Cryptocurrencies

Beneath the bubble

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- Cryptocurrencies have soared in popularity since 2008, with more than 1,000 in existence today and an aggregate value greater than the market capitalization of IBM. But we are highly doubtful whether they will ever become mainstream currencies. The need for companies and individuals to pay tax receipts in government-issued currency, and the potentially unlimited crypto-money supply, pose significant barriers to widespread adoption. We think the sharp rise in crypto-currency valuations in recent months is a speculative bubble.
- But while we are doubtful cryptocurrencies will ever become a mainstream means of exchange, the underlying technology, blockchain, is likely to have a significant impact in industries ranging from finance to manufacturing, healthcare, and utilities. We estimate that blockchain could add as much as USD 300-400bn of annual economic value globally by 2027.
- Investing in the blockchain wave is akin to investing in the internet in the mid-nineties. Blockchain could lead to significant disruptive technologies in the coming decade. But for the time being, technological shortcomings still need to be resolved, it remains unclear which specific applications will prove most useful/profitable, and actual revenue and profitability associated with the industry is currently limited. Despite these challenges, investors seeking long-term opportunities from blockchain technology can start to position in two broad groups: technology enablers – in software, semiconductors, and platforms; and early & successful adopters – in finance, manufacturing, healthcare, utilities, and the sharing economy.

Interview on pp 9-10 has been amended. Please disregard the earlier version of this report.

Introduction

Cryptocurrencies have soared in popularity since 2008, with more than 1,000 in existence today and an aggregate value greater than the market capitalization of IBM. But we are highly doubtful whether they will ever become mainstream currencies. The need for companies and individuals to pay tax receipts in government-issued currency, and the potentially unlimited crypto-money supply, pose significant barriers to widespread adoption. We think the sharp rise in crypto-currency valuations in recent months is a speculative bubble.

What is a cryptocurrency?

Most of us are familiar with using digital currencies. Ever since IBM released their 3651 controller and 3663 checkout terminals in 1973, the role of digital currency has grown, pushing the bounds of mobility, convenience, and security. Debit and credit cards, automated teller machines, point-of-sale chip and pin and contactless technology, the rise of e-commerce, and new peer-to-peer payment methods like Venmo and Square, have all promoted the use of digital currency as an alternative to traditional cash and checks.

But in recent years, interest has grown in a new type of currency – cryptocurrency. Seeking to satisfy the demand of individuals looking for a digital platform to transact securely, anonymously, and outside of government influence, since 2008 the volume and usage of cryptocurrency has exploded. At of the end of September 2017, Coinmarketcap – a cryptocurrency market tracker – lists over 1,100 cryptocurrencies that trade in over 5,500 markets worldwide and with an aggregate value approaching USD 150bn; more than the market capitalization of IBM and McDonald's. The most prominent, Bitcoin, accounts for just under half of this.

So what is cryptocurrency, and why would one use it?

Under development in some form or another since 1983 (see timeline), cryptocurrencies are digitally coded scripts that attempt to replicate the government-backed currencies we use today. However, while transactions in government-backed currencies are tracked by central clearing houses or banks, cryptocurrency transactions are tracked by blockchain, a publically-viewable, digital ledger. The backbone of the cryptocurrency network is made up of 'miners': individuals or syndicates who use highly-efficient networks of computers to solve complex mathematical sequences in exchange for transaction fees and, in some cases, newly created cryptocurrency.

This distributed, rather than centralized, set-up creates a number of advantages over government-backed currencies. First, by allowing transactions to be made directly between two parties, rather than through an intermediary, blockchain could make transacting quicker and cheaper. Second, raising funding in cryptocurrencies is also more straightforward than through a traditional initial public offering (IPO). This has helped spur growth in the initial coin offering (ICO) market. Finally, the pseudonymous nature of cryptocurrencies (the accounts transacting are known but the owners are not) and non-governmental nature of the currencies, means that cryptocurrencies have also gained traction among people concerned about privacy, among those politically opposed to government management of currencies, and as a medium of exchange on the online black market.

Will they ever become true currencies?

Although cryptocurrencies, and the underlying blockchain technology, have advantages that have spurred their growth, we are doubtful that cryptocurrencies will ever become mainstream currencies. Currencies have two basic roles, which cryptocurrencies lack.

Timeline

1983: Berkeley programmer David Chum invented Blind Signature technology – an untraceable payment system that separated a person's identity from their transaction[1].

Late 1980s: Self-proclaimed libertarian anarchist group 'Cypherpunks' outline some mainstays of modern cryptocurrency (pseudo-anonymous protection of identity, proof-of-work systems[2], private/public-key encryption and separation from government-backed currency[3]) in their memorandum The Crypto Anarchist Manifesto.

1997: Adam Beck introduces first successful proof-of-work algorithm, such algorithms would become an important means of controlling the money supply of a given cryptocurrency.

1997: Wei Dei – another member of the Cypherpunks and a researcher for Microsoft[4] – released B-money, indulging the concepts of decentralization and digital contracts[5].

2004: Hal Finney – a computer scientist and Cypherpunk[6] – developed the first successful reusable proof-of-work (RPOW) protocol based on Beck's earlier work. RPOW allowed users to transfer digital tokens by destroying and creating tokens during each transfer[7]. This process constituted the first proof-of-work digital cash system.

2004: Nick Szabo – a computer scientist and cryptographer – launched a protocol that merged Wei Dei's concept of decentralization and Hal Finney's RPOW to create Bit Gold, the cryptocurrency that served as the predecessor to Bitcoin[8].

2009: The first popularized cryptocurrency – Bitcoin – is launched following the release of a paper titled, *Bitcoin: A Peer-to-Peer Electronic Cash System,* by someone writing under the pseudonym Satoshi Nakamoto.

Failing as a medium of exchange – why crypto-currencies will never be used for a majority of transactions

The first and most important role of a currency is to act as a widely accepted medium of exchange. Currencies in themselves have no natural value – gold, for instance, is naturally as worthless as paper[9], sea shells, or wooden sticks (all of which have been used as currencies). Currencies only have value when they can buy things that are useful.

In this regard, government backed currencies carry a huge advantage. Governments set taxes, and tax is the largest single payment in almost any economy. In developed economies over a third of all economic activity that takes place in a year is paid to the government as tax. As such, people will always demand government-backed currencies because they are useful for paying taxes. One of the earliest government-backed paper currencies was that of the Chin dynasty of northern China. In 1192 the Chin Emperor decreed that certain taxes (previously paid in copper coin) must instead be paid in paper currency. This created a demand for the paper currency, giving it a value[10].

In theory, a company could receive a crypto-currency for goods sold. But it would then need to pay corporation tax, payroll tax and sales taxes in government-backed currency. And the company would be taking an exchange rate risk. If the government-backed currency rose in value against the crypto-currency the company would be at risk of significant loss.

