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11 January 2018
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The Credit Suisse Connections Series leverages our exceptional breadth of macro and micro research to deliver incisive cross-sector and cross-border thematic insights for our clients.

Research Analysts

Charles Brennan CFA
44 20 7883 4705
charles.brennan@credit-suisse.com

Brad Zelnick
212 325-6118
brad.zelnick@credit-suisse.com

Mathew Yates
44 20 7883 5370
mathew.yates@credit-suisse.com

Blockchain 2.0

CONNECTIONS SERIES

Cryptocurrencies are only the beginning

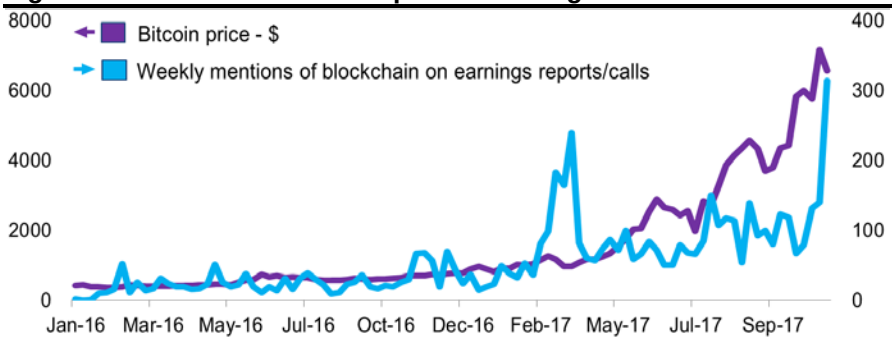
Launching the Credit Suisse Blockchain Revolution Series: In this in-depth report, we analyse the market implications of blockchain technology in light of the bitcoin boom since our initial cross-sector and cross-border publication, *Blockchain: The Trust Disrupter*, roughly a year ago. While we make no comment on the valuation of particular cryptocurrencies, we believe the rise of bitcoin and Initial Coin Offerings highlights how transformative the underpinning blockchain technology will be across sectors, with financial services and capital markets at the front of the queue.

Various blockchain projects we discussed in our previous report are arriving at preliminary conclusions, transitioning from Proof of Concept to Pilot and even Production phases of development. To contextualise these over the medium to long term, we once again deliver a collaborative analysis of the following:

- **Cryptocurrencies and ICOs:** Crucially, we see these providing momentum for further blockchain development, even if bitcoin and Initial Coin Offerings continue to encounter challenges to widespread adoption.
- **Blockchain's utility:** We examine the key advances and diversification of the applications that sit atop blockchain platforms – as well as the theoretical risks to blockchain itself. We also show project timelines to illustrate current and future positioning on the blockchain landscape.
- **Market implications:** Contributions from 23 analysts across three geographies provide us with a cross-sector blockchain window through which we examine the Payments, Security, Banks, Exchanges, Business Services, Leisure, and Real Estate sectors.

  Featured stocks include Sophos (Outperform; CS European SMID Focus List), Square (Neutral), LSE (Outperform; CS European Focus List), ASX (Underperform), Equiniti (Underperform), Experian (Outperform; CS European Focus List) and Playtech (Outperform).

Figure 1: Bitcoin's rise has corporates talking about blockchain



Source: Sentieo, Quartz - Jason Karaian, Credit Suisse research

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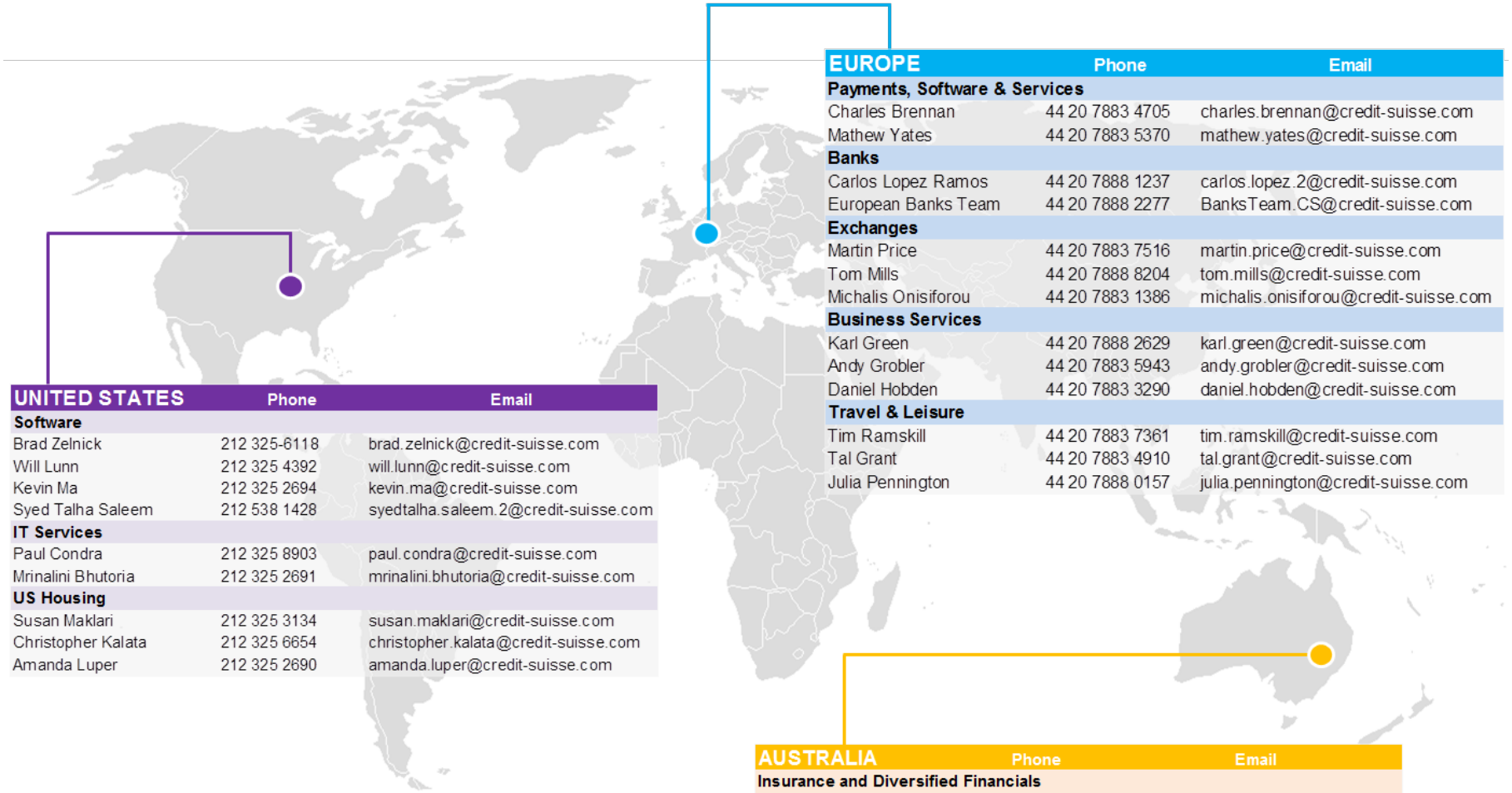
Differentiated research from **23** analysts, covering **9** sectors, across **3** geographies



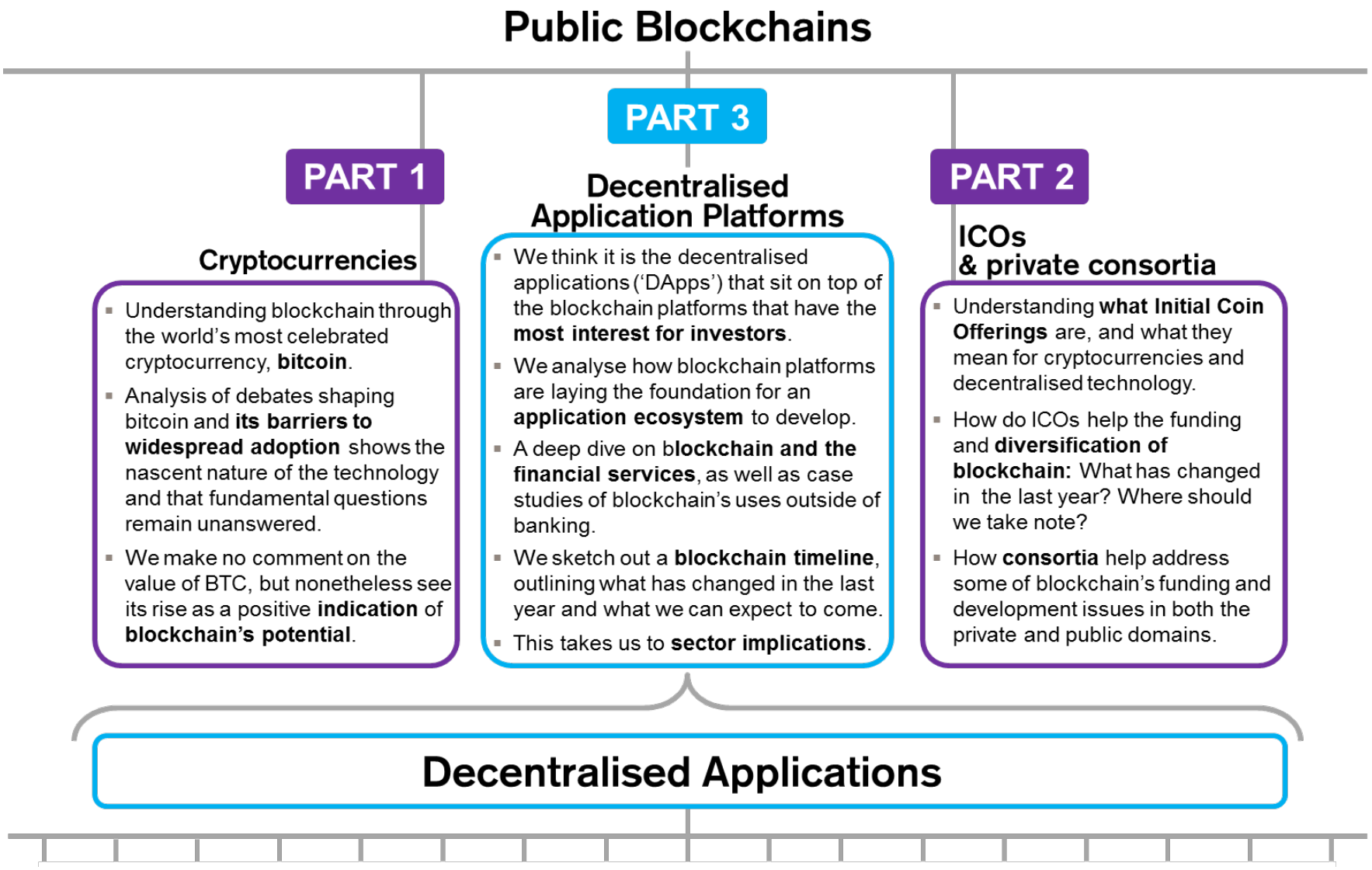
UNITED STATES	Phone	Email
Software		
Brad Zelnick	212 325-6118	brad.zelnick@credit-suisse.com
Will Lunn	212 325 4392	will.lunn@credit-suisse.com
Kevin Ma	212 325 2694	kevin.ma@credit-suisse.com
Syed Talha Saleem	212 538 1428	syedtalha.saleem.2@credit-suisse.com
IT Services		
Paul Condra	212 325 8903	paul.condra@credit-suisse.com
Mrinalini Bhutoria	212 325 2691	mrinalini.bhutoria@credit-suisse.com
US Housing		
Susan Maklari	212 325 3134	susan.maklari@credit-suisse.com
Christopher Kalata	212 325 6654	christopher.kalata@credit-suisse.com
Amanda Luper	212 325 2690	amanda.luper@credit-suisse.com

EUROPE	Phone	Email
Payments, Software & Services		
Charles Brennan	44 20 7883 4705	charles.brennan@credit-suisse.com
Mathew Yates	44 20 7883 5370	mathew.yates@credit-suisse.com
Banks		
Carlos Lopez Ramos	44 20 7888 1237	carlos.lopez.2@credit-suisse.com
European Banks Team	44 20 7888 2277	BanksTeam.CS@credit-suisse.com
Exchanges		
Martin Price	44 20 7883 7516	martin.price@credit-suisse.com
Tom Mills	44 20 7888 8204	tom.mills@credit-suisse.com
Michalis Onisiforou	44 20 7883 1386	michalis.onisiforou@credit-suisse.com
Business Services		
Karl Green	44 20 7888 2629	karl.green@credit-suisse.com
Andy Grobler	44 20 7883 5943	andy.grobler@credit-suisse.com
Daniel Hobden	44 20 7883 3290	daniel.hobden@credit-suisse.com
Travel & Leisure		
Tim Ramskill	44 20 7883 7361	tim.ramskill@credit-suisse.com
Tal Grant	44 20 7883 4910	tal.grant@credit-suisse.com
Julia Pennington	44 20 7888 0157	julia.pennington@credit-suisse.com

AUSTRALIA	Phone	Email
Insurance and Diversified Financials		
Andrew Adams	61 2 8205 4106	andrew.adams@credit-suisse.com
James Cordukes	61 2 8205 4858	james.cordukes@credit-suisse.com

Research map – the blockchain ecosystem

Figure 2: Contextualising analysis – mapping out our decentralised future



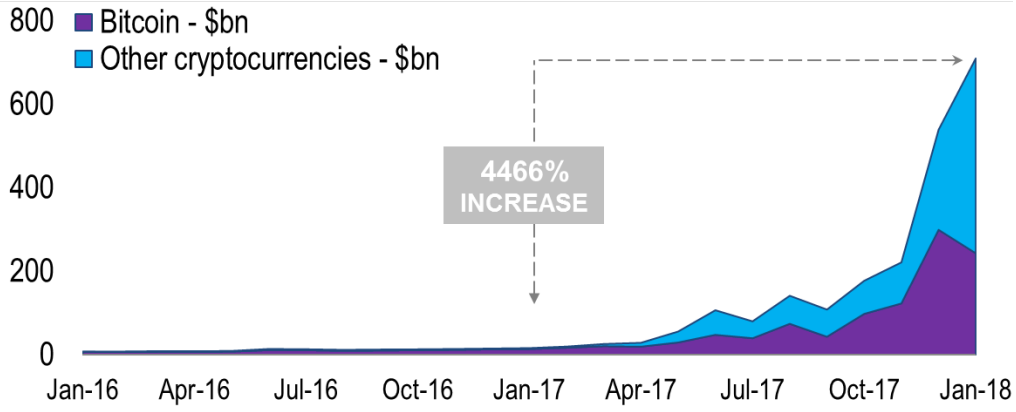
Source: Credit Suisse research, Blockchain ecosystem map inspired by p.20 of the CoinDesk.com - State of Blockchain Q2 2017 report

Executive summary

Implications of blockchain becoming clear

Since we published our cross-sector and cross-border report, *Blockchain: The Trust Disrupter* (3 August 2016) the blockchain landscape has changed significantly. Rarely a day passes without bitcoin and a plethora of new cryptocurrencies making headlines: Although exact figures are hard to come by, when we published *The Trust Disrupter*, the estimated total market cap for all cryptocurrencies in existence was roughly $12bn. Today it sits at well over $700bn, an increase of more than 4,000% — see Figure 3.

Figure 3: Market cap of cryptocurrencies has grown over 4,000% since Jan 2017



Source: Credit Suisse research, coinmarketcap.com – 10 January 2018

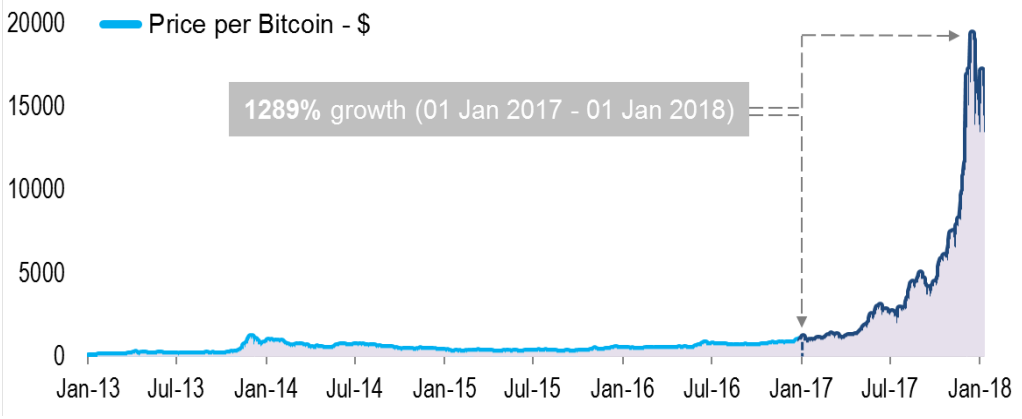
Please note: Ahead of our analysis we wish to highlight that this report draws upon a variety of sources in its mapping of the blockchain (and thereby cryptocurrency) landscape. While every effort has been made to investigate and verify the authenticity and reliability of these sources, we highlight that – given the nascent and fast-developing nature of this space – certain companies that provide data on cryptocurrencies may directly or indirectly benefit from the continued financial performance of certain technologies and cryptocurrencies. We do not within this report make any judgement on the valuation or feasibility of any cryptocurrency; we seek only to use the emergence of such a dynamic phenomenon and the available data as a lens through which we can examine the developments of the blockchain space in the last year or so.

'Cryptocurrency mania' – Part 1

It's difficult to remove bitcoin from an analysis of blockchain, so we begin our analysis by focusing on the most famous application of blockchain technology to date. Bitcoin was originally designed as a system to allow online (i.e. digital) payments to be sent directly from one party to another, without the need for a trusted third party (i.e. a financial institution). So first and foremost, bitcoin was designed as a payments system.

Bitcoin's sharp rise in the past year has more recently been accompanied by a surge in the popularity of Initial Coin Offerings (ICO)—a process in which tokens or digital currencies are issued in return for funding. These unregulated and at times controversial rounds of funding have started to grab the attention of the media, investors—and regulators—alike.

Figure 4: Bitcoin has risen over ~1200% in the past 12 months



Source: Credit Suisse research, coindesk.com – 10 January 2018

The performance of bitcoin and newly emerging cryptocurrencies, notably in the past six months, has intensified debates on the stability and sustainability of the digital currencies – see Figure 4. For instance, we note that although bitcoin's value has soared in the past 12 months, there has not been a proportional explosion in transactional volume. Indeed, as we later explore, the number of daily bitcoin transactions has remained roughly at the same level.

Around 12 months ago, bitcoin essentially *was* the cryptocurrency market. Since then, c900 different cryptocurrencies have launched, pushing bitcoin's share of the total cryptocurrency down to a minority share at roughly 40%, despite the historic gains of the currency in the past 12 months - see Figure 3.

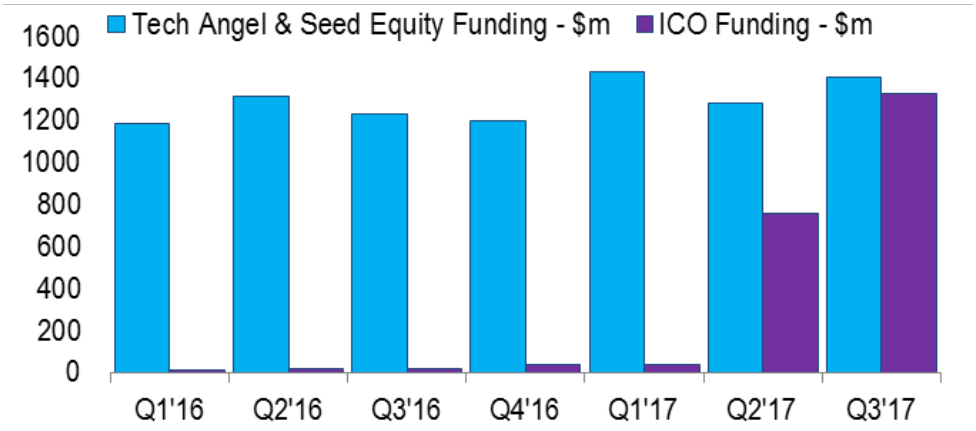
We continue to think the technical and ideological debates around the scalability and sustainability of digital currencies – which we cover in this report – will in aggregate result in bitcoin and other cryptocurrencies remaining niche payment networks for the foreseeable future. We make no comment on the value of bitcoin and other cryptocurrencies; rather, our work indicates that cryptocurrencies are primarily being used as digital stores and speculative vehicles of value – not digital systems poised to disrupt the existing payments space in the near term.

From an equity market perspective, therefore, we have no strong view on bitcoin and other cryptos currently. We are primarily interested in the technological – i.e. blockchain – implications of the crypto boom, and find it difficult to contextualise digital currencies during this intense period of speculation. We think cryptocurrencies are only the beginning of a potential revolution in how information is transacted and verified across the world.

Initial Coin Offerings – Part 2

The recent sharp rise in Initial Coin Offerings (ICO) appears to have more than doubled the size of the cryptocurrency market – to over $700bn – in a matter of weeks. Between 2014 and the end of 2016, a total of $295m was raised in ICOs, whereas over $3bn was raised last year alone, according to industry data.

Figure 5: ICO funding has almost surpassed angel and seed funding in tech



Source: Credit Suisse research,, CB Insights, TokenData, CoinSchedule

Instead of raising funds from the public in dollars or euros, investors in ICOs pay in cryptocurrencies, such as bitcoin and ether. In return for the investment, they receive a 'coin' or 'token', which essentially is meant to function similar to a share. The offerings have been used for a wide range of initiatives, ranging from new cryptocurrencies to charitable fundraising. ICO funding for tech projects and startups almost surpassed traditional Angel and Seed equity funding rounds in 3Q'17 – see Figure 5.

As of November 2017, there were around 50 ICOs taking place each month, with funding reaching record highs and fuelling the general enthusiasm around cryptocurrencies, of which there are now over 1,000 available online.

The second section of the report thus outlines the trends behind the ICO boom (as well as the recent increase in regulatory scrutiny, including by the SEC—see page 27). We also discuss the rise of blockchain consortia, which act as a sort of blockchain public/private 'hybrid' vehicle for collaboration; sitting between private, permissioned distributed ledger technology projects on one side and open, public blockchain collaborations – such as bitcoin – on the other. As with ICOs, the popularity of consortia increased sharply in 2017 – research by Deloitte estimates that to date more than 40 consortia have been formed globally – with most of these having been established in the last 6 months.[1]

[1] https://dupress.deloitte.com/dup-us-en/focus/signals-for-strategists/emergence-of-blockchain-consortia.html

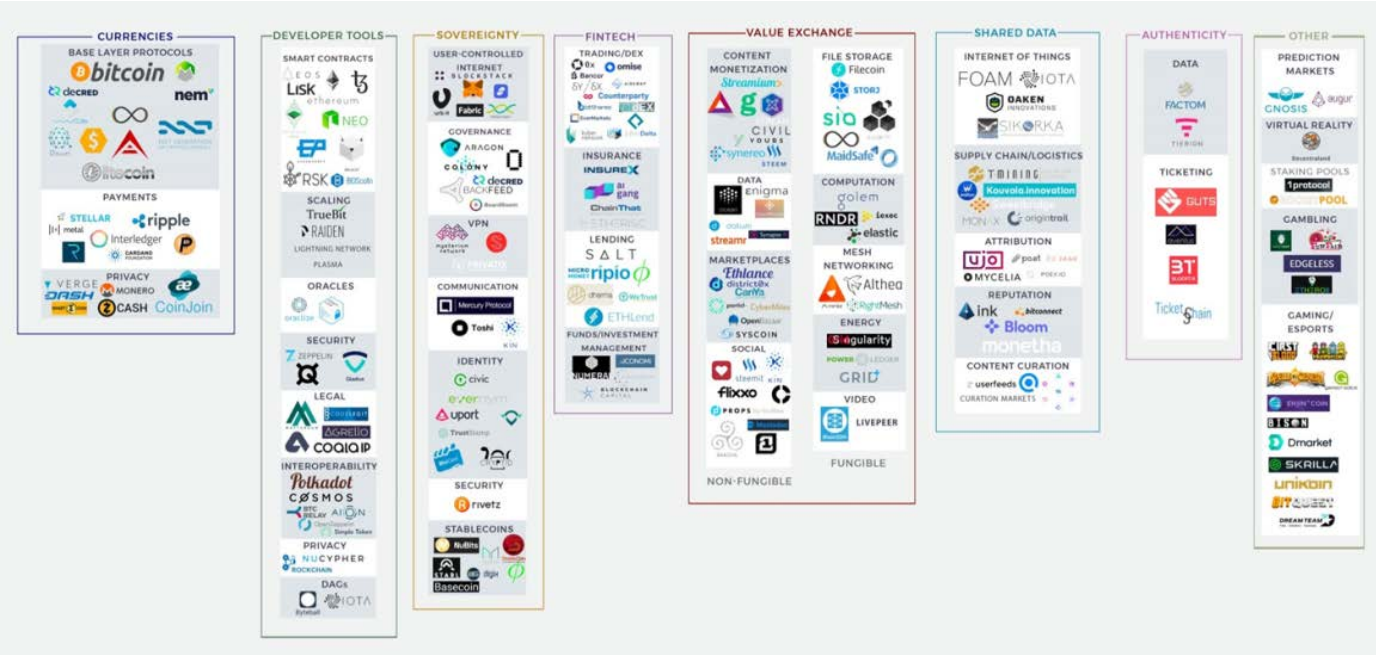
Blockchain's utility and applications – Part 3

Analysing 'cryptos', ICOs and consortia helps us to map out what has changed in the blockchain space in the past 12-18 months. It is only when we contextualise the extraordinary developments of the past year – which have in the space of a few months come to dominate the discourse around blockchain – that we can begin to see what might be in store.

In the third part of our analysis we therefore turn to look at the development of public blockchain platforms, on which a handful of blockchain project seeds have begun to germinate. These seeds give an insight into the real-world, commercial potential of blockchain technology outside of bitcoin and other cryptos: in time they could provide the infrastructure on which an entire ecosystem of blockchain ideas and concepts could flourish.

While these projects remain in the early stages of development – many are still in a Proof of Concept/Prototype phase and there are theoretical risks to blockchain itself – we can nonetheless start to see how blockchain might transform a range of industries, from energy and utilities, to charity and humanitarian efforts. See Figure 6 for a selection of current projects contributing to this blockchain ecosystem.

Figure 6: The blockchain application ecosystem is expanding and diversifying[2]



Source: Company data, Compound - Josh Nussbaum

[2] https://medium.com/@josh_nussbaum/blockchain-project-ecosystem-8940ababaf27

Market implications

We think cryptocurrencies such as bitcoin are only the beginning of what's in store—the initial manifestation of a technology that will help shape how we communicate, trust, and transact in the future. In the final section of this report, we examine the implications of blockchain on Security, Payments, Banks, Exchanges, Business Services, Travel & Leisure, and Real Estate.

The analysis pulls together contributions from 23 analysts, spanning nine sectors and three geographies. In this section, featured stocks include Sophos (Outperform; CS European SMID Focus List), Square (Neutral), LSE (Outperform; CS European Focus List), ASX (Underperform), Equiniti (Underperform), Experian (Outperform; CS European Focus List) and Playtech (Outperform).

- Building upon Unintended consequences: cryptos and security, Brad Zelnick, Kevin Ma and Syed Talha Saleem outline the implications of blockchain on the **Security** software sector. They note that as interest in blockchain has risen there has been increased speculation that future systems predicated on blockchain technology have the potential to be substantially more threat-resistant than those based on more traditional protocols. Brad and team further outline the theoretical risks to blockchain's security, such as "double-spending" and "51% attacks." This also includes an assessment of the implications of quantum computing on blockchain; in particular, there are two quantum algorithms that pose potential threats to blockchain and security in general: Shor's and Grover's algorithms.
- We conclude the Security section of analysis with a stock view of **Sophos** (Outperform), a report in which Charles Brennan and Mathew Yates note how cryptocurrencies can make it easier for cyber criminals to monetise crime: as cryptocurrencies offer a secure and often untraceable method of sending and receiving payments, making them an ideal currency for those who wish their financial activities to remain hidden from authorities.
- We then turn our attention to **Payments**, where Charles Brennan and Mathew Yates briefly outline a number of barriers to the more widespread adoption of cryptocurrencies as a payment method. Paul Condra and Mrinalini Bhutoria then take a stock view of **Square** (Neutral), where they examine the revenue potential of Square's piloting of bitcoin sales via its Square Cash app. In their scenario analysis, they estimate that if Square can accumulate 10m bitcoin buyers over two years (tracking Coinbase's growth), this could drive an incremental $30m in revenue (~2% additional growth to the current forecast).
- Carlos Lopez Ramos and the CS **European Banks** team then provide us with an overview of blockchain from a European banking perspective. In particular they flag that while blockchain collaboration in banking is becoming increasingly pervasive and will no doubt play a key role in the future of the sector, potential efficiency savings are uncertain, difficult to corroborate and given the long-term nature are not a key consideration for bank investors currently.
- This takes us to an analysis of the **Exchanges** space by Martin Price, Tom Mills and Michalis Onisiforou, in which they outline the major opportunities – and hurdles – posed by blockchain. For the **London Stock Exchange** (Outperform), the Exchanges team highlights how blockchain poses more opportunity than threat and that the existing market infrastructure providers are thus best placed to apply blockchain technology, with the team seeing little risk of disintermediation in the near future.
- Our Australian colleagues Andrew Adams and James Cordukes then provide another Exchanges stock overview; this time of **ASX** (Underperform), which has recently announced that it intends to use blockchain to manage the clearing and settling of equities. They note that at this stage, the financial outcome of ASX's Distributed Ledger

Technology-based settlement service is difficult to determine with pricing yet to be agreed with clients and fees payable to Digital Asset also unknown. As such, the authors highlight that the shift to blockchain-underpinned technology may not necessarily be accretive for ASX at this stage.

