make a sound decision, as the SEC needs more time to consider issues including: 1) the legal questions raised by untested products traded on largely unregulated markets, to 2) the security and surveillance of the spot market and to 3) whether frequently traded ETFs can be accurately valued when cryptocurrencies are highly volatile and illiquid.

Below in Table 6, we show funds awaiting approval from the SEC.

[21] Source: https://financialadvisoriq.com/c/1845473/216173
[22] Source: https://www.sec.gov/rules/sro/batsbzx/2017/34-80206.pdf

[23] Source for each fund's SEC filings:
https://www.sec.gov/Archives/edgar/data/1137360/000093041318000050/c89704_aw.htm
https://www.sec.gov/Archives/edgar/data/1174610/000119312518006998/d506454daw.htm
https://www.sec.gov/Archives/edgar/data/1561785/000144554618000121/etf7_aw.txt
https://www.sec.gov/Archives/edgar/data/1424958/000119312518006127/d511119daw.htm
https://www.sec.gov/Archives/edgar/data/1547950/000139834418000305/fp0030144_aw.htm

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Table 6: Bitcoin ETFs Pending Approval

Table	Filing Date	Underlying	Status
Winklevoss Bitcoin Trust ETF	Jul-13	Bitcoin	Denied, but Appealing
Bitcoin Investment Trust ETF	Mar-16	Bitcoin	Withdrawn
Ether ETF	Jul-16	Ether	Awaiting Approval
VanEck Vectors Bitcoin Strategy ETF	Aug-17	Bitcoin Futures/Funds	Withdrawn
Rex Bitcoin Strategy ETF	Aug-17	Bitcoin Futures	Withdrawn
Rex Short Bitcoin Strategy ETF	Aug-17	Bitcoin Futures	Withdrawn
ProShares Bitcoin ETF	Sep-17	Bitcoin Futures	Withdrawn
ProShares Short Bitcoin ETF	Sep-17	Bitcoin Futures	Withdrawn
Evolve Bitcoin ETF (Canada)	Sep-17	Bitcoin Futures	Awaiting Approval
First Trust Bitcoin ETF	Dec-17	Bitcoin Futures	Awaiting Approval
Direxion Bitcoin ETF	Dec-17	Bitcoin Futures	Withdrawn
GraniteShares Bitcoin ETF	Dec-17	Bitcoin Futures	Awaiting Approval
GraniteShares Short Bitcoin ETF	Dec-17	Bitcoin Futures	Awaiting Approval
Direxion Daily Bitcoin 1.25x Bull ETF	Jan-18	Bitcoin Futures	Awaiting Approval
Direxion Daily Bitcoin 1.5x Bull ETF	Jan-18	Bitcoin Futures	Awaiting Approval
Direxion Daily Bitcoin 2x Bull ETF	Jan-18	Bitcoin Futures	Awaiting Approval
Direxion Daily Bitcoin 1x Bear ETF	Jan-18	Bitcoin Futures	Awaiting Approval
Direxion Daily Bitcoin 2x Bear ETF	Jan-18	Bitcoin Futures	Awaiting Approval

Source: Bloomberg and Company Filings

Existing cryptocurrency asset management product – limited in nature and scale

Despite the lack of success in launching a Cryptocurrency ETF, there are a handful of fund products currently in the market. However, we feel they lack the size and scale to constitute a major new asset class.

- Grayscale's Bitcoin Investment Trust is the largest of the major Bitcoin offerings. It has ~$1.3bn of AUM as of Feb 5th and is structured as an open-ended trust. It invests exclusively in Bitcoin and derives its value from the price of Bitcoin. However, the fund is not considered to be very efficient, as it trades at a large premium (50% premium) against the underlying spot market, setting possible sell-offs if premiums collapse.

- Outside the US we see two products. In May 2015, Sweden's firm, XBT Provider, launched the first authorized Bitcoin-based security—an ETN called the Bitcoin Tracker One-- publicly trading on NDAQ OMX. The fund has ~$187mn of AUM as of February 5th. XBT has also launched a euro-denominated sister product—Bitcoin Tracker EUR. In France, a French asset manager launched a Bitcoin-based mutual fund—Tobam's alternative investment fund—approved by Autorité des Marchés Financiers, one of the country's top financial regulators. That fund has ~$1.8mn of AUM as of February 5th.

Other Developments –Blockchain ETFs, Bitcoin Trust, ETN, and European CC-based Products

In addition to Bitcoin ETFs, we see asset managers also filing for Blockchain-based ETFs. These products do not directly hold physical Bitcoins, but are structured as equity baskets investing in Blockchain companies. As these products are essentially stock ETFs, they are getting faster approval than Bitcoin ETFs, but these funds would not have the purity of exposure and returns as Bitcoin ETFs do. In Table 7, we show a list of BlockChain ETFs filed. Two of the funds: Amplify Transformational Data Sharing ETF and Reality Shares NASDAQ NextGen Economy ETF successfully launched on January 17th.

Days before launch, both funds were encouraged by the SEC to drop the word "blockchain" from its proposed names, suggesting the SEC's cautious approach on Bitcoin in our view. Amplify Transformational Data Sharing ETF was renamed from Amplify Blockchain Leaders ETF and Reality Shares NASDAQ NextGen Economy ETF was renamed from RealityShares NASDAQ Blockchain ETF.

Both funds seem to be well-received by investors; volumes started off pretty strongly on the funds' first trading day, with Transformational Data Sharing ETF trading more than $12mn and Reality Shares NASDAQ NextGen Economy ETF trading more than $21mn. The first fund now has $160mn AUM, and the second one has $100mn.

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Table 7: Blockchain ETFs Applications Filed

Figure	Filing Date	Underlying	Status
Amplify Blockchain Leaders ETF	11/1/2017	Equity Basket	Awaiting Approval
RealityShares Nasdaq Blockchain ETF	11/2/2017	Equity Basket	Awaiting Approval
InnovationShares Blockchain Innovators ETF	11/13/2017	Equity Basket	Awaiting Approval
First Trust index Blockchain ETF	11/13/2017	Equity Basket	Awaiting Approval
Horizons Blockchain ETF	11/22/2017	Equity Basket	Awaiting Approval

Source: Bloomberg and Company Filings

Migration to futures exchange trading could help drive fund approvals

Cryptocurrencies began trading on futures exchanges in late 2017. Both the CBOE and the CME launched trading in December to much fanfare. We see the launch of Bitcoin Futures contracts as a milestone for traditional asset managers because futures exchanges are highly regulated, highly transparent, and are another source of liquidity and access for mutual funds and ETFs. However, the structuring of funds around futures, despite their transparency and liquidity has yet to drive broader product approval in the U.S.

Cryptocurrency Trading Dominated 'Exchanges' – But there Are Cost and Security Concerns

Prior to the launch of Bitcoin Futures Contracts on the CME and the CBOE, cryptocurrencies were and continue to be traded on 'exchanges'. These online trading venues allowed for the exchange of various Cryptocurrencies, priced both in fiat currencies, as well as in other cryptocurrencies. According to Coin Market, at least 124 cryptocurrency exchanges exist, and are generally divided into three categories: 1) Trading Platforms that resemble traditional brokers where buyers and sellers trade based on the current market price of CCs and charge fees on transactions. Examples include Coinbase's GDAX, Gemini and Kraken. 2) Direct Trading Platforms, which are peer-to-peer platforms where sellers set their own exchange rate. Examples include LocalBitcoins and Wall of Coins. 3) Cryptocurrency Brokers are website-based exchanges where buyers can buy cryptocurrencies at a price set by the brokers. The well-known Coinbase is an example of this type.

Bitcoin trading volumes have grown as popularity in CC grows. The number of Bitcoin transactions has steadily grown from fewer than 100 transactions per day in 2009 to over 400ktransactions per day more recently.

Transaction Costs Have Soared

Despite the number of transactions rising so meaningfully, the cost to complete a Bitcoin transaction has soared. In 2015, it costs less than 10 cents to get a transaction accepted by the Bitcoin network. The average transaction fee has soared to more than $30 recently.

Security Concerns on Cryptocurrency Exchanges

Security concerns have mounted in Bitcoin exchanges as hackers have infiltrated a number Cryptocurrency exchanges, generating large losses. It is estimated that a third of Bitcoin trading platforms have been hacked and these cyber theft / hackers took over $630mn in Bitcoins. See below for a table of historical incidences of hacks and losses. The biggest hack here is the double hack on Mt. Gox. Mt. Gox was the biggest Bitcoin exchange at that time, processing ~70% of bitcoin transactions. The ~$490mn lost would equate to more than $140bn today.