Equally, if a company decided to start paying staff costs (on average 70% of costs in a developed economy) in bitcoins, the firm would be expecting its staff to take on an exchange rate risk. This is unlikely to be acceptable to most employees. Staff also need to pay tax in government-backed currency.

This does not stop crypto-currencies from being accepted as a limited form of medium of exchange (see "the currency of crime"). But if governments refuse to accept crypto-currencies for tax payments, the single most important transaction in an economy, that significantly reduces demand for crypto-currencies. Governments are highly unlikely to ever take this step. Governments generally prefer taxes to be raised in the same currency as their liabilities, and also generally prefer to issue liabilities in the same currency that they can control if necessary. This makes it highly unlikely that crypto-currencies could ever be used for a majority of transactions in an economy.

Failing as a store of value – why crypto-currencies will never be used as a store of value

The second role of a currency is to act as a store of value. People need to believe that what their cash can buy today, their cash will buy tomorrow. In order to maintain the store of value, central banks take a lot of trouble to keep a currency's value roughly stable (i.e. control inflation). This is done by making sure that the supply of currency generally matches the demand for a currency. If the balance is maintained the currency will broadly keep its store of value.

An individual crypto-currency cannot achieve this balance, which explains their volatility. Crypto-currency supply cannot go down. A fall in demand for a specific crypto-currency will therefore cause that crypto-currency's value to collapse as supply outstrips demand. For context, Bitcoin's collapse in value in early September was worse than the collapse in the value of the German mark at the start of the Weimar hyperinflation[11]. To be sure, this is nothing to do with the immaturity of the market. Singapore's cash and

demand deposits are about USD134bn, not much more than Bitcoin (at $4500 per unit Bitcoin's total value is about USD74bn). But Singapore's dollar is a very stable store of value, because the Monetary Authority of Singapore spends a lot of time and effort making it a stable store of value. Bitcoin's value gyrates wildly because its supply cannot be readily changed.

The store of value of a crypto-currency is further damaged by tax risks. Holding a currency generally has a different tax treatment to holding an asset. If a British subject holds pounds sterling, the recent rise in the value of the pound against the dollar generates no tax liability. However, if the government considers Bitcoin as an asset (rather than a currency) then a rise in Bitcoin's value against sterling could create a capital gains tax liability. And if there is uncertainty about where tax liabilities may arise, or whether they would be incurred, it is likely to undermine peoples' belief in the currency as a store of value[12].

While the supply of individual crypto-currencies cannot be readily changed, the supply of crypto-currencies overall can be infinitely increased. Crypto-currencies have few barriers to entry. Anyone who wants to set up a new crypto-currency can do so. This means that while there may be limits on how much of an individual crypto-currency can be created, there are no limits on how many different crypto-currencies can be created.

The possibility of limitless supply of different crypto-currencies creates the risk of further collapses in value. If a new crypto-currency were created which is easier to "mine," and which allows more transactions to take place more quickly, demand for that crypto-currency might naturally increase. Existing crypto-currencies would likely see demand fall; a crypto-currency that has been superseded by a new crypto-currency with superior technology has little value. As the supply of existing crypto-currencies cannot fall to match the decline in demand, the result would be a collapse in the value of existing crypto-currencies. A good example of this are New York City taxi medallions, which were previously seen as a "store of value" due their limited supply, providing the right to earn cash flow from riders. Their value has plunged in recent years following the advent of ride-hailing apps.

The currency of crime?

While crypto-currencies will almost certainly never be used for a majority of transactions in an economy, they could conceivably be used for some purchases. The possible role of crypto-currencies in illegal transactions is interesting. It could be argued that greater banking regulation and transparency along with more sophisticated attempts to identify money laundering have reduced the supply of government-backed money to the illegal economy. If this is so, then it is entirely in line with historical precedent that those operating in the illegal economy will seek to create their own alternatives to government-backed money, and crypto-currencies could fill that role.

The problem with crypto-currencies as criminal-currencies is that the criminal economy is not a closed economy. The desire to, at some stage, transfer money or assets between the illegal and legal economies would mean that there would have to be a conversion rate between crypto-currencies and government-backed currencies. This would fluctuate with the effectiveness of law enforcement, the demand for illegal goods and services from otherwise law-abiding citizens, and possibly with the penalties for crime. This would make for an uncertain store of value, in a way that a cash-based criminal economy does not.

Are crypto-currency prices a bubble?

What are bubbles?
The term "bubble" is a bit like the term "recession" – a word that is much used in the media but does not have a formal definition in economics. A bubble is assumed to occur when asset prices cannot be explained by fundamentals. However, there has to be more to a bubble than pricing alone. Fundamentally-based models are not entirely accurate, and so a price may appear to deviate from fundamentals and not be a bubble. Deviating from fundamental value must be a necessary condition, but not a sufficient condition for a bubble.

Bubbles nearly always occur when there is something new, or relatively new in the economy. Change, by definition, creates uncertainty about the future. The tulips of the seventeenth century were new and exotic (to Europeans). The joint stock companies of the Mississippi and South Sea bubbles in the eighteenth century were relatively new financial structures. The 1920s saw mass entertainment (radio and cinema) and mass transport (cars). The dot com bubble had the internet. A constant theme of bubbles is the ability of speculators to shout that dreaded cry "this time it's different." Logical arguments against the bubble can then be disregarded as speculators declare that the doubters simply do not understand that the world has changed. The problem with this theory is that the world never changes that much.

A second characteristic of bubbles is that there must be a delay in expected real-world (rather than asset-market) returns. If an asset promised a real-world return in a short space of time, any failure to deliver would undermine the asset price. The great thing about the tulip bulb speculation was that the purchaser had to wait until the bulbs had grown in order to be able to see what flowers had been purchased. The Mississippi and South Sea bubbles both depended on fabulous wealth from far distant colonies and trade that was supposed materialize in a few years. The dot com bubble promised future wealth, and in the meantime nothing as vulgar as earnings need be considered. Of course there were asset price gains to be realized immediately in each bubble, but the underlying value story could not materialize for some time.

In the later stages of a bubble there is normally a mix of buyers in the market. There are those who still believe in the potential real-world profit at some distant point in the future, and there are those that are likely to be investors who are buying purely in anticipation of a rising asset price, without any reference to future profit. Such investors are not looking to future value, they are hoping that they can get out before the bubble bursts. In the Mississippi Bubble in 1720, the promoter (Law) complained that people were trying to convert shares into gold for speculative gain, rather than holding on in the expectation of future returns (which never materialized). The South Sea bubble in the United Kingdom in 1720 saw similar speculation – not just in the South Sea company, but in the hundreds of imitator companies that were launched at the same time. When there was a regulatory attack on such companies, the speculative owners of stock were forced to sell earlier than anticipated. These stocks had been bought on margin, meaning that the owners were looking entirely for speculative short-term gain and not for longer-term value. The regulatory tightening precipitated a sudden collapse in price.