- From a **Business Services** perspective, Karl Green, Andy Grobler and Daniel Hobden explain how and why they continue to see immense potential for blockchain technology to improve efficiency and reduce friction across a broad range of private and public sector administrative processes over the long term. However, as the debate has migrated from the theoretical to the practical, the team believe that the roll-out of blockchain applications is likely to be slower and more complicated than initially envisaged.
- The Business Services section includes stock takes on **Equiniti** (Underperform), which provides administration and payment services across the UK. While the team are bearish on the stock due to concerns around slowing organic growth, they continue to see limited risk to the core strategy and the opportunity for EQN to make cost savings as blockchain is adopted through its ecosystem. In looking at **Experian** (Outperform), the team further note how, following the Equifax breach in September 2017, there have been an increasing number of suggestions that credit bureaus should be replaced by decentralised blockchain technology. Nonetheless, Andy and team continue to feel that the value of having regulated third-party entities at the heart of the credit economy will be maintained.
- We then turn to **Travel & Leisure**, where Tal Grant, Tim Ramskill and Julia Pennington outline how blockchain technology and cryptocurrencies may help drive increased adoption of online gambling and do not appear to represent a significant threat to incumbent players. The team takes a look at **Playtech** (Outperform), which is making money out of blockchain technology and cryptocurrencies by: 1) Allowing users to trade the spreads on different cryptocurrencies, and 2) Supplying gaming content to casinos that accept cryptocurrencies as payment.
- Finally, Susan Maklari, Christopher Kalata, and Amanda Luper form the **US Housing** team take an overview of blockchain from a Real Estate perspective, noting that blockchain offers significant potential in the form of streamlining the purchase and sale of land & buildings, as it eliminates human error and prevents data loss. In an industry that has undergone relatively little change to date, this view is formed by the need for businesses to adjust for higher land and input costs as well as to adapt to secular shifts in the construction labour force. They argue that blockchain is poised to revolutionise real estate in ways of simplifying property ownership and provide greater transparency.

Industry expertise

Is there really “one chain to rule them all”? What are the key impediments to widespread adoption? How long will it be before we see blockchain become truly mainstream? Why are blockchain-based applications or infrastructure better suited to solving enterprise problems?

In light of such questions, we end the report with some insights from an interview our US colleagues conducted with Maxwell Stein and Griffin Anderson at **ConsenSys**. ConsenSys is a leading blockchain venture production studio building decentralised applications and various developer and end-user tools for blockchain ecosystems, primarily focused on Ethereum.

PART 1

Cryptocurrencies

What happened to bitcoin in 2017?

Is it a store of value?

What are their barriers to adoption?

What are the security implications?

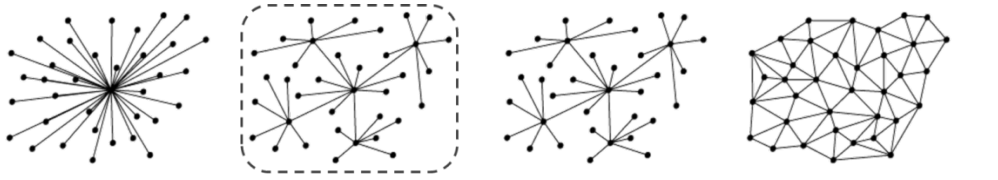
What does this all show?

Part 1: Cryptocurrencies

Understanding blockchain through bitcoin

Bitcoin (BTC) is the most developed system predicated on blockchain. It is a decentralised, permissionless public ledger peer-to-peer payment network whereby transactions are verified by nodes in the network and recorded in the public distributed ledger (the blockchain). Understanding the underpinnings of the bitcoin network explains why a significant proportion of investor interest has focussed on the payments industry when coming to terms with blockchain.

Figure 7: How nodes/members of a network connect at each level of a ledger



Source: Credit Suisse research based on data from Consult Hyperion and On Distributed Communications Networks by Paul Baran, 1962

The performance of bitcoin and newly emerging cryptocurrencies, notably in the past six months, has intensified debates on the stability and sustainability of the digital currencies. JP Morgan CEO Jamie Dimon's comment in September that bitcoin was "a fraud" led to bitcoin dropping almost 10% in the days that followed.[3] Bitcoin advocates, including John McAfee, hit back and so the debates continue[4] (with Dimon more recently saying he regretted calling bitcoin a fraud ("The blockchain is real… The bitcoin to me was always what the governments are gonna feel about bitcoin as it gets really big, and I just have a different opinion than other people.").[5]

We also note that a survey by blockchain research website coindesk.com revealed that 58% of its readers believe that digital asset valuations are in a bubble, while 72% believe bitcoin mining is too centralised, with over half expecting it to get worse.[6]

Figure 8: 2Q 2017 blockchain survey

Source: CoinDesk.com - State of Blockchain Q2 2017

[3] https://www.theguardian.com/technology/2017/sep/13/bitcoin-fraud-jp-morgan-cryptocurrency-drug-dealers

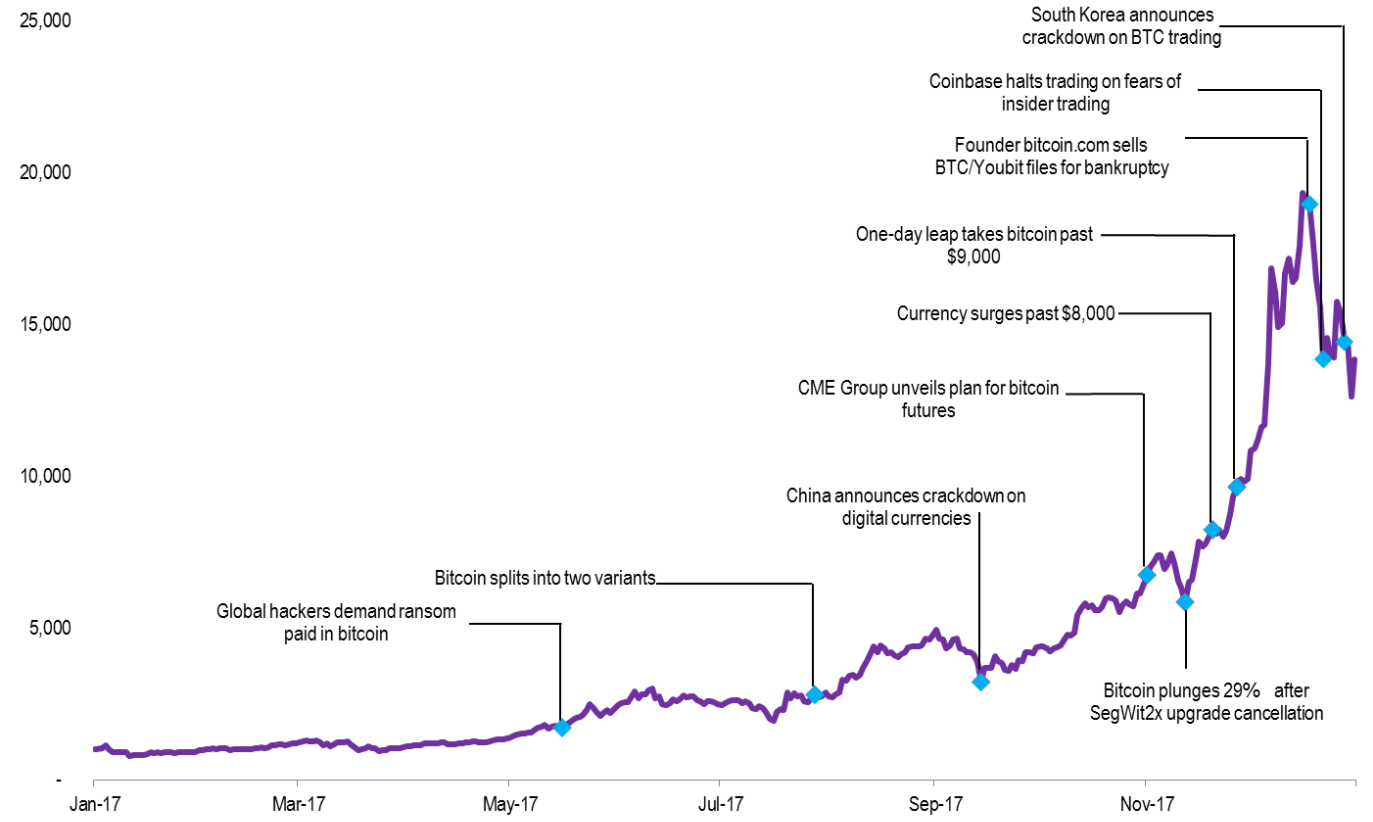
[4] https://www.cnbc.com/2017/09/13/john-mcafee-challenges-jamie-dimon-bitcoin-skepticism.html

[5] http://www.foxbusiness.com/markets/2018/01/09/exclusive-jpmorgan-chase-chairman-ceo-jamie-dimon-regrets-saying-bitcoin-is-fraud-but-still-isnt-interested-in-it.html

[6] https://media.coindesk.com/uploads/2017/09/state_of_blockchain_q2_2017.pdf

About 12 months ago bitcoin essentially *was the* cryptocurrency market. Since then, c900 different cryptocurrencies have launched, meaning that bitcoin is now straddling 40% of the total cryptocurrency market. Specifically, bitcoin has seen its price rise more than tenfold since January 2017. Figure 9 documents the life-cycle of the cryptocurrency since then – illustrating key events, such as the announcement by the CME of the intention to permit the trading of bitcoin futures. Intense price swings have drawn in traders in search of relief from low-volatility markets, while media and regulatory attention has broadened awareness of the digital currency among institutional and retail investors alike. BTC's gains have grabbed headlines on a global scale, making it difficult to draw out the debates that will ultimately determine bitcoin's path to mainstream adoption. We examine these in further detail below.

Figure 9: Bitcoin – a year in review



Source: CoinDesk.com, Credit Suisse research, Bloomberg news

Bitcoin – the debates continue

Shortcut to Bitcoin's barriers to dominance – a recap.

The scalability issues around bitcoin have given rise to several debates that are both political and technical in nature. When creating the digital currency, Satoshi Nakamoto – the developer/s behind bitcoin – introduced a block size limit of 1 megabyte (MB). This was to prevent potential attacks from hackers that would otherwise be able to theoretically create blocks of an infinite size and flood the network, thereby paralysing the blockchain. The limit of 1MB means that one block can support roughly 3-7 bitcoin transactions per second. The spike in activity has therefore pushed the limits of bitcoin's network capacity. The average block size has been approaching the 1MB limit – see Figure 10. Furthermore, increased demand on the network has at times created a backlog in the system, meaning that users must pay for their transactions to be prioritised by miners of the network –

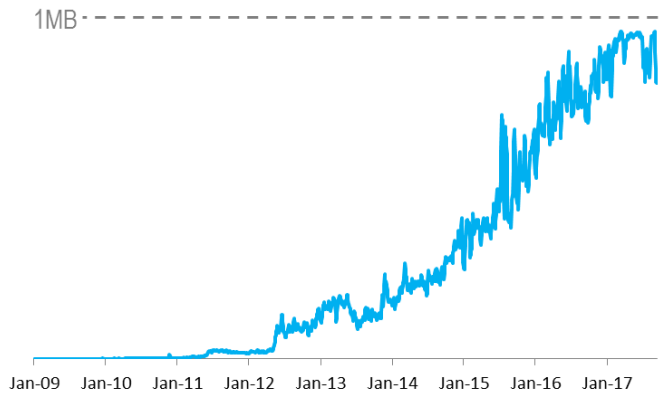
known as the "replace-by-fee" system. This has pushed transaction costs higher and made bitcoin increasingly expensive and inaccessible – see Figure 11. Indeed, the average fee at the time of writing for a transaction to be included in the next six blocks is roughly $30,[7] making bitcoin much more expensive than existing payment infrastructure for smaller-sized transactions.

The question of how to upgrade the network to handle even more transactions is pushing fees so high that, for certain transactions, bitcoin is nearly unusable. In June 2017 – when the BTC price was a sixth of what it is today – Forbes reported that transactions were taking days to go through, or not being processed at all, with the average fee at the time costing $4.75 (as of 07 January 2018 it was in the region of $30).[8]

Both transaction times and fee sizes have been increasing, adding to bitcoin's existential quandary. Furthermore, commentators note that claims for bitcoin's value are self-referential and contain inherent contradictions, notably that bitcoin cannot be a speculative investment prone to quintupling while at the same time be a useful currency for making or receiving payments: "If it cannot be both, it must be neither" concluded the FT's Lex columnists.[9]

Aside from potential speculative gains/losses, bitcoin buyers may purchase the cryptocurrency to spend at retailers, such as Dell and Overstock, or on coffee and pizza.[10] For instance, using bitcoin to purchase items in some instances may earn shoppers a discount: Purse.io and Foldapp are two bitcoin startups that offered discounts to bitcoin users who shopped at Amazon, Starbucks and Target.[11] Furthermore, as we later cover in this report, owning bitcoin is often a necessary prerequisite for those interested in taking part in an Initial Coin Offering: instead of raising funds from the public in dollars or euros, participants in ICOs pay in cryptocurrencies, such as bitcoin and ether.

Figure 10: Avg. total block size – MB (2009 >)



Source: Credit Suisse research, blockchain.info

Figure 11: Miners revenues / no. of transactions - $

Source: Credit Suisse research, blockchain.info

[7] https://bitinfocharts.com/comparison/bitcoin-transactionfees.html

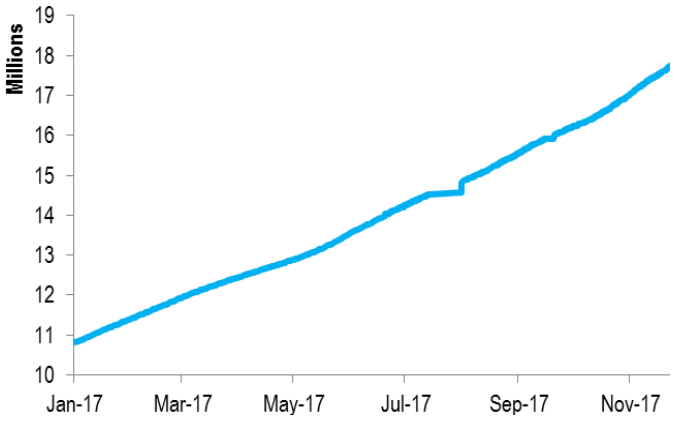
[8] https://www.forbes.com/sites/laurashin/2017/06/07/bitcoin-is-at-an-all-time-high-but-is-it-about-to-self-destruct/#6d26108ccb31

[9] https://www.ft.com/content/e5ed2e98-9875-11e7-b83c-9588e51488a0

[10] https://www.makeuseof.com/tag/bitcoins-actually-used-now-2016/

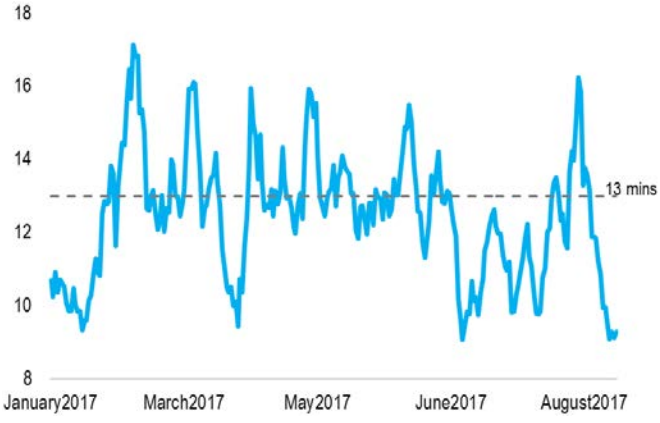
[11] http://www.nasdaq.com/article/its-2016-what-are-bitcoins-real-use-cases-cm611665

Figure 12: Total no. of BTC wallets created



Source: Credit Suisse research, blockchain.info

Figure 13: Median confirmation time – mins



Source: Credit Suisse research, blockchain.info

The fork(s) in the road

In apparent recognition of these issues, bitcoin went through what is known as a 'hard fork' on 1st August 2017, which gave birth to bitcoin cash (BCH). Bitcoin cash is a fork of bitcoin, which would inherit the transactional history of bitcoin but from that point behave as a separate-but-related bitcoin currency. One of the reasons for its launch was that certain members of the bitcoin community felt that previous Bitcoin Improvement Proposals (BIP) (such as the SegWit 'soft fork' earlier in the year) were not adequately addressing bitcoin's growing problems and favoured those who wished to treat bitcoin as a digital asset and not a digital currency (more on this later). Specifically BCH increased the total block size to 8MB, in order to improve BTC's transactional efficiency. Bitcoin can process about 3-7 transactions per second (TPS), while Ethereum's tops out at about 20 TPS. Meanwhile, Visa typically processes over 1,500 transactions per second.

A 'hard fork' occurs when a new rule is introduced, one that is no longer compatible with old software. If you do not join the upgraded version of the blockchain, you do not get access to the new system's user base and transactional traffic. Think PlayStation 3 and PlayStation 4: In a hard fork, you cannot play PS3 games on PS4 and you cannot play PS4 games on PS3. Should a soft fork take place, sticking with the PlayStation analogy, you would be able to play PS3 games on the PS4 (but not PS4 games on PS3).

The issue of how to address bitcoin's mounting problems – via a hard or soft fork – remains controversial. In BCH's case, increasing the size of the block to 8MB will not by default lead to a wider adoption of the currency – indeed, one of the most popular cryptocurrency exchanges, Coinbase, rejected BCH upon its inception.[12]

Furthermore, increasing the size limit will put greater pressure on the miners of bitcoin and the nodes of the network, leading to a centralisation of the network, as smaller miners (who do not have the required computational power to host the full c150 gigabyte bitcoin blockchain) are unable to process transactions. Thus the network itself also needs to be scaled to avoid larger mining groups creating monopolistic positions in the market[13]. An examination of trends in bitcoin's processing, storage, and ownerships reveals significant levels of centralisation in the cryptocurrency's core infrastructure.

Another hard fork on the way is Bitcoin Gold (BTG), which will seek to improve the technology behind bitcoin by changing how its competition for rewards is conducted. BTG seeks to achieve two goals: 1. make it so powerful that mining systems known as ASICs can no longer be used (changing bitcoin's proof-of-work algorithm), and 2: free bitcoin

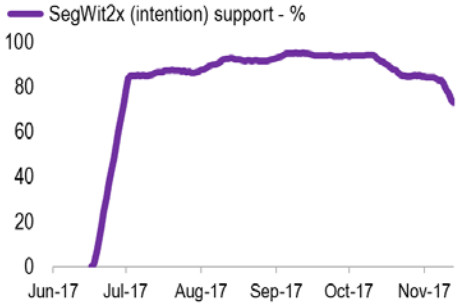
[12] Coinbase announced at a later date that they would look into supporting BCH in 2018.

[13] https://cointelegraph.com/news/bitmains-mining-monopoly-compromises-bitcoins-decentralized-nature

from the large companies that have come to dominate the bitcoin network. We analyse these two issues in greater detail in the next section, *Recentralisation: mining and ownership of bitcoin*. The point of BTG is to "make bitcoin decentralised again" and take the cryptocurrency back to its egalitarian roots.[14] And as with all forks, BTG is not free from controversy – some bitcoin developers are sceptical about whether the project will in reality be able to decentralise the mining as planned.

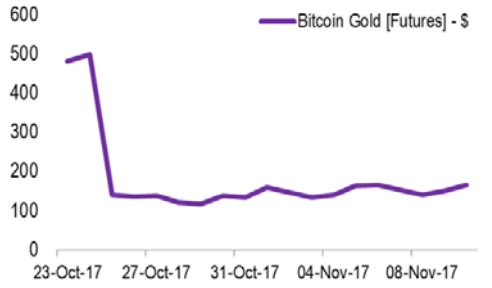
Lastly there is Segwit2x - or "2x", a follow-up to the August 2017 Segregated Witness (SegWit) soft fork, which improved the transactional capacity of the current bitcoin blockchain and, as a soft fork, was compatible with all previous version of the bitcoin software. 2x is a hard fork, and if adopted will make certain changes to BTC's rules, changing the size of the blocks passed regularly around the network and stored in the bitcoin blockchain from 1MB to 2MB. Yet again, controversy surrounds the proposed fork, with debates around 2x's stability becoming very heated online. In contrast to BTG, an argument against the 2x fork is that it will give miners and businesses too much power, resulting in a centralisation of decision making.[15] Segwit2x's adoption looked all but certain until early November, when support for the move suddenly dropped and its advocates called off the fork – at least for the time being – see Figure 14.

Figure 14: Hard fork SegWit2x support drops suddenly



Source: Credit Suisse research, coin.dance

Figure 15: BTG Futures plummeted upon their inception



Source: Credit Suisse research, coinmarketcap.com

Examining the essentials of these forks and the debates that underpin them is helpful for developing an understanding of the stability and security of cryptocurrencies and the kinds of issues that blockchain technology encounters when utilised in practice. Such points of contention and uncertainty reinforce our view that cryptocurrencies will remain niche payment networks for some time, functioning more as a digital asset class for a select and central group of people. Nonetheless, they demonstrate the tangible and disruptive implications of decentralised technology in a particular field and underscore blockchain's place in our future.

Recentralisation: crypto mining and ownership

Bitcoin is enabled by a network of computers running bitcoin mining software. This software consists of a copy of all past bitcoin transactions in the form of a blockchain (currently c.150GB), and a program which connects to peers in the network and follows a set of rules to authenticate new transactions and add blocks of these to the chain. The bitcoin blockchain relies on cryptography to secure the payment network and requires that miners produce hashes, which encrypt transactions and add to the BTC ledger.

In a similar way that gold miners allocate capital to buy equipment and dig in search of the precious metal, bitcoin miners acquire specialised hardware, because every block rewards the miner with BTC. Currently, each successful miner of a block is allowed to write code into their finished block to pay themselves a defined amount of newly created coins. The devotion of computing power by miners acts as a proof of commitment to the blockchain.

[14] https://www.coindesk.com/bitcoin-gold-know-blockchains-next-split/

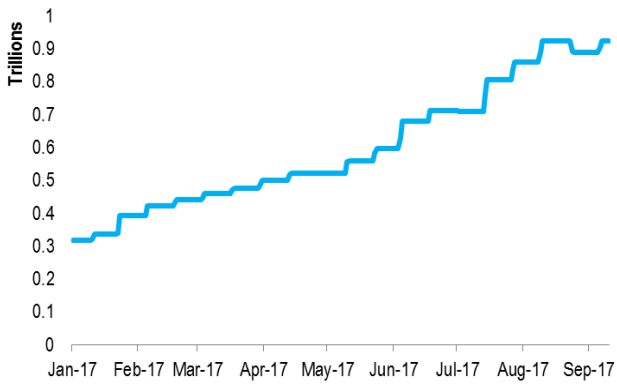
[15] https://www.coindesk.com/understanding-segwit2x-bitcoins-next-fork-might-different/

As we later cover, this reward is programmed to halve every 210,000 blocks – roughly four years, capping the ultimate supply of BTC at 21m. Clearly, miners' revenue streams are contingent on 1) the value of bitcoin, and 2) the reward era's BTC payout per block (currently 12.5 BTC – Figure 23). Thus in theory miners tend to be rational economic actors, and therefore will produce where marginal revenue is equal to marginal cost. Fixed costs for miners are mainly the purchase of specialised mining computers, while variable costs includes the power bill of running bitcoin mining equipment.

A hash function is any computation which transforms input data of any size to output data of a fixed size. The input message can be any sort of data (text, character strings, binary etc.), of any length. A specific set of mathematical transformations are then applied to this message to create a fixed size output (in bits). Each time miners perform the hash function on bitcoin's block "header" with a new random number, they end up with a new result. To win the mining "lottery" they must find a hash which begins with a certain number of zeros – how many zeros exactly is predetermined by how much processing is currently contributing to the bitcoin network at that time: roughly every two weeks mining software will set the number of zeros needed – known as the "difficulty level" (see Figure 16).

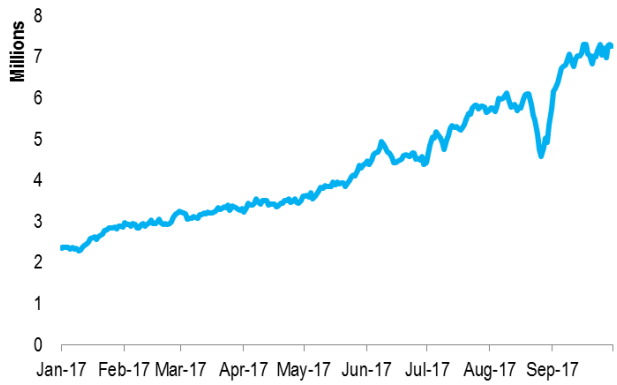
In short, the chance of winning the BTC "lottery" depends upon the speed at which a miner can generate a new hash, relative to the other miners. Thus, like lottery, the more tickets – or in this case connected mining rigs – you have, the more likely you will win and solve the transaction in return for BTC payment.

Figure 16: Relative measure of how difficult it is to find a new block



Source: Credit Suisse research, blockchain.info

Figure 17: Total number of tera-hashes per second the bitcoin network is performing



Source: Credit Suisse research, blockchain.info

Bitcoin's price is directly proportional to the amount of electricity that can profitably be used in the mining process. The more lucrative the price of bitcoin, the more people worldwide who connect to the network to mine the digital currency and earn the rewards. The bitcoin network regularly needs to increase the difficulty (see Figure 16) of mining to allow for more mining capacity without overloading the network. This has led to what is dubbed a bitcoin "arms race", whereby miners must always add more power to compete with others for the rewards.

Statistics from Digiconomist revealed that as bitcoin broke the $9,000 mark for the first time, the BTC mining network was using more electricity in a year than the whole of Ireland.[16] At these levels, it is estimated that bitcoin uses around 300KWh of electricity – enough to boil roughly 36,000 kettles full of water. As a comparison, it was reported that one of Visa's two data centres in the US runs on about 2% of the power that bitcoin demands. Combined, Visa's two US datacentres process c.200m transactions per day, bitcoin handles less than 350,000 per day.[17]

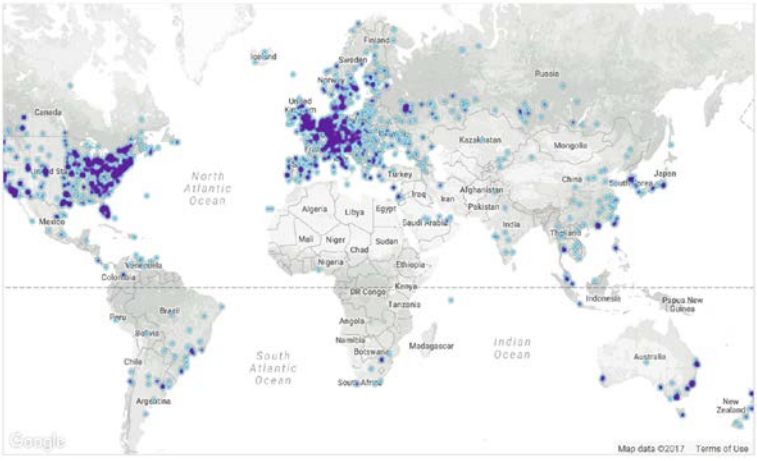
[16] https://digiconomist.net/bitcoin-energy-consumption

[17] https://www.theguardian.com/technology/2017/nov/27/bitcoin-mining-consumes-electricity-ireland
http://usatoday30.usatoday.com/tech/news/story/2012-03-25/visa-data-center/53774904/1

Such comparisons raise serious questions around bitcoin's long-term sustainability and environmental impact. Indeed, debates around the environmental effects of bitcoin mining intensified somewhat earlier this year when an Australia-based sustainability think tank claimed that bitcoin could – at least in theory – eventually consume up to 60% of annual global electricity production.[18] It is estimated in a report by meteorologist and journalist Eric Holthaus that in just a few months from now, at bitcoin's current growth rate, the electricity demanded by the cryptocurrency network will require more electricity than the entire United States currently uses: "By February 2020, it will use as much electricity as the entire world does today".[19]

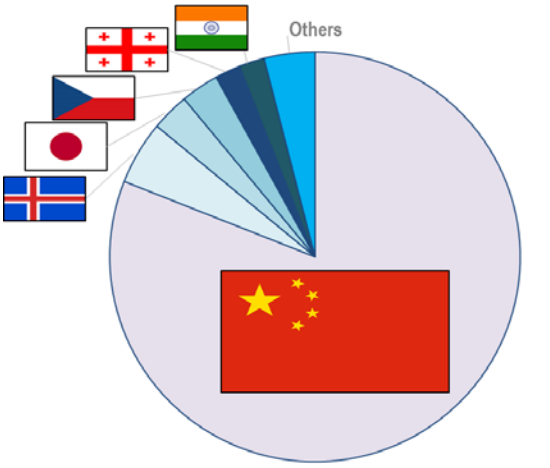
The rise of bitcoin has thus given birth to an entire ecosystem of mining infrastructure, and the lucrative bitcoin rewards have pushed smaller miners aside, making mining a big-player game. Bitmain, a Chinese firm that sells bitcoin mining rigs built up of bitcoin-specific Application Specific Integrated Circuits (ASICs), claims that 70% of the bitcoin mining rigs in operation today are made by the company, while a study by the University of Cambridge's Judge Business School found that the majority of mining sites are located in China.[20] Indeed, China dominates the mining market, with industry watchers, such as Jordan Tuwiner, founder of Buy Bitcoin Worldwide, estimating that 60-85% of all bitcoin network processing power comes from China mining pools.[21] Cheap electricity and labour – alongside leadership in mining hardware – are the main factors contributing to China's dominance in the mining market – see Figure 19.