Table 8: Bitcoin Hack Incidences

Table	Time	Amount ($mn)
Mt. Gox	Jun-11	9.0
Linode	Mar-12	0.2
Bitconica	May-12	0.5
Bitfloor	Sep-12	0.3
Mt. Gox	Feb-14	487.0
Bitstamp	Jan-15	5.2
Bitinex	Aug-16	72.0
NiceHash	Dec-17	63.0

Source: J.P. Morgan Research

Futures Exchanges Launch Bitcoin Trading – Adding Security and Legitimacy

Bitcoin trading is evolving to more highly regulated, highly regarded trading venues. Chicago-based futures exchanges CBOE and CME received CFTC approval and began listing and trading Bitcoin Futures on Dec. 10th and December 18, respectively. These launches should both add more security and credibility to Bitcoin trading; Contracts are cleared through commission-regulated clearing houses and trading activities are closely monitored by CFTC.

Advantages to Moving to Futures Trading

1) Futures exchanges are regulated. US-based futures exchanges are subject to regulatory oversight under the Commodity Futures Trading Commission (CFTC). 2) Futures exchanges invest in technology. Futures exchanges are well-capitalized and have big technology budgets. 3) Futures exchanges are established. Futures

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exchanges has established customer base and trading volumes already average $110bn per day. 4) Futures exchanges have a central counterparty. The central counterparty clearing house helps facilitate trading and provides efficiency and stability. 5) Futures risks are managed through margins. Futures exchanges set margin rates based on the volatility of the underlying market to lower risk exposures. They have mechanisms to collect and manage margins.

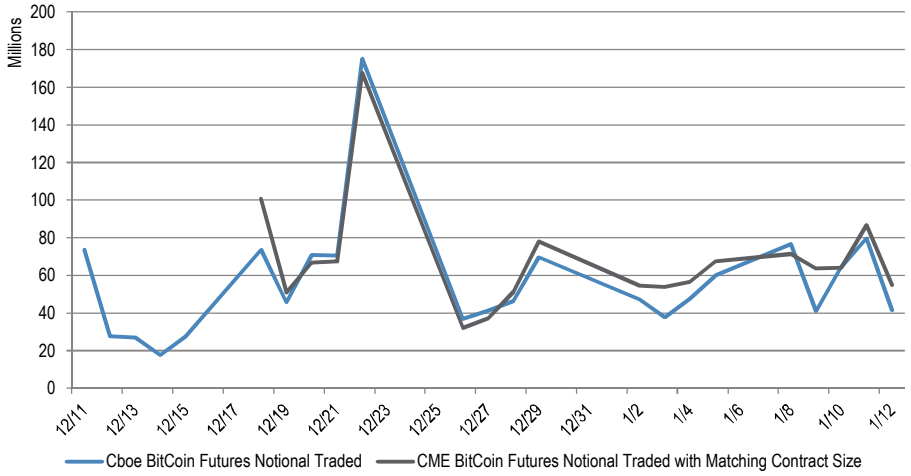
In Table 9, we show a comparison of CME and CBOE Bitcoin Futures contracts.

Table 9: CME and CBOE Bitcoin Futures are Structured Differently

Figure	CBOE	CME
Ticker	XBT	BTC
Contract unit	Equals 1 Bitcoin	Equals 5 Bitcoins
Pricing and Settlement	Priced in USD off of a single auction at 4pm ET on the final settlement date on the Gemini cryptocurrency exchange	Priced in USD off of the CME Bitcoin Reference Rate Index compromising data from different cryptocurrency exchanges, including Bitstamp, GDAX, itBit and Kraken
Trading Venue	CFE	CME Globex
Margin Rate	Initial margin of 44% and maintenance margin of 40%	Initial margin of 43% and maintenance margin of 43%
Clearing	Through OCC	Though CME ClearPort
Contract Expirations	Offers both weekly contracts and monthly contracts	Offers only monthly contracts

Source: Company reports

Figure 26: Bitcoin futures volumes have faded after launch ($mn)



Source: Company reports, J.P. Morgan estimates

Activity Levels in Bitcoin Futures – Early Days and Still Developing

Despite the fanfare, activity levels are still developing on CBOE and CME. As compared to Bitcoin's ~450k transactions per day on the Bitcoin exchanges, Bitcoin Futures volumes have been rather muted with an average of ~6.1k contracts traded by Cboe per day and an average of ~1.3k contracts by CME per day. The combined contracts traded represent an average notional size of ~$170mn traded per day thus far through Feb 5th, with the low end of the range at ~$80mn and the high end at ~$380mn. We note that this is a pretty high volume for new contracts that started trading in December, but does not compare with activity on more established venues.

Bitcoin Futures Add More Credibility and Legitimacy for Funds to Build Products

While Bitcoin Futures have started somewhat more slowly, we note that they do bring a legitimacy and credibility to Bitcoin trading. Here, in response to the Winklevoss Bitcoin Trust application, the SEC indicated that Bitcoin had to trade on an exchange with surveillance-sharing agreements with significant markets for trading the underlying commodity or its derivatives and that those markets must be regulated.

Many funds have based investments off of futures for decades, as derivatives readily track underlying assets pretty well without having to own the physical assets. This is used often for commodities, such as ETF tracking for gold, oil and gas, for example. We have seen some of

the most reputable asset managers using futures to launch products.

Shifting to Futures-Based Trading Is Not Necessarily Enough

Despite the launch of Bitcoin Futures trading, more funds have withdrawn their applications for Bitcoin ETFs. In fact, seven funds out of the eight withdrawn applications from SEC are structuring their products on the more regulated and more liquid Bitcoin Futures, rather than the spot Bitcoin on other exchanges. Many have assumed that a shift to Bitcoin futures as underlying assets would ease the original concerns raised by the SEC on the Winklevoss ETF, and would add legitimacy and security to the ETF products so that they would readily get approved. However, according to SEC's staff letter titled "Engaging on Fund Innovation and Cryptocurrency-related Holding" published on Jan 18th[24], staff at the SEC raised questions pertaining to the funds' valuation, liquidity, custody with regard to Bitcoin futures as underlying assets. At the current stage, our view is that the shift to Bitcoin futures as underlying assets will not necessarily give the green-light to ETFs based on Bitcoin.

The fact that the SEC didn't issue any stop orders or application denials for Bitcoin-Futures based products means to us that these products could be well within the realm of possibility. The SEC wanted to see a robust, regulated derivatives market, David Shillman, an SEC associate director, said in a conference last November, though it remains unclear what level of trading volumes and how long of a trading history window is SEC looking at. We see more comments coming through as the futures market becomes more mature.

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[24] Source: https://www.sec.gov/divisions/investment/noaction/2018/cryptocurrency-011818.htm

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Cryptocurrency Retail Payments

- **Although cryptocurrencies have certain advantages over incumbent payment forms (such as faster settlement times and lower fees), wide-scale adoption seems unlikely in the medium-term given (1) a lack of trust in the currency by many merchants and consumers, and (2) a limited progression to-date in its demand-and-acceptance cycle**
- **We see a place for cryptocurrency adoption in the existing payment ecosystem, balancing their advantages and hurdles, but envision them as an ancillary payment method, rather than gaining traction as a primary source of exchange**
- **While cryptocurrencies get the most attention and news flow, we believe the underlying principle of a distributed ledger (or Blockchain) with suitable access control and permissions could have wide applications in the Payments space**

In its simplest form, a retail payment is a guarantee of funds between a seller and a buyer. Such an exchange requires **(1)** a trusted form of payment that is **(2)** accepted and used by both parties and considered good funds. While cryptocurrencies have certain advantages over incumbent payment forms (such as faster settlement times and lower fees, discussed below), wide-scale adoption seems unlikely in the medium-term given **(1)** a lack of trust in the currency by many merchants and consumers, and **(2)** a limited progression to-date in its demand-and-acceptance cycle. We see a place for cryptocurrency adoption in the existing payment ecosystem, balancing their advantages and hurdles, but envision them as an ancillary payment method, rather than gaining traction as a primary source of exchange.

Below we explore both the hurdles and the advantages to cryptocurrency adoption from a merchant and a consumer perspective.