Are crypto-currency prices a bubble?
Applying the aforementioned characteristics to cryptocurrency prices, they demonstrate most of the characteristics of a bubble. Cryptocurrencies are relatively new. The real world benefits are said to take years to materialize, even among evangelists. And the relatively high volume of cryptocurrency turnover, against limited real-world use, suggests that many buyers are seeking speculative gain, never intending to use cryptocurrencies to make a real-world transaction. The remaining characteristic – fundamental value – is the most difficult to assess, since unlike in government-backed currencies, no crypto-currency has an economy behind it. But with each of the other characteristics of typical bubbles in evidence, a twenty-fold increase in bitcoin prices in just two years, and an absence of any fundamental economic backing, cryptocurrency prices are almost certainly a bubble.

What is Blockchain?

While we are doubtful whether cryptocurrencies will ever become a mainstream means of exchange, the underlying technology, blockchain, is likely to have a significant impact in industries ranging from finance to manufacturing, healthcare, and utilities. We estimate that blockchain could add as much as USD 300-400bn of economic value globally by 2027.

Imagine UBS analysts were asked to write this research paper in a single master document. In such a scenario, only one analyst would be able to work at a time. A shared platform would improve efficiency, allowing multiple analysts to work on their respective segments in a single master document, with changes made visible in real-time.

This is a gross oversimplification of blockchain technology, but helps explain the concept. Blockchain is essentially a distributed database, which is shared and continuously reconciled. Traditional databases are run on a master-replica architecture (see Fig. 1), where a trusted party alone can update the master copy, while replica databases mirror the transactions updated in the master database.

Fig. 1: Traditional databases run on master-replica architecture

Source: UBS, as of September 2017

Traditional databases are cumbersome and require huge investments in back-offices to reconcile and verify the validity of transactions.

In contrast, with distributed databases, or ledgers, under a blockchain, every user in the system has a copy of the database (see Fig. 2). This structure reduces costs – individual users do not need to rely on a central party or intermediary, it improves security – any potential change to the database has to be verified by the majority of users using cryptography, and it makes the system more robust – there is no central party at risk of cyber-attack or malfunction.

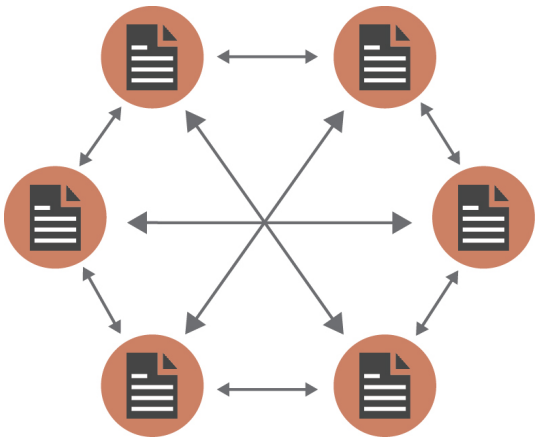
How does it work? Put simply, every 10 minutes or so, all users are required to approve all the transactions (called blocks) done on the network, using cryptography (or hash values), and record them in a chronological order (chain). The term block-chain refers to this block of transactions recorded in a ledger through an immutable chain (see Fig. 3).

Security is improved by the use of hash values – strings of letters and numbers which transform data through mathematical transformation. If an individual user were to make any changes, the hash function would return a totally different hash value, demonstrating that the record has been altered. This helps prevent any malign user from altering past transactions, making the network immutable.

To summarize the key advantages of a blockchain network:

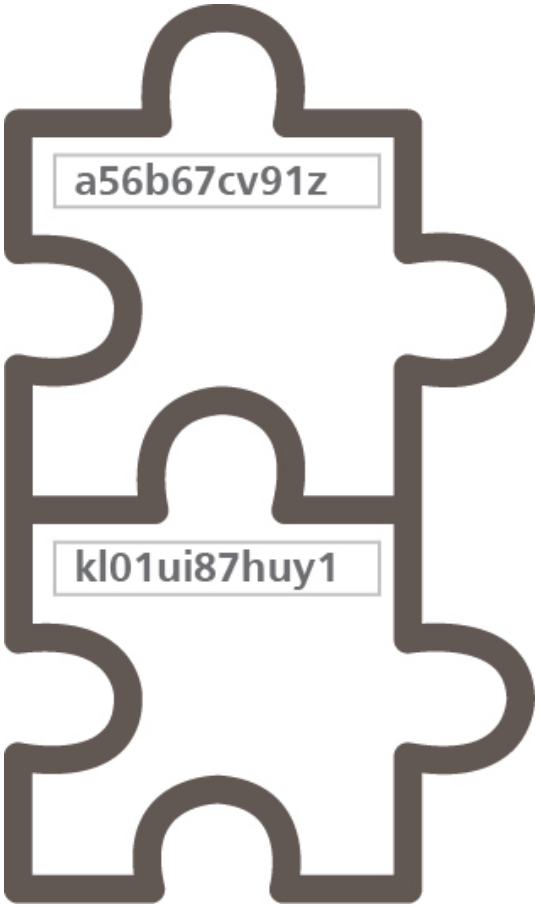
- Disintermediation: Blockchain makes the centralized server less relevant. This allows peer-to-peer transactions with less oversight or intermediation of a third party, while still not exposing the system to counterparty risks.
- Security: The cryptographic nature of blockchain transactions makes the network more secure than traditional databases. Hash values prevent any maligned user from altering the transactions.
- Resilience: In addition to its immutability, blockchain networks are resilient as they do not have a central point of failure. Also, given the encrypted and chain nature of the data blocks, any potential damage to the data would not affect records of historical transactions.
- Lower costs: By eliminating or reducing the reliance of intermediates and associated costs, blockchain networks can significantly reduce transaction costs. The ability to monitor transactions in real-time, for example, can reduce the effort needed to reconcile dispute resolutions.