Figure 18: 74% of active bitcoin nodes are in North America and Western Europe…



Source: bitnodes.earn.com, Credit Suisse research

Figure 19: … while Chinese mining pools process ~80% of the network



Source: Company data, Credit Suisse estimates, buybitcoinworldwide.com

The computational power of the bitcoin network has pushed out all but the strongest and richest miners, creating quasi-monopolistic positions in the mining industry. People who once had a half decent chance of earning some BTC by mining on their home PCs have been pushed out of the way in the bitcoin "arms race", replaced by vast mining warehouses, strategically located in countries where electricity is cheap, such as China and India. Mining facilities house tens of thousands of rigs in giant warehouses that are cooled by industrial fans, generating millions of dollars of income every year.

[18] https://www.coindesk.com/think-tank-debate-bitcoin-mining-environment/

[19] https://www.wired.com/story/bitcoin-mining-guzzles-energyand-its-carbon-footprint-just-keeps-growing/

[20] https://spectrum.ieee.org/computing/networks/why-the-biggest-bitcoin-mines-are-in-china
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2965436

[21] https://www.buybitcoinworldwide.com/mining/pools/

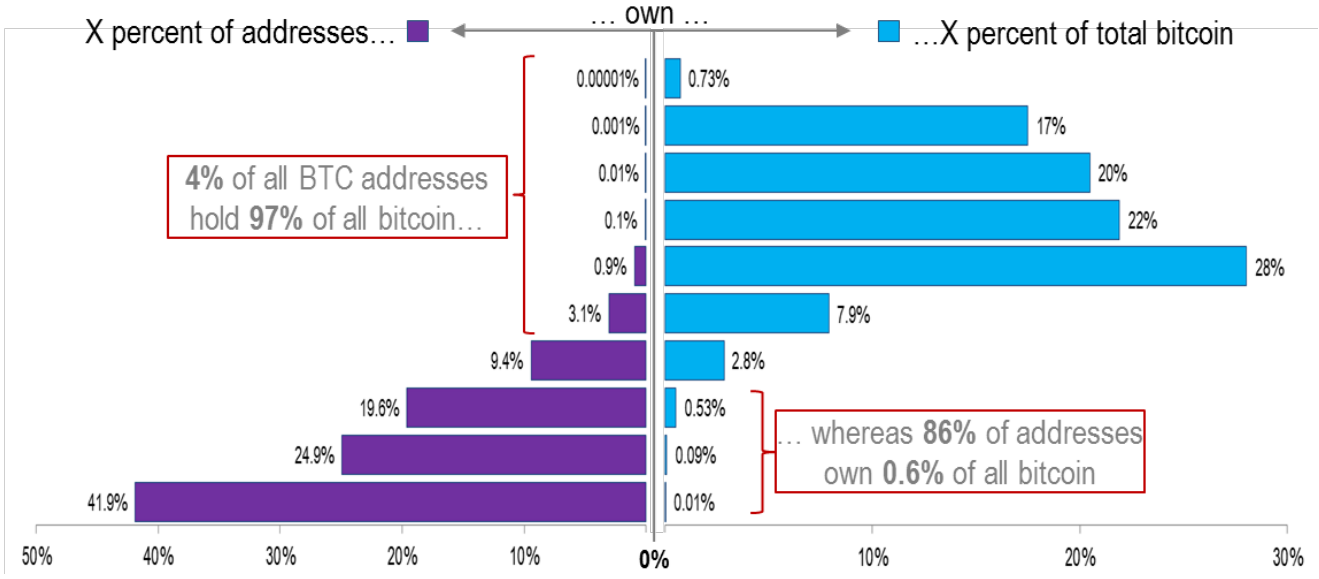
Bitmain is not the only hardware manufacturer to target the cryptocurrency market. Global graphics leaders such as NVidia and AMD have also released products targeting those wishing to mine bitcoin. Indeed, it is interesting to note some global hardware manufacturers now mentioning on earnings conference calls the shift to specialised ASIC chipsets and high-end graphics cards used for cryptocurrency mining.[22]

The rise and dominance of these mining pools and rig manufacturers demonstrates just how powerful certain actors are in the bitcoin space and serves as a reminder that the security and stability of a fully-decentralised technology can ultimately come under the control of a handful of players. In April 2017 a shockwave ran through the mining community when it emerged that a developer had found a backdoor called Antbleed in the firmware of Bitmain's S9 Antminer – one of the most popular mining rigs used across the world. Bitcoin magazine reported at the time that the backdoor could have been used by the company to track the location of the rigs and remotely shut them down.[23]

Another (digital) asset class for the 1%?

Centralisation is also prevalent when examining the ownership of bitcoin. The concentration of wealth at a small group of addresses – be it individuals or exchanges – means that a few key players in the game can have a massive influence on the bitcoin market. Significant proportions of bitcoin and other cryptocurrencies are apparently being held like precious assets, thereby severely restricting the flow and availability of the digital currencies – see Figure 20. For instance, c97% of all bitcoins in circulation are held by roughly 4% of bitcoin addresses.

Figure 20: Re-centralisation? ~97% of all bitcoins in circulation are held by ~4% of bitcoin addresses[24]



Source: bitcoinprivacy.net, HowMuch.net (cost information website), Credit Suisse estimates

[22] For example, see NVIDIA's Q3 2018 corporate earnings call transcript.

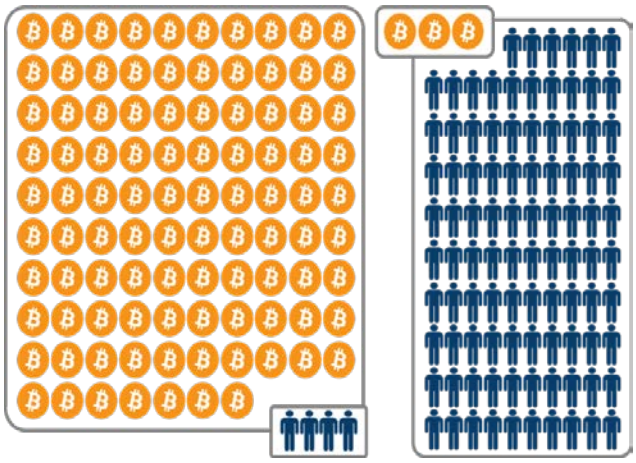
[23] https://bitcoinmagazine.com/articles/bitmain-can-remotely-shut-down-your-antminer-and-everyone-elses/

[24] https://howmuch.net/articles/bitcoin-wealth-distribution
https://bitcoinprivacy.net/

It is important to note here that each address can represent more than one individual person: bitcoin wallets and exchanges, which hold currency for many different people, will often have one address for a particular group of people. As such, we view the data should as illustrative rather than actual. Nonetheless, it is interesting to observe bitcoin's concentration in a handful of addresses and, as we examine next, the ways in which the digital currency is being treated as one might treat a precious metal or stone.

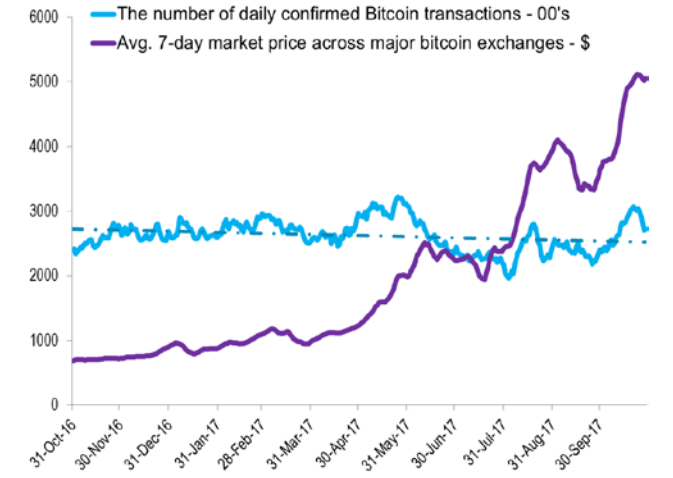
Like gold, bitcoin cannot simply be created arbitrarily. While gold and other precious and finite resources are mined or extracted from the ground, bitcoin must be digitally mined, and like these precious resources, there is theoretically a limited and finite supply of bitcoin – only 21m bitcoins can be mined in total – unless enough support gathers in the bitcoin community to change the protocol to allow for more than 21m coins.

Figure 21: A digital asset class? 97% of all bitcoins are held by 4% of addresses[25]



Source: Company data, Credit Suisse estimates, blockchain.info

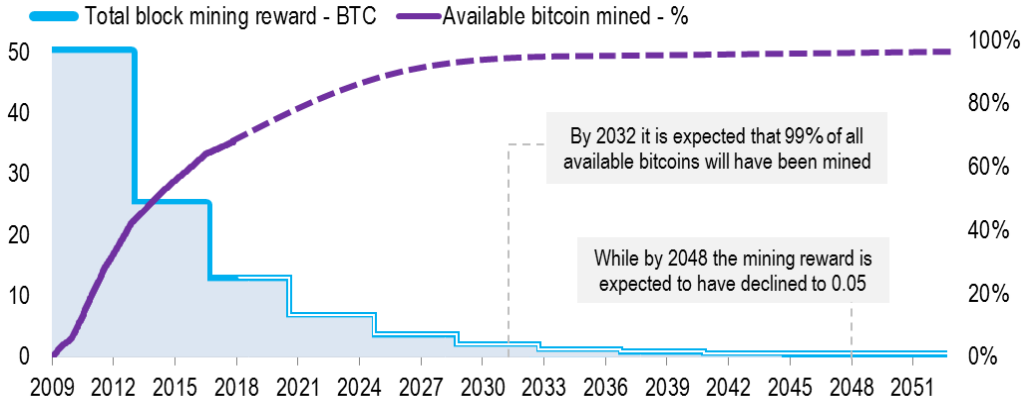
Figure 22: Transaction momentum is largely unchanged by bitcoin's rise



Source: Credit Suisse research, HowMuch.net

According to industry data (Figure 23), by 2032 it is estimated that over 99% of all bitcoins will have been mined. Around this time it is expected that the total reward paid to miners for mining a bitcoin block will have shrunk to 1 BTC, dropping to 0.05BTC in 2048. This is down from the initial reward of 50 BTC upon bitcoin's inception. The block reward, which is paid using freshly-mined bitcoin, is halved every 210,000 blocks – roughly every 4 years. Naturally, as the availability of bitcoin to be mined decreases, so too must the amount rewarded to those who have done the mining.

Figure 23: It's estimated that 99% of all BTC will have been mined by 2032



Source: Credit Suisse estimates, blockchain.info, bitcoinblockhalf.com, bitcoin.it

[25] https://howmuch.net/articles/bitcoin-wealth-distribution; https://bitcoinprivacy.net/

From payment method to store of value

It is interesting to observe that bitcoin was originally designed as a system to allow online (i.e. digital) payments to be sent directly from one party to another, without the need for a trusted third party (i.e. a financial institution). So first and foremost, bitcoin was designed as a payments system.

The first successful trade using bitcoins to buy real world goods is generally assumed to be a purchase of 2 pizzas for 10,000 bitcoin[26]. This transaction was only in 2010 and, at that time, it valued the pizzas at $41. At the current bitcoin price of c$16,000, it values those 2 pizzas at ~$160m.

We think this dramatic rise in value undermines the utility of bitcoin as a payments method, as keeping the bitcoin becomes more valuable than using it as a digital currency. Instead, the fact that bitcoin supply is capped at c21m coins and protected from supply inflation means that it may be increasingly seen as a "store of value", akin to reserve currencies or gold.

To give the current value of bitcoin some context, according to the World Gold Council,[27] there are 187,200 tonnes of gold that have been mined throughout history, with around two-thirds of that being mined since 1950. Based on a current gold price of $1300/oz, this values the stock of gold at $7,875bn. At c$16,000, the 16.6m bitcoin in circulation, created in seven years, is theoretically worth $265bn.

Bitcoin's 'Fort Knox'

The rise of "cold storage" solutions for cryptocurrencies is perhaps the best indicator of the ways in which bitcoin and other digital currencies are being treated the same as one would secure gold. Cold storage refers to the process of storing cryptocurrencies offline – with deep cold storage being a process in which not only are the digital currencies stored offline, but the systems that store the coins (such as hard drives) have never been online or connected to a network of any form. Indeed, bitcoin storage facilities now exist whereby the coin addresses are saved to hard drives that have been closely guarded through every stage of the manufacturing process to ensure no connection to the network. These drives are then stored in a secure vault-like site, where they are guarded and maintained. Other methods include paper wallets with a physical record of the (e.g. bitcoin) private keys, or on a bearer item, such as a physical bitcoin.

One cannot help but notice the irony of storing a currency that is purely digital in nature on physical paper or coins, or locked away in a central location deep underground. Those storing digital currencies in such a way are clearly holding the digital currency as an asset, not an enabler of payments. This likely helps explain why the explosion in popularity and value of bitcoin has not been accompanied by a proportional explosion in transactional volume. Indeed, the number of daily bitcoin transactions has remained at the same level in the last 12 months while bitcoin's value has soared – see Figure 22.

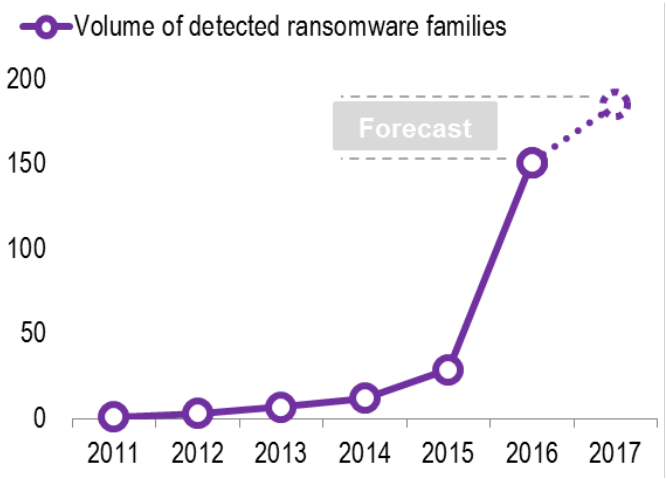
[26] https://bitcointalk.org/index.php?topic=137.0

[27] https://www.gold.org/about-gold/gold-supply/gold-mining/how-much-gold-has-been-mined

Unintended consequences: cryptos and security

The ubiquity of bitcoin and the ability to hide the transactional trail of a cryptocurrency naturally has global security implications, the key facets of which we address further in this report. It is worth highlighting at this point, however, the argument that bitcoin in particular has been an enabler of malicious code such as ransomware, fuelling its sharp rise in the last few years: a study by IBM Security found that the number of ransomware-infected emails increased 6,000% in 2016 compared to 2015, for example – also see Figure 24.[28]

Figure 24: The cryptocurrency boom may have helped to fuel the rise of ransomware[29]



Source: Credit Suisse research, Trend Micro (Dec 2016)

Figure 25: Criminals behind the May 2017 WannaCry ransomware attack demanded payment in bitcoin

Source: Credit Suisse research

Cryptocurrencies such as bitcoin offer a secure and often untraceable method of sending and receiving payments, making them an ideal currency for those who wish their financial activities to remain hidden from authorities. The WannaCry ransomware attack in May 2017, which paralysed hundreds of thousands of computers across the world, including large parts of the UK's National Health Service network, demanded that users who wished to unlock their computers transfer $300 worth of bitcoin to specified wallets – see Figure 25. Citrix CEO Kirill Tatariov noted at a conference in New York that the decision by companies to stockpile bitcoin in order to pay future ransoms, such as those demanded in the WannaCry attack, was one of the key drivers of bitcoin's price at that time.[30]

Furthermore, earlier this year it was reported that many websites were harbouring malicious malware code that secretly used visitors' computers to mine bitcoin.[31] Hundreds of websites were found by security professionals to be running code developed by Coin Hive, which was being harnessed to behave like malware by piggy-backing users' computers and using processing resources to mine cryptocurrencies without permission. Research by cyber security vendor Check Point found that crypto-miners can fraudulently use up to 65% of an end-user's total computer processing resources without their approval. One of Check Point's Threat intelligence Threat Managers noted at the time that "crypto mining is a new, silent, yet significant actor in the threat landscape, allowing threat actors to make significant revenues while victims' endpoints and networks suffer from latency and decreased performance".[32]

[28] https://www.cnbc.com/2016/12/13/ransomware-spiked-6000-in-2016-and-most-victims-paid-the-hackers-ibm-finds.html

[29] http://blog.trendmicro.com/ransomware-growth-will-plateau-in-2017-but-attack-methods-and-targets-will-diversify/

[30] https://www.prnewswire.com/news-releases/cyber-attacks-driving-up-bitcoin-price-says-citrix-ceo-jim-cramer-hosts-the-deals-2017-corporate-governance-conference-300471609.html

[31] http://www.bbc.co.uk/news/technology-41693556

[32] https://globenewswire.com/news-release/2017/11/13/1185370/0/en/Cryptocurrency-Mining-Presents-New-Threat-to-Business-says-Check-Point.html

Theoretical risks to blockchain's security

As we further cover in A chain is only as strong as its weakest link, blockchain protocols are exposed to several significant theoretical security risks, including "double-spending" and "51% attacks." In the former, an attacker can, upon solving a hash, generate a block and record diverging chains to send coins to a seller in one chain while pocketing the same coins in the other, thereby double-spending—a problem with electronic payments that predicating systems on blockchain is meant to avoid. For many forms of executing double spending, other miners may simply build blocks off of the authentic transaction, and the quickest solution often involves waiting for confirmation of subsequent blocks (e.g. with bitcoin, usually five or six transactions are appended to a block before it is confirmed).

A significant, albeit still theoretical, potential risk to the reliability of a blockchain is known as a "51% attack," in which an individual or collection of attackers holds a significant share (not necessarily a majority) of hash-solving power for mining and therefore has a probabilistic superiority in the mining hash rate. With this advantage, the attacker could then add the majority of new blocks to forks of their choosing, eventually establishing the longest chain on a new fork and resultantly guiding consensus view of the blockchain.

While to our knowledge the blockchain protocol that underpins bitcoin has never been compromised, the facilities in which people store their bitcoins have been. According to media reports, approximately 980,000 bitcoins have been hacked to date – a total value of over $16bn at current prices.[33] Hackers have reportedly even go so far as to contact victims' mobile phone providers to transfer the victim's number to a phone in their possession, so as to be able to pass the two-layer SMS authentication that many bitcoin wallet facilities offer. One victim reportedly tried in vain to stop a mobile phone carrier from transferring his number before the totality of his bitcoin wallet vanished from his Coinbase account. While Coinbase's systems appear to have never been compromised – a claim that has helped it attract over $3bn of cryptocurrency – others have not been so successful: last summer hackers stole $72m worth of bitcoin from a crypto-exchange, and the $500m hack and subsequent collapse of bitcoin exchange Mt. Gox is still regularly cited in media reports.[34]

More recently, the spectre of hacking blockchain has been raised in discussions around quantum computing, which in theory might lead to significantly superior computers being able to break down blockchain's encryption with ease.[35] While there is little to suggest that this is likely to happen any time in the foreseeable future, the intricacies of the technology and implications for blockchain are worth examining in some detail – see Quantum Computing in Blockchain.

We further explore the security implications of cryptocurrencies and blockchain in the Security segment of the market implications section.

[33] http://fortune.com/2017/09/29/cryptocurrency-exchanges-hackings-chaos/

[34] http://fortune.com/2017/08/22/bitcoin-coinbase-hack/

[35] https://medium.com/@jomari.peterson/preparing-for-a-post-quantum-world-blockchain-and-technology-3fb4af6e88bb

Bitcoin's barriers to dominance – a recap

Although we think cryptocurrencies will likely have a place as a store of value and digital vehicle of speculation and tokenisation, we continue to believe that the technical and ideological debates around the scalability and sustainability of digital currencies will in aggregate result in bitcoin and other cryptocurrencies remaining niche payment networks for the foreseeable future. As we explained in more detail in our *Trust Disrupter* report, we see 13 key barriers to bitcoin's widespread adoption:

1. **Extreme volatility** – it is not uncommon for bitcoin to fluctuate 20-30% in a day. While recent gains may well offset this risk for some, BTC's lack of stability greatly reduces its utility as a value store and payment method – see Figure 4.
2. **Transaction confirmation too slow,** despite attempts to speed up and improve the capacity of the BTC blockchain through various hard/soft forks – see Figure 13.
3. **Reduced decentralisation** – or a recentralisation of bitcoin has led to monopolistic positions and geographies in the cryptocurrency markets – see Recentralisation: crypto mining and ownership.
4. **Conflicts and lack of inertia** – debates around how to change and improve bitcoin's protocol continue, further fuelled by BTC's meteoric rise in recent months. Increased polarisation is leading to factionalism within the bitcoin communities, as evidence by recent hard and soft forks (and their respective U-turns) – see The fork(s) in the road.
5. **Costs are high and hidden** – mining bitcoin is increasingly expensive and resource intensive. An Australia-based sustainability think tank claimed that bitcoin could – at least in theory – eventually consume up to 60% of annual global electricity production.
6. **Unguaranteed security** – while at this point in time this admittedly looks unlikely, it is worth noting that should coin rewards (see Figure 23) decrease to such a low level that miners are not incentivised to process the BTC blockchain, a serious drop in mining would make the BTC network vulnerable to malicious attacks, as less hashpower would be required to overwhelm a majority of the network.
7. **Third parties make bitcoin vulnerable** – BTC users tend to use exchanges to convert fiat to BTC and vice-versa, and wallet software to facilitate transactions—both of which take on responsibilities akin to 'trusted third parties' see Bitcoin's 'Fort Knox'.
8. **Scalability** – Transactions per Second (TPS) and an increasing cost per transaction reduce BTC's scalability and chances of becoming a widely used payment method. Due to the reasons highlighted in Understanding blockchain through bitcoin, BTC has a limit of approx. 7 TPS, while Visa has a peak capacity of around 56,000 TPS.
9. **Regulatory uncertainty** – regulators on the whole have held the cryptocurrency markets at arms' length, partly to avoid stifling innovation. However, the ICO boom and potential securitisation of cryptos on regulated exchanges has firmly fixed the spotlight on the crypto 'wild west', and in certain cases – such as in China – led to decisive regulatory action. We outline in greater detail the increased scrutiny ICOs and cryptocurrencies are receiving from regulators including the SEC in the next section, More than meets the I-CO. We expect regulatory oversight to increase significantly in the short-term, especially now that some ICOs and crypto projects are targeting retail consumers.
10. **Legal issues** – BTC's pseudo-anonymous nature continues to make it gain notoriety as a potential facilitator of criminal payments. The rise of ransomware – enabled by bitcoin's rise – has further fuelled this illicit image. Bitcoin has also been cited in the media as a potential medium for money-laundering and illicit capital flight.

11. **Limited adoption** – Bitcoin appears to be at a strange stage of its adoption life-cycle. Many of those purchasing it appear to be doing so purely because the price is rising at the moment, creating a viscous cycle. Yet that increase in value has not been accompanied by an increase in use: Figure 22 shows that the number of daily bitcoin transactions has remained at the same level in the last 12 months, while bitcoin's value has soared. It may be difficult for bitcoin to overcome these challenges and move beyond BTC being a store of speculative value, held by a select few. We think it must first provide solutions to the problems outlined in this report before it can escape this rift.
12. **Irrecoverability** – It is a testament to the security of the network that should your private key be lost, the BTC associated with that address are fully unrecoverable. Equally, it is a barrier to widespread adoption.
13. **Irreversibility** – Lacking a trusted central party, there is nobody who can be appealed to or arbitrate disagreements between transacting parties. Should you, for example, send bitcoins to the wrong address, once broadcast to the network the transaction is only reversible at the discretion of the receiving party. There is no authority or mechanism for error correction.

Debates moving beyond the theoretical

It is therefore interesting to see the debates we highlighted in our original report begin to take centre stage in the public arena. Irrespective of where you stand in these debates, and what you feel about the cryptocurrency mania, it is difficult to deny the now real-world implications of these conversations and points of contention. Indeed, we think the themes we have outlined above provide us with two interesting conclusions:

- We think the nascent nature of blockchain-based technology is apparent, given that there is still scope for debate around the fundamental rules that underpin even the most mature cryptocurrency.
- We also think these conversations show that the appetite for blockchain-backed technology is increasing in new channels and domains. The explosion in popularity of Initial Coin Offerings – which we turn to next – shows the willingness to experiment with these imperfect, unregulated, and potentially dangerous concepts and is indicative of a change in momentum of blockchain development.

PART 2

ICOs
& private consortia

How does an ICO work?

What are they funding?

What does their rise mean for blockchain?

What are blockchain consortia?

Which are the ones to watch?

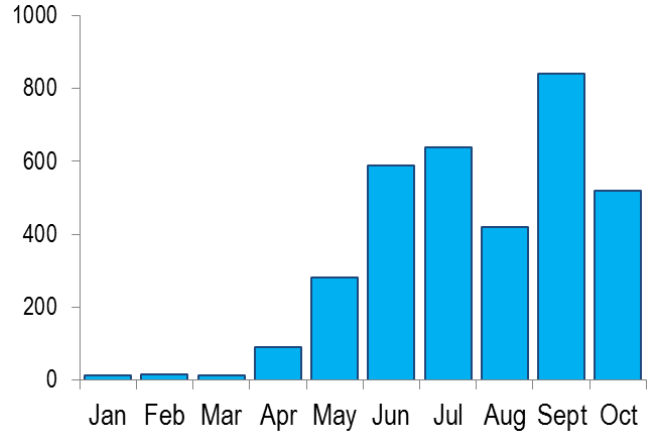
Part 2: Initial Coin Offerings and consortia

More than meets the I-CO

Accompanying bitcoin's historic gains in 2017 is a hitherto relatively unknown phenomenon, Initial Coin Offerings (ICO). An ICO is a mechanism of fundraising through which new projects sell underlying cryptocurrencies or tokens in exchange for either bitcoin or ether. ICO "coins" are therefore in essence digital coupons, tokens issued on a permanent distributed ledger, i.e. blockchain. This has led to some terming the tokens a form of digital share; however, ICOs do not confer ownership rights.

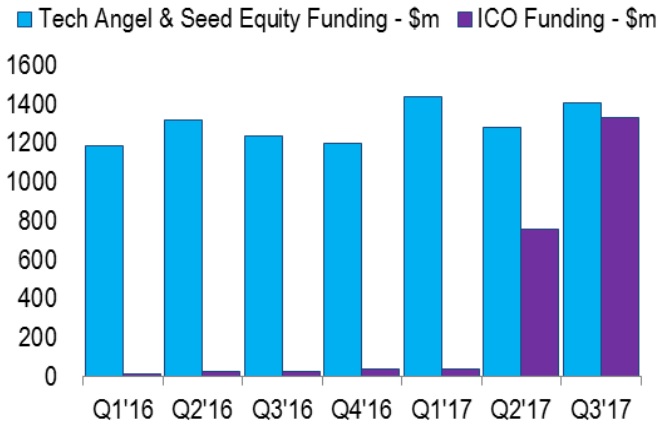
As of early November, there were around 50 ICOs taking place across the world each month, with funding reaching record highs and fuelling the general boom in cryptocurrencies, of which there are now over 1,000 available online. Momentum is such that ICO funding in the tech sector almost surpassed traditional angel and seed funding in 3Q17 – see Figure 27. This trend shows no sign of slowing, leading to concerns from industry experts and regulators of overcapitalisation.