Merchant acceptance

Traditional merchants will choose to accept payment types that are in wide circulation (consumers want to pay this way), liquid and hold certainty in value to cover costs. While cryptocurrencies like Bitcoin are gaining mindshare, they generally lack these attributes for merchants to rush and accept them alongside of a myriad of known payment types and tenders (e.g. Visa/Mastercard credit/debit cards, Amex, private-label store cards, PayPal, Apple Pay, cash, eChecks, etc.).

Challenges aside, we do expect cryptocurrencies to be initially adopted by merchants or "marketplaces" where individuals and small businesses are the beneficiaries, as they might be more willing to take such payments in lieu of fiat currencies. Examples of such marketplaces include Etsy, Overstock and Shopify merchants, some of which are now already testing Bitcoin payments.

Limited and niche consumer demand

As with many new age payment methods (like mobile wallets) there is a co-relationship between consumer adoption and merchant acceptance. Each typically needs to be present for the other to gain traction. Given cryptocurrency's arguably niche consumer adoption, most merchants do not prioritize accepting it, which could limit widespread consumer adoption. That said, we note that there are a handful of merchants testing the adoption of cryptocurrencies currently, many of whom are tech-related (likely due to their customer profile) or software companies that power sole proprietors or small businesses:

- **Tech merchants:** Microsoft (digital purchases), Tesla, Virgin Galactic (orbital flights), Newegg (online electronics retailer), Zynga (mobile gaming), Namecheap (domain registrar), and formerly Steam (no longer accepts Bitcoin; online videogame retailer).
- **Traditional merchants:** Overstock.com (online retailer), Expedia, some Subway locations, KYC Canada and Dish.
- **SMB "exchanges":** WordPress (blog builder), Etsy, Intuit (QuickBooks, Mint, etc.), and Shopify (eCommerce software).

Currency volatility risk

Merchants who accept cryptocurrencies will likely intend to convert the funds into their domestic fiat, and given the volatility in most cryptocurrencies this is likely a hurdle to acceptance. Both Microsoft and Steam (an online video game seller) have suspended Bitcoin payments (Microsoft temporarily) due to this volatility. Some crypto wallets and merchant service providers (such as Coinbase) help to mitigate this risk by locking in an exchange rate for merchant payout at the time of purchase.

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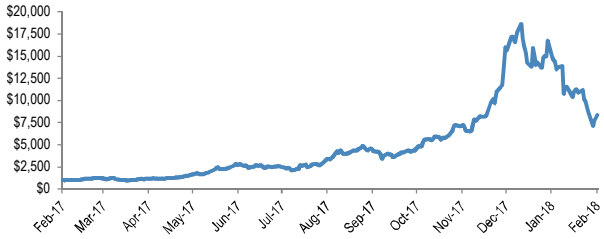
Figure 27: Bitcoin/USD Price over the last year



Source: Bloomberg

Complexity
Integration and operational complexity may keep mainstream merchants on the sidelines as safe and interoperable platforms gain scale. Overstock.com, a large merchant early to promote Bitcoin acceptance, recently had a technical glitch, which allowed customers to purchase items using Bitcoin Cash (a separate cryptocurrency) while being quoted Bitcoin prices, representing a steep discount. In our view, technical errors such as this may keep large merchants from accepting cryptocurrencies in the medium term.

Regulation uncertainty
Since cryptocurrencies and the ecosystems they thrive in are largely unregulated, large merchants might be hesitant to accept crypto funds until regulatory clarity is given.

Cost of acceptance
A key advantage to cryptocurrency usage is lower transaction costs for merchants. Fees paid to cryptocurrency payment providers like Coinbase and Bitpay charge a lower cost than the fee paid to traditional ecommerce payment providers. Coinbase is free to use when processing a Bitcoin transaction, but merchants pay 1% of funds transferred to their bank account. Bitpay charges 1% per transaction with daily bank settlement included. Typically, a small network fee is also paid by the buyer (through their cryptocurrency wallet provider) to induce a faster transaction time when using some cryptocurrencies. These fees compare to 2.9% +$0.30 at both PayPal and Square for online purchases (4.4% for international purchases through PayPal).

Faster settlement times
For many merchants currently, transaction funds are settled over a period of days (typically two business days), and are processed in batches to reduce costs. Although incumbent payment processors are working to reduce these settlement periods with initiatives like Same-Day ACH and Real-Time Payments, cryptocurrencies have the structural advantage of immediate settlement times once completed, assuming the merchants choose to keep their funds in that currency (and do not convert to a local fiat). Additionally, some cryptocurrencies take more time to complete than traditional payments, as their ledgers have block limitations that could hold back scalability. Bitcoin's ledger, for example, currently supports up to about seven transactions a second, while Visa's network can handle 24,000 transactions a second.

Consumer adoption

Limited merchant acceptance
As discussed above, there is a cycle of consumer and merchant adoption of new payment methods. Each typically needs to be present for the other to gain traction. Until merchants begin committing to accepting cryptocurrencies as a payment type, widespread consumer adoption of currencies seems unlikely to us. As a point of reference, Visa is currently accepted at over 44 million merchants worldwide.

Irregular sources of funds
Cryptocurrency adoption is an unusual case study in payments, as it requires consumers learning both (1) how to source funds and (2) how to use funds - see "Complexity" below. While some merchants receive and keep cryptocurrency payments (Overstock.com keeps a portion of its Bitcoin payments in Bitcoin), and some companies even pay employees in Bitcoin (Coinbase gives its employees this option), the vast majority of cryptocurrency funds are either mined or converted from a local fiat. Further, a few major U.S. banks (BoA, Citi and JPM) recently announced that they will prohibit their customers from purchasing cryptocurrencies with a credit card, wanting to avoid the associated credit risk. We believe such complexities relating to sourcing CC funds will make widespread adoption a challenge.

Complexity
When paying with cryptocurrencies, consumers are often required to complete an online order, and then typically have a short period of time (Newegg requires fifteen minutes) to transfer the funds. While this process is made simpler if the payment provider is also the customer's cryptocurrency wallet (such as Coinbase or Bitpay), it can be a relatively complex process requiring multiple steps, using multiple portals and can leave the consumer uncertain if a transaction was completed. This helps demonstrate the advantage to a scaled, interoperable payment network(s), such as PayPal's and Visa/Mastercard's.

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Payment adoption of Blockchain tech seems more imminent than cryptocurrency

While cryptocurrencies get the most attention and news flow, we believe the underlying principle of a distributed ledger (or Blockchain) with suitable access control and permissions could have wide applications in the Payments space. We expect increased interest in the area, with various payment processing firms increasingly partnering with technology firms/Blockchain providers to offer an alternative settlement engine to various payment participants.

Specifically, we believe Blockchain adoption rates (or application) could be higher in international or cross-border payments that are often costly, time-consuming, and require multiple banks to process the transaction. By comparison, a Blockchain-based distributed ledger provides instant access to appropriate entities in a secure and transparent way, cutting out middlemen and connecting a buyer's bank directly with a supplier's bank. The entire architecture may or may not involve use of cryptocurrencies, e.g. IBM's cross-border solution announced last year included partnership with Stellar.org and KlickEx Group, and settles transactions using Stellar's Digital assets as FX bridge. By comparison, Mastercard's Blockchain payment solution (also announced in Oct last year) leverages Blockchain as a means to link distant entities, and accepts payments in traditional fiat currency. Separately, Visa also launched its Blockchain solution in November 2017 along with the commercial launch of its Visa B2B connect. The company partnered with a Blockchain start-up, Chain, to offer its solution. We expect various Blockchain based ecosystems to co-exist and compete with each other (similar to Payments networks in the current environment), with success predicating on technology capabilities (such as API features), number of participants on the network, and ease of adoption. V/MA should benefit from their existing relationships with various banks and financial institutions across the globe.

Similarly, various money transfer firms, such as Western Union and Moneygram, also announced partnerships with Ripple this year, which we believe could have implications in the money transfer industry. Our early thoughts indicate the firms are going to use the underlying technology (or Blockchain) as a settlement engine (with or without converting funds into cryptocurrencies), which could result in cheaper, faster payments to remote corridors that could be too costly right now.

Finally, IBM is also launching Blockchain-based solutions in areas of trade finance, KYC, clearing and settlement, which also rely on the basic principle of increased transparency, shared ledger, and lower cost. For example, IBM's Global financing includes thousands of partners and suppliers, and provides technology financing services in 60+ countries. The company implemented a Blockchain-based solution, which assembles all relevant information from order to delivery on a shared platform accessible by all appropriate partners and suppliers. The solution resulted in increased visibility across the supply chain and a >75% reduction in dispute resolution time and number of disputes.