Fig. 2: Every transaction needs to be verified by all the users in distributed databases like blockchain



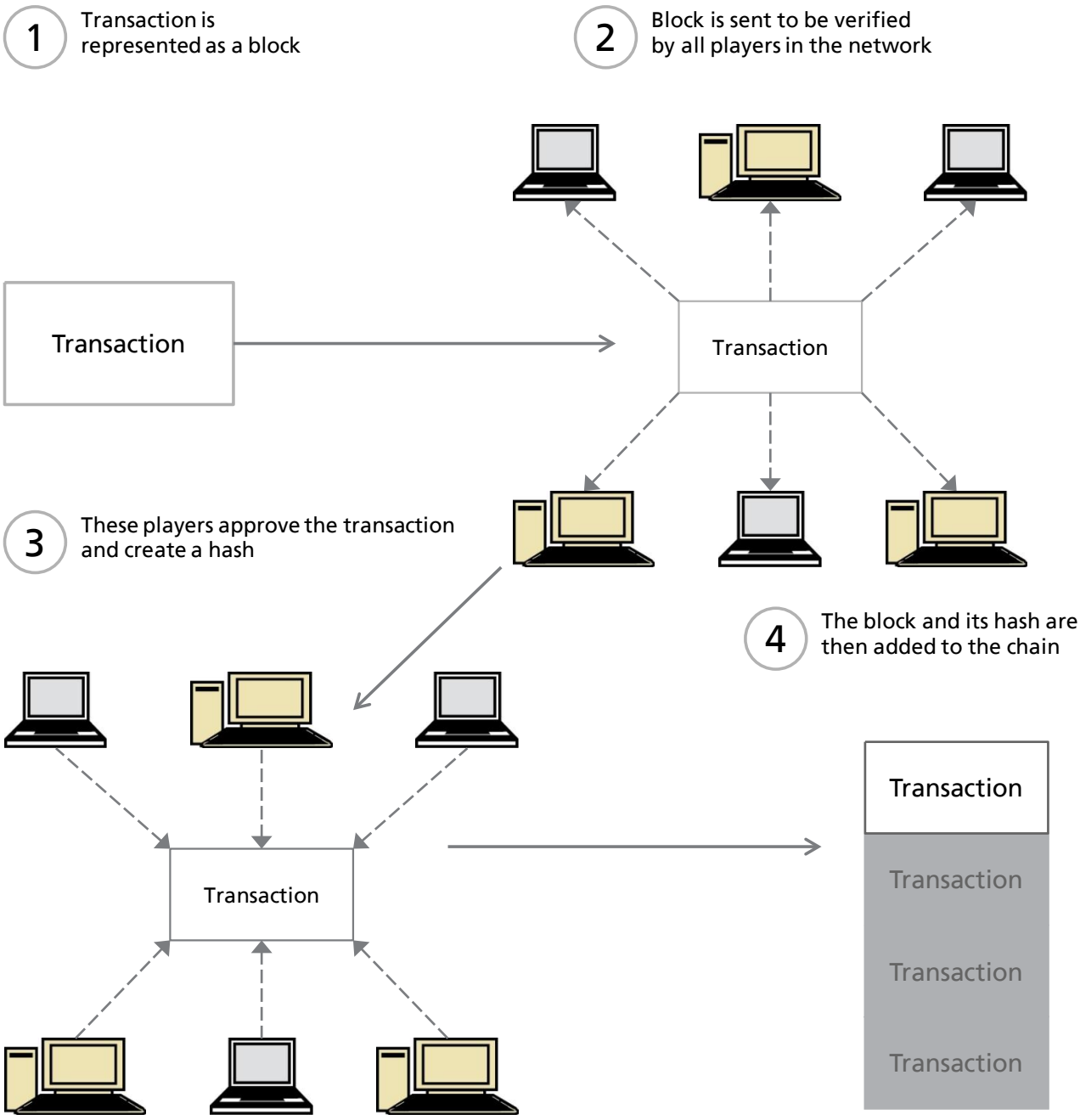
Source: UBS, as of September 2017

Fig. 3: An example of hash values in blockchain transactions



Source: UBS, as of September 2017

Fig. 4: How blockchain networks work



Source: Reuters, FT, WEF, UBS

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Interview

Peter Stephens leads UBS's exploration and development of Distributed Ledger Technology solutions, based out of the Level39 FinTech accelerator in London's Canary Wharf. Since 2003, he has worked at UBS in a variety of technology roles in Europe and Asia. He spent the last nine years based in Hong Kong, where most recently he represented the UBS Group CTO in Asia Pacific, with an added focus on the UBS global strategic regulatory change portfolio. His earlier career focused on UBS Investment Banking Operations technology, prior to which he worked as a technology consultant for IBM and PwC, based out of London.

Peter Stephens, Head of Blockchain and UK Innovation, UBS AG

What is UBS technology's involvement in blockchain?
We are exploring distributed ledgers and smart contracts and how they may apply to complex financial instruments, and we are engaging in a variety of experiments and the development of new business models. We are platform agnostic and the way we incubate blockchain projects is to move from a very early stage that is largely conceptual with a proof of concept or demo, after which we try to get stakeholder buy-in to take it to the next level. Assuming everything goes smoothly, and the project gets funding from the UBS Group Innovation Board, we go through an acceleration phase to make a minimum viable product and run a production pilot. Today we have five such blockchain projects that have reached that level of maturity, all planning to enter the live pilot stage next year. Interestingly, most are running on different blockchain distribution ledger platforms, so there is limited technology overlap. One of the things we found at an early stage of our research is that there are several fundamental building blocks required for the technology to be useful on an institutional level. Two of these key building blocks, which we require for almost every project, are digital cash and digital identity.

Can you shed more light on the utility settlement coin project?
The Utility Settlement Coin (USC) project began as a project between UBS and Clearmatics Technologies in late 2015, to explore a new model for digital cash. The project is currently in its third phase and now involves 10 other consortium members. USC is an asset-backed digital cash instrument implemented on distributed ledger technology and is being designed for use within institutional financial markets. It will be fully backed by cash held at a central bank and will be convertible at parity with a bank deposit in the corresponding currency. In summary, USC is not a new cryptocurrency that we are issuing, but a way of using tokens that are fully asset-backed to reduce risk, improve capital efficiency and ultimately improve the time and complexity involved to clear and settle trades.

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What are the other projects UBS is currently working on?
The first project likely to go live is a rather unusual one. It is related to the reference data area, and basically creates a golden resource public reference data, specifically Legal Entity Identifiers and associated data attributes, that can be used across financial institutions. This data is key to accurate regulatory reporting. We are collaborating with market participants and traditional reference data providers to use Ethereum as a consensus mechanism to improve the quality of this data across the market. Another major project we are currently engaged in is related to trade finance, where we are partnering with IBM. Many other organizations are also investigating the potential of distributed ledger technology in the area of supply-chain finance. In the trade finance offering, we are targeting a solution that offers the best of both worlds – the security of letters of credit and the convenience of open account. Another interesting project, where we are working together with ZF and IBM, is providing a car e-wallet. It positions us for a future with electric, autonomous cars, as it would provide, for example, wallet financing for micro payments like charging, parking and tolls. It also gives us an opportunity to understand consumer markets and the interaction with Internet of Things (IoT) devices. Finally, we have other consortium projects pairing us with R3 as well as a project with Ripple on real-time, cross-border payments.