Figure 26: Initial Coin Offerings, 2017 - $m



Source: Credit Suisse research, CoinSchedule

Figure 27: ICO funding has almost surpassed angel and seed funding in tech



Source: Credit Suisse research, CB Insights, TokenData, CoinSchedule

Token Report, a company that keeps a record of token sales information, recently noted that of the 226 ICOs they analysed, only 20 tokens, such as prediction markets company 'Augur' and Cloud storage company 'Storj,' are currently being used in the running of the networks. The rest can only be traded and are purely speculative instruments, said Token Report's CEO, Galen Moore.[36] While it is of course early days for a phenomenon that has only really taken hold in the latter stages of last year, a less than one in ten realisation rate has inspired caution.

[36] https://www.bloomberg.com/news/articles/2017-10-23/only-one-in-10-tokens-is-in-use-following-initial-coin-offerings

A self-fulfilling prophecy?

The fact that the ICOs – many of which bring to bear a new form of digital currency – are funded using digital currencies potentially creates a kind of hype cycle or self-fulfilling prophecy: the demand for bitcoin or ether to fund ICOs drives up the existing currencies' value, which in turn increases investors' appetite for the lucrative cryptocurrency market, which in turn leads to further ICOs. And so the cycle continues.

Such cycles have led many regulators to urge caution around ICOs – or in China's case, an outright ban ICOs – while many high-profile figures and regulatory officials have spoken out against the schemes:

In December 2017, the Securities and Exchange Commission (SEC) cautioned investors – not for the first time[37] – in a Statement on Cryptocurrencies and Initial Coin Offerings. SEC Chairman Jay Clayton urged "extreme caution" on ICOs and reminded investors to "be aware of the risk that your investment may be lost". Earlier that year in July the SEC ruled in SEC Issues Investigative Report Concluding DAO Tokens, a Digital Asset, Were Securities that some of the coins for sale in certain ICOs (such as the DAO) were actually securities and thus subject to the agency's regulation.

The intervention in December once again reignited the series of debates that surround cryptocurrencies and ICOs; determining the fundamentals such as whether cryptos should be treated as securities, currencies, or even commodities has so far proven tricky. While we make no comment on such debates, the repeated statements by the SEC indicate how seriously – in the space of roughly 12 months – international regulators have begun to view cryptocurrencies and ICOs. It is reported by news agencies such as Fortune that the SEC now has a division dedicated to ICOs – a division which for the first time filed in December charges against an ICO operation.[38] "This first Cyber Unit case hits all of the characteristics of a full-fledged cyber scam and is exactly the kind of misconduct the unit will be pursuing," said Robert Cohen, Chief of the Cyber Unit, in a press statement.[39]

As such, and as we cover in What lies ahead?, we expect 2018 to be defined by regulatory responses to and involvement in blockchain-underpinned technologies, such as ICOs and cryptocurrencies.

Thus, like many emerging technological trends, there are potentially serious concerns relating to this fast-growing trend. Nonetheless many of these issues may not be insurmountable, while analysis of the general characteristics of the ICO boom may reveal some positive longer-term trends for blockchain.

[37] Also see: Statement on Potentially Unlawful Promotion of Initial Coin Offerings and Other Investments by Celebrities and Others (Nov. 1, 2017), available at https://www.sec.gov/news/public-statement/statement-potentially-unlawful-promotion-icos; Investor Alert: Public Companies Making ICO-Related Claims (Aug. 28, 2017), available at https://www.sec.gov/oiea/investor-alerts-and-bulletins/ia_icorelatedclaims; Investor Bulletin: Initial Coin Offerings (July 25, 2017), available at https://www.sec.gov/oiea/investor-alerts-and-bulletins/ib_coinofferings; Investor Alert: Bitcoin and Other Virtual Currency-Related Investments (May 7, 2014), available at https://www.investor.gov/additional-resources/news-alerts/alerts-bulletins/investor-alert-bitcoin-other-virtual-currency; Investor Alert: Ponzi Schemes Using Virtual Currencies (July 23, 2013), available at https://www.sec.gov/investor/alerts/ia_virtualcurrencies.pdf.

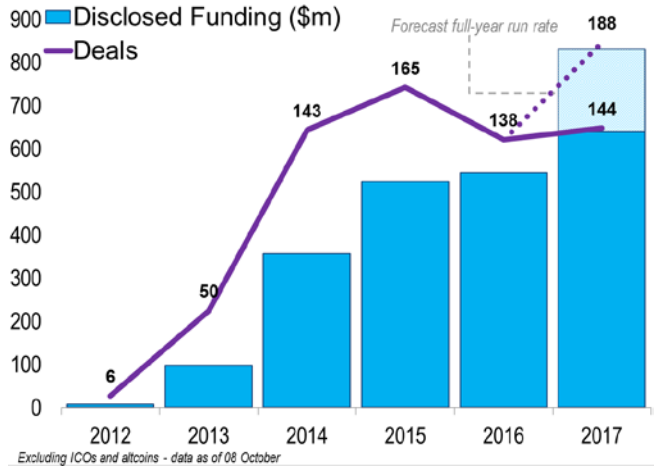
[38] http://fortune.com/2017/12/04/cryptocurrency-bitcoin-sec-ico-scam/

[39] https://www.sec.gov/news/press-release/2017-219

ICOs are funding and diversifying blockchain technologies

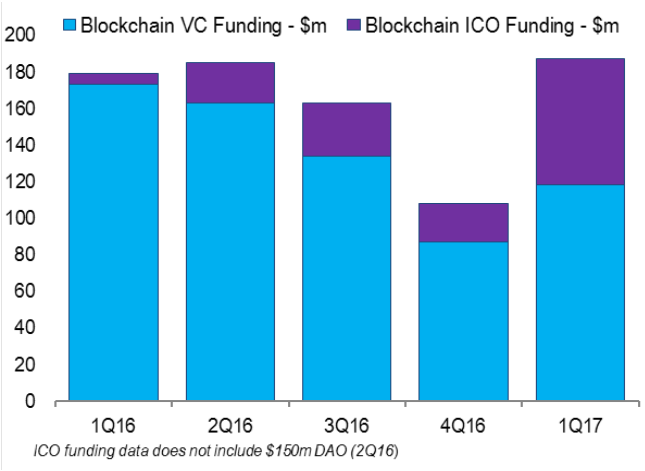
When we examine blockchain funding, we see that in in 1Q17, 37% of blockchain funding came from ICOs, compared to 3% in 1Q16 – see Figure 29. These statistics were taken before the ICO spike in September, so it is more than likely that ICO funding has by now surpassed that of traditional VC funding for blockchain.

Figure 28: Blockchain global financing history incl. 2017 forecasts



Source: Credit Suisse research, CB Insights

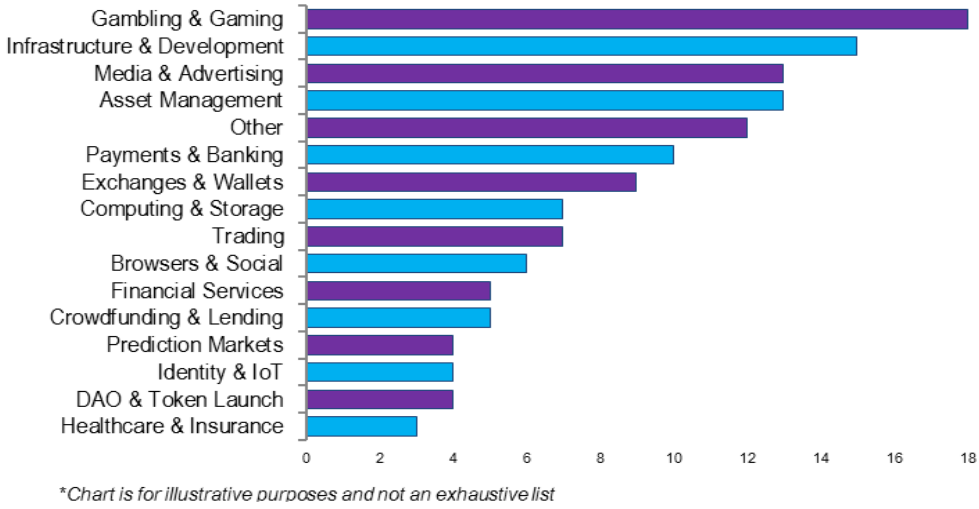
Figure 29: 37% of all blockchain funding in 1Q17 came from Initial Coin Offerings



Source: Credit Suisse research, CB Insights, TokenMarket, Smith + Crown

As of November 2017 Initial Coin Offerings had raised more than $3bn – up from $222m in 2016 (see Figure 5), with ICOs appearing poised to remain the financing method of choice for blockchain start-ups. Financial services firms are no longer the only firms investing in blockchain: decentralised technology projects are being worked on in all manner of industries, from real estate to charity – and Figure 30 – and, while we acknowledge the scope for the wider information technology landscape to change, we think blockchain presents more opportunity than risk.

Figure 30: 135 cross-sector blockchain startups funded via ICO



Source: CB Insights, TokenData.io, Company data, - 9th August 2017

"I am not convinced that it is a great fundraising method for a business. But the point of an ICO, done right, is that you are not building a business; you're building an unowned system for everyone to use. There are not many other good ways to fund that."

– Matt Levine, Bloomberg View

ICOs are perhaps a natural consequence to the nature of blockchain technology – which by definition is a decentralised and theoretically democratic technology. Borrowing the analogy Matt Levine at Bloomberg View uses,[40] imagine you would like to build a cloud-storage business – you raise money from investors, spend it on servers etc., store files on them, charge some fees and hopefully make a profit. But suppose you wished to develop a decentralised cloud storage network (e.g. https://filecoin.io/), in which people can use open protocol to buy and sell file storage directly from each other, utilising individual resources like bitcoin does miners, then you need a different type of funding model: the business – in this case the decentralised cloud platform – will not just benefit you but all users, and, due to the non-centralised nature of the model, you will not take a cut of all the cloud storage fees. Once the protocol is out in the open users of it do not need to rely on you to use it, just like users of bitcoin do not rely on Satoshi Nakamoto now that the bitcoin protocol is fully public, decentralised, and freely available to all users.

In theory, ICOs are therefore a way of allowing the protocol to remain universally available to all, but it also provides funding (and thereby incentive) at the initial stages of development: once you have an idea – for example, a protocol you believe to be scalable and valuable, you could pre-sell that potential value to people who intend to either: 1) use the protocol and the token ownership will give them a certain kind of access, or 2) wish to speculate on the adoption of the protocol and any potential rise in the value of the token. As the developer of the protocol, you might also be incentivised to benefit from its adoption by retaining some tokens yourself in the hopes of their value increasing.

Thus, in contrast to the traditional VC model – whereby investors expect to get value from owning the protocol, funding comes from individuals who expect to get value from using (or speculating on) a network that you (and they) will not own or control upon its inception.

However, not all ICOs and blockchain-underpinned technologies are necessarily 'altruistic' in nature; critics have contended that some ICOs may be exploiting investors.[41] We also note in Figure 30 the high number of gaming and gambling companies that have been funded via ICO.

Our colleagues provide an overview of the Travel & Leisure sector – and a subsequent stock analysis of Playtech – in Casinos and gaming stand to benefit, where they highlight that blockchain and cryptocurrencies are driving increased adoption of online gambling, rather than representing a threat to incumbent payers in the space

[40] https://www.bloomberg.com/view/articles/2017-10-13/icos-marxism-and-credit-reports

[41] http://uk.businessinsider.com/ico-cryptocurrency-pump-and-dump-telegram-2017-11

Consortia: the greater good

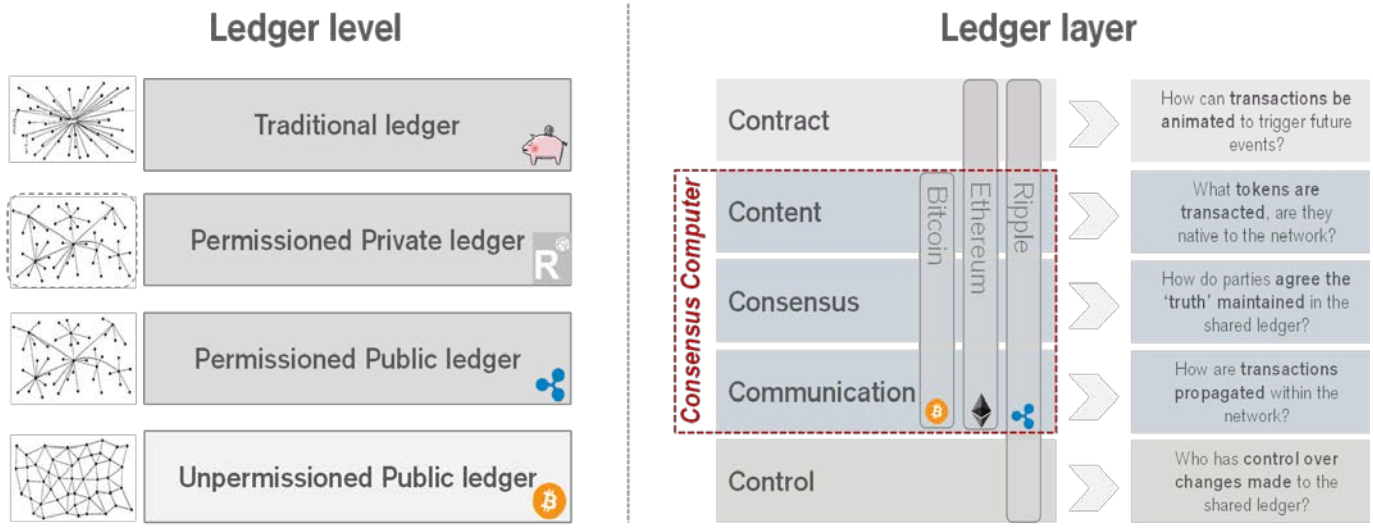
"There's only so much fun you can have on your own with blockchain."

- Richard Crook, Head of Innovation Engineering, RBS[42]

Like ICOs, blockchain consortia form partly as a consequence of the technology itself. Distributed Ledger Technology (DLT) derives its utility from network effects: The greater the number of users, the more valuable the technology is to those in the network. Consortia provide a vehicle through which a private enterprise can explore DLT with players it may normally compete with, while at the same time restricting non-permissioned actors in the blockchain market from accessing said projects.

Consortia are interesting as they occupy a middle ground for collaboration; sitting in-between fully private DLT projects on one side and public efforts – such as bitcoin – on the other. They work by aligning key organisations from similar operational verticals and integrate them onto a distributed database with less centralised control than a private project but more so than the public – thus the consortium provides a cooperative arena for like-minded companies wishing to develop a platform that will prove mutually beneficial for their operations. (It should also be noted that public blockchains can also be split into permissioned and unpermissioned public ledgers – see Figure 31 for more information on the ledger level and layer breakdown.)

Figure 31: Ledger levels (govern read/write permissions) and ledger layers (govern functionality)



Source: Credit Suisse research based on data from Consult Hyperion and On Distributed Communications Networks by Paul Baran, 1962

The combined resources and expertise pooled in these projects is giving the blockchain movement some real momentum – many consortia members are also running their own private blockchain projects in tandem with contributing to the cooperative projects.

[42] Blockchain Summit London, 28/11/17. Panel: Exploring Opportunities for Applications Beyond Cryptocurrencies

Research by Deloitte estimates that to date more than 40 consortia have been formed globally – with most of these having been established in the last 6 months.[43] Figure 32 provides a comparative overview of the leading consortia in the blockchain space, Ethereum Enterprise Alliance, R3, Hyperledger, Digital Asset Holdings (DAH), and Ripple. While most consortia have until now focused on the financial services, we are beginning to witness a shift into new industries, including logistics, gaming, and healthcare. Critically, regulators, central banks and governments are beginning to support the projects, further encouraging enterprises to apply for membership and paving the way for legal and regulatory infrastructure that is compatible with distributed ledger technology.

Figure 32: Distributed we stand – 5 key blockchain consortia

	Area of Focus	Membership / Scheme	Core Offering	Investment Opportunities	Fees
ENTERPRISE ETHEREUM ALLIANCE	General purpose blockchain advancement on the Ethereum blockchain	c.200 members	Coordinates the engineering of versions of the Ethereum blockchain to address interests in banking, management, consulting, automotive, pharmaceutical etc.	Boasts the largest membership. Backed by major academic and financial instutions and giants like Microsoft	Customised: stages go up to $25k/year
r3	General financial transactions & agreements	c. 84 members Flat membership	Corda, a distributed ledger for recording and managing financial agreements	Yes, equity in spin-off company that would control Corda.	Flat advisory fee
HYPERLEDGER	General purpose blockchain	c.142 members Tiered membership – Premier, General & Associate members	3 Frameworks: IBM-Fabric, Soramitsu-Iroha and Intel-Sawtooth Lake	Open-source collaborative effort, projects are funded by membership fees. Started by Linux Foundation	$250k/year premier, $5-50k/year for general, $0 for associate
Digital Asset Holdings	Capital markets – Post-trade settlement	Sells software to banks, dealers, exchanges, custodians and clearing house clients.	Digital asset platform which uses distributed ledger technology for mutualisation of financial market data and processes across distinct market participants.	Backed by JP Morgan, Goldman Sachs, ABN AMRO, BNP Paribas, IBM and Deutsche Borse, among others.	Customised
ripple	Payments	c.90+ members Regional membership clusters. Ex: RC Cloud in Japan	Integration for corporate disbursements and retail remittances.	Backed by Santander Innoventures, Standard Chartered Bank, Accenture, Digital Currency Group among others.	Customised

Source: Company data, Credit Suisse estimates, LetsTalkPayments.com, CoinDesk.com

We take the view that consortia are a healthy sign of the commitment companies and institutions are making to blockchain and, at this stage in the development of blockchain, are perhaps a necessary vehicle to drive forward real-world applications for DLT. Pooling resources and expertise to create a communal, collaborative platform then paves the way for smaller, private enterprise-specific projects. Think of what HTML did for the development of the internet, or what the App Store has done for the world of software development: common ground and utility perhaps needs to be firmly established before we see the kind of individual development we have seen in the mobile applications market. Collaborative, global platforms are likely to sit better with regulators, too, in our view.

[43] https://dupress.deloitte.com/dup-us-en/focus/signals-for-strategists/emergence-of-blockchain-consortia.html

Part 3: Blockchain

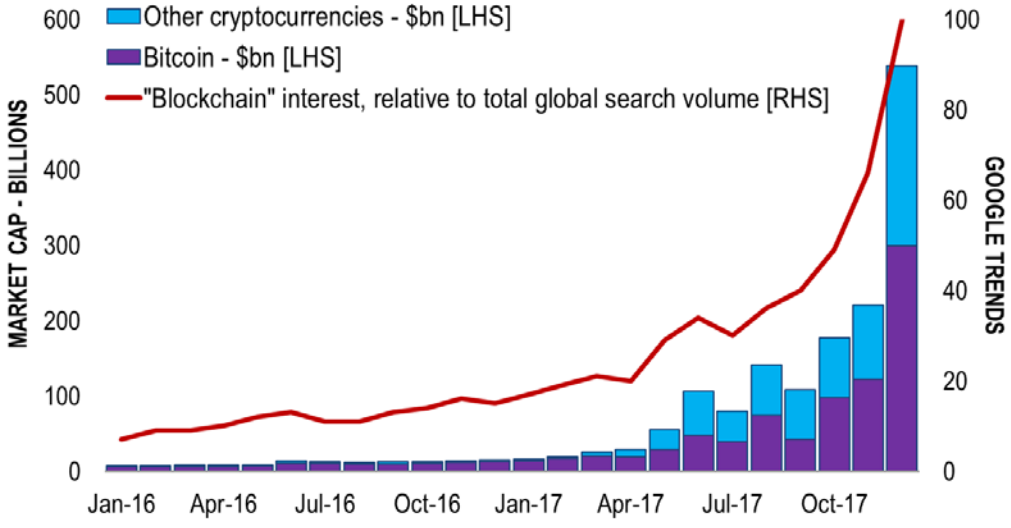
On decentralisation we stand united

"Bitcoin's popularity is proving blockchain's usefulness in finance, but entrepreneurs have come to believe blockchain could transform many more industries. Ultimately, the use cases for a transparent, verifiable register of transaction data are practically endless — especially since blockchain operates through a decentralized platform requiring no central supervision, while still remaining resistant to fraud."

CB Insights, August 2017[44]

To summarise the previous section, we interpret the rise of consortia and the explosion of ICO funding mechanisms as a material boost for blockchain's development; the emergence of ICOs as a blockchain funding vehicle represents perhaps the biggest change to the blockchain landscape since we published *Trust Disrupter*. The ICO boom has fuelled interest in the blockchain technology that enables ICOs and the cryptocurrencies/tokens that underpin them. Figure 33 illustrates that a surge in interest in blockchain has accompanied the ICO/cryptocurrency boom, with Google Trends data revealing new highs in the momentum of searches for blockchain. This is matched by the data in Figure 1 (front page), which shows that this interest has made its way to the boardroom.

Figure 33: Interest in blockchain soared to an all-time high at the end of 2017 as the cryptocurrency market doubled in a matter of weeks in a matter of weeks



Source: Company data, Credit Suisse research, coinmarketcap.com, Google Trends (www.google.com/trends). - as of 02 January 2018

[44] https://www.cbinsights.com/research/industries-disrupted-blockchain/

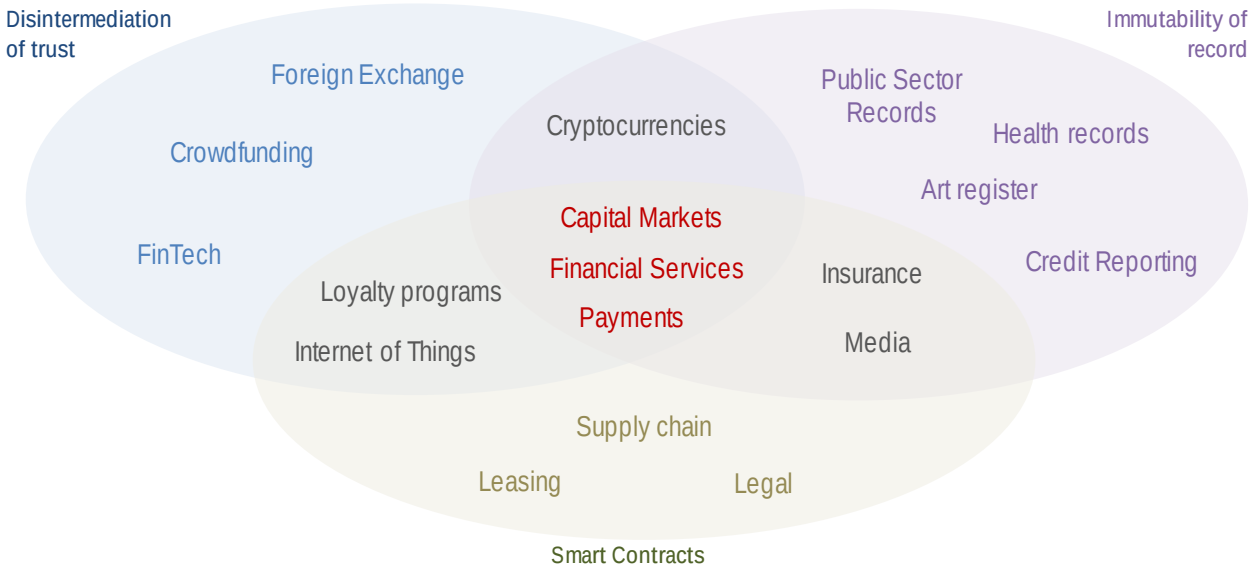
As outlined in our initial *Trust Disrupter* report and in Figure 34, we continue to find it most beneficial to distil blockchain's benefits into the following three succinct points:

- **Immutability of record.** All participants share and update the record after reaching a consensus. This translucent, immutable and permanent record imparts confidence in the provenance of value being transacted and enhances fraud detection.
- **Disintermediation of trust –** Less reliance on trusted third parties. Third-party risk is reduced or eliminated as trust is distributed over the network, rather than centralised in one potentially fallible 'single point of failure'.
- **Smart contracts.** These are self-executing commitments, fulfilment of which can be trusted. Obligations codified by smart contracts are easily replicable, and have the benefit of security, verifiability, translucency and immutability of the blockchain.

Approaching blockchain's utility in such a way allows us to go beyond bitcoin and the cryptocurrency market, as we can begin to visualise the other areas of life blockchain looks primed to transform. Furthermore, visualising blockchain's disruptive benefits through these three lenses explains why payments, the capital markets, and the financial services have hitherto dominated the discourse around blockchain: these three areas stand to be disrupted in all three ways and thus appear poised to reap the biggest and quickest benefits.

In its most basic sense, blockchain is a trust machine. As with bitcoin, cryptography is used to maintain a peer-to-peer distributed, time-stamped and immutable consensus ledger of all past transactions. Each transaction is similar to a ledger line item, which is then aggregated with others into a block of transactions - similar to a page of a ledger – we are left with a chain of blocks, each connected to the last. As each block of transactions needs to be agreed upon by consensus to be added to the chain, transaction records cannot be forged, censored or reversed once a block is added, and transacting without trust in a counterparty or third party becomes possible.

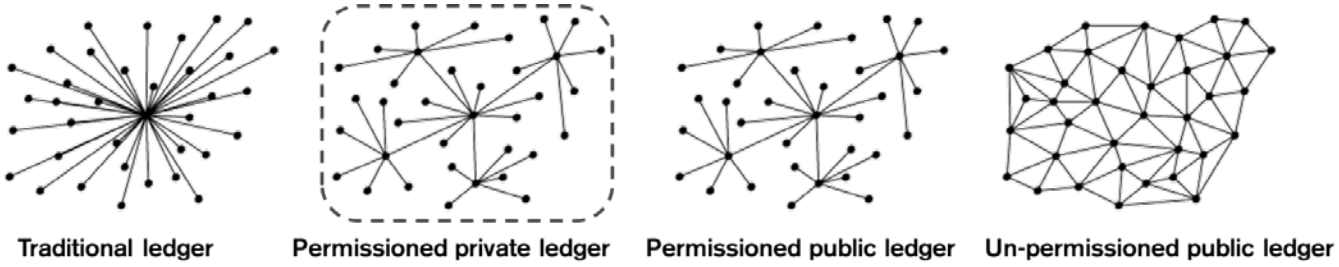
Figure 34: The three disruptive benefits of blockchain, and where they could potentially be beneficially implemented



Source: Credit Suisse research

It is important to stress that blockchain is not a single, unified concept; there are different levels of decentralisation (see Figure 35) from a permissioned private ledger, such as R3's Corda (which we later analyse in a case study on banking), to a fully public, permissionless ledger, such as Ethereum and Bitcoin.

Figure 35: How nodes/members of a network connect at each level of a ledger



Source: Credit Suisse research based on data from Consult Hyperion and On Distributed Communications Networks by Paul Baran, 1962

The key distinction is whether or not one needs permission to access, read and/or write the network – see Figure 36 for a more detailed comparison. As touched upon in the consortia section, private, private/enterprise blockchain projects are usually open only to approved members, and thus are usually quite niche in scope (i.e., focusing on serving the needs of a select group of stakeholders). In such cases the blockchain is not fully decentralised but rather "distributed" among groups of nodes in the network.

Public blockchains are ultimately the 'purest' 'form of blockchain technology: they are fully decentralised, with no node in the network having more power or centrality than any other. Implementing changes to a public blockchain – e.g. whether to proceed with a proposed bitcoin fork – thus requires consensus from the network (usually at least a simple majority, depending on the rules). Thus they are known as decentralised ledger technologies.

Figure 36: Comparing public and enterprise-level blockchains

	PUBLIC	ENTERPRISE
		Chain ripple HYPERLEDGER
ACCESS	Open, read and write	Permissioned write and /or read
SPEED	Slower	Faster
SECURITY	Open network	Approved participants
IDENTITY	Anonymous or pseudonymous	Known identities
ASSET	Native assets	Any asset

Source: Company data, Credit Suisse research, CoinDesk.com

Platforms: blockchain's infrastructure

We think decentralised platforms are best understood as the 'infrastructure' on which blockchain applications will be developed, thereby creating a blockchain 'ecosystem'.