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Cryptos in China

- **China's central bank has made it clear that CC are only a virtual commodity instead of legal tender**
- **All financial services related to CC are banned in China**
- **Neither of China's large two online payment platforms (i.e. Ant Financial and Tencent) have deployed Blockchain technology in their core payment solution**

China has a clear stance on CC: a virtual commodity, not money

PBOC has made it clear that it views cryptocurrencies (CC) as only a virtual commodity rather than legal tender. This was highlighted in an announcement (Notice on Risk Prevention related to Bitcoin) by PBOC (China's Central Bank) back in December 2013. The Notice was mainly regarding regulation on Bitcoin, but in our view, what PBOC actually referred to was not only limited to Bitcoin, but referred to all CC. Two key points from the Notice:

- ***The nature of CC***: Bitcoin is not a currency, and thus not a legal tender. Instead, it is a form of virtual commodity transacted on an internet platform.
- ***Financial services related to CC are banned***: all financial institutions (banks, trust, insurance companies, asset managers, etc.) and payment providers, are forbidden to provide services for or products denominated in Bitcoin. This ban includes but is not limited to financial services such as market making, guarantee, insurance, client registration, transaction, settlement and custodian services, etc. And financial institutions are not allowed to accept Bitcoin as a means of payment and settlement. Any issuance of financial products, such as trust or funds with Bitcoin as underlying investments, is strictly prohibited.

With such clear stance, we believe financial institutions' involvement in CCs will be very limited. Nonetheless, the development of CCs has been rapid raising the risk that regulators could easily find themselves behind the curve. For example, instead of directly providing financial services, or issuing products denominated in CC, money finds its way, indirectly, to fund investors of ICO.

Intensifying regulatory tightening on CC since 2017

CC has gained momentum in China in recent years; a Bloomberg report in December 2017 claimed that ~58% of the world's large CC mining pools were located in China, followed by the US at 16%. And Xinhua news reported that from Jan to July 2017, ICO completed in China raised the equivalent of RMB2.6bn, though the amount is still small (vs RMB141bn raised from IPOs in the equities market in China over the same period of time), but the rapid growth (Figure 28 and Figure 29) has certainly alerted regulators, and entailed a round of regulatory tightening.

Please see Table 10 below for details on regulatory actions taken by the Chinese government on CC. Measures mainly involved rising inspection on CC exchange or trading platforms in and banning of ICOs.

- Intensifying onsite inspection of major CC trading platforms in January to February 2017, resulting in closure of several of such platforms (according to the platforms' websites). The inspections focused on spotting any business operations that are out-of-scope, identifying any unlicensed business practices (including financing, payment and exchange), any market manipulation, and any financial security risks. Any major deviating and non-compliant activities would lead to forced platform shutdowns. Note that CC trading denominated in RMB plummeted from more than 90% of transaction volume in Jan 2017 to less than 20% in March 2017.
- Ban on ICOs in September 2017: In addition to banning ICO and restricting CC trading activities, PBOC reiterated the stance that CC is not legal currency and FIs are banned from providing services to related activities. This time, PBOC use CC instead of Bitcoin in the regulatory announcement, eliminating any potential room for regulatory arbitrage.

PBOC is studying issuance of virtual currency

According to a news report (South China Morning Post, Nov 5, 2017), PBOC is conducting research on the potential issue of the country's own sovereign digital currency. However, we should not confuse this with the concept of government-backed CC. One key difference between CCs and digital currencies is the flexibility on supply of the currency, and thus if CC gains the status of legal tender, this may lower central bank's ability to adjust its monetary policy, in our view. As such, we

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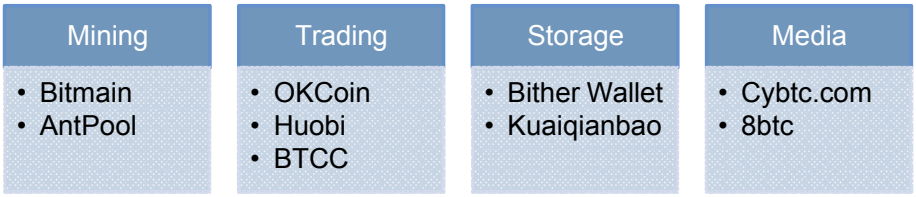
believe PBOC's research is on issuance of digital currency instead of China's sovereign CC. To sum up, we believe PBOC is likely to be more open to the idea of digital currency, but to remain vigilant on CC.

Bitcoin in China: leading in mining capability and forming a complete value chain

Bitcoin is banned in China as a currency. Nonetheless, China leads in global Bitcoin mining capability and has approximately 3/4 of global Bitcoin mining pools, according to a joint report prepared by Tsinghua University, Sina Tech and Bitcoin transaction platform Huobi. China was also leading in Bitcoin transaction volume and accounted for some 80% of global Bitcoin transactions before PBOC banned Bitcoin trading in China in September 2017. In addition to mining and trading, the industry has formed a complete value chain including Bitcoin storage and related media platforms.

Figure 28: Bitcoin value chain and representative companies in China



Source: J.P. Morgan

Flaws in Bitcoin as currency

Compared to real currencies, we don't think Bitcoin will have a material impact on current payment systems in China or become a widely used official currency because:

- **From a regulatory perspective**, Bitcoin's features and characteristics such as decentralization, anonymity, and bypassing existing regulation system could cause severe regulatory issues, such as increased money laundering, etc.
- **From a technical perspective**, Bitcoin's core Blockchain technology is still at an early stage and can't handle large transaction volumes. For instance, the daily transaction volume for large Bitcoin networks is approximately 200k versus 100 million for large commercial banks in China. Current Blockchain technology is far from mature, and it sometimes takes several hours or even a day to confirm a Bitcoin transaction when there is network congestion.
- **From a currency value perspective**, there's no benchmark to determine the value of Bitcoin, and its daily price volatility can be as high as 40%. Due to this high uncertainty in value and price, it's hard to use Bitcoin in daily transactions.
- **From a liquidity perspective**, the total supply of Bitcoin is set to be 21mn globally, while approximately 16.5mn Bitcoin have been mined. The limitation of supply may cause deflation effect on Bitcoin and affect liquidity if it's used as currency.

Applications of Blockchain technology by major China online payment players

China's online payment market is dominated by Ant Financial and Tencent with the two taking c90% of the market share collectively. Neither Ant Financial nor Tencent have deployed Blockchain technology in their core payment technologies due to regulation and technical issues discussed above. Although Blockchain is not applied to their core payment business, we note both companies are actively exploring this technology and have initiated trial application in other use case. As Blockchain technology is still at an early stage, these trials are mostly in relatively small-scale and low-frequency use cases.

- **Ant Financial** applies Blockchain in a 'use case' of public welfare donation. It allows donators to track progress of their donation, as well as the specific money flow. Ant is also exploring to apply Blockchain in its cloud business.
- **Tencent** has incorporated Blockchain technology into its financial cloud service and named this solution as BaaS (Blockchain as a Service). It can be used in scenarios such as mutual insurance, cross-border audit and supply chain finance, etc.

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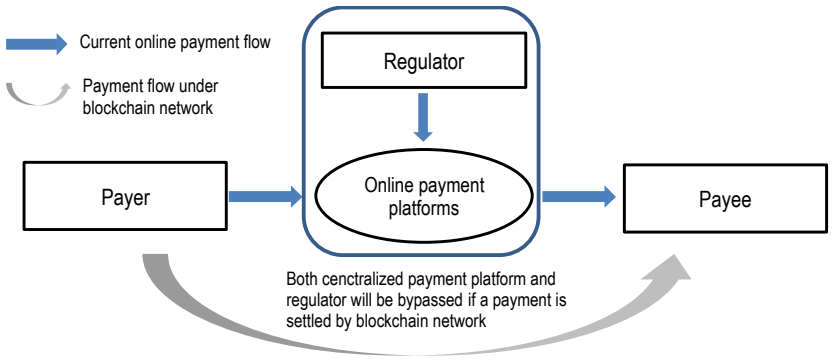
Potential impact of Blockchain technology on China online payment market

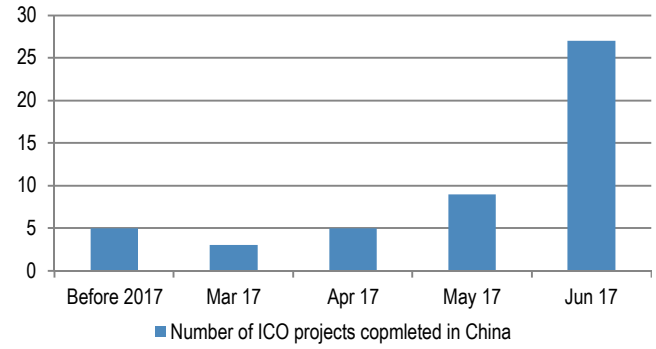
Blockchain, as the underlying technology of Bitcoin potentially, can be a disruptive technology for payment industry. A purely Blockchain backed network doesn't require a centralized clearance house for payment settlement, therefore theoretically no transaction fee can be generated from such a network. If over time Blockchain technology becomes mature and is allowed to be used as a key infrastructure for online payment network, the industry incumbents such as Ant Financial and Tencent may need to build new monetization models (e.g., cloud service or other technology services to support the Blockchain network) for online payment business.