How do you see blockchain affecting some regular banking functions?
It is possible that blockchain will be adopted faster in other sectors, as it is sometimes difficult to collaborate as quickly in the highly regulated area of financial space. Nonetheless, the progress so far in financials has been impressive. At the moment, the most popular areas include supply chain finance, where blockchain help create efficiencies and help solve the double spending problem, or in areas like liquidity management and capital efficiency. For example, tokenization in a fully regulatory-approved environment could help traditionally illiquid assets become more liquid, and be more attractive as collateral. Post-trade is another interesting area of development. A lot of people are excited about DLT potential for clearing and settlement, but we believe financial assets have to be fully digitized and managed on a blockchain network, with regulators on board, before any real efficiencies can be realized. Regulatory reporting will then be able to become a function of the regulator having a node on the network rather than using DLT as a dedicated channel only for reporting.

What are some of the challenges you see with blockchain adoption?
Like any new technology, blockchain faces many challenges, including issues of privacy, scalability, security, regulatory topics and collaboration. While public blockchain or cryptocurrency networks may be more secure than centralized solutions, apart from around the edges, a whole new security conversation will need to begin once private or permissioned networks scale up and as user data gets increasingly stored in a distributed form across multi-party networks. On the collaboration front too, it is a challenge as getting a lot of traditionally competing organizations to essentially work together and create efficiencies out of the underlying infrastructure is not going to be an easy task, given the varying pace, expectations and also legal frameworks.

Any other key messages you would like to deliver?
While we are excited about blockchain technology and happy with the way some of our projects are heading toward production, we are only in the initial stages, as many other projects are still in the experimental phase. We hope the blockchain-related challenges get fixed in the next few years, and we expect a steady increase in the technology's adoption. It's time to get the stuff running, and in the process learn and finally decide where its biggest potential is.

What are the potential applications?

Despite the media attention on cryptocurrencies like bitcoin, we believe blockchain has far greater potential. Just as internet has transformed our lives with email, e-commerce, or smartphone apps, we believe blockchain as an infrastructure technology can power future disruptive technologies through distributive ledgers, smart contracts, tokens or identity management.

We expect blockchain to generate an annual economic value of USD 300-400bn globally by 2027 across six major industries: financials, manufacturing, healthcare, public services, utilities and the sharing economy. This includes the additional economic value created by the introduction of new product services and categories, and a consumer surplus arising from better products, lower prices, and an overall improvement in efficiency. Our estimate, which represents 0.5–0.7% of the combined revenues/spending of the six industries, is consistent with our belief that blockchain will become mainstream over the next 5-10 years, offering both cost savings and new business opportunities.

While in developed markets blockchain can help corporations to fix legacy system challenges and drive efficiency gains, blockchain could have a particularly big impact in emerging markets, where it could build "trust" and allow countries to leapfrog stages of digital development. Transaction costs, access to sufficient capital, public service provision, and bureaucracy are all particular challenges in emerging markets that could be improved with adopting blockchain technologies.

Financials
In an industry that relies on acting as an intermediary in transactions, the distributed nature of blockchain could be seen as a potentially major threat to financials. But it also promises significant cost savings for incumbents. Four out of five banks will already be adopting blockchain technology by 2018, according to the World Economic Forum.

As part of this report, we have interviewed UBS's Head of Blockchain and UK Innovation (see page 9) to show how the technology provides significant growth opportunities, and not just risks.

- **Post-trade services:** While typical stock exchange transactions happen in real-time, post-trade services like settlement, custody, stock lending, and collateral management may take days. Blockchain can help reduce reconciliation and other operational risks. The DTCC (Depository Trust and Clearing Corporation), a central book-keeper for trades in New York processing almost USD 1.6 quadrillion of trades annually, is currently rolling out blockchain solutions for its post-trade services.
- **Compliance:** Blockchain can significantly improve the current know-your-client (KYC) and compliance processes across banks by creating digital identities for clients, inter-operable across multiple platforms and institutions. The process would also allow clients to control the kind of information that is shared with the ability to keep track of authorizations.
- **Trade finance:** Blockchain can greatly enhance trade finance services currently offered by banks by leveraging smart contracts, which can automatically trigger contingent payments. This would help free up capital, and boost efficiency particularly among small businesses and

in emerging markets, where the bulk of transactions are still done on paper. Even today in China, almost three-quarters of trade or bill financing transactions are carried out on paper-based platforms.

- **FX transfers:** From early 2018, Bank of Tokyo-Mitsubishi UFJ is teaming up with six major banks from the US, Europe and Australia to start cross-border remittance services using blockchain. In doing so, blockchain could help improve speed and reduce transaction costs, relative to current processes.
- **Insurance claims:** A major bottleneck in the insurance industry is the claims management process, where often there are disputes between customers and insurers, and between insurers and reinsurers. Blockchain technology can solve the problem by time stamping and auditing insurance documents, and also embedding smart contracts that could automate payments once a payment-triggering event occurs.
- **Digital currencies:** Blockchain technology can be used to improve the inter-bank settlement system for existing mainstream currencies. Early this year, a few global banks decided to join a group led by UBS to create a digital cash system that would make payments via a ledger-based technology, known as the USC; please see Page 9 for more details on this.

Manufacturing

While blockchain might seem most applicable to service-driven industries, the opportunities in manufacturing are not to be underestimated, and we expect billions of dollars of savings or economic value being created. We see two areas where blockchain can have the biggest impact: supply chain and Internet of Things.

- **Supply chain:** Global manufacturing supply chains are currently opaque and suffer from significant inefficiencies. Blockchain can improve transparency through identification management, improve inventory management through transparent entry of activities, and manage product quality through verifiable transactions and by making payments faster through smart contracts. Walmart is already using blockchain technology to track its pork supplies from farms in China to its US stores.
- **IoT:** The distributive nature of blockchain technology can empower IoT units, such as smart sensors in industrial equipment, by making networks quicker and more resilient. For example, blockchain could allow a sensor in the manufacturing line to communicate directly with one at point-of-sale, bypassing the traditional hub, saving both time and money.

Healthcare

Healthcare companies generate around 5% of all the data generated globally, according to Bloomberg, but data is not widely shared, as patients are often uncomfortable sharing their medical history. Blockchain can solve some of the problems by providing anonymized clinical data as part of a distributed ledger, allowing inspection agencies like the US Food and Drug Administration (FDA) or research institutes to access only the relevant information, while maintaining patient confidentiality.