The blockchain platform space can be split into three main camps, each of which advocates for its respective blockchain platform; Ethereum, Hyperledger Fabric, and R3's Corda. R3's Corda is primarily focused on exploring use cases for the financial services industry, whereas Ethereum and Hyperledger Fabric present themselves as being independent from any specific domain of application. A more detailed analysis of the differences between the three is not particularly useful in our context – we simply surmise that the three frameworks are backed by very different visions in terms of potential fields of blockchain's application, and outline the key and differing characteristics in Figure 37.

Figure 37: Comparing the three main blockchain platforms[45]

	Ethereum	Hyperledger Fabric	R3 Corda
Description of platform	• Generic blockchain platform	• Modular blockchain platform	• Specialized distributed ledger platform for financial industry
Governance	• Ethereum developers	• Linux Foundation	• R3
Mode of operation	• Permissionless, public or private	• Permissioned, private	• Permissioned, private
Consensus	• Mining based proof-of-work (PoW) • Ledger level	• Broad understanding of consensus that allows multiple approaches • Transaction level	• Specific understanding of consensus (i.e. notary nodes) • Transaction level
Smart contracts	• Smart contract code (e.g. Solidity)	• Smart contract code (e.g. Go, Java)	• Smart contract code (e.g. Kotlin, Java) • Smart legal contract (legal prose)
Currency	• Ether • Tokens via smart contract	• None • Currency and tokens via chaincode	• None

Source: Frankfurt School Blockchain Center - Martin Valenta, Philipp Sandner - *Comparison of Ethereum, Hyperledger Fabric and Corda*, Credit Suisse research

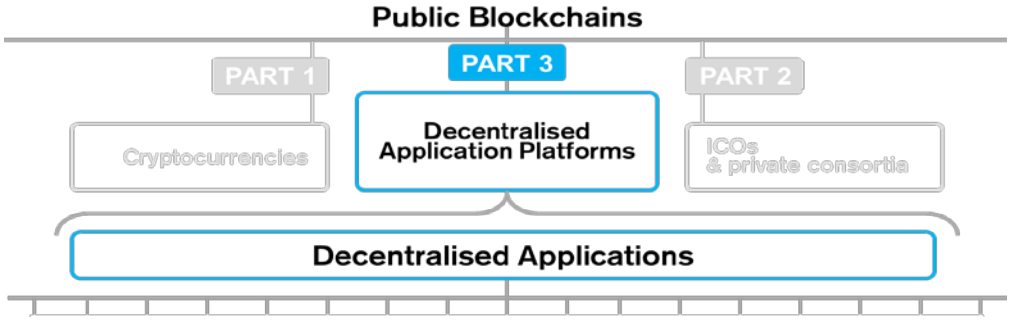
The key point here is that these three frameworks are the platforms on which applications are being developed. That is not to say that the platforms are themselves void of development – teams work on them night and day – just that these three have so far emerged as the three leading "next generation" information protocols on which the blockchain ecosystem will be developed.

The previous generation of internet protocols, HTTP, SMTP, TCP/IP etc., have shaped how we communicate in an immeasurable way – TCP/IP is for example one of the foundational protocols that created the internet, outlining a suite that provided end-to-end communication, specifying how data should be packaged, addressed, transmitted, routed, and received. The transformative nature of these protocols cannot be overstated.

Decentralised blockchain protocols such as those above have the potential to have the same effect: they provide a foundation on which an entire ecosystem of blockchain applications can be built. From an investor standpoint, it is these applications that will unleash the monetary potential of blockchain. Companies that developed applications on the internet – Microsoft, Facebook, Google, etc – made the profits, not those who created the protocol.

[45] http://explore-ip.com/2017_Comparison-of-Ethereum-Hyperledger-Corda.pdf

Beyond the theoretical: blockchain applications



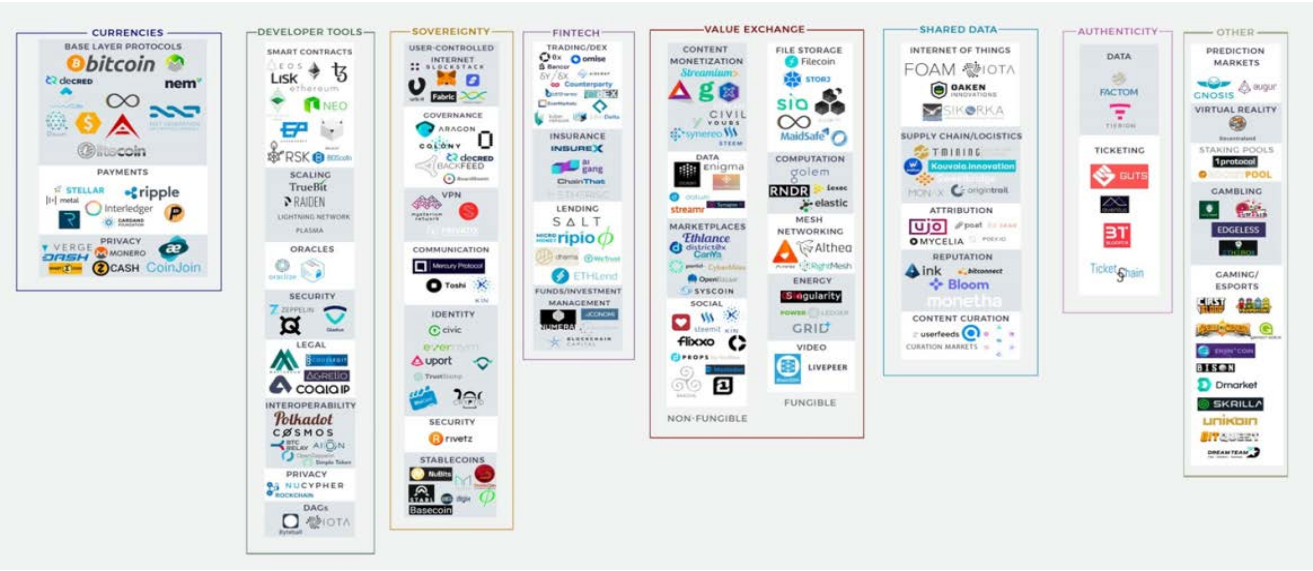
DApps – the blockchain ecosystem

"The [blockchain] business model is shifting from those who create the platforms to those who provide the services."

– Sam Chadwick, Director of Strategy in Innovation and Blockchain, Financial & Risk, Thomson Reuters[46]

We think it is the decentralised applications ('DApps') that sit on top of the blockchain protocols that have the most interest for investors, either as new business model disrupters to existing processes or as future investment opportunities themselves. At this stage, we think it is still hard to see how the profits will be divided. In the world of the Internet, there is a "fat" application layer that has captured virtually all of the value (e.g. Facebook and Google) and a very "thin" protocol layer that has captured limited value. In the blockchain world, the protocol layer will likely be fatter; for instance, developers of Ethereum can benefit from its increasing adoption through the price of Ether. However, we still believe there will be substantial value that is created by the applications layer that will play out over the next five years. Take, for example, the blockchain applications in Figure 38.

Figure 38: The blockchain landscape is expanding and diversifying[47]



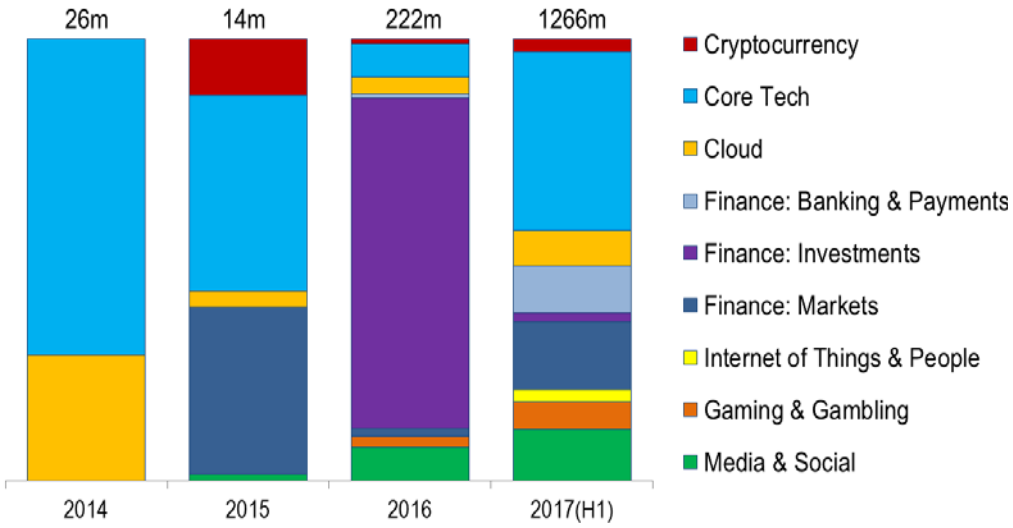
Source: Compound - Josh Nussbaum

[46] Blockchain Summit London, 28/11/17. Keynote speech: *Making Blockchain Real: the Effect on Industry Forces and Obstacles Organisations Face Along the Way*

[47] https://medium.com/@josh_nussbaum/blockchain-project-ecosystem-8940ababaf27

Interestingly, the influx of ICO-facilitated funding we covered previously has fuelled a widespread diversification of the type of blockchain applications under development. Figure 39 shows that ICO-funded projects – while more than quadrupling so far this year when compared to 2016 – are no longer dominated almost entirely by finance (outside of those focusing on core blockchain technology). For example, blockchain-enabled technology is being developed to help solve music's attribution problem, encourage investment in athletes, track land and property deeds, monitor unlawful gun purchases, trade stocks, authenticate voting, and protect internet-enabled devices.

Figure 39: An increase in and diversification of ICO-funded projects (total - $m)



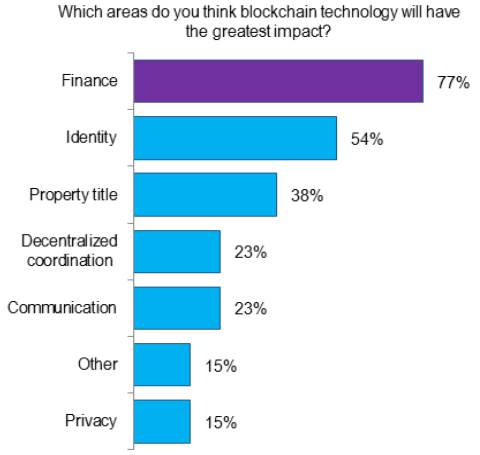
Source: Credit Suisse research, Autonomous NEXT

Banking, a case study

Nonetheless, approximately half of all identified potential use cases for blockchain are in the financial services; financial services and payments have long been at the front of the queue for blockchain applications and it makes sense to examine these as our first case study.

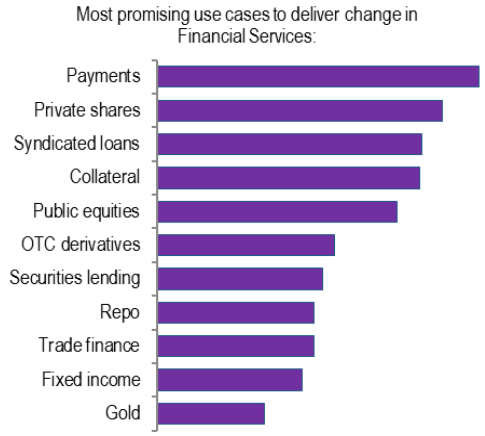
These are industries that rely on old-fashioned intermediaries to solve the problem of trust and, based on legacy technology, are subject to extended settlement times. We believe that blockchain technology is well suited to solving these inefficiencies. The relevance for financial services is well recognised by the industry, as supported by recent surveys, see Figure 40 and Figure 41.

Figure 40: Blockchain thought leaders believe blockchain will most impact Financial Services…



Source: Bitcoin and Blockchain Thought Leaders Annual Survey (2016), Credit Suisse research

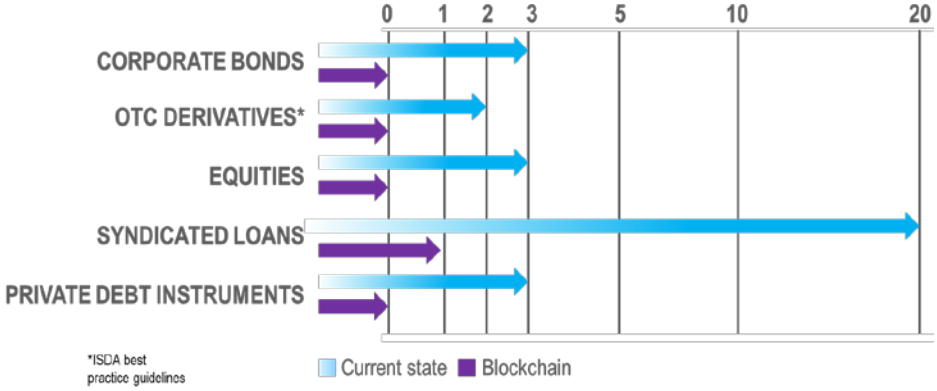
Figure 41: ….within financial services, Payments and Capital markets appear most at risk of disruption



Source: Greenwich Associates 2016 Blockchain Adoption Study, Credit Suisse research

Among others, blockchain's uses in financial services for the FX, derivatives, ETF, and CDS markets are currently being explored by banks and the powerful blockchain alliances they have formed with global corporates and tech pioneers. We see medium-term scope for blockchain to change the structure of capital markets, speeding up settlement times and consolidating disparate processes across clearing, settlement and registration. This opens the door to shifting revenue shares across the value chain.

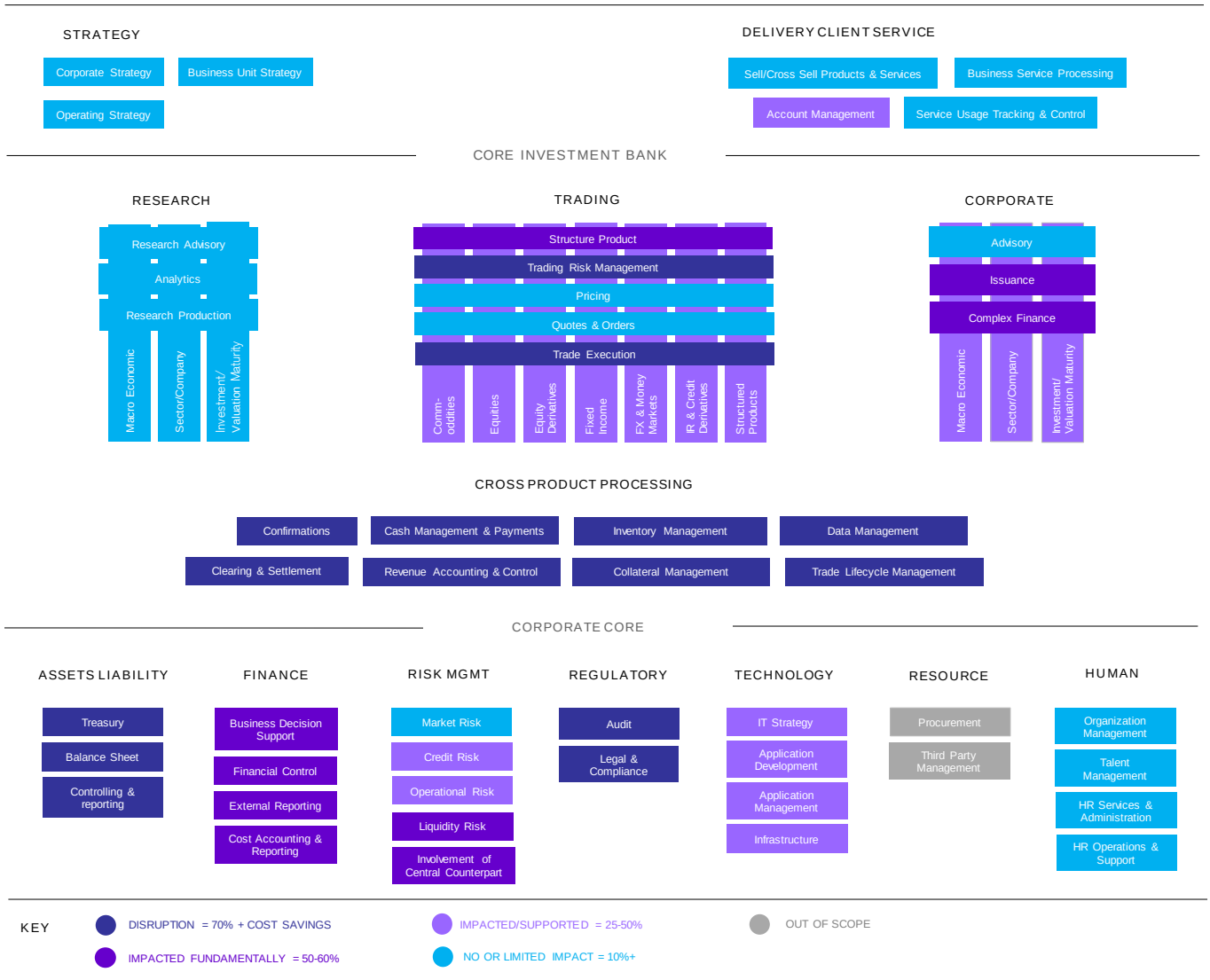
Figure 42: Blockchain impact on financial settlement times (days)



Source: Raconteur, Accenture

We think the graphic overleaf from Accenture clearly shows the very broad scope of potential disruption within the sector – see Figure 43.

Figure 43: A comprehensive view of blockchain's potential disruption in the financial services



Source: Accenture, Credit Suisse research

More broadly, Deloitte identifies within the financial services five broad blockchain use cases that could comprehensively transform the sector: 1. Speeding up and simplifying cross-border payments; 2. the future of share trading; 3. smart contracts; 4. online identity management; and 5. loyalty and rewards.[48] The wide-ranging scope of blockchain for the banking industry helps us to appreciate why financial institutions have been first in line in researching and developing blockchain. In addition, the availability of high levels of capital, immutability of record, disintermediation of trust, and smart contracts should lead to significant material cost savings for financial institutions:

In terms of quantifying the disruption, Accenture estimates that the global investment banking industry has a $30bn cost base and that blockchain-enabled technologies could save financial institutions up to 70% in reporting costs, 50% in compliance and on-boarding costs, and 30% infrastructure costs, thereby reducing opex for the world's 10 largest investment banks by $8-12bn.[49]

[48] https://www2.deloitte.com/nl/nl/pages/financial-services/articles/5-blockchain-use-cases-in-financial-services.html

[49] https://www.accenture.com/gb-en/insight-banking-on-blockchain

Spotlight on: DApps

Many blockchain concept and prototype projects have moved to 'pilot phase' testing, to be refined in advance of going into production phases in the next 6-12 months. The natural evolution of this ecosystem is that applications will be built on top of the blockchain protocol and consequently come later. In terms of timing, it is our view that it is best to conceptualise FY16 as a year of idea generation or proof of concept. There was positive progress in FY17 and we see building evidence that Proof of Concepts are moving on to prototypes, pilots, and in some cases production.

One of the first blockchain projects to be released by the financial sector for real-world use comes from a financial corporation that mediates a US$1trn/year market: the Depository Trust & Clearing Corporation (DTCC) is a post-trade financial services company providing clearing and settlement services to the financial markets. Almost every broker or institutional investor in the world that trades a US-based security settles it through DTCC.[50] When it is implemented later this year, the new swap network will first operate in the background, running parallel to the existing warehouse – this is known as the "production parallel" phase. However, managing director and chief technology architect of DTCC Robert Palatnick has stated that the goal is for the blockchain system to replace that of the legacy warehouse by the end of 2018. From that moment on, the entire $11trn global market for credit-default swaps will be traded on a blockchain.

Another example making headlines is the Australian Securities Exchange (ASX), which recently announced that it intends to use blockchain to manage the clearing and settling of equities. ASX will operate a secure private blockchain network and has emphasised the system had nothing to do with bitcoin. While it has been reported in the Financial Times that certain analysts have questioned how DLT can be made secure and fast enough for such a large institution, Dominic Stevens, CEO of ASX, said that the introduction was an opportunity for more timely and accurate information.[51] The announcement was hailed by Digital Asset Holdings CEO Blythe Masters at the time as "the first meaningful proof that the technology can live up to its potential".[52]

As our Australia-based colleagues, Andrew Adams and James Cordukes, later cover in Exchanges - ASX: Shift to DLT may not necessarily be accretive, the financial outcome of ASX's DLT-based settlement service is difficult to determine with pricing yet to be agreed with clients and fees payable to Digital Asset also unknown. Andrew and James also discuss the full consideration of ASX's new system in *ASX: Pending DLT decision may not necessarily be positive; Maintain Underperform* (28 November 2017).

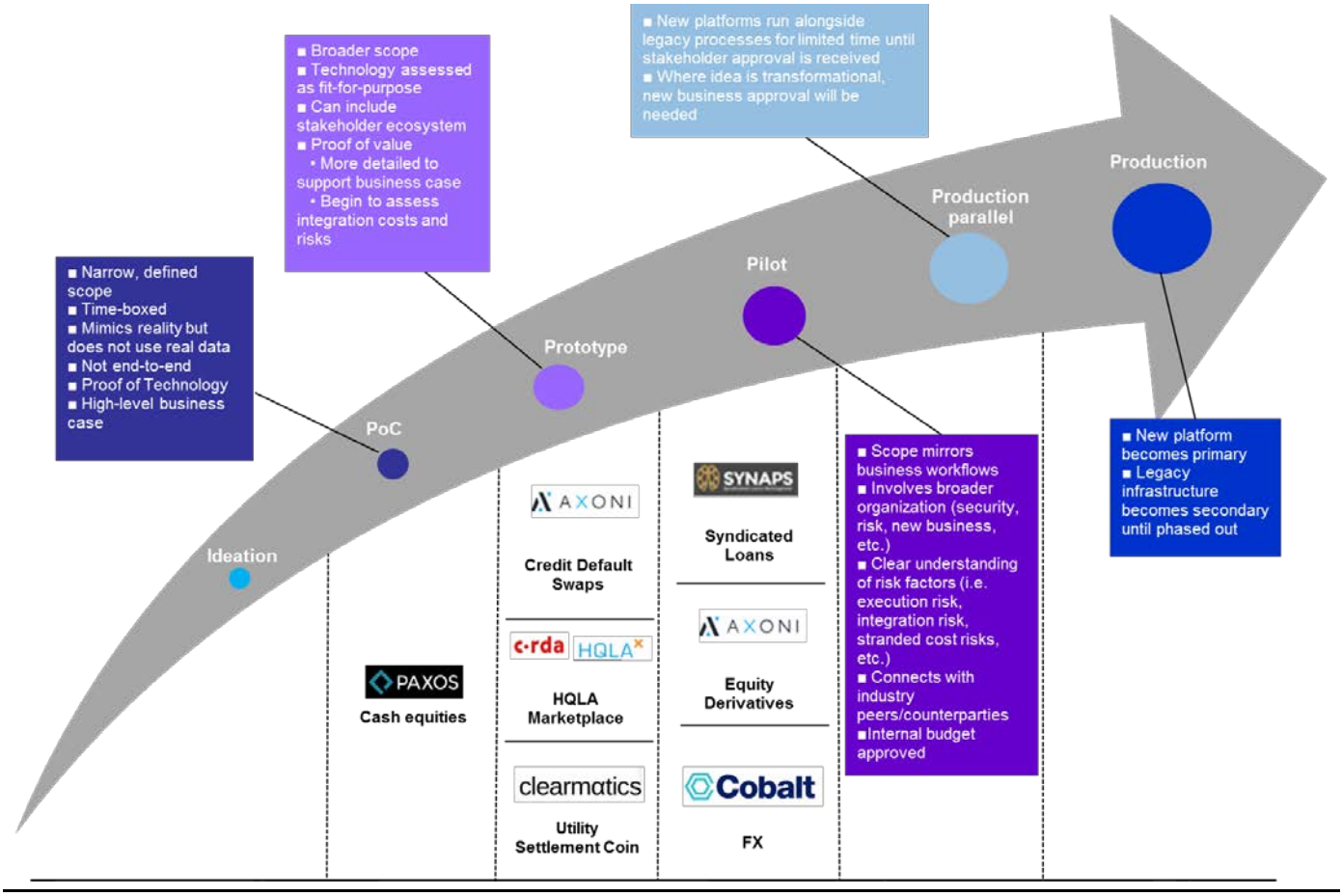
This shows that blockchain projects are moving beyond the proof of concept (PoC) phase we initially discussed in *The Trust Disrupter*, and moving onto the prototype and pilot phases – and in some cases even moving into production parallels alongside existing legacy infrastructure.

[50] https://spectrum.ieee.org/telecom/internet/wall-street-firms-to-move-trillions-to-blockchains-in-2018

[51] https://www.ft.com/content/e0a32840-4f68-11e6-8172-e39ecd3b86fc

[52] https://www.ft.com/content/c9b86e8e-dae4-11e7-a039-c64b1c09b482

Figure 44: We think that FY18 will see gathering momentum for full production systems



Source: Company data, Credit Suisse estimates – list not exhaustive; included projects for illustrative purposes only

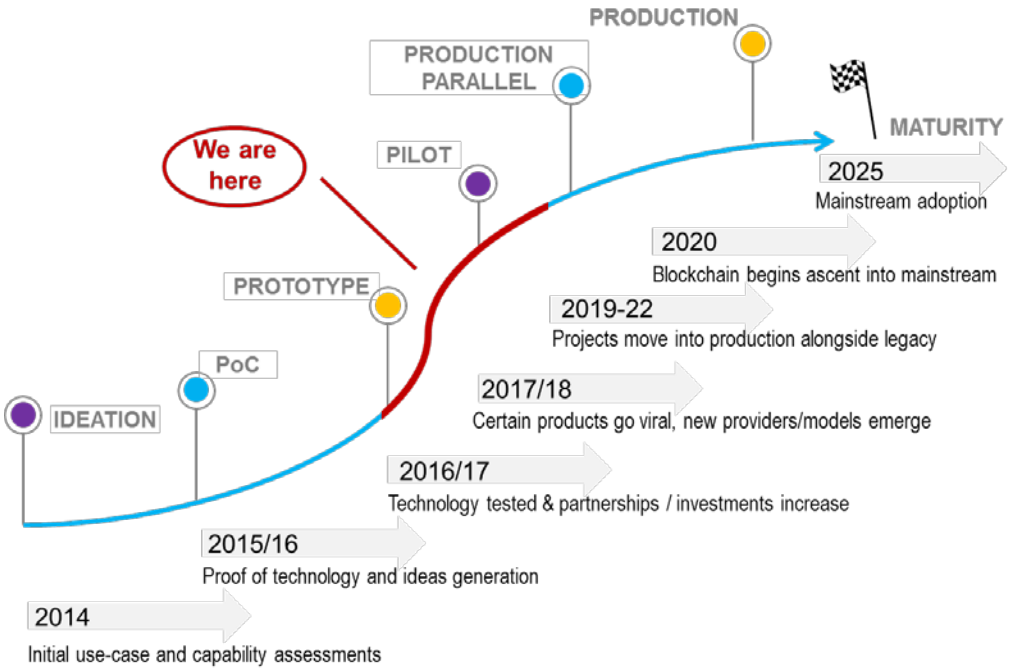
In Figure 44 we provide an illustrative overview of blockchain financial projects that are in development. Those such as syndicated loans, equity derivatives, and FX DLT blockchain projects have moved beyond the prototype phase and into the pilot phases. Our impression is that development has moved from early R&D to wider areas of business, such as security and risk, as wider parts of the enterprise are beginning to involve themselves in blockchain projects. The next stage will be for these applications to run alongside the current legacy programmes until they have proven themselves to such an extent that they can be approved for full-scale production.

To production and beyond

Mapping out a timeline of development

Figure 45 provides us with a take on which we can sketch a broad blockchain timeline: In 2018 we are entering a growth phase, where the products and platforms we have discussed in this report should move into more comprehensive production phases. For the time being, we do not expect them to replace current legacy systems, but rather to run alongside to allow for testing and refining. After all, much of blockchain's utility is derived from its network – the more development and the more applications that can be built upon the platforms, the more solutions we will arrive at through blockchain.

Figure 45: Development timeline – where are we now?



Source: Accenture, Credit Suisse estimates

Figure 45 also suggests that blockchain's development is far from linear, and that we are currently in a period in which news and successes around blockchain projects appear to have softened, especially when compared with bitcoin and cryptos. However, when we attended the November Blockchain Summit in London, we were struck by the consistency of the message that attributed this apparent "lull" to the fact that blockchain had at last moved past what was referred to as a "press release" / "marketing hype" phase; that a toning down of marketing campaigns by companies and consortia in the news was a sign that they were now focusing on research and development – i.e., the comparative quiet is a good sign. After speaking with various industry specialists our impression is that blockchain may be entering a PR 'dark period', with companies focused on winning the race to deployment. Blockchain exploration and development has become a given for many companies; the test is who can deliver first. Such sentiment was reiterated, for example, by Noelle Acheson, Editorial Producer at Coindesk, who noted in a panel discussion that "blockchain has become part of branding and PR… we're moving beyond that".