Figure 29: A purely Blockchain backed online payment system will bypass centralized clearance house and regulation body



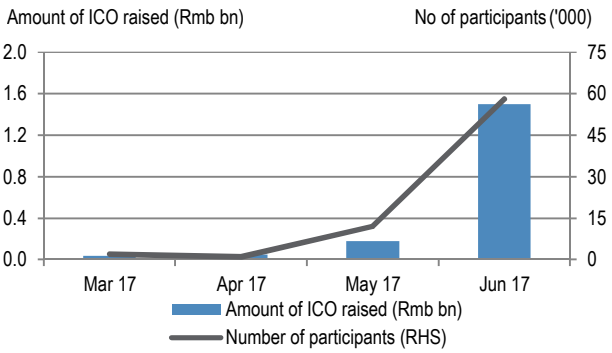
Source: J.P. Morgan

Figure 30: Number of ICO projects completed in China



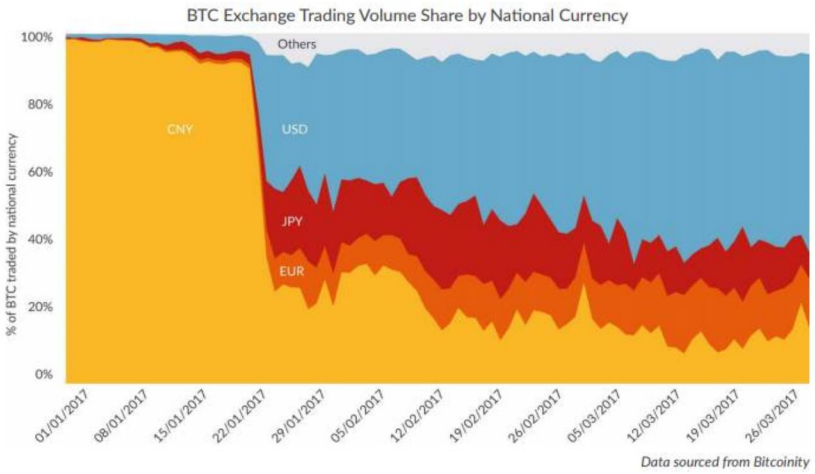
Source: Xinhua, J.P. Morgan estimates

Figure 31: Amount of ICO raised and number of participants (2017 Mar-Jun)



Source: Xinhua, J.P. Morgan estimates

Figure 32: Transactions in RMB plummeted when China tightened on CC transaction platforms



Source: Global Cryptocurrency Benchmarking study by Visa

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Table 10: Summary of regulatory changes on cryptocurrency

Date	Rules	Details
Feb 4, 18	Prohibit online trading of virtual currencies	According to local media (Yicai), PBOC will take further measures to tighten CC, and prohibit trading of virtual currency on overseas and domestic platforms.
Jan 17, 18	Ban on payment institutions providing services to CC transactions	According to local news (Sina), PBOC released the notice to payment institutions, forbidding them to provide payment services to cryptocurrency transactions. The notice required the institutions to conduct self-inspections, improve daily supervision and report the inspection status before Jan 20, 2018.
Sept 4, 17	Ban on initial coin offerings (ICOs)	The Chinese regulatory entities (PBOC, Office of Central Leading Group for Cyberspace Affairs, Ministry of Industry and Information Technology, State Administration for Industry & Commerce, CBRC, CSRC, and CIRC) jointly announced a blanket ban on all Bitcoin trading and ICOs effective immediately. Organizations that had raised funds via ICOs should liquidate the proceeds and pay refunds to investors, in order to protect investors' rights and to properly handle any risk associated. Non-compliant activities would be subject to punitive measures. The notice prohibited token coin or "virtual currency" being treated as currency and clearly stated that they are not legal and cannot be circulated in the market as any form of currency. The announcement also prohibited all Bitcoin trading platforms from conducting any exchange business among fiat currency, token coin and "virtual currency." The notice also bans them from buying or selling or acting as central counterparty to buy or sell any token coin or "virtual currency", or providing any pricing and information. The notice barred banks and other FIs from conducting any token coin or "virtual currency"-related products or services, such as account opening, registration, trading, settlement, etc. They are also not allowed to participate in any insurance-related business for token coin or "virtual currency." The rule requires all FIs to properly analyze the regulation, to supervise member units to resist any illegal financial activities related to the issuance of any token coin or "virtual currency," and to help to increase investor awareness.
Feb 9, 17	Continued inspections on more Bitcoin exchanges in China	The Beijing branch of the PBOC issued an announcement that it initiated talks with the chiefs of nine more Bitcoin trading platforms in Beijing to identify any potential issues associated with Bitcoin exchanges. The notice laid out specific directives to businesses, reiterating that platforms conducting cryptocurrency business must enforce anti-money laundering (AML) and foreign exchange regulations, with zero tolerance on violations. Bitcoin exchanges are banned from providing financing to Bitcoin participants.
Jan 11, 17	On-site inspection of select Bitcoin exchanges in Beijing	The Beijing branch of the PBOC announced that it would initiate on-site inspections with OKCoin and Huobi on compliance with foreign exchange and AML policies as well as other exchange management related policies.
Jan 11, 17	On-site inspection of select Bitcoin exchanges in Shanghai	The Shanghai branch of the PBOC issued an announcement that it would carry out site inspection on Bitcoin China, checking for any business operations that are out-of-scope, identifying any unlicensed business practices (including financing, payment and exchange), any market manipulation, and any financial security risks. The inspection would also examine the progress of AML rule implementations.
Jan 6, 17	Initiation of talks with leaders at major Bitcoin exchanges	The PBOC announced that it initiated talks with the chiefs of China's major Bitcoin exchanges in an attempt to understand the exchanges' operating conditions and to identity any potential legal, regulatory, and technical risks in their business operations.
Dec 5, 13	Notice on Risk Prevention related to Bitcoin	First regulatory paper laying out the legal and regulatory status of Bitcoin. The notice barred banks and financial institutions from treating Bitcoin as a currency and from developing any Bitcoin-related service. This ban includes but is not limited to providing services such as market making, guarantee, insurance services, clients' registration, transaction, settlement and custodian services, etc. And FIs are not allowed to accept Bitcoin as a means of payment & settlement, or issue any financial products such as trust or fund, with Bitcoin as underlying investments The announcement also required Bitcoin exchanges to register with telecommunications regulatory authorities and demanded that all Bitcoin platforms comply with any AML-related policies.

Source: PBOC, local news

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Examining Bitcoin's cost structure

- **Prices of commodities and economic goods are ultimately driven by their cost of production.**
- **This is to some extent also true for Bitcoin, but because by design its supply is fixed, the concept of marginal cost support does not really apply here**
- **Rather, the cost level of the lowest-cost producer is likely a more important driver**
- **We believe the lowest cost producer currently is likely a Chinese miner with cheap access to power and overall mining costs around $3,200 per Bitcoin**

Cryptocurrencies have much in common with commodities: they are both yield-less, and have associated tangible, derivable costs of production, a finite supply and an increasingly diminishing production yield. In fact, cryptocurrency industry lingo is borrowed straight from the commodities world: Bitcoins are *mined* by *miners* using *rigs*. While industrial and precious metals mining is an energy-intensive process, requiring specialized tools and human labor to drill, transport, crush, and process ore, mining bitcoins requires purchasing and powering computers custom-designed to run the hash functions used to win blocks of newly minted Bitcoins.