Public services

While government agencies maintain trusted records like the registration of births, marriages, property transfers or new companies, many records are still made on paper, and even where records are stored electroni-

cally, databases often work independently. Blockchain can help integrate databases, as well as maintaining the integrity and security of records. A good example is real estate registration. According to the American Land Title Association, about 30% of property titles in the US are found defective at the time of registration, due to a lack of a proper chain of titles. Blockchain's resilient and secure chain-based database could help resolve this kind of problem. It could also revolutionize the current electoral voting process by integrating identity management and cryptography to maintain the confidentiality, resilience, security, and integrity of an election.

Utilities

We are positive on the growth prospects for smart grids that use decentralized, smaller electricity generation resources, e.g. solar panels and energy storage (or even electric cars). Future smart grids will allow households to consume according to their needs, and even sell their surplus electricity back to the grid. Subject to regulation, blockchain could take the concept of smart grids to the next level by allowing users to conduct peer-to-peer transactions, i.e. selling power to consumers in their locality and collecting payments real-time through smart contracts.

Sharing economy

The sharing economy has been gaining traction in recent years as seen by the success of ride-sharing services like Uber or Didi, or home-sharing services like Airbnb. China is a global leader, and the government's State Information Center expects the sharing economy to account for 10% of its GDP in 2020, and around 20% by 2025. Blockchain's identity management solutions fit well with the sharing economy, by helping build trust and making networks more secure. In particular, blockchain could help manage the integrity of user reviews by making them difficult to alter. By embedding smart contracts, blockchain could also accelerate payments when pre-set conditions are met.

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Interview

Jennifer Zhu Scott is the co-founder and principal of Radian and Radian Blockchain Ventures, focusing on Artificial Intelligence, blockchain, and renewable energy. Before this, she was head of business development and strategy in APAC for Thomson Reuters and led the firm's speech-to-text, deep search, video-indexing projects. She co-founded one of the first education companies in China and exited before moving to the UK as a senior advisor to the education subsidiary of Daily Mail & General Trust. During 2014-16, Jennifer served as one of the 18 council members of China Council convened by the Global Agenda Council, the World Economic Forum's think-tank. She is currently serving as one of 20 members of the Council of The Future of Blockchain. In 2013, Jennifer was honored by WEF as a Young Global Leader. Jennifer studied Applied Mathematics at Sichuan University in China and also holds an MBA in Finance with Manchester Business School. She also studied public policy and leadership at Yale University in 2013 and Harvard Kennedy School in 2016. Jennifer is China Fellow of Aspen Institute and a permanent member of the Aspen Global Leadership Network.

Jennifer Zhu Scott, Co-founder and Principal, Radian and Radian Blockchain Ventures

Where are we in the blockchain cycle?

Two factors prohibit us from having a straightforward answer: a) There are uneven adoption speeds and hype between cryptocurrencies and every other application; and b) arguably, blockchain is the least understood disruptive technology at the moment. This lack of understanding, plus over-exuberance in the space contributes to an unhealthy hype in terms of what the technology can and cannot do. We need to realize that blockchain's applications are much narrower than the hype claims. But for the right applications, the implications and impacts are profound. Many people are starting to pay attention to blockchain due to the cryptocurrencies' price surge, which is an incomplete view that overlooks many other meaningful applications in identity, supply chain, etc. I would argue that the interest in blockchain is slightly over the peak of inflated expectations in the hype cycle, especially in the cryptocurrency space. Regulators' necessary interventions will stop some irresponsible actors and allow compliant and responsible players to leverage the technology's capabilities. However, there is a need to bring more attention to non-financial applications for blockchain.

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During the past decade, technology has helped create totally new business models like apps, social networking or the sharing economy. What new businesses could emerge from blockchain in the future?
If the internet has enabled people to share and transfer information, then blockchain technology will enable people to share and transfer value. Regardless of everyone's views on bitcoin, one undeniably powerful fact that bitcoin has demonstrated is that with blockchain, it is easy to create a decentralized peer-to-peer economy. This will empower and transform any online community-driven business, from e-commerce to social media. Blockchain will also change how people transfer and monitor online physical goods of value. The decentralized nature of blockchain makes fraud impossible; therefore, for tracing and tracking diamonds, art, wines, and some (not all) organic goods supplies and trades, adopting blockchain will become essential. I estimate such a necessity will be realized within the next three to five years. Smart contracts have the potential to reorganize how renewable energy is shared, distributed, and scaled. At Radian, it is important for us to be a positive and intelligent force as the renewable sector adopts smart contracts. For governments and large corporations, the applications and implications in identity, traceability and decentralized transactions are very real in a reasonable time horizon. I also believe that IoT related blockchain protocols will play a crucial role in the debates about data ownership in the coming 3-5 years. A new data trading, transaction and owning ecosystem will become possible in the foreseeable future.

Between developed and emerging markets, where do you see blockchain creating more impact?
In general, an absence of legacy issues is always an advantage in making emerging markets adopt faster than in the markets where existing infrastructure needs to be replaced or displaced. As an extreme example, deep in an economic collapse, many Venezuelans aren't trading gold, but bitcoins. I'm also aware of efforts being made by REFUNITE, an NGO serving refugees, to use distributed ledger and middleware to secure data, enable scalable transactional systems across its ecosystem and create a vibrant and inclusive network for communications and online transactions for the under-served population that has no access to internet. Having said that, the decentralized nature is also a threat to the countries that enforce capital controls. Most of these countries are emerging markets. We will see a mixed impact on different countries depending on the political system, regulatory environment, the availability of talent, etc.

Where is the biggest upside for blockchain? In B2C or B2B applications?
Neither. The most powerful upside of blockchain will be on C2C (consumer-to-consumer). The companies that are first to figure out how to use the decentralized nature to empower their individual customers, users or audience with the right incentives and infrastructure will be able to scale, fast and cheap. It's hard to compare and generalize B2C (business-to-consumer) and B2B (business-to-business) because it would really depend on each use case.

How will the user interface of blockchain evolve over the next few years?
I believe that moment will arrive faster than we realize. In the past six months, I have seen significant user-interface (UI) improvements in many blockchain applications. People who truly understand the underlying coding and math of blockchain are in the minority, just like there aren't many people who truly appreciate the complex technology behind iPhone screens. It's worth mentioning that we are at the infancy stage of a potentially multi-decade development and one day blockchain-enabled applications need to be as seamless as smartphones. We need to get to a place where ordinary users can intuitively interact with an application without realizing it is empowered by blockchain.

Any other key messages you would like to deliver on blockchain?
If we truly care about the long-term potential and impact that blockchain technology will have, a healthy dose of skepticism is urgently needed. I understand many people in this space are very passionate about the technology, the protocols of their interests, and all the potential that has been promised. Such passion disables them from taking any constructive criticism. It's very short-sighted. Not every solution needs to be decentralized. Several popular protocols still have a lot of work to do to prove themselves in terms of scalability and security. Blockchain application is not universal and can't solve every single problem. But if we find the right problems, the technology can be profoundly transformational.