Indeed, this view is broadly consistent with this year's Gartner "hype cycle for emerging technologies", which shows that within the next 5-10 years, blockchain will move beyond the "peak of inflated expectations" phase, to a "plateau of productivity", but only after travelling through a "trough of disillusionment" and a subsequent "slopes of enlightenment". This indicates we have as a minimum moved beyond a period of overhype in blockchain, and that efforts are under way to create more real-world applications of the technology. A key point is that development in emerging technologies is typically non-linear – and cycles of hype and disillusionment should be expected along the journey.[53]

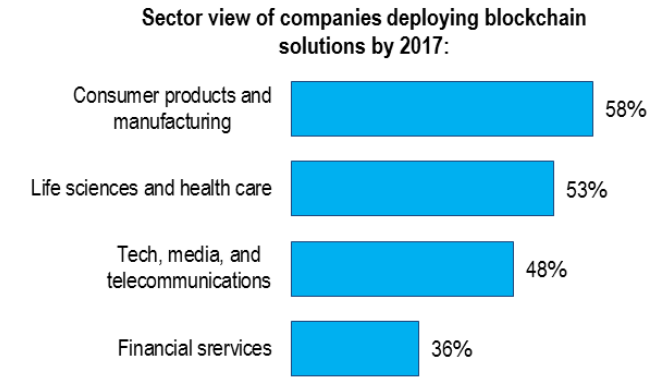
More broadly, as a timeframe we look to data from the World Economic Forum, whose survey of over 800 executives found that 58% of respondents expect 10% of GDP to be stored on the blockchain before 2025; and 73% of those surveyed expect tax to be first collected on-chain pre-2025. The report considers blockchain as important to the sharing economy and distributed trust and identifies it as one of six megatrends isolated in the report.

Not just the financial services

Financial services blockchain projects – while perhaps the most numerous – are not necessarily the most advanced in terms of development and production. This is partly due to the sensitive and riskier nature of shifting financial systems to blockchain prototypes – one slip can lead to major consequences, and intense regulatory oversight necessitates extreme caution. In fields where there is perhaps more room to experiment with real-world applications, such as consumer products and manufacturing, we have seen companies begin to deploy blockchain solutions in 2017.

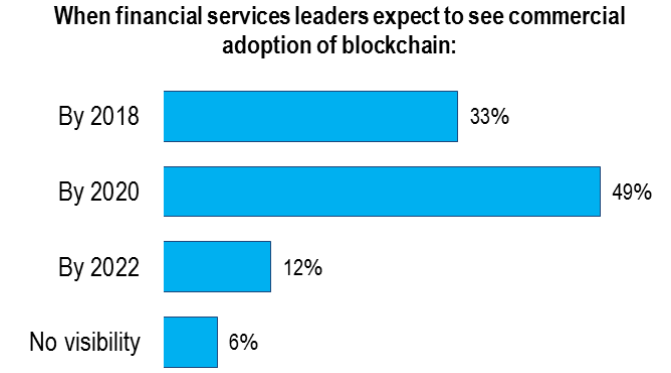
Figure 46 illustrates that 58% of senior executives in consumer products and manufacturing interviewed by Deloitte said they were deploying blockchain solutions in 2017, while 53% of executives of life sciences and healthcare companies said they would deploy some type of blockchain solution in 2017, compared to 36% of executives in the financial services.

Figure 46: Not just about the financial services…



Source: BI Intelligence, Credit Suisse research

Figure 47: …which in many instances are behind



Source: BI Intelligence, Cognizant, Credit Suisse research

[53] https://www.gartner.com/smarterwithgartner/top-trends-in-the-gartner-hype-cycle-for-emerging-technologies-2017/

To illustrate this, we outline below a selection of three notable, non-financial services applications of blockchain technology that have grabbed our attention in the past 12 months, all of which are to varying degrees in the later stages of development.

Three non-financial applications:[54]

Grid+*

Grid+ is a distributed energy platform that aims to offer customers direct access to the wholesale energy markets (and thereby wholesale prices). Using the Ethereum blockchain and an internet-enabled, always-on device called 'Smart Agent', the company is developing an ecosystem wherein customers can pay for electricity in real time and directly from distributed energy providers. By offering market-based energy pricing, Grid+ encourages users to adopt distributed generation (e.g. home solar panels) and distributed energy storage (batteries). The decentralised grid structure then directly connects different nodes – i.e. users and producers – in the network. Nodes are grouped based on geographical location, meaning the energy's production and consumption can take place within a single neighbourhood. This reduces infrastructure and carry costs. Grid+ expects its hardware production to be fully scalable by late 2019.

uPort*

Identity has been described as the "holy grail of blockchain"[55] and uPort aims to tackle this using its blockchain application built on Ethereum. uPort is what is known as a self-sovereign identity application – enabling people to fully own their identity on a blockchain and to control the flow of their personal information. Users will be able to authenticate themselves on and off the blockchain, but without needing to rely on this authentication being done by a centralised identity provider, or setting up multiple different identities of varying degrees of security for applications such as Facebook and Google. Each identity can only be changed or blocked by the uPort identity itself – and since no personal data is stored on the chain (just the unique hash verifying your data), the problem of identity loss or theft can be overcome. By allowing users to control the information stored on the blockchain network, uPort allows them to access digital services without using passwords, digital signatures, transactions, and documents – all modes of authentication that can ultimately be stolen or forged. With this system the user holds and owns his or her personal data, which is backed by the security of the Ethereum blockchain.

Provenance

Provenance is one of the many companies aiming to solve supply-chain challenges using blockchain technology. Around 200 retailers and producers in the food and drinks industry use Provenance's software services to track the origins and movements of their products. Storing the various supply-chain certifications on a blockchain means product information can easily be checked throughout the entire process, and that this information cannot be changed (or more certifications added) without validation. For a retail customer, the concept once implemented means that they are able to scan a product in a store and obtain details about the producer, the method of production, and also verify details on the quality of the product. The blockchain also renders the central body that maintains the system redundant, and eliminates the shortcomings of the current systems by providing a continuous chain of custody from manufacturing to sale. The company is currently working towards an open traceability protocol – so that anyone can use it to track the provenance of anything, from coffee beans to a roll of fabric.

[54] *Grid+ and uPort are both blockchain applications that have been developed/incubated by ConsenSys, the blockchain venture production studio. A summary of our interview with ConsenSys is available at the end of the report - ConsenSys Interview

[55] Noelle Acheson, Editorial Producer at Coindesk, speaking at Blockchain Summit London, 28/11/17. Panel: Exploring Opportunities for Applications Beyond Cryptocurrencies

Obstacles in the road for blockchain

While we remain convinced of blockchain's cross-sector utility, we also acknowledge before concluding this section that, like bitcoin, the technology is not immune from hype. We update and recap below the challenges we believe blockchain faces on the path to widespread production and implementation.

1. **Security vs cost trade-off** – Permissionless, public blockchains like those that underlie the bitcoin system can be seen as the 'purest' form of blockchain. Full distribution and permissionless participation mean authority is fully devolved; it is in theory infeasibly costly for any one entity to gain even a semblance of control. This truly trustless architecture means high security, but such security comes at a price not dissimilar from the transaction costs we see in legacy systems. Thus, the result is that blockchain can either be expensive and secure or cheap and (comparatively) risky.

2. **Do you actually need a blockchain?** The old adage 'if it ain't broke, don't fix it,' comes to mind when assessing the applicability of some proposed blockchain use-cases. For a blockchain to be relevant, you must 1) require a database, 2) need shared write access, 3) have unknown writers whose interests are not unified, and 4) not trust a third party to maintain the integrity of the data. To summarise, some proposed blockchain use-cases appear to be solutions in search of problems.

3. **Critical mass is essential** – Blockchain-based solutions intrinsically rely on multiple users, particularly at the authoring level. We see clear threats to achieving critical mass: 1) fragmentation of platforms, and 2) institutional and social inertia to transition to and/or agree on a platform. To achieve critical mass, firstly a single open-source platform would need to be built upon by all developers. We see projects like Ethereum as attempting to assume this mantle. Secondly, industry consortia would need to unanimously agree on chain projects. We also see R3CEV as instrumental to establishing the consensus necessary to implement a consensus ledger.

4. **What you get out is only as good as what you put in** – there is no guarantee of 'truth' just because information is on a blockchain. In reality the 'truth level' of on-chain info is only as good as barriers employed to (1) ensure the quality of data being added is high, and (2) ensure the quality of node permissioned to add to the chain is high.

5. **The hackable 'surface area'** – hackable entry points of a distributed network increase with each node added. While we think there are data-security solutions in a blockchain world; e.g. each node's copy of the blockchain could be air-gapped (i.e. the secure network is physically isolated from unsecured networks like the internet), data waiting to be added to the next block must surely be accessible over a network as it is being shared with other nodes.

6. **You have to see it to believe it…** Although it may appear that blockchain data is by nature encrypted, this is not actually the case. On the bitcoin, blockchain identity is encrypted, but transactional data is not. The key reason is that to validate additions to the chain, nodes must have visibility over what they are validating. This may not be an issue on private chains where we trust permissioned nodes to handle sensitive data; however, the limited anonymity/privacy this mandates on public chains may be a barrier to adoption.

7. **How is the identity problem solved?** We think many blockchain use-cases rest upon the assumption that identity can be reliably determined and managed on-chain, thereby enabling disintermediation of the trusted third-party identity management function. However, as we have noted regarding bitcoin, on-chain asset ownership by virtue of private key knowledge essentially makes all on-chain assets bearer instruments. The issue with bearer instruments, e.g. cash, is you can lose them.

8. **A forked road, the lesson of the DAO attack** - The Decentralised Autonomous Organisation, which holds hundreds of millions of dollars' worth of digital currency Ethereum, was hacked in June 2016, forcing it to fork its network to prevent the thieves from stealing more. However, like bitcoin, Ethereum is a decentralised network and thus needed the consensus of the community before it could make the immediate changes. The 'hard fork' undertaken by the Ethereum community shows that blockchains are only immutable when consensus wants them to be.

What lies ahead?

We think 2018 will be yet another critical year for blockchain's development. Bitcoin's rise and the meteoric expansion of ICOs have provided insight into the impacts and rewards of blockchain technologies. Below we present a selection of industry quotations that provide us with a fitting snapshot of the kind of development trends that will likely define blockchain in the 12 months or so.

1. **"2018 is the year for production; it's the year for implementation."**

   - Todd McDonald, co-founder of R3 consortium (Oct 2017)[56]

   Prototype and production phases – We believe 2017 will prove to have been the year when blockchain discourse moved beyond hype and marketing. The elevation of blockchain technology from marketing press release to boardroom reports and conference calls (as illustrated on the front page of this report – Figure 1) shows just how seriously enterprises and institutions are taking decentralised technology. The pressure is on to deliver, to be one of the first to roll out successful distributed solutions, and to deliver cost savings to shareholders. In our view, 2018 will likely be the year when many decentralised technology projects enter the real growth phases; be them prototype or even production parallel stages.

   Blockchain solutions will come into production as the "low-hanging fruit" of the industry is addressed – i.e. where blockchain's use is immediately obvious, such as payments and trade finance. It seems fitting to stress this point further with another quote from the R3 banking consortia, again hitting home the developmental emphasis being placed on 2018: David Rutter, the CEO of R3, said recently in an interview: "But next year proves a lot. If you and I were here this time next year and we don't have half a dozen to a dozen apps in full production environment, that would be problematic. That's true for Fabric and Ethereum-based solutions too."[57]

2. **"Nine out of 10 governmental organizations plan to invest in blockchain for use in financial transaction management, asset management, contract management and regulatory compliance by 2018."**

   - IBM Institute for Business Value (IBV) and Economist Intelligence Unit (Feb 2017)

   Regulation – Likely as a result of this acceleration in development, we expect 2018 to be defined by regulatory responses to and involvement in blockchain. The rise of ICOs, rapid gains made by bitcoin, and recent announcements by exchanges such as the CME to start allowing for the trading of BTC futures, have pricked the ears of regulators around the world. Accenture has identified 2017 as a year in which regulatory authorities "realise[d] the benefits [of blockchain adoption] for auditing and compliance; [and] rule making begins". This appears to align with the recent waves of regulatory announcements surrounding blockchain; we have noted an increase in the frequency of regulatory statements surrounding cryptos and decentralised technology in 2H17: Most recently important moves have been made by the SEC and CFTC in the US, along with historic announcements from other regulatory bodies in the UK,

[56] https://www.waterstechnology.com/industry-issues-initiatives/3436601/2018-to-be-the-year-of-implementation-for-blockchain

[57] https://www.gtreview.com/news/fintech/r3s-ceo-missing-full-production-next-year-would-be-problematic/

China, and Russia. These appear to have been triggered by the increased involvement of retail investors in ICOs and cryptocurrencies, while the security implications of bitcoin and other cryptos (discussed earlier) have placed blockchain on the radar of tax authorities and crime agencies. The UK Treasury, for example, announced on 4 December that it is "working to address concerns about the use of cryptocurrencies by negotiating to bring virtual currency exchange platforms and some wallet providers within anti-money laundering and counter-terrorist financing regulation".[58]

Nonetheless, regulators do not appear to want to stifle innovation; many acknowledge already the important role DLT will play in the future and recognise the need to create a safe space to experiment with the technology. Indeed, when we consider that the IBM survey data has revealed that 90% of governments plan to invest in blockchain in 2018, it should come as no surprise that powerful and comprehensive regulatory frameworks are likely to follow. The survey data further revealed that seven in ten government executives predicted that blockchain will significantly disrupt the area of "contract management", which is often the point at which the public and private sectors intersect in commercial operations. It is expected that new blockchain ecosystems developed around smart contract technology will arise in 2018, as integration platforms interlink between industries.[59]

3. **"Blockchain isn't the solution in itself… it is the vehicle through which we can arrive at a solution."**

- Michele Nati, Lead Technologist, Personal Data and Trust, Digital Catapult (Nov 2017)[60]

Diversification of landscape – On top of the "low hanging [blockchain] fruit" going into production, we expect to see a continued diversification of the decentralised technology landscape, driven in no small part by the ongoing ICO phenomenon. Indeed, blockchain watchers expect for the ICO process to become "professionalised" in 2018 (especially with regulatory pressure previously outlined), so much so that they may morph into a kind of IPO 2.0,[61] which will help further fuel blockchain's ascent into the public and commercial domain.

Blockchain is increasingly being understood in its own right, independent of bitcoin and the financial services. Its role as an enabling technology will make blockchain even more ubiquitous in 2018; more entities will adopt a blockchain infrastructure for data integrity, security, and transparency. For example, Sol Lederer, Blockchain Director at LOOMIA, predicts that in 2018 we will most likely see social media platforms such as Reddit and YouTube "integrate a blockchain token to reward and incentivize their content creators". Such thoughts have also been echoed by Jonathan Chou, CEO of Bee Token, who noted that 2018 "will see the first wave of everyday applications that gets blockchain into the hands of the everyday user starting from obvious case studies like Uber for blockchain or Airbnb for blockchain", while Dmitry Zhulin, Co-founder of INS Ecosystem, expects to see In 2018 blockchain "becoming a widely adopted mainstream technology, transforming a whole host of industries from financial services and retail, to logistics and medicine". [62]

[58] https://www.theguardian.com/technology/2017/dec/04/bitcoin-uk-eu-plan-cryptocurrency-price-traders-anonymity

[59] https://www.coindesk.com/2018-will-another-growth-year-blockchain/

[60] Blockchain Summit London, 28/11/17. Panel: Exploring Opportunities for Applications Beyond Cryptocurrencies

[61] https://www.coindesk.com/2018-will-another-growth-year-blockchain/

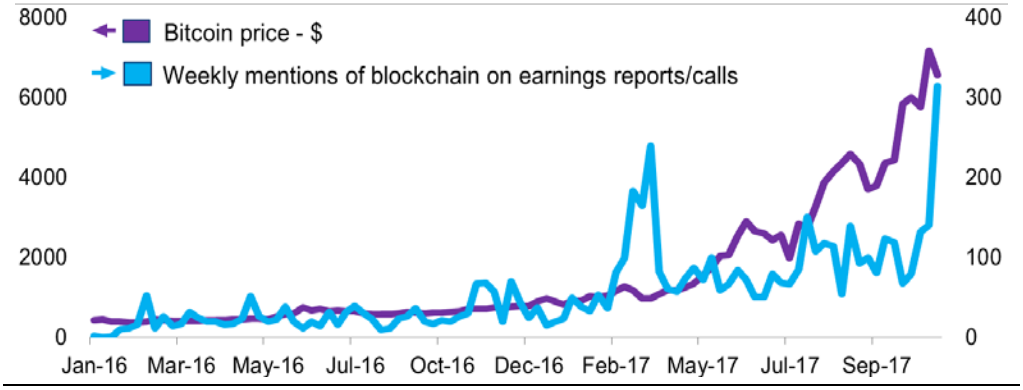
[62] Josh McIver, CEO and founder of ULedger:
Sol Lederer, Blockchain Director at LOOMIA:
Jonathan Chou, CEO of Bee Token:
Dmitry Zhulin, Co-founder of INS Ecosystem:
http://www.valuewalk.com/2017/12/2018-predictions-from-bitcoin-and-blockchain-experts/

To summarise, we remain convinced of the substantial cross-sector opportunity being borne out of the wider transformation of the digital information ecosystem. In the next section we look into blockchain's implications for the equity market, providing outlines on the payments, security, and financial services spaces.

Implications for the equity market

At the time of writing *The Trust Disrupter* in 2016, blockchain appeared an exciting, albeit conceptual or nascent technology, where it was difficult to articulate the direct impact on the equity market. Roughly a year on, we think it is increasingly clear that blockchain is starting to impact investment cases. Specifically, there were over 300 mentions of blockchain in the 3Q17 results season conference calls each week, up tenfold on 3Q16 – see Figure 48. Conference calls are a summary of the most important business drivers, so we view this increasing prominence as a clear indication of the growing importance of blockchain.

Figure 48: Bitcoin's rise has corporates talking about blockchain

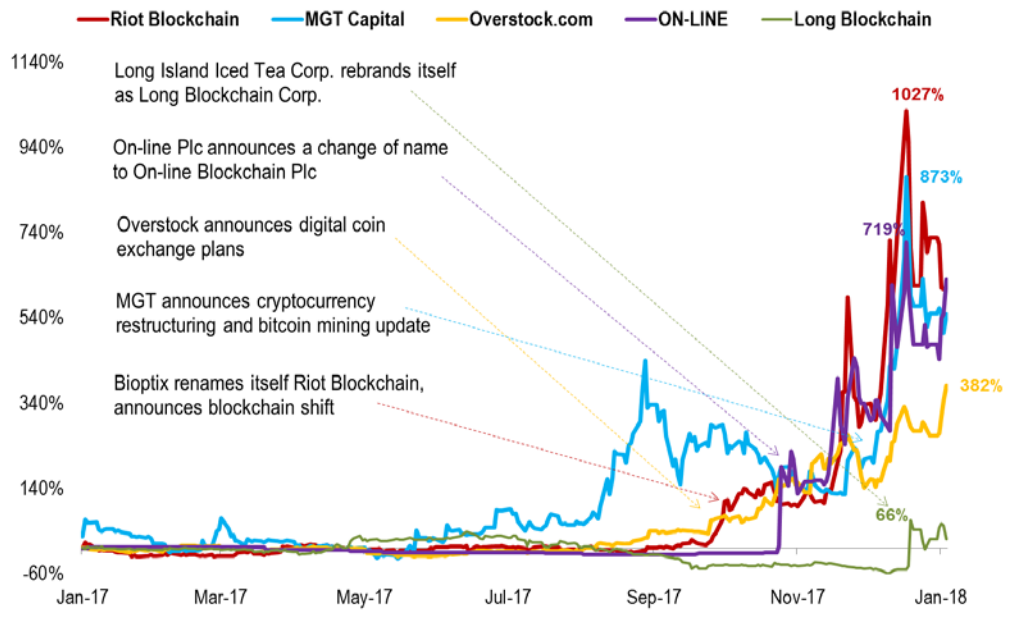


Source: Credit Suisse research, Sentieo, Quartz - Jason Karaian

All in the name?

At the smaller market cap end of the spectrum, the impacts are starting to be significant. Figure 49 tracks the share price of four companies following a blockchain-related announcement. One company, On-line Plc – a UK investment company based in Essex – saw its shares rise c191% on the day it renamed itself to On-line Blockchain Plc.

Figure 49: Sharp share gains for companies with a perceived blockchain focus



Source: Company data, Thomson Reuters Datastream, BLOOMBERG NEWS

Current newsflow is not just restricted to small caps. Even amongst large caps / well established companies, blockchain is starting to feature as a meaningful business driver, as evidenced by these quotes from two well-established companies.

> "Cryptocurrency and blockchain is here to stay. The market need for it is going to grow, and over time it will become quite large. It is very clear that new currencies will come to market, and it's very clear that the [cryptocurrency-specific] GPU [Graphics Processing Unit] is just fantastic at cryptography. And as these new algorithms are being developed, the GPU is really quite ideal for it. And so this is a market that is not likely to go away any time soon, and the only thing that we can probably expect is that there will be more currencies to come. It will come in a whole lot of different nations."
>
> - Jensen Huang, Founder, President and CEO, NVIDIA[63]

> "GPU sales were lifted by demand from increasing mining activity, or Ethereum. We serve a large portion of this specialized market with a dedicated board, as seen in our OEM sales, and some with GeForce GTX boards. Our strategy is to stay alert to this fast-changing market, knowing that GPUs are highly efficient at running the algorithms used to mine cryptocurrencies."
>
> - Colette Kress, EVP & CFO, NVIDIA[64]

> "ASX has been carefully examining distributed ledger technology for almost two-and-a-half years, including the last two years with Digital Asset, in order to understand its potential application… Having completed this work, we believe that using DLT to replace CHESS will enable our customers to develop new services and reduce their costs, and it will put Australia at the forefront of innovation in financial markets."
>
> - Dominic Stevens, CEO, ASX[65]

Expect the unexpected

We think it has been obvious for some time that exchanges / financial services would be at the coal-face of a blockchain debate. However, the other point to highlight is that blockchain is an emerging technology. As such, use cases are only just beginning to surface now and it is highly likely that some of the most important future applications of blockchain have not even been conceived today.

We think a good example of this is "Security". Previously, we never prioritised "Security" as a key sector in the blockchain debate. However, one of the major unintended consequences of cryptocurrencies is that they have become a currency through which cyber criminals can monetise their activities. The fact that users are anonymous makes it an ideal vehicle for potentially monetising crime. This is well illustrated by the fact that the Wannacry ransomware demanded bitcoin. As a result, bitcoin has become an unexpected driver of cybersecurity.

[63] Taken from the transcript of NVIDIA's 2Q18 earnings call, held on 10th August 2017

[64] Taken from the transcript of NVIDIA's 2Q18 earnings call, held on 10th August 2017

[65] http://www.asx.com.au/documents/asx-news/ASX-Selects-DLT-to-Replace-CHESS-Media-Release-7December2017.pdf

We think there are likely to be numerous more surprises like this over the coming years. The quote below from Sophos's Simon Reed illustrates the way cryptocurrencies can become an enabler of cybercrime:

> "Where we are today, we're in a ransomware world, okay? Ransomware is a large-scale attack that's affecting people across the planet. Now the interesting thing about ransomware is it wasn't technology advancement from the cyber criminals that enabled these attacks. Effectively, the availability of cryptocurrency was the last link in the chain to make, to build them an effective business model. This allows the cyber criminal to directly monetize from the affected end user in a phased manner. This was the final link in the chain."
>
> - Simon Reed, VP, SophosLabs[66]

In order to bring this debate closer to equity investors, we re-visit our thinking in the following key areas:

1) Security
2) Payments
3) Banks
4) Exchanges
5) Business Services
6) Travel and Leisure
7) Real Estate

We end the report with some unique insights from an interview we conducted with Maxwell Stein and Griffin Anderson at ConsenSys, a leading global blockchain venture production studio – see Insights from a leading blockchain venture production studio.

[66] Taken from the transcript of Sophos's Capital Markets Day, held on 06 September 2017

Security

Research Analysts

Brad Zelnick
212 325-6118
brad.zelnick@credit-suisse.com

Kevin Ma
212 325 2694
kevin.ma@credit-suisse.com

Syed Talha Saleem, CFA
212 538 1428
syedtalha.saleem.2@credit-suisse.com

Blockchain is highly relevant for software

Blockchain is relevant to our Infrastructure Software coverage…

We see great value in understanding, and staying abreast of the development of blockchain protocols. The technology has natural relevance to our coverage, which includes infrastructure software, as its very essence is a reimagining of how transaction-based systems might function. Numerous companies in our coverage—predominantly infrastructure plays— have signaled blockchain-related intentions:

- **Red Hat:** "Red Hat Introduces New Partner Initiative for Blockchain Software Vendors"
- **Oracle:** "Oracle Launches Enterprise-Grade Blockchain Cloud Service"
- **VMware:** "VMware Unveils Blockchain Technology Proof-of-Concept at Money 20/20"
- **Hortonworks**: "Blog Post: The Advantages of Blockchain Technology"
- **CA Technologies:** "Mainframe is a great workhorse for…Blockchain-oriented applications." – CEO, Mike Gregoire, 12/7/2017.

… as well as our Security Software coverage

We also see relevance for our Security Software coverage universe. Not only do cryptocurrencies (enabled by blockchain architectures) significantly increase the viability and profitability of agnostic cyber-attacks such as ransomware, but (ironically) some perceive a world predicated on blockchain to be a world free from cyber risk. We disagree, and address this contention herein.

A chain is only as strong as its weakest link

As interest in blockchain has risen, we have noticed increasing speculation that future systems predicated on blockchain technology have the potential to be substantially more threat resistant than those based on more traditional protocols. The logic goes that the decentralization and encryption properties of blockchain protocols offer immutability, availability, and confidentiality, and thus greater integrity in the face of malicious activity vis-a-vis traditional methods of recording and transacting value.

- **Confidentiality:** Strong end-to-end encryption—in which hashing generates addresses that are practically impossible to reverse, and only private key holders can decrypt and see the data—allows confirmation of transaction validity without revealing the identity of transacting parties.
- **Integrity:** Consensus protocols of distributed ledger systems make it difficult for an attacker to create fraudulent transactions within a sufficiently large network, as each new block typically requires confirmation of validity by a plurality or majority of nodes.
- **Availability:** The distributed, peer-to-peer node network characteristics of blockchains greatly reduce the impact of single-point failures. For example in a DDoS attack scenario, a sufficiently large network could maintain its integrity in the event that one or even several nodes are incapacitated.

While we acknowledge these benefits as well as the potentially positive ramifications for security of IT systems, we struggle to see a world predicated on blockchain to be a world free from the risk of cyber-attacks:

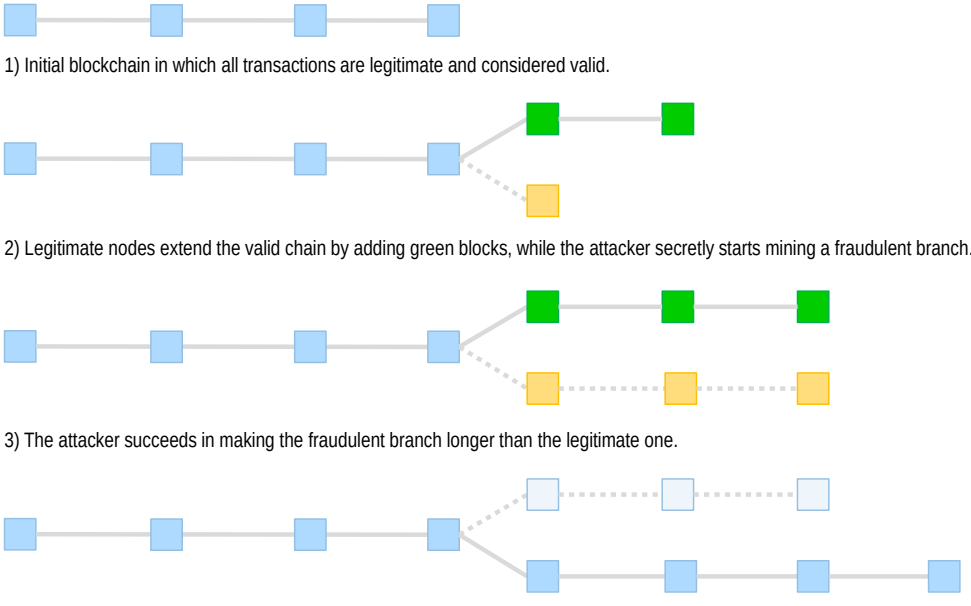
- **Dependency on Consensus:** Blockchain protocols' reliance on consensus mechanisms (often proof-of-work) exposes them to the risk of "crowd rule."
- **Transaction Reversals:** The immutability offered by consensus algorithms prevents transaction reversal without compromising chain integrity.
- **Ecosystem Dependency:** Blockchain protocols are exposed to the flaws of what is built atop them – we think about the DAO hack here.
- **Risk from Quantum computing:** Further innovation in quantum computing could put key cryptography that underpins many Blockchain protocols at risk.