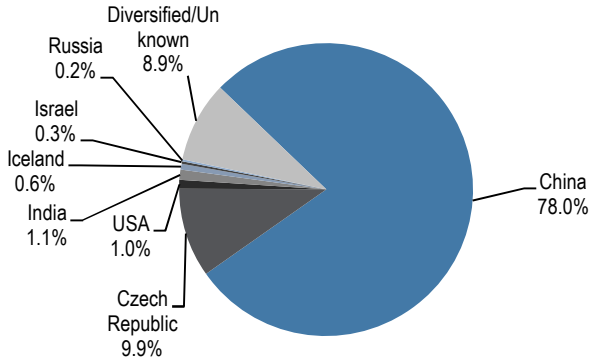
Cost structure of Bitcoin mining

As mentioned above, the largest variable cost for Bitcoin mining is energy, not only to power the computers but also to cool them if no natural alternative (cold water, cold climate) is available. If we make the conservative assumption that every miner is operating one of the most popular and most efficient mining rigs in the market, the S9 Antminer from Bitmain, and that cooling and other services require around 30% of total energy consumption, Bitcoin mining alone as of January 21, 2018, is likely consuming around 26 TWh of energy on an annualized basis, around 0.1% of global power consumption, or on par with the consumption of Ecuador. Again, as a back-of-the-envelope estimate, this is likely pretty conservative given its efficiency assumptions, with Digiconomist, a cryptocurrency analysis blog, using a different framework to arrive at a current energy consumption estimate of nearly 44 TWh a year.

Given the highly energy-intensive nature of bitcoin mining, it is no surprise that costs are closely correlated to the price the miner must pay for electricity. We estimate that **energy makes up 44% of the total costs of Bitcoin mining, very close to the 40% in aluminum smelting**. To arrive at our estimates for costs globally, we expand upon a framework used to estimate Chinese Bitcoin mining costs by analysts at Bloomberg New Energy Finance (BNEF) (see *Bitcoin in Energy Crisis as China Cracks Down,* Lu et al., 10 Jan 2018). Essentially, we look at the distribution of Bitcoin mining around the globe, apply suitable power tariffs to these segments of production and account for the capital costs associated with purchasing and replacing mining rigs to construct a regional cost curve for Bitcoin mining.

As with nearly every tangible commodity these days, analysis for Bitcoin hinges on China. **Over the four days ending January 16, 2018, nearly 80% of the Bitcoins mined globally were done by Chinese-owned companies**, according to data from BNEF (Figure 33).

Figure 33: Bitcoin hash rate distribution by country, Jan 13-16



Source: Bloomberg New Energy Finance. Country refers to country of ownership

Following on BNEF's analysis, given the wide variation in power pricing throughout China, we have elected to further split the country's production into 3 separate power tariff buckets. Looking at the geographical distribution of Bitcoin mines in China, we estimate that roughly 70% of the country's production falls within a low-cost bucket representing a discounted tariff of $0.03/kWh, which would typically be the result of a direct power purchasing agreement with a generator, for example an aluminum smelter looking to sell some of its excess power generation. Next, we estimate around 25% of production falls within a mid-cost bucket that pays $0.06/kWh which is the average wholesale coal power price in China plus distribution and transmission fees, according to BNEF. Finally, we estimate the remaining 5% falls within a high-cost bucket, which pays $0.13/kWh, the average Chinese rate for small

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industrial users. To put this in perspective, a residential user in New York paid about $0.19/kWh for electricity usage last October.

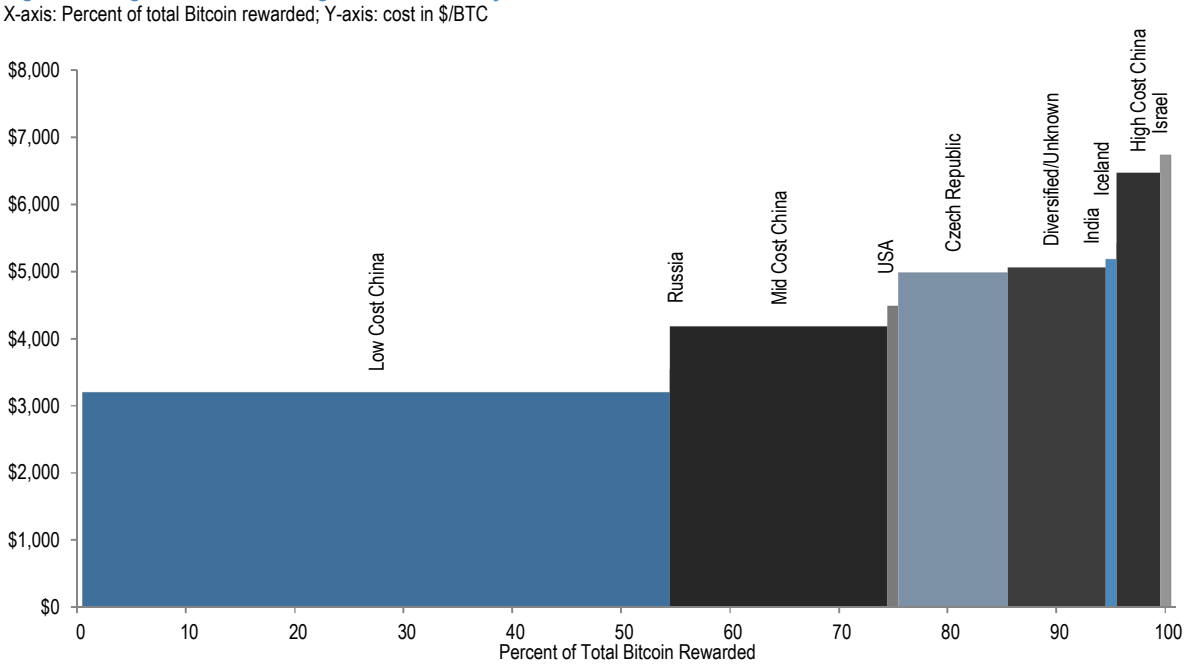
Outside of China, we apply the average industrial power tariffs for the respective countries which we gathered from various governmental statistical releases and news reports. For the roughly 9% of production that either comes from unknown sources or a globally diversified background, we apply an arithmetic average of ex-China tariffs, or roughly $0.09/kWh.

Similar to our total power estimate calculation above, given a lack of more detailed information available, we make the broad assumption that every miner is using the S9 Antminer rig, which according to Bitmain's website retails for $2,320 and has a hash rate of 13.5 TH/s (+/- 5%) and a power efficiency of 0.01 J/GH. Furthermore, we assume these rigs will have to be replaced every 2 years and that on top of just powering the mining rigs, cooling and other services will require around 30% of total energy consumption.

Putting all our assumptions together, we estimate that at the average total Bitcoin hash rate for 2018 year-to-date through January 21 (16.9 million TH/s), **the production-weighted average cost of bitcoin mining globally is around $3,920/BTC (Figure 34).**

Moreover, average **bitcoin mining costs are rising, fast**. Our estimates for Bitcoin mining costs are driven by energy usage and energy prices, with energy usage largely being determined by the efficiency of mining rigs and the number of rigs being employed. While both computational power and efficiency of mining rigs have certainly increased sharply over the last five years, we do not think that a move higher in computational power explains the exponential increase in hash rate over 2017. Rather we believe this is more attributable to an increasing overall number of mining rigs being employed. Thus, holding efficiency, computational power, and power tariffs constant, **our estimates show more than a four-fold increase in average costs in the last year alone (Figure 35).**

Figure 34: Regional Bitcoin mining cost curve, 2018 year-to-date
X-axis: Percent of total Bitcoin rewarded; Y-axis: cost in $/BTC



Source: Bloomberg New Energy Finance, Bitmain, Eurostat, EIA, Rosstat, News Reports, J.P. Morgan

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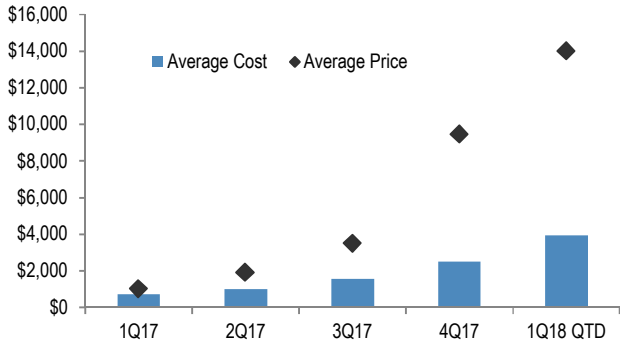
As hash rate increases are accompanied by greater and greater difficulty levels, ensuring block rewards stay steady at one block roughly every 10 minutes, this boost in average cost estimates is driven by more and more rigs being employed and consequently greater levels of energy being consumed for the same overall production level**.** Yet, as can be seen from Figure 35, the more than 10-fold jump in prices has still greatly expanded global average mining margins, despite the rising average cost level. Essentially, the industry is currently in a hash rate arms race, as the current Bitcoin price is incentivizing the addition of more and more mining capacity. If this growth in hash rate continues (as it likely will if margins stay positive) without an offsetting increase in energy efficiency of miners, average costs globally will likely continue to rise.