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Interview

David Treat is a managing director and the global head of Accenture's Financial Services Blockchain practice, co-lead of Accenture's Firm-wide Blockchain Strategic Growth Initiative and manages Accenture's relationship with several large Financial Services clients. He is well known as an advocate for the power of Blockchain technologies. He most recently worked with Microsoft to build a digital ID network using blockchain technology, as part of a United Nations-supported project to provide legal identification for 1.1 billion people worldwide with no official documents.

David Treat, Managing Director, Financial Services, Blockchain Lead, Accenture

How do you see blockchain adoption at your customers over the next few years compared to previous software-driven cycles like office automation or cloud transition?

The pieces of the puzzle are coming together and will continue to move quickly. We're seeing enterprise leaders engaged and driving innovation; a flourishing start-up community; innovation coming from large tech companies across the full spectrum of technology; governments and regulators engaged; and consortia collaborating and providing a forum to discuss and set standards.

And the technology itself is continuing to mature, as we've seen through our evaluation framework. As with all major business transformations, challenges will arise from the risk, control and legal aspects of how new innovations are applied. The good news is that there is active engagement by legislators and regulators to understand and contribute to how blockchain technology will play out.

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Why should business processes transition to blockchain?
While not a panacea, this technology is already being deployed across industries, across processes and across the globe. Two of our broader themes are identity and supply chain / trade finance. With identity, for example, we are working with a UN-affiliated program called ID2020, in partnership with Microsoft and Avanade. Here, we are working to help address the digital identity challenges of more than 1.1 billion individuals. We demonstrated the proposed solution at the ID2020 Summit at the United Nations in June. It includes biometric innovations that we've had in the field for years with UNHCR, blockchain and a unique identifier (like a DNS). This project has broad commercial applications as well, and it illustrates how profoundly this technology can improve the way we live and work.

Other than Financials, which industries should be early adopters of blockchain?
We are seeing activity across all industries, from digital-rights management for musicians and artists; to track and trace for everything from diamonds and pharmaceuticals, to livestock and fashion; to greater transparency in financing trade; to simplification of real estate and lending; to data management in government and healthcare, and much more.

From a return on investment perspective, how do companies evaluate returns while investing in blockchain – from a revenue maximization or cost reduction?
We published a study earlier this year illustrating how and where eight of the ten largest investment banks would find the most value by implementing a blockchain solution. The study, which can be found (https://www.accenture.com/us-en/insight-banking-on-blockchain), found significant value across the middle and back office.

How will blockchain adoption differ in emerging markets compared to previous enterprise technologies?
One of the more significant differences may be a leapfrog effect, moving from paper-based processes to blockchain-based digital processes where appropriate. In addition, in emerging markets, blockchain-based systems will allow more individuals to have access to banking, education, healthcare, aid and more.

Enterprises will also clearly benefit, but their journey through the technology will require some dismantling of systems and, for blockchain to reach its full potential, a complete reimagination of how processes are run and business is conducted. While we're seeing really interesting projects emerge across the globe, we haven't even begun to scratch the surface.

Investing in the blockchain wave

Investing in the blockchain wave is akin to investing in the internet in the mid-nineties. Blockchain could lead to significant disruptive technologies in the coming decade. But for the time being, shortcomings with the technology still need to be resolved, it remains unclear which specific applications will prove most useful/profitable, and actual revenue and profitability associated with the industry is currently limited.

Resolving challenges
We see five particular challenges that need to be resolved:

- **Speed:** Despite a secure and resilient network, the current design of blockchain technology suffers from slower speeds due to performance-related challenges associated with data computation, storage, and transmission. For example, encryption requires significant computation capacity on each terminal, slowing down network performance. Increased users and transactions, and higher storage and transmission requirements may also slow speeds.
- **Regulatory challenges:** Blockchain is still perceived skeptically by regulators, thanks in part to the association with cryptocurrencies. Regulators may be uncomfortable that the anonymous or pseudonymous nature of blockchain transactions means regulators may not be able to fully monitor transactions. The legal system may also need to adjust to the existence of smart contracts. Data may also reside across national boundaries due to the distributive nature of databases, creating regulatory complexity.
- **Lack of talent:** With blockchain being an emerging technology, there is a serious shortage of talent globally, which may slow down adoption. In particular, integrating blockchain into business processes requires managers and senior executives to fully understand the concept, which is still a work in progress.
- **Integration challenges:** With many traditional business processes still expected to run on traditional databases even after blockchain projects are launched across corporations, integration challenges may arise in terms of how to integrate both databases and deal with the costs of switching and overhaul in related business processes. These integration challenges may force some companies and governments to take a wait-and-see approach.
- **Finding the right applications.** There are many processes which may not benefit meaningfully from blockchain. For example, while blockchain adoption would improve the payments network, we see limited need to overhaul the current retail payment processing system with blockchain. Retail payments using card networks are widely accepted, with reasonable transaction costs, and are real-time in nature with strong protection for both consumers and merchants. Similarly, while blockchain could conceptually be implemented in high-frequency trading, it is more cost efficient to settle balances at the end of the day versus in real-time for every transaction. Additionally, blockchain is unlikely to fully replace many traditional databases or networks running on standard protocols.

Investing today
Despite these challenges, we are confident that as blockchain technology matures, and with increased investments from large corporations and gov-

ernments, these teething problems will eventually be resolved, but it will take time.

Investors today seeking long-term opportunities from blockchain technology can start to position in two broad groups: technology enablers, and early & successful adopters.

Among technology enablers, we believe software companies stand to benefit from increased blockchain adoption as their solutions help run blockchain networks, and it also worth paying attention to semiconductor companies, as blockchain networks would increase demand for storage and particularly memory due to faster write-and-read speeds. Encryption of blockchain networks requires additional processing speed, benefiting companies exposed to semiconductors like application specific integrated circuits (ASIC) central processing units (CPUs), application processors, and graphics processing units (GPUs). Major technology platform companies who embrace blockchain technology would also be able to launch new products and services and further disrupt incumbent companies in other industries.

In incumbent industries, companies that are early movers and successfully adopt blockchain will reap the benefits of the technology both in the form of cost savings, and in the introduction of new products and services. We believe investors will be best rewarded by identifying these as beneficiaries. Conversely, we would avoid technology laggards in incumbent industries that fail to invest in blockchain technology, and those are most exposed to significant disruption risks.