Double Spending

Blockchain protocols are exposed to several significant theoretical security risks, including "double-spending" and "51% attacks." In the former, an attacker can, upon solving a hash, generate a block and record diverging chains to send coins to a seller in one chain while pocketing the same coins in the other, thereby double-spending—a problem with electronic payments that predicating systems on blockchain is meant to avoid. For many forms of executing double spending, other miners may simply build blocks off of the authentic transaction, and the quickest solution often involves waiting for confirmation of subsequent blocks (e.g. with bitcoin, usually five or six transactions are appended to a block before it is confirmed).

A significant, albeit still theoretical, potential risk to the reliability of a blockchain is known as a "51% attack," in which an individual or collection of attackers holds a significant share (not necessarily a majority) of hash-solving power for mining and therefore has a probabilistic superiority in the mining hash rate. With this advantage, the attacker could then add the majority of new blocks to forks of their choosing, eventually establishing the longest chain on a new fork and resultantly guiding consensus view of the blockchain.

Figure 50: Illustration of Double-Spending Attack



Source: Credit Suisse research

Although with many blockchains, it is difficult for any one party to acquire a substantial share of hash rate within a large public network—the electrical costs alone of running such a scale of processing power would likely be too burdensome—perhaps the most feasible means to gain the necessary majority for an attack would be to use other people's computers.

In May, EternalBlue, a hacking tool originally developed by the NSA and exposed to the public by a hacker group the prior month, was used by attackers to mine cryptocurrencies using infected computers. EternalBlue leveraged a vulnerability in an older version of Microsoft Server Message Block (SMB)—an application-layer network file-sharing protocol—and, in combination with DoublePulsar, an NSA-developed backdoor, was used to install a cryptocurrency mining software called Adylkuzz. These were the same tools used to spread the WannaCry infection, which made headlines shortly after.

Adylkuzz, which shuts down SMB networking to prevent additional infections from other malware and thus may have actually limited the spread of WannaCry in May 2017, is believed to be the cause of several large organizations' network issues that were initially attributed to WannaCry.[67] Perhaps most relevant is the fact that Adylkuzz predated WannaCry by many days and was able to steal Monero, a cryptocurrency whose mining process can be more easily distributed across a botnet than in Bitcoin.

Transaction Reversals and Ecosystem Dependency

A fundamental challenge with blockchain is transaction reversals. When a private key is stolen or lost, for example, the inherent confidentiality of blockchains means that the credentials are either lost forever or that its operators must have its transaction reversed. The latter, however, would likely undermine the very integrity of the platform. For example, with an estimated 30% of Bitcoins as "zombie coins," which have been untouched for over a year and a half, transaction reversals would require upheaval of many blocks early in the chain and thus invalidation of all subsequent dependent blocks.[68]

Lost keys are furthermore not the greatest potential risk. Rather, the applications built atop a blockchain and relying on its native tokens can, in some cases, threaten the integrity of the entire platform.

In June of 2016, the DAO (Distributed Autonomous Organization)—a leaderless organization comprised of a series of smart contracts built on the Ethereum platform and intended as a decentralized fund through which its backers collectively vote on new projects for investment—was hacked.[69] An oversight in the DAO's code allowed the attacker to execute a recursive call and use the same tokens to continuously withdraw ether from the DAO smart contract, and the attacker ultimately stole 3.6 million ether (~$50+ million value at the time), which was raised as a portion of a $150 million crowdfunded ICO only months before.

While the hack did not result from a flaw in the Ethereum code itself, the stolen funds from the DAO represented 15% of all ether in circulation. Because the magnitude of the theft put at risk the value of the token and consequently the integrity of the platform, Ethereum's creators ultimately implemented a hard fork, establishing a divergent chain in which the attacker's ether would be invalid.[70]

[67] https://www.proofpoint.com/us/threat-insight/post/adylkuzz-cryptocurrency-mining-malware-spreading-for-weeks-via-eternalblue-doublepulsar

[68] https://letstalkbitcoin.com/blog/post/rise-of-the-zombie-bitcoins

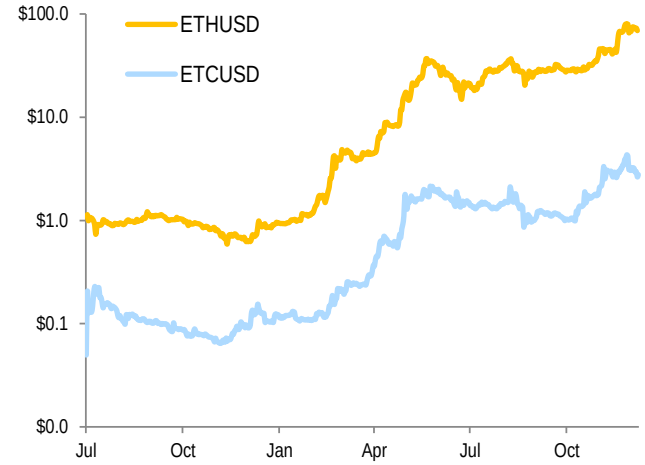
[69] https://medium.com/@pullnews/understanding-the-dao-hack-for-journalists-2312dd43e993

[70] https://medium.com/@pullnews/understanding-the-dao-hack-for-journalists-2312dd43e993

The hack demonstrates a critical shortcoming present in existing blockchain technologies—that its viability is sensitive to the vulnerabilities of its ecosystem. This dependency is arguably more the case with blockchain technologies than with centralized architectures, as the former is dependent on the value of its tokens to incentivize participation. As was the case with Ethereum, hardforks often divide the user base, making maintaining a protocol difficult for its participants and ultimately threatening its likelihood of more widespread adoption.

Figure 51: Ethereum's Market Cap Has Well Exceeded Ethereum Classic's Since the Hardfork…

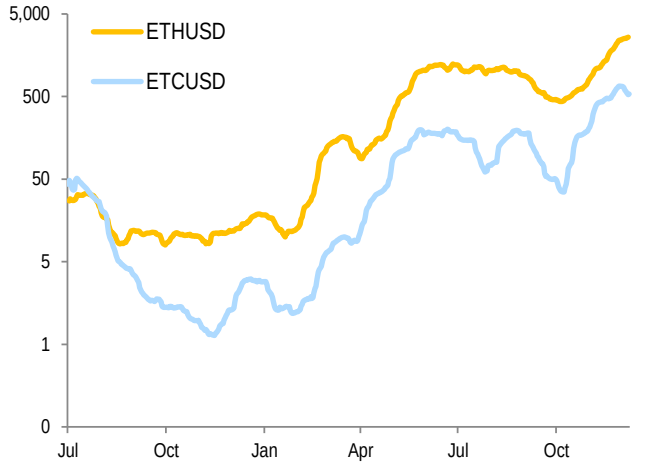
Ethereum (ETH) vs. Ethereum Classic (ETC)
Market Capitalization Since Hardfork ($bn, log scale)



Source: CoinMarketCap.com, Credit Suisse research

Figure 52: …But Ethereum Classic Still Maintains Growing Interest, and Activity Remains Divided

Ethereum (ETH) vs. Ethereum Classic (ETC)
30-Day MA Volume Since Hardfork (mn, log scale)



Source: CoinMarketCap.com, Credit Suisse research

Quantum Computing in Blockchain

Quantum computing has in recent months been a particularly popular topic of interest, with IBM announcing development of a 50-qubit quantum supercomputer and Volkswagen partnering with Google to use quantum computers for developing electric vehicle batteries. Given its potentially immense computing power—current quantum computing technology nearly rivaling supercomputer capabilities—areas believed to be unachievable by current computer technology are now becoming increasingly within the realm of possibility.

Of particular importance is quantum computing's threat to cybersecurity. Specifically, modern cryptosystems used for the vast majority of communications today and which form the bedrock for much of the security protocols used within the Internet are at significant risk of being insufficient in the face of quantum computers, which could solve in minutes what would take today's supercomputers years to crack.

What is Quantum Computing?

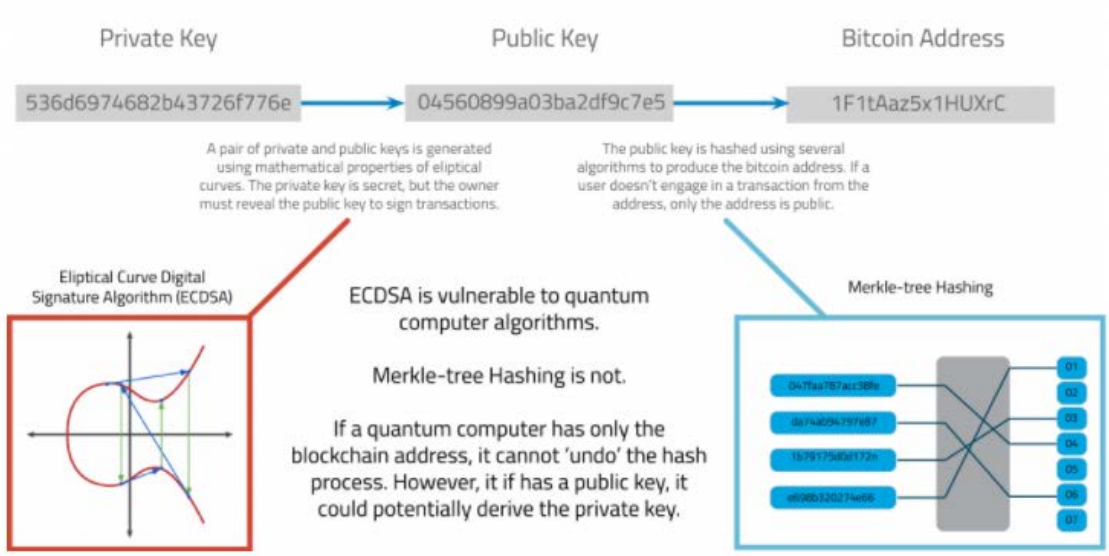
Quantum computing circumvents the limitations of classical computers, which rely on one-state bits and are ultimately limited by the physical capacity of transistor capacities. Whereas conventional bits are in a strictly fixed state (0 or 1), quantum bits, or "qubits," can be prepared in a superposition between binary values, such that the qubit can represent 0, 1, or both simultaneously. Instead of stringing together bits, as is the case in conventional computers, quantum computers must describe all correlations among different qubits—the number of which increases exponentially with more qubits (i.e. 2^n correlations per n qubits). This enables the potential for immense compute throughput, with qubits capable of processing multiple operations simultaneously.

Implications for Blockchain

Quantum computing likewise has notable implications for blockchain, whose rapid rise in popularity among various large enterprises, is predicated in part on its high fidelity and security. There are two quantum algorithms that pose threats to blockchain and security in general: Shor's and Grover's algorithms. The former solves for integer factorization and discrete logarithm problems, on which ECDSA (Elliptic Curve Digital Signature Algorithm) is based—that is, the scheme used by Bitcoin and Ethereum for generating public/private-key pairs. As such, any address that is reused could potentially have its private key compromised by a quantum computer and resultantly allow an attacker to forge transactions and steal a user's balance.

However, for addresses that have not been used for a transaction, the threat of quantum algorithms is fairly small. This is because the public key is further secured by hash algorithms, for which quantum algorithms provide only a quadratic runtime improvement. Using Grover's algorithm to solve for SHA-256 or SHA3-256 would take around 2^{128} logical cycles instead of 2^{256}—effectively halving the key lengths. However, even with a mining ASIC capable of a billion hashes per second, it would likely take 10^{29} years to solve the key.

Figure 53: Quantum Algorithms vs. Bitcoin's Cryptosystem



Source: Smith + Crown, Credit Suisse research

Firstly, quantum computing technology is still several years off from use in advanced functionalities and even farther from commercial application. Moreover, while public-key cryptographies are most at risk, symmetric encryption standards will likely remain secure. One study estimates that solving for 256-bit keys encrypted using the Advanced Encryption Standard (AES)—developed by and widely used among U.S. government agencies—would require nearly 6,700 qubits to solve.[71] For perspective, Google and IBM are both currently developing approximately 50-qubit prototypes.[72]

[71] https://arxiv.org/pdf/1512.04965v1.pdf

[72] https://gizmodo.com/ibm-announces-two-fancy-new-quantum-computers-1820311244

Moreover, environmental challenges present a further obstacle, as qubits are highly sensitive to noise, susceptible to decoherence and collapsing into a classical state. IBM's 20-qubit computer leads in this field, using superconducting wires to help maintain an average coherence time of 90 microseconds.[73] Thus, practical use cases like breaking ECC or RSA algorithms are still arguably more theory than reality—though increasingly becoming the latter—and black-box models may not perfectly replicate the true capabilities of quantum computers.

Nevertheless, some estimate quantum computing technology to be a closer threat than many expect, with one estimate predicting a one-in-seven probability of quantum computing capable of cracking public-key cryptographies by 2026 and a 50% chance by 2031.[74] Should quantum computing technology reach such levels, existing public key encryption standards used for digital signatures—including those used in popular blockchains like Bitcoin and Ethereum, both of which use ECDSA—would be susceptible to quantum algorithms.

Figure 54: Asymmetric Encryption Standards—Including ECC—Are the Most At Risk in a Quantum World

Cryptographic Algorithm	Type	Purpose	Quantum-Resistant?
AES-256	Symmetric key		Partially—larger key size needed
SHA-256, SHA-3		Hash functions	Partially—larger output needed
RSA	Public key	Signatures, key establishment	No
ECDSA, ECDH (Elliptic Curve Cryptography)	Public key	Signatures, key exchange	No
DSA (Finite Field Cryptography)	Public key	Signatures, key exchange	No

Source: U.S. National Institute of Standards and Technology, Credit Suisse research

The threat of quantum computing to existing encryption standards has not gone unnoticed, however, as numerous projects seek to develop quantum-resistant, public-key cryptosystems. Various quantum-resistant cryptosystems being developed use cryptographies that rely on problems of non-deterministic, polynomial-time hardness (*NP*-hard)—that is, put simply, the defining characteristic of a class of problems that are at least as hard as the hardest problems in NP—making it effectively no more efficiently solvable by quantum computing.

[73] https://www-03.ibm.com/press/us/en/pressrelease/53374.wss

[74] http://globalriskinstitute.org/publications/quantum-computing-cybersecurity/

Beyond hash-based problems, noteworthy candidates of post-quantum encryption standards include:

- Lattice-based cryptography, which involves finding the closest point—associated with the private key—in a lattice with hundreds of spatial dimensions, given an arbitrary point—associated with the public key—within the same multidimensional space. One type of lattice-based problem is called the Shortest Vector Problem, which involves approximating the shortest nonzero vector in a given lattice and is believed to be computationally difficult even for quantum computing.
- Code-based cryptography is based on the problem of decoding a general linear code, which is known to be NP-hard. One popular scheme is the McEliece public-key encryption scheme, which was proposed 40 years ago and has yet to demonstrate vulnerability to being efficiently solved. The scheme uses an arbitrary basis of a specified linear, error-correcting code to create a generator matrix that serves as the public key and adds random errors to the code. Legitimate users who know the secret decoding algorithm can, in polynomial time, remove the errors to find the original text.[75]
- Multivariate cryptography, while in practice complex, is conceptually perhaps the most straightforward of the quantum-secure cryptosystems. It requires solving for systems of multivariate quadratics that are NP-hard or NP-complete.

It is lastly important to note that, while some quantum-resistant cryptosystems have proven to be highly secure and versatile, most if not all are still inefficient. Code-based cryptography schemes, for example, require relatively sizable key lengths. To achieve 80-bit security with RSA would require a 1,024-bit key, while a McEliece scheme would require a 437-kilo*byte* (i.e. ~3.5-million-bit) key to provide the same level of security.[76] Thus, further improvements must be made for such cryptographies to have broad application.

Nonetheless, given momentum in quantum computing, advancements in encryption methods will likewise continue in pursuit of durable post-quantum cryptosystems. Google, for example, has already begun to experiment with a lattice-based cryptography problem called Ring Learning with Errors (RLWE). To test the problem, Google has integrated the particular algorithm, dubbed New Hope, into the original conventional elliptic-curve algorithm used to secure Web requests in its Chrome browser.[77] Google also recently collaborated with Microsoft, NXP Semiconductors, Stanford University, and McMaster University to develop some new techniques for optimizing RLWE-based protocols.[78]

In the context of blockchains, enhancements are likewise being made to quantum-proof protocols, as already there are some blockchains that claim to be “quantum-resistant.” Nonetheless, should the day of reckoning for public-key cryptographies arrive—when quantum computing capabilities surpass the security of asymmetric encryptions—much of the Internet’s traffic would likely be at risk, and blockchains would be far from the largest concern.

[75] http://ieeexplore.ieee.org/document/8012331/

[76] https://www.emsec.rub.de/media/attachments/files/2013/03/mastersthesis-hudde-code-based-cryptography-library.pdf

[77] https://security.googleblog.com/2016/07/experimenting-with-post-quantum.html

[78] https://eprint.iacr.org/2016/659.pdf

Sophos Group PLC (SOPH.L)

SMID FOCUS LIST STOCK

Rating	**OUTPERFORM**
Price (08 Jan 18, p)	634.50
Target price (p)	700.00
Market Cap (£ m)	2,964.9
Enterprise value (£ m)	3,098.2

Target price is for 12 months.

Research Analysts

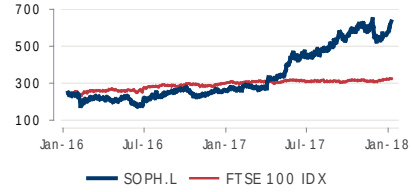
Charles Brennan CFA
44 20 7883 4705
charles.brennan@credit-suisse.com

Mathew Yates
44 20 7883 5370
mathew.yates@credit-suisse.com

Crypto cybercrime fuelling security demand

- **We rate Sophos Outperform:** We recently initiated coverage of Sophos, a leading security software company focussed on the mid-market. We believe it has the ability to take market share in a structurally growing market and initiated with an Outperform rating and a target price of 700p.
- **Cryptocurrencies have been used to monetise cybercrime:** One of the four drivers of the security industry we identify in our 9 January report, *Sophos: Structural growth*, is the rising complexity of cyberattacks, which have brought about a commodification and sophistication of cybercrime, with cryptocurrencies potentially making it easier to monetise cybercrime: cryptos offer a secure and often untraceable method of sending and receiving payments, making them attractive for those who wish their financial activities to remain hidden from authorities. For instance, the May 2017 WannaCry ransomware attack demanded that users who wished to unlock their computers transfer $300 worth of bitcoin to specified wallet, leading to Citrix CEO Kirill Tatariov noting that responses to WannaCry were driving up bitcoin's price at the time.
- **This fuels security demand:** The ransomware phenomenon fuelled an opening of new channels of business for Sophos, as small enterprises (<500 employees) turned to outsourcing their security operations after learning of their vulnerability to such attacks. Our discussions with Value Added Resellers in the space revealed that there was a significant spike in deal flow in the aftermath of WannaCry. We note that Sophos's closing share price was up 8.4% two days following the WannaCry attack.
- **Risks to our investment case:** We believe security software is less sticky than core systems like ERP; being a leader with one version of the product doesn't guarantee success with the next.

Share price performance



The price relative chart measures performance against the FTSE 100 IDX which closed at 7723.7 on 08/01/18
On 08/01/18 the spot exchange rate was £.88/Eu 1.-Eu.84/US$1

Performance	1M	3M	12M
Absolute (%)	16.1	6.6	135.8
Relative (%)	11.6	4.1	129.1

Financial and valuation metrics

Year	3/17A	3/18E	3/19E	3/20E
Revenue (US$ m)	529.7	630.6	725.4	861.3
EBITDA (US$ m)	47.7	42.7	60.8	91.2
Pre-tax profit adjusted (US$ m)	33.30	9.74	32.58	66.21
CS EPS (adj.) (US$)	0.06	0.02	0.05	0.10
Prev. EPS (US$)	-	-	-	-
ROIC (%)	1.8	3.4	14.4	-58.2
P/E (adj.) (x)	153.3	548.7	168.0	84.0
P/E rel. (%)	835.2	3593.8	1173.2	629.1
EV/EBITDA (x)	90.2	98.3	66.7	42.3

Dividend (03/18E, US$)	0.05	Net debt/equity (03/18E,%)	188.5
Dividend yield (03/18E,%)	0.6	Net debt (03/18E, US$ m)	179.1
BV/share (03/18E, US$)	0.2	IC (03/18E, US$ m)	274.2
Free float (%)	80.8	EV/IC (03/18E, (x)	15.3

Source: Company data, Thomson Reuters, Credit Suisse estimates

Sophos Group PLC (SOPH.L)

Price (08 Jan 2018): **634.50p**; Rating: **OUTPERFORM**; Target Price: **700.00**; Analyst: **Charles Brennan**

Income statement (US$ m)	3/17A	3/18E	3/19E	3/20E
Revenue	530	631	725	861
EBITDA	**48**	**43**	**61**	**91**
Depr. & amort.	(29)	(39)	(39)	(40)
EBIT	**9**	**12**	**21**	**51**
Net interest exp.	(5)	(22)	(16)	(12)
Associates	-	-	-	-
PBT	**33**	**10**	**33**	**66**
Income taxes	(7)	(2)	(7)	(15)
Profit after tax	**27**	**8**	**25**	**52**
Minorities	-	-	-	-
Preferred dividends	-	-	-	-
Associates & other	0	0	0	0
Net profit	**27**	**8**	**25**	**52**
Other NPAT adjustments	0	0	0	0
Reported net income	**27**	**8**	**25**	**52**

Cash flow (US$ m)	3/17A	3/18E	3/19E	3/20E
EBIT	9	12	21	51
Net interest	(5)	(22)	(16)	(12)
Cash taxes paid	-	-	-	-
Change in working capital	122	133	158	188
Other cash and non-cash items	(8)	42	47	36
Cash flow from operations	**119**	**165**	**210**	**262**
CAPEX	(11)	(13)	(15)	(17)
Free cashflow to the firm	**107**	**151**	**195**	**245**
Acquisitions	(102)	(3)	0	0
Divestments	-	-	-	-
Other investment/(outflows)	(5)	(12)	(7)	(8)
Cash flow from investments	**(118)**	**(29)**	**(21)**	**(25)**
Net share issue/(repurchase)	3	2	0	0
Dividends paid	(11)	(22)	(23)	(24)
Issuance (retirement) of debt	25	(50)	0	0
Cashflow from financing	**7**	**(85)**	**(40)**	**(37)**
Changes in net cash/debt	(278)	98	148	200
Net debt at start	-	278	179	31
Change in net debt	**278**	**(98)**	**(148)**	**(200)**
Net debt at end	278	179	31	(169)

Balance sheet (US$ m)	3/17A	3/18E	3/19E	3/20E
Assets				
Total current assets	**237**	**324**	**498**	**725**
Total assets	**1,223**	**1,357**	**1,513**	**1,726**
Liabilities				
Total current liabilities	**530**	**655**	**821**	**1,018**
Total liabilities	**1,097**	**1,262**	**1,428**	**1,625**
Total equity and liabilities	**1,223**	**1,357**	**1,513**	**1,726**

Per share	3/17A	3/18E	3/19E	3/20E
No. of shares (wtd avg.) (mn)	474	488	496	504
CS EPS (adj.) (US$)	**0.06**	**0.02**	**0.05**	**0.10**
Prev. EPS (US$)	**-**	**-**	**-**	**-**
Dividend (US$)	**0.05**	**0.05**	**0.05**	**0.05**
Free cash flow per share (US$)	0.23	0.31	0.39	0.49

Key ratios and valuation	3/17A	3/18E	3/19E	3/20E
Growth/Margin (%)				
Sales growth (%)	-	19.0	15.0	18.7
EBIT growth (%)	-	30.1	80.6	138.6
Net income growth (%)		(71.3)	232.0	103.2
EPS growth (%)	-	(72.1)	226.7	100.0
EBITDA margin (%)	9.0	6.8	8.4	10.6
EBIT margin (%)	1.7	1.9	2.9	5.9
Pretax profit margin (%)	6.3	1.5	4.5	7.7
Net income margin (%)	5.0	1.2	3.5	6.0

Valuation	3/17A	3/18E	3/19E	3/20E
EV/Sales (x)	8.1	6.7	5.6	4.5
EV/EBITDA (x)	90.2	98.3	66.7	42.3
EV/EBIT (x)	472.6	354.9	189.6	75.6
Dividend yield (%)	0.53	0.56	0.58	0.60
P/E (x)	153.3	548.7	168.0	84.0

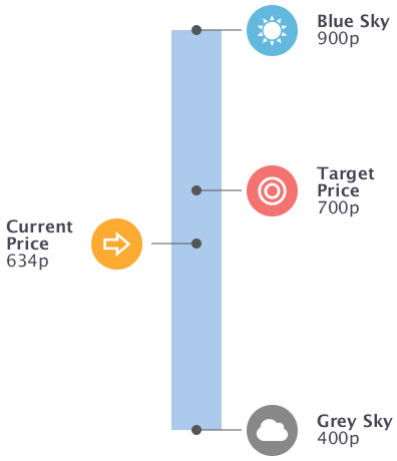
Credit ratios (%)	3/17A	3/18E	3/19E	3/20E
Net debt/equity (%)	219.1	188.5	36.1	(167.9)
Net debt to EBITDA (x)	5.8	4.2	0.5	(1.9)
Interest coverage ratio (x)	1.8	0.5	1.3	4.1

Source: FTI, Company data, Thomson Reuters, Credit Suisse Securities (EUROPE) LTD. Estimates

Company Background

Sophos provides information technology security and data protection products. The Company offers protection against viruses, known and unknown malware, spyware, intrusions, unwanted applications, spam, policy abuse, and data leakage.

Blue/Grey Sky Scenario



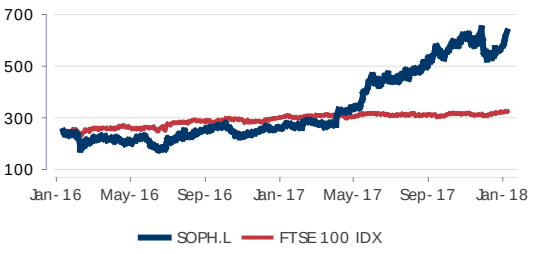
Our Blue Sky Scenario (p)	900.00

In our blue sky scenario, we assume that investors do not make a tax adjustment to uFCF and use headline FCF forecasts. Applying a 4% FCF yield to our stated FY20 forecasts yields a 900p blue sky scenario.

Our Grey Sky Scenario (p)	400.00

Our grey sky scenario assumes that investors remove all long term deferred income from their view of FCF. This methodology essentially brings FCF back in line with P&L profits. Valuing this lower FCF on a 4% FCF yield results in a 400p grey sky scenario.

Share price performance



The price relative chart measures performance against the FTSE 100 IDX which closed at 7723.7 on 08/01/18

On 08/01/18 the spot exchange rate was £.88/Eu 1.- Eu.84/US$1

Payments

Widespread adoption still appears unsurmountable

Research Analysts

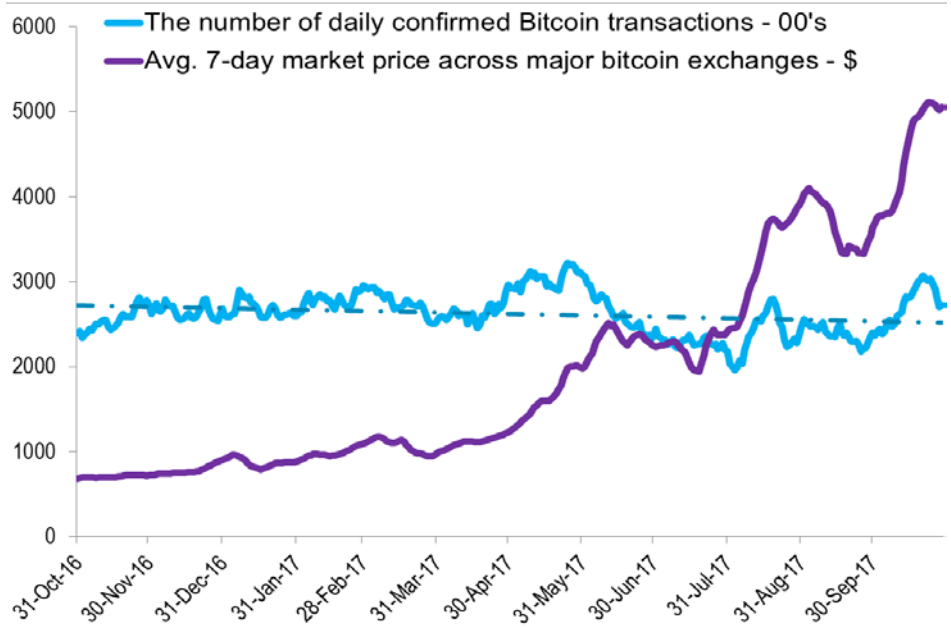
Charles Brennan CFA
44 20 7883 4705
charles.brennan@credit-suisse.com

Mathew Yates
44 20 7883 5370
mathew.yates@credit-suisse.com

Payments is one of the sectors that is always closely aligned with the bitcoin / blockchain debates. After all, the very substance of cryptocurrencies is designed as an alternative payments method. However, while we understand the use case, we continue to believe there are too many barriers for mainstream consumer adoption. Instead, we maintain our view that the largest opportunity lies in disrupting the bank-to-bank payments markets.