Figure 35: Average Bitcoin mining costs compared to price

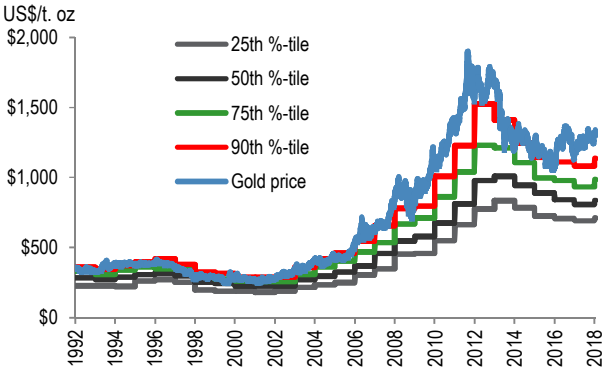


Source: Bloomberg New Energy Finance, Bitmain, Eurostat, EIA, Rosstat, News Reports, J.P. Morgan

Rather than the marginal cost, the cost level of the lowest producer is more important

In commodities, economic theory teaches us that in times of balanced, or surplus markets, the marginal cost level will act as a floor to prices as rational economic actors will cease to engage in an activity if it becomes unprofitable, thus reducing supply and supporting prices. For example, using gold mining cost data from Wood Mackenzie, our analysis indicates that over the past quarter-century, gold prices have traditionally found support at the 75th percentile of the all-in sustaining cash cost curve (Figure 36). In the tight markets, however, when there is a lack of capacity and new production needs to be incentivized, the incentive or capital intensity price should serve as a guide to the future direction in prices. Accordingly, in a bull market, prices tend to rise well above the marginal cost, only to deflate back to the historical norm, when the cycle turns.

Figure 36: All-in sustaining gold mining costs compared to price



Source: Wood Mackenzie, J.P. Morgan

However, unlike commodities, where supply is endogenous, i.e. it responds to changes in production technology and demand, Bitcoin supply is exogenous as it is predetermined by its Blockchain algorithm. In gold, higher prices incentivize more expensive production to come online, which increases the supply of gold. Similarly, lower prices squeeze out marginal miners, causing them to stop producing and reducing supply. This reduction in supply is the mechanism that supports prices at the marginal cost level.

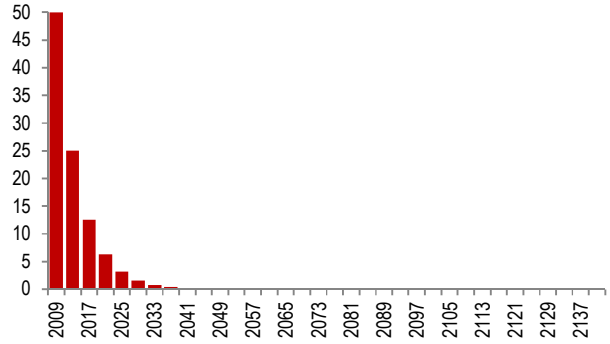
In the case of Bitcoin, higher prices incentivize more expensive mining operations to come on-stream, but the production remains constant at least in the near term (i.e. ignoring for now the halving in the amount of Bitcoins rewarded per block which occurs every 210,000 blocks) as difficulty will rise right along with the hash rate. Similarly on the downside, as prices fall through the cost curve, higher cost operators will close their operations to avoid losses but production will not shrink as difficulty will drop along with the decrease in hash rate and a block of Bitcoins will still be awarded every 10 minutes. **This constant rate of block rewards rather radically alters the application of marginal cost analysis for Bitcoin.** This means that, unlike gold, where the marginal cost producers sit somewhere around the 75th percentile on the cost curve, **the marginal producer of Bitcoin, and hence its cost support floor, technically sits at the cost level of its lowest cost producer**. As long as it's still profitable for the lowest cost producer to mine, they will still receive a block of Bitcoins about every 10 minutes and the supply will remain the same compared to if there were thousands of miners.

Using the assumptions detailed above, the current lowest cost producer globally is likely a Chinese miner that has access to a discounted power tariff from a direct power

purchasing agreement with a generator (the 'Low Cost' China bucket). **Currently, we peg their costs at around $3,200/BTC**; however, the cost level of the low cost producer is not static and, all things equal, would actually drop in '$/BTC-rewarded' terms in a bear market as competition for blocks overall decreases and they are rewarded an increasing amount of blocks and hence Bitcoins for the same amount of energy consumption. As an extreme example, even if all other assumptions, like power usage and tariffs are held constant, a back of the envelope calculation shows that **mining costs for the 'Low Cost' China tranche would likely fall to below $1,750/BTC if they were to be the only group left mining.**

Over the long term, all things equal, when block rewards halve, we estimate costs in '$/BTC-rewarded' terms will indeed increase for all miners including the lowest cost producer. The next such drop in rewards is tracking to take place sometime in 2Q2020 (Figure 37). Looking further out, as cost basis likely rises and production yield falls off, higher transaction fees could become a more major source of mining revenue (). However, putting everything together, while a cost analysis is very insightful in general, the mechanism of costs decreasing in '$/BTC-rewarded' terms as competition for blocks decreases, leaves us with little confidence in pegging a firm cost support floor over the long term.

Figure 37: Block reward
Bitcoins per block



Source: Bitcoin Wiki

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Technical Analysis

- **Utilizing a Technical framework for Cryptocurrencies can be an effective way to highlight short and medium-term investment decisions**
- **For a broader perspective, we compare current price action in Bitcoin to previous boom-bust periods in other markets to provide a guideline for a corrective phase**
- **Moreover, a specific focus on several technical factors including moving average crossover signals, momentum divergences and an Elliott wave perspective demonstrate the effectiveness of a technical framework**
- **The start window for a broader recovery is open but confirmation of a sustained shift is lacking at the moment**

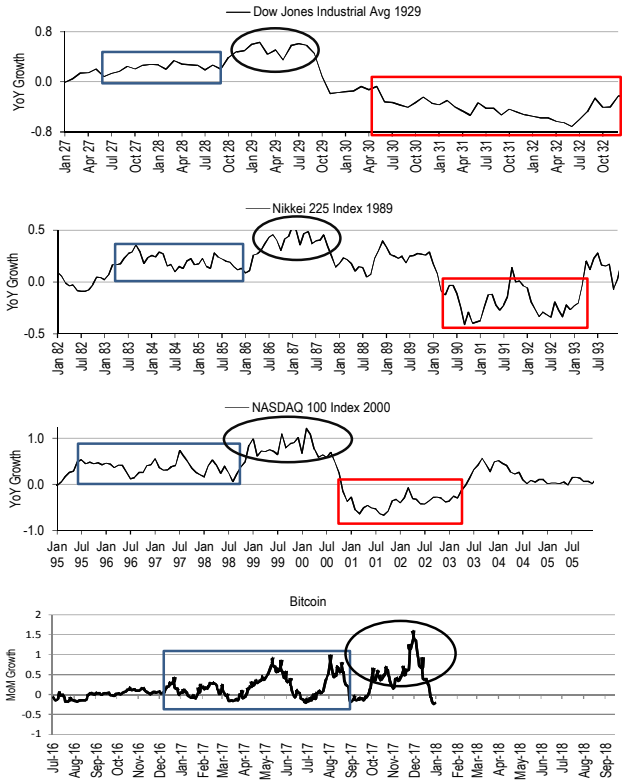
Utilizing a technical framework for cryptocurrencies

For a security that rallied nearly 14,000% since early-2016 (BTC) finding a framework that can identify whether a market is "rich" or "cheap" may not be the best starting point to an analytic process. It is likely that this security appeared expensive for much of that timeframe. Moreover, the extent of the rally likely led to lengthy discussions whether a "bubble" was about to pop.