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Interview

Bart Stephens is a Founder and Managing Partner of Blockchain Capital, the General Partner of Crypto Currency Partners. He is also a Managing Partner of Stephens Investment Management, LLC (SIM). Stephens Investment Management is a family owned and operated hedge fund and venture capital firm. Bart and his brother and Co-Founder Brad pioneered "Nanocap" investing – venture capital style investing in public markets focused on sub-micro-cap equities. Prior to co-founding SIM, Bart was Executive Vice President, Venture Capital for Ivanhoe Capital Corporation (ICC), an international investment firm. And before joining ICC, Bart was a founding investor and Head of Corporate & Business development for Oncology.com. Oncology.com grew to become the internet's largest cancer related web-site before being sold to Pharmacia (now Pfizer) in 2001.

Bart Stephens, Managing Partner and Co-founder, Blockchain Capital

How is blockchain positioned vis-à-vis previous technology cycles?
Blockchain is difficult to compare with previous technology cycles like the internet, cloud or social. It is not only a significant technology breakthrough in data architecture or in terms of security providing distributive or decentralized networks, but we also get a feeling of a major movement happening globally.

A lot of people attracted to bitcoin or ethereum, or the ideas that underpin these technologies, are connected based on political or philosophical ideas. A lot of technologists investing in blockchain or bitcoin are here not to make money but they want to be part of a new universe. They believe the financial system is broken after what happened in 2008 and the way financial institutions are interconnected. What is interesting about the cryptocurrency world is it is like a parallel universe as Wall Street and Cryptostreet don't intersect. In terms of the broader blockchain technology, we are in the early stages of the cycle as the technology is used to solve new business problems, which is threatening the status quo of incumbents in a frictionless way without the involvement of intermediaries.

How do you see blockchain technology's role in disruption?
When I sent my first email in the 90s, I was still in college and I was too narrowly focused and thought email was bad for US postal service. Fast forward 25 years, the internet has disrupted many businesses and not just postal service - whether it is E*Trade disrupting financial institutions or Amazon disrupting retailers. The internet has been a horizontal-enabling technology that has impacted every vertical. We see blockchain as being somewhat similar to internet. As one of the oldest VC firms investing in blockchain technology, we invest in companies that are set to disrupt financial services or legal services with smart contracts, or healthcare and, international trade. We see blockchain as not just a technology breakthrough but a social movement set to impact every single industry.

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How do you see the future of tokenization?

Most people like to focus on ICOs, which is about transactions. What is more important than the transaction is the idea about the tokenized networks, which we call Capitalism 2.0. Tokenized networks allow not just crowd-sourcing of capital, where they may attract investors or speculators but they also attract the future users of the company's technology that can build a strong ecosystem by generating significant value. It is a better meritocratic way to reward value creators, not passive investors or speculators.

How do you see the role of regulators evolving on blockchain technology?
What regulators got right with the US tech companies, where today the platform companies alone have a combined market cap of around USD 4 trillion, is they took a light-touch attitude during their initial days. Today, Silicon Valley is home to global innovation, and if not for a favorable regulatory regime during its early days, the spectacular growth we've seen wouldn't have been achieved. What we are trying to lobby with regulators is that blockchain technology represents the internet of value – it is crucial that we get this right, to allow the innovation to grow. Blockchain technology is transnational and the US regulators are doing a great job in trying to find a balance between regulating it and making sure the US remains competitive on a global basis. They are watching the space and in the process learning, and we hope they get it right and foster innovation in the country.

What are the challenges you see investing with blockchain networks?
The first and foremost risk is regulatory given the mixed messages from global regulators on the topic. The other risk is leadership risk as bitcoin is a leaderless movement focusing on decentralized or distributed networks. Finally, there is sociological risk as blockchain is a movement where the interests of most participants are aligned towards the lack of centralized networks, but the question is whether they continue to share the same values in the future. That being said, one risk blockchain doesn't have is technology risk as the open-source nature of technology is going to stay, with significant improvements seen in the future.

Any other key messages you would like to deliver on blockchain?
Blockchain technology is here to stay and if you don't have exposure to blockchain technology, start looking at it. Ignoring this technology would be like staring at the internet two decades back or even the last decade and missing the huge disruption and growth opportunities we have seen with the internet industry. Blockchain is a game-changing technology and we are only in the first innings.

End notes

[1] "Blind signatures for untraceable payments" D. Chum. 1983.

[2] Note: Timothy May referred to proof-of-work system as proof system.

[3] "The Crypto Anarchist Manifesto", Timothy C. May, https://www.activism.net/cypherpunk/crypto-anarchy.html, Accessed 25 September 2017.

[4] Bitcoinwiki. https://en.bitcoin.it/wiki/Wei_Dai. Accessed 27 September 2017.

[5] "b-money". W. Dai. http://www.weidai.com/bmoney.txt. Accessed 25 September 2017.

[6] Satoshi Nakamoto Institute. http://nakamotoinstitute.org/finney. Accessed 27 September 2017.

[7] "RPOW – Reusable Proofs of Work". Hal Finney. August 2004. http://nakamotoinstitute.org/finney/rpow/index.html. Accessed 28 September 2017.

[8] "Bit Gold". Nick Szabo. 29 December 2005. http://nakamotoinstitute.org/bit-gold/. Accessed 25 September 2017.

[9] A fact discovered by early European settlers in North America, who tried to purchase food and other essentials from the local population using gold coin as a medium of exchange. North American locals did not use gold as a medium of exchange, saw no practical use for gold whatsoever, and so rejected the exchange.

[10] Unfortunately, the Chin Dynasty printed money faster than they could engineer demand for it, and over time the system gave way to hyper-inflation. This is a clear demonstration of why money supply should be controlled by economists. Nonetheless, the point remains that throughout the rising inflation paper currency was demanded, and had some value, because taxes had to be settled using paper notes.

[11] There is no technical definition for what constitutes hyperinflation. However a decline in spending power of 50% over the course of a month (or any pro rata decline over a different time period) is generally considered to constitute hyperinflation. Measured in Bitcoins per dollar, Bitcoin's spending power declined 40% in the first two weeks of September 2017.

[12] There is a parallel with gold here. Gold is not considered currency in the United Kingdom – and gold bullion is subject to capital gains tax as with any other asset. However British gold coins produced by the Royal Mint (a sovereign or a Britannia) are considered currency and are not subject to capital gains tax.

Appendix

Terms and Abbreviations

Term / Abbreviation	Description / Definition	Term / Abbreviation	Description / Definition
A	actual i.e. 2010A	COM	Common shares
E	expected i.e. 2011E	GDP	Gross domestic product
Market cap	Number of all shares of a company (at the end of the quarter) times closing price	Shares o/s	Shares outstanding
UP	Underperform: The stock is expected to underperform the sector benchmark	CIO	UBS WM Chief Investment Office

Appendix

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