Technical analysis provides a framework for investment decisions across all markets, but can be especially useful for cryptocurrencies given the almost purely speculative aspect of these securities and how that translates into identifying potential trends and price patterns. In this report, we highlight several ways that a technical framework can help provide a basis for defining whether a trend is still intact, or poised to correct. Given the astounding rally over the past few years, it would be ideal and beneficial for investors to be able to utilize a framework that keeps them invested in a trend without fear of missing the "next big move". However, using technicals can also help when a market's momentum demonstrates signs of decelerating. In this report, we discuss several perspectives, including trend-following and mean-reversion factors, as well as an Elliott wave framework to help identify potential investment decisions.

Before moving deeper into the analysis, an attempt should be made to answer whether we are witnessing a potential bubble. That cryptocurrencies have experienced a precipitous rally over the past few years does not automatically confirm a bubble. Certainly, all markets may be prone to boom and bust periods, which is another reason why technical analysis can be useful. As we highlight in our regular reports for FX and commodities, an early warning signal of a shift in trend can be as simple as a break of a key support or resistance level—something that is usually dismissed when the only fear is missing the next trend. We do note the anecdotal stories in the press are eerily consistent with a market that may be experiencing a certain measure of froth. However, that perspective is likely an oversimplification. Instead, we utilize a framework that our equity technical strategy team recently highlighted to gauge whether the US equity market currently reflects a bubble-like environment (*US Equity Index Technical Strategy*, Hunter/Tepper, 9 January 2018). That report compared several boom-bust periods in various markets. As mentioned, this approach is more of a guideline than a clear rule. Moreover, limited data for Bitcoin relative to other securities highlights the nascent aspect of this market. Still, the chart does highlight some concerns that the month-over-month changes could present a potential blow-off top. Note that this result would line up with other factors that we describe below.

Figure 38: Comparing boom-bust periods –the reversal in Bitcoin highlights the potential for a more protracted corrective phase; still, keep in mind it is a shorter timeframe



Source: J.P. Morgan, Bloomberg

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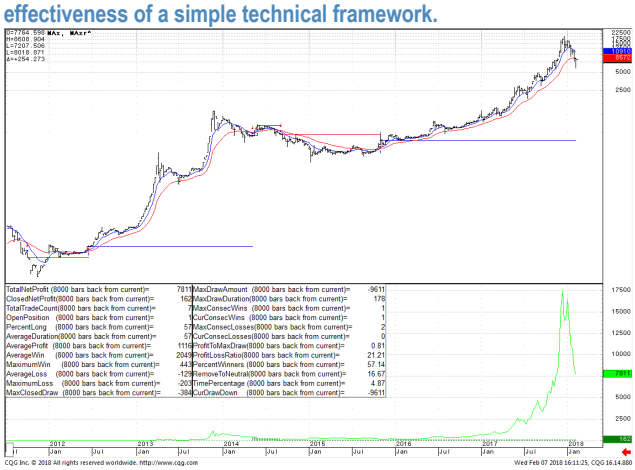
Many of the tools of technical analysis easily translate to cryptocurrencies. Even using a simple moving average crossover system (10/30 period exponential averages) has demonstrated positive results for Bitcoin. While this may seem obvious given the sharp trends for cryptocurrencies of late, this particular system has been correct 57% of the time along with a positive equity curve using weekly data since inception of Bitcoin (2008). Note this is without a risk management component.

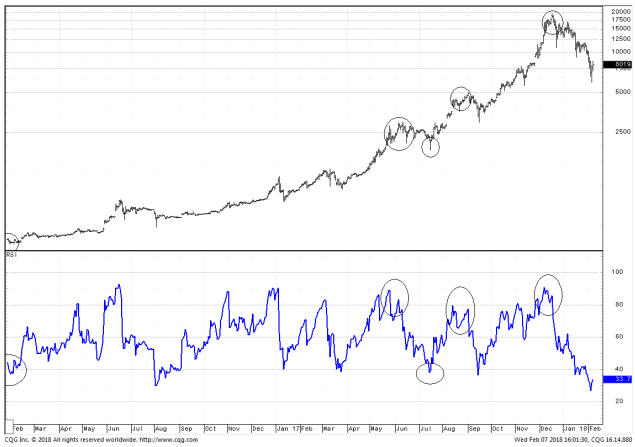
Despite the trending bias to cryptocurrencies, it is important to note that momentum divergences have also been an effective tool to monitor for Bitcoin. In this regard, both bullish and bearish divergences have highlighted times when a corrective phase developed, or when the medium-term uptrend resumed. We do note these signals have been less effective during the recent rally phase, which is to be expected when a market has traded with a strong trending bias. Still, we will continue to monitor these signals for signs of a potential shift. To that point, with the current corrective phase underway, bullish divergent signals would imply an increased risk that the corrective phase is ending and a bullish shift is underway.

Figure 39: Bitcoin – Weekly Chart: Using a moving average crossover system has been an effective strategy (10/30 exponential moving averages/log scale) demonstrating the effectiveness of a simple technical framework.



Source: CQG, Bloomberg

Figure 40: Bitcoin – Daily Chart: Bullish and bearish momentum divergences have highlighted specific timeframes for the onset of a corrective phase and when the medium-term uptrend has resumed.



Source: CQG, Bloomberg

From an Elliott wave perspective, we have seen clear patterns that have helped define not only whether the market could see an extension to the bull trend, but also signs of corrective phase. The fairly impulsive structure within the initial sell-off from 19511 to 10776 last December already provided a strong warning signal that a broader Up-cycle (a 5-wave pattern in Elliott terms) might have been completed. The extent of this massive sell-off, which included a decisive break below key-Fib.-support at 12119 (int. 38.2 %) was another indicator that we are not only dealing with an intermediate 4th wave setback of lower scale, but most likely with a IInd wave setback on higher scale. The rebound from the December low at 10776 to the January high at 16933 in a classical zigzag fashion was typical for a countertrend rally and already implied that the wave A down will be replicated in a classical wave C down to 8197 where C equals A. But having overshot the latter by far, the big question now is whether we have seen a sustainable bottom at 5922 earlier this week. The latest bounce and break above 8160 (minor 38.2 %) can in this context be seen as a Positive, but in order to eliminate the risk of missing one leg down towards 4605 (76.4 %), if not to 2799 (internal wave 3 projection) 00), it would require breaks above 8953 (daily trend), above 9186 (17th of January low) and ultimately above the key-resistance zone between 10128 and 10776 (int. 38.2 %/December low). Only such breaks would confirm a scale jump in favor of a much broader countertrend rally to 14334 and possibly to 16304 (76.4 % retracements on higher scales). It, however, requires a decisive break above the latter (i.e. above 16549 using a 1.5 % filter) to allow for a re-test of the 19511 top and a potential trend extension into 25433 (C = A). Particularly below 10128 through the risk of at least retracing 76.4 % of the recent bounce remains fairly high.

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Following up on what we discussed in the first paragraph and already showing a fairly strong rebound which took out the first crucial resistance at 8160 (minor 38.2 %), we now see room for a stronger rebound, which would have to clear key-resistance between 10128 and 10776 (int. 38.2 %/December 2017 low) though to support a broader countertrend B-wave rally on higher scale to 14334, if not to 16304 (int. 76.4 % on different scales). But given the fact that the 50 % retracement at 9756 has already been broken decisively, we see a significant risk that the market will ultimately head for 4605 (76.4 %), which is the classical wave II target on higher scale and follows the completion of the so-called accumulation phase. The question is whether we go there straight away, indicated on a failure to clear 10128 and 10776, or at a later stage after a stronger countertrend rally.

The massive down-consolidation from the December top at 19511 in a classical 3-step countertrend decline pattern already exceeded a projected target zone between 8197 (C = A) and 7453 (61.8 %), but managed to launch a promising recovery from the recent low at 5922. But unless key-resistance between 10128 and 10776 has been cleared, we still see a fairly high risk that a completing 5th wave sell-off towards 4605 (76.4 %) could be missing. Above 10776 though, the door for a broader countertrend rally to 14334 if not to 16304 (76.4 % on different scales) would be wide open.

Figure 41: Bitcoin – hourly

Source: Bloomberg

Figure 42: Bitcoin – Daily

Source: Bloomberg

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