The clearest indication to us of this bifurcation in the payments landscape is the transaction volume of bitcoin, the most mature cryptocurrency. In spite of the exploding interest in bitcoin, the volume of real-life transactions has remained largely unchanged.

Figure 55: Transaction momentum is largely unchanged by bitcoin's rise



Source: Company data, HowMuch.net (a cost information website)

We see a number of reasons limiting mainstream adoption. These include, but are by no means restricted to:

1. Uncertain value – In an environment where prices of cryptocurrencies are volatile, holders may see more value in holding/speculating in further price gains than in actually spending the currency.
2. No problems to solve – Adoption of cryptocurrencies requires consumers to change behaviour. Natural inertia is reinforced by the fact that current payment systems work well and provide solid user experiences; card schemes like Visa are accepted globally, authorisation is instant and transaction costs are minimal.
3. No dispute resolution – The existing card schemes have been established over decades and have built strong global brands that instil trust in card payments. This is underpinned by an ecosystem that bears the responsibility of dispute resolutions; if a consumer is not happy, they are entitled to a refund. There is no current way of resolving serious cryptocurrency problems. Even if you accidently send payment to the wrong person, you cannot demand that they return it.

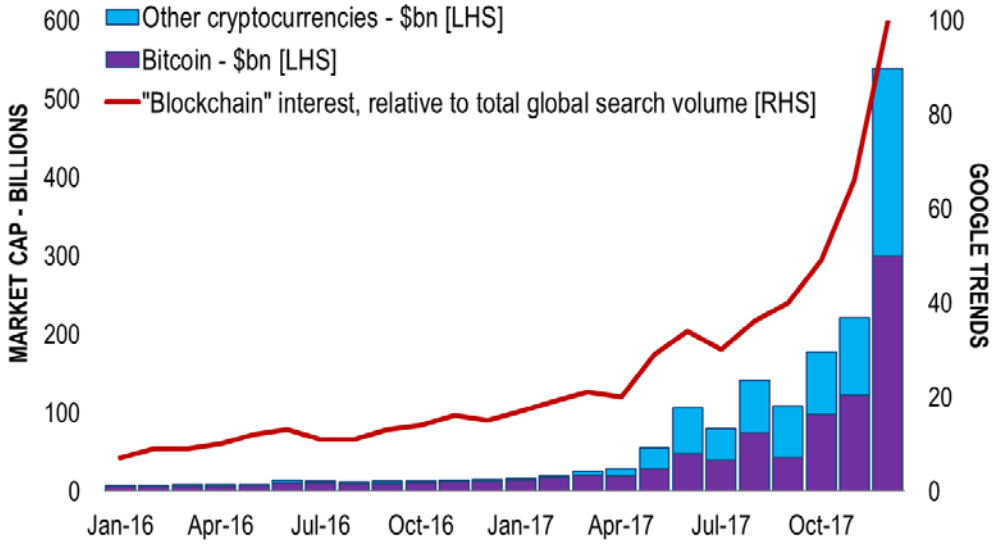
4. Is it too secure? – Access to cryptocurrencies like bitcoin requires the user to keep and remember their private key details. Losing the private key means that any associated bitcoin are unrecoverable. For many people, we think this will act as a barrier to adoption. This irrecoverability also acts as a point of failure; in order to help people control their accounts, an ecosystem of intermediaries (exchanges) and facilitators (wallets) has developed, each representing a potential risk of hacking.
5. Scalability – The constraints of the bitcoin network still mean that transaction speed is limited to a single-digit number of transactions per second. This compares to peak capacity of, say, Visa at well over 50,000 transactions per second. Not only is speed an issue, but also transaction costs. Bitinfocharts.com estimates that the current cost per transaction in bitcoin is currently around $30.[79]

Overall, we believe these barriers will limit cryptocurrencies, like bitcoin, to niche scenarios. We think the most likely scenarios are where the participants value the anonymity of the network.

Initial Coin Offerings (ICOs)

Away from mainstream payments, ICOs represent an alternative source of funding. Interest in ICOs and blockchain has risen sharply over the past 12 months, see Figure 56.

Figure 56: Interest in blockchain soars to an all-time high as the cryptocurrency market doubles in a matter of weeks



Source: Company data, Credit Suisse research, Google Trends - as of 02 January 2018, coinmarketcap.com

[79] https://bitinfocharts.com/comparison/bitcoin-transactionfees.html

However, at this early stage, it remains to be seen whether this will prove to be a sustainable business model. Specifically, regulation remains a significant challenge. China has already banned ICOs, while we note that the US Securities and Exchange Commission (SEC) has just stepped in to stop an ICO from a restaurant review app[80] after the company failed to register it as a security. SEC Chairman Jay Clayton said in a statement in December: "A number of concerns have been raised regarding the cryptocurrency and ICO markets, including that ... there is substantially less investor protection than in our traditional securities markets, with correspondingly greater opportunities for fraud and manipulation."

According to Reuters, Clayton warned that ICOs in many cases would need to comply with federal rules governing the issuance of securities, including registering with the SEC or qualifying for an exemption that allows issuers to sell shares privately to accredited investors. He also said that many platforms trading in cryptocurrencies may be in violation of laws that require them to register as an exchange, or an alternative trading platform.

As we covered in More than meets the I-CO, the SEC has on several occasions urged caution around ICOs and cryptocurrencies. In December, the SEC's newly created cyber unit had filed its first ICO charges against a privately held company, alleging it had defrauded investors with its ICO. The intervention in December once again reignited the series of debates that surround cryptocurrencies and ICOs; determining the fundamentals such as whether cryptos should be treated as securities, currencies, or even commodities has so far proven tricky. While we make no comment on such debates, the repeated intervention of the SEC indicates how seriously – in the space of roughly 12 months – international regulators have begun to view cryptocurrencies and ICOs.

Looking for an opportunity

While there are barriers to mainstream adoption of cryptocurrencies, given the scale of potential disruption, we continue to expect some companies to try and participate in the current wave of interest. We see Square as an example of this – a company that has launched an initiative to enable consumers to buy and sell bitcoin. Our thoughts on the announcement are presented overleaf.

[80] https://www.reuters.com/article/us-munchee-ico/sec-halts-virtual-coin-offering-issues-investor-warning-idUSKBN1E52CR

Square, Inc. (SQ)

Rating	**NEUTRAL [V]**
Price (08-Jan-18, US$)	40.76
Target price (US$)	37.00
52-week price range (US$)	48.86 - 13.89
Market cap(US$ m)	15,838

Target price is for 12 months.
[V] = Stock Considered Volatile (see Disclosure Appendix)

Research Analysts

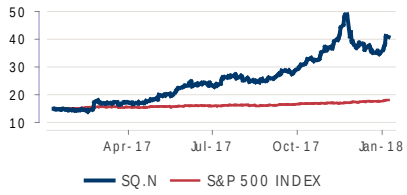
Paul Condra
212 325 8903
paul.condra@credit-suisse.com

Mrinalini Bhutoria
212 325 2691
mrinalini.bhutoria@credit-suisse.com

Going Crypto: Exploring the Bitcoin Play

- **Biggest beneficiary could be bitcoin:** Following Square's recent announcement that it is piloting bitcoin sales via its Square Cash app, we provide our thoughts on the revenue potential and some context to help understand the emerging crypto landscape and drivers of demand for bitcoin. While we are positive on Square's strategy, to the extent it may boost the legitimacy of bitcoin and prompt adoption by other providers (i.e., PayPal), the biggest beneficiary may be the crypto-asset industry.
- **Low risk of payments disruption:** While we don't entirely dismiss the disruptive potential of cryptocurrencies, we see low risk that bitcoin will disrupt mainstream payments for the following reasons: buying bitcoin still requires the use of traditional bank accounts and/or credit/debit cards; consumers must pay fees to send bitcoin; merchant knowledge and acceptance of bitcoin is very low; and bitcoin buyers currently appear more interested in holding it than spending it. While there are other crypto-coins that may provide better payment utility (i.e., Litecoin, Bitcoin Cash), we see similar obstacles to their use in consumer payments.
- **We expect ~$30m revenue opportunity in two years:** We estimate that if Square can accumulate 10m bitcoin buyers over two years (tracking Coinbase's growth), this could drive an incremental $30m in revenue (~2% additional growth to our current forecast). This assumes average bitcoin purchases of $200/year and fees of 1.5%.
- **Risks:** Risks include bitcoin regulation and lower-than-expected volume growth.
- **Valuation:** On 20 November 2017, we raised our target price to $37 as we added optionality from the crypto-business. Our target reflects 52x 2019E EPS.

Share price performance



On 08-Jan-2018 the S&P 500 INDEX closed at 2747.71
Daily Jan09, 2017 - Jan08, 2018, 01/09/17 = US$15.06

Quarterly EPS	Q1	Q2	Q3	Q4
2016A	-0.05	0.02	0.01	0.05
2017E	0.05	0.07	0.07	0.07
2018E	0.06	0.12	0.13	0.13

Financial and valuation metrics

Year	12/16A	12/17E	12/18E	12/19E
EPS (Excl. ESO) (US$)	0.04	0.26	0.44	0.71
EPS (CS adj.,)	0.04	0.26	0.44	0.71
Prev. EPS (CS adj., US$)	-	-	-	-
P/E (CS adj.) (x)	995.3	157.9	93.6	57.3
P/E rel. (CS adj., %)	4353.9	765.2	505.4	341.6
Revenue (US$ m)	686.6	966.1	1,279.8	1,629.8
EBITDA (US$ m)	45.0	136.9	234.7	367.1
Net Debt (US$ m)	-452	-87	-551	-729
OCFPS (US$)	0.06	-0.13	1.24	0.72
P/OCF (x)	652.5	-304.0	32.9	56.6

Number of shares (m)	388.57	Price/Sales (x)	17.82
BV/share (Next Qtr., US$)	-1.9	P/BVPS (x)	-21.8
Net debt (Next Qtr., US$ m)	-304.2	Dividend (current, US$)	-
Dividend yield (%)	-		

Source: Company data, Thomson Reuters, Credit Suisse estimates

Square, Inc. (SQ)

Price (08 Jan 2018): **US$40.76**; Rating: **NEUTRAL [V]**; Target Price: **US$37.00**; Analyst: **Paul Condra**

Income Statement	12/16A	12/17E	12/18E	12/19E
Revenue (US$ m)	**686.6**	**966.1**	**1,279.8**	**1,629.8**
Sales	**686.6**	**966.1**	**1,279.8**	**1,629.8**
EBITDA	**45.0**	**136.9**	**234.7**	**367.1**
Operating profit	**(171.6)**	**(44.6)**	**38.8**	**164.2**
Recurring profit	**(170.8)**	**(52.1)**	**31.3**	**156.7**
Cash Flow	**12/16A**	**12/17E**	**12/18E**	**12/19E**
Cash flow from operations	**23**	**(57)**	**559**	**330**
CAPEX	(25)	(26)	(32)	(41)
Free cashflow to the firm	**(2)**	**(83)**	**527**	**289**
Cash flow from investments	**(123)**	**(52)**	**(32)**	**(41)**
Net share issue(/repurchase)	96	112	0	0
Dividends paid	0	0	0	0
Issuance (retirement) of debt	-	-	-	-
Other	(15)	(372)	(63)	(111)
Cashflow from financing activities	81	(260)	(63)	(111)
Effect of exchange rates	(0)	4	0	0
Changes in Net Cash/Debt	**(19)**	**(365)**	**464**	**179**
Net debt at end	(452)	(87)	(551)	(729)
Balance Sheet ($US)	**12/16A**	**12/17E**	**12/18E**	**12/19E**
Assets				
Other current assets	182	157	93	103
Total current assets	**1,001**	**1,264**	**1,558**	**1,894**
Total assets	**1,211**	**1,980**	**2,456**	**2,999**
Liabilities				
Short-term debt	0	0	0	0
Total current liabilities	577	715	892	1,061
Long-term debt	0	354	354	354
Total liabilities	635	1,139	1,326	1,508
Shareholder equity	576	841	1,130	1,491
Total liabilities and equity	**1,211**	**1,980**	**2,456**	**2,999**
Net debt	(452)	(87)	(551)	(729)
Per share	**12/16A**	**12/17E**	**12/18E**	**12/19E**
No. of shares (wtd avg)	370	425	451	459
CS adj. EPS	0.04	0.26	0.44	0.71
Prev. EPS (US$)	-	-	-	-
Dividend (US$)	0.00	0.00	0.00	0.00
Free cash flow per share	(0.01)	(0.19)	1.17	0.63
Earnings	**12/16A**	**12/17E**	**12/18E**	**12/19E**
Sales growth (%)	51.9	40.7	32.5	27.4
EBIT growth (%)	(17.8)	74.0	187.0	323.2
Net profit growth (%)	122.7	623.8	79.0	66.0
EPS growth (%)	110.4	530.5	68.7	63.2
EBIT margin (%)	(25.0)	(4.6)	3.0	10.1
Valuation	**12/16A**	**12/17E**	**12/18E**	**12/19E**
EV/Sales (x)	22.41	16.30	11.95	9.27
EV/EBIT (x)	(89.7)	(353.2)	394.1	92.0
P/E (x)	995.3	157.9	93.6	57.3
Quarterly EPS	**Q1**	**Q2**	**Q3**	**Q4**
2016A	-0.05	0.02	0.01	0.05
2017E	0.05	0.07	0.07	0.07
2018E	0.06	0.12	0.13	0.13

Company Background

Square, Inc. is a provider of mobile payment services to merchants and consumers via credit card payment services through iPhone, Android, or iPad. The products it offers include the Square Card Reader, Square Register, and Pay with Square app.

Blue/Grey Sky Scenario

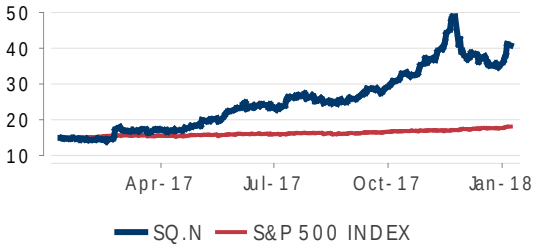
Our Blue Sky Scenario (US$)	47.00

Our $47 blue sky scenario assumes the company can grow earnings 75% in 2019, which we believe would be very favorably viewed by the market.

Our Grey Sky Scenario (US$)	27.00

Our $27 gray sky scenario assumes the company grows earnings only 57% in 2019, which we believe would be viewed somewhat negatively by the market.

Share price performance



On 08-Jan-2018 the S&P 500 INDEX closed at 2747.71
Daily Jan09, 2017 - Jan08, 2018, 01/09/17 = US$15.06

Source: Company data, Thomson Reuters, Credit Suisse estimates

Square to add bitcoin buying capability

In mid-November, Square (SQ) announced that it is piloting the ability to purchase and sell bitcoin (BTC) from within its Square Cash app. According to the statement by SQ, management believes digital currencies can expand global financial inclusion. We think management also recognises that demand to own crypto-assets is growing and driving a new potential revenue stream.

While there are an increasing number of sophisticated investors getting involved in the crypto-industry, we believe the majority of buyers represent younger demographics experimenting with transactions on a small scale. For now, we believe SQ is primarily targeting this second group. While specifics of the pilot are still unclear, we assume SQ fulfills purchases by going to a bitcoin dealer or an exchange, or pre-buying bitcoin in anticipation of demand.

As shown in our scenario tables below, we estimate that if SQ can accumulate 10m users by 2019 with an average purchase volume of $200 and a 1.5% transaction fee, this would generate about $30m in incremental revenue, or roughly 2% additional revenue growth.

Figure 57: Bitcoin Wallet revenue scenarios

Revenue potential

		Annual average BTC purchase volume per user ($)				
		25	**50**	**100**	**200**	**500**
Users (M)	**1**	$0	$1	$2	$1	$6
	5	$2	$4	$8	$15	$38
	10	$4	$8	$15	$30	$75
	20	$8	$15	$30	$60	$150

Impact to existing 2019 rev. forecast

		Annual average purchase volume per user ($)				
		25	**50**	**100**	**200**	**500**
Users (M)	**1**	0%	0%	0%	0%	0%
	5	0%	0%	0%	1%	2%
	10	0%	0%	1%	2%	5%
	20	0%	1%	2%	4%	9%

Source: Credit Suisse estimates

Incremental custody and crypto-volatility risk

We see incremental risk from both custody (acquiring and storing bitcoin for customers); and volatility in crypto-assets (i.e., the risk of a crash in bitcoin).

Storing bitcoin is complicated. For example, Coinbase has several security measures built into its platform, such as two-step verification to access accounts. Users also have the ability to place some or all of their holdings in a digital “vault”, which allows the addition of co-signers to verify transactions. Vaulted assets require both a primary and secondary email to confirm transactions and a 48-hour delay period during which transactions can be cancelled.

Coinbase also stores 98% of its digital assets in “cold storage”. Cold storage is when the digital keys (cryptographic codes) that allow access to accounts on the public blockchain are moved fully offline, either to storage devices that aren’t connected to the internet or they are printed on paper. These offline devices are then stored in bank safe deposit boxes. In other words, traditional banks are securing crypto-assets.

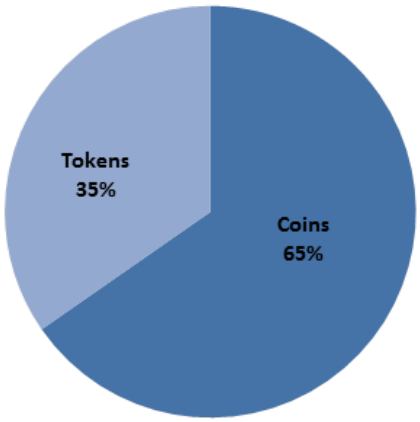
Overview of the Coin/Token Universe

There are over 1,200 different crypto-assets trading on crypto exchanges today, each of them seeking to be the next bitcoin. This ecosystem can be divided between coins and tokens.

- **A crypto "coin"** refers to a currency or means of payment, a literal digital *coin*. Coins enable the ability to store, send and receive value. Relative to bitcoin, other coins seek to differentiate themselves by providing faster payment confirmation times, lower fees, more privacy, and confirmation algorithms that use far less energy.
- **A crypto "token"** can have value, but is not considered money like a coin is. Tokens are generally hosted on other blockchains, which is often the Ethereum blockchain that was built to help startups launch decentralised applications. Tokens usually offer some kind of functionality aside from money, such as a vote, or a right to access a digital service. A helpful analogy is to think of the tokens purchased to play games at an arcade.

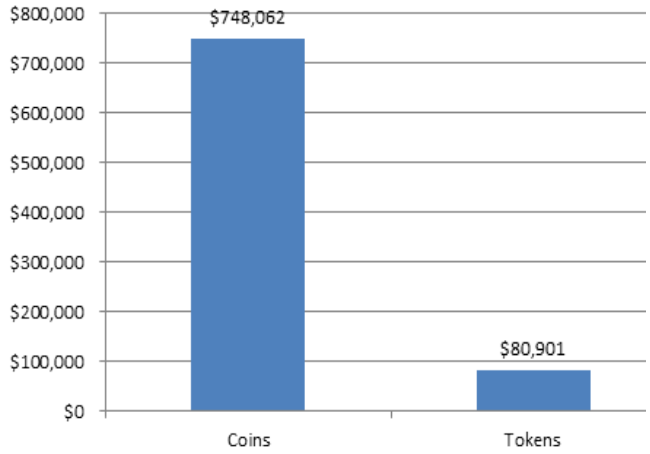
According to CoinMarketCap data, there are about 900 coins and 375 tokens trading on exchanges. The market cap of coins at c$700bn (as of 8th Jan '17) is significantly higher than that of tokens at c$80bn. We believe coins are relatively easier to develop and use, relative to tokens.

Figure 58: Tokens (478) vs Coins (901)



Source: CoinMarketCap, Credit Suisse research. Pricing as of 8 January 2018

Figure 59: Market Cap: Tokens & Coins ($bn)



Source: CoinMarketCap, Credit Suisse research. Pricing as of 8 January 2018

Figure 60: Top 10 Crypto-*Tokens* by market cap

	Tokens	Platform	Cap ($M)	% of Mkt	Function
1	TRON	Ethereum	$13,231	16%	Ecosystem for digital content
2	EOS	Ethereum	7,406	9%	Platform for dapps, competing with Ethereum platform
3	ICON	Ethereum	3,736	5%	Allows blockchains to interact via smart contracts
4	OmiseGO	Ethereum	2,547	3%	Cross currency digital wallet payment processor
5	Dentacoin	Ethereum	2,156	3%	Blockchain for dentistry industry
6	Populous	Ethereum	2,082	3%	Enables buying and selling of invoices
7	Binance Coin	Ethereum	1,859	2%	Token for Binance platform
8	Ardor	Nxt	1,829	2%	Blockchain-as-a-Service for business
9	Status	Ethereum	1,795	2%	Interface to access Ethereum
10	Tether	Omni	1,473	2%	Token pegged to one USD, backed by currency in bank.

Source: CoinMarketCap, Credit Suisse research. Pricing as of 8 January 2018

Figure 61: Top 10 Crypto-*Coins* by market cap

	Coins	Platform	Cap ($M)	% of Mkt	Function
1	Bitcoin	BTC	$276,579	37%	Payments, Store of value
2	Ripple	XRP	$129,513	17%	Payments (non-mineable)
3	Ethereum	ETH	$114,236	15%	Decentralized application network
4	Bitcoin Cash	BCH	$46,975	6%	Payments (faster, lower fees relative to bitcoin)
5	Cardano	ADA	$25,635	3%	Smart contracts
6	NEM	XEM	$16,233	2%	Smart contracts, permissioned
7	Litecoin	LTC	$15,669	2%	Payments (faster than bitcoin)
8	Stellar	XLM	$12,276	2%	Payments
9	IOTA	MIOTA	$11,347	2%	Cryptocurrency for IoT
10	Dash	DASH	$10,025	1%	Payments (faster than bitcoin)

Source: CoinMarketCap, Credit Suisse research. Pricing as of 8 January 2018.

In recent years, alternatives to bitcoin have been taking market share, which we view primarily as a function of investment diversification.

Impact on card networks

While it is commonly thought that bitcoin and other digital currencies could disrupt the Mastercard/Visa payments ecosystem, we're not yet convinced. Let's examine how a consumer would use bitcoin for normal everyday payments:

1. Download a bitcoin (BTC) wallet (of which there are many) and link a credit/debit card or bank account.
2. Purchase BTC at a 1.5% fee and potentially wait several days for it to show up in the wallet. Alternately, a consumer could receive BTC at no fee if it were given to him/her by somebody else.
3. Find somewhere to spend BTC via mobile app. This is likely easier to do online (though still difficult) but challenging to find physical merchants that accept.
4. Pay a fee to the merchant of roughly 75-150bps to accept the transaction. Some merchants might provide an offsetting discount to purchasers using BTC.
5. Wait for the merchant to receive confirmation of the transaction, which could take 10 minutes or more.
6. Trust the merchant will make good on the sale as there is no fraud-liable intermediary like there is with credit/debit cards.

Note that unless the merchant institutes some kind of discount or rewards programme, transaction fees are paid by consumers. While this may be a clear incentive for merchant acceptance (though not without a systems upgrade), we believe it creates a significant barrier to consumer use, especially when the experience is not notably different from - or more convenient than - using a credit card.

This is not to say cryptocurrencies will not find a use case in payments; we just believe it will be difficult to improve on the current retail payments experience and a more likely scenario is that they find use cases outside of the traditional Mastercard/Visa domain.

Risks to owning cryptocurrencies

- **Regulation:** We expect multiple agencies, governments and rules-making bodies to weigh in on the industry, including the SEC, IRS, FINCEN, CFTC and Congress. Countries including China and Russia have announced outright bans on certain activities – see More than meets the I-CO for more on this. While the mainstreaming of crypto-assets can help solve problems relating to KYC/AML, the issue of state-less decentralised quasi-banking systems could prove more complicated. Many states and countries are taking a very pro-blockchain approach to regulation as a means of attracting and maintaining talent.
- **Hacking:** While blockchain protocols themselves have been resilient to hacking, the surrounding applications (exchanges, wallets) remain vulnerable, as evidenced by Mt. Gox, the DAO and most recently the Parity wallet hack. Additionally, if the private keys to an account are lost, there is no way of retrieving them.
- **Limited technical talent:** Despite expanding interest and investment in digital assets, technical talent in the space remains limited, and this will likely prevent widespread adoption in both the enterprise and public setting.
- **Forking:** Forking is when a digital currency splits, resulting from a change in the underlying protocol of the platform. While we view forking as part of the growth process for cryptocurrencies, it nonetheless drives volatility and contributes to the argument that crypto-assets are inherently unstable and can be influenced by the whims of various political or business groups.
- **Custodian/storage risk:** Storage of digital assets remains complicated with a range of different service providers and home-grown methods. While consumer wallets are making this easier (i.e., Square, Coinbase, Bitpay), large-scale storage at the institutional level is highly fragmented with no clear industry-wide standards.
- **Early-stage business models:** Some startups that raised large sums via ICO may consist of little more than a concept white paper, posing a high degree of execution, governance and business risk.

Banks

Research Analysts

Carlos Lopez Ramos
44 20 7888 1237
carlos.lopez.2@credit-suisse.com

European Banks Team
44 20 7888 2277
BanksTeam.CS@credit-suisse.com

Collaboration is pervasive

Most of the large European banks are collaborating on a number of blockchain-related projects, and also have in-house FinTech development businesses (e.g. 'Barclays Accelerator'), which allow them to take advantage of developing blockchain technologies. The scale of technological progress means banks are involved in a number of payment platforms, (e.g. Standard Chartered is a founding investor in Ripple but also working with Homesend, a subsidiary of MasterCard).

We flag, however, **that potential efficiency savings are uncertain, difficult to corroborate and given the long-term nature are not a key consideration for bank investors currently. We don't expect them to materially improve efficiency on any investable time horizon.** It's also worth flagging that for large banks the adoption and deposit of blockchain-based cryptocurrencies such as bitcoin is still unexpected in the short and medium term. This is due to the lack of regulation as well as potentially high reputational risk.

One key example of collaboration amongst large European entities is the blockchain platform '**We.trade**' – founded by SAN, DBK, HSBC, KBC, CNAT, Rabobank, SOGN and UCG, in which NDA joined in December 2017. The consortium is developing a "*platform based on distributed ledger technology (DLT) that aims at making domestic and cross-border commerce easier"* (NDA, 5 December, 2017). The platform is expected to start being tested with real clients in Q2 2018. Its goal is to manage, track, and protect trade transactions between SMEs. It links the parties involved in trade and registers the entire trade process, from order to payment, displaying it in an at-a-glance, user-friendly interface, and guaranteeing automatic payment when all contractual agreements have been met. The platform is fully automated and available 24/7, making the order-to-payments process quicker than the traditional exchange of documents.

We have also witnessed examples of collaboration between banks in different parts of the world. The SWIFT DLT project aimed at making cross-border payments more efficient using blockchain is currently under the proof of concept (PoC) stage. In this project, up to 33 of the largest banks from regions ranging from Australia, New Zealand, US, Canada, Europe, Japan and Asia are working together.

Uses of blockchain for the financial sector are diverse. For example, DBK's Head of Disruptive Technologies Sajindra Jayasena expects that potential applications include *"settlement of trades in shares and derivatives, implementing transparency requirements for trading in financial instruments, settlement of bond trades and minimising risk of default via smart contracts".* That said, in mid-2016 DBK noted the blockchain technology is *"still five to ten years from widespread use"*, mainly due to *the "lack of regulatory and legal framework"*, while in terms of technology, "*blockchain technology at DBK is only 24 months from being ready to be launched"* (ComputerworldUK, 17 June 2016).

UK banks are amongst the most active investors in blockchain technology. In 2015 SAN UK was the first bank to introduce blockchain technology for small international payments (up to £10,000) made around the clock at any time of the day. RBS' blockchain project *('Emerald platform"*), HSBC (delivered a proof of concept of blockchain in trade finance) and Barclays (part of the first ever blockchain transaction in 2016) are some other examples of banking blockchain technologies currently under development.

In the Nordic banks space, NDA has been active since 2015, working on a number of different distributed ledger initiatives internally and participating in a range of larger external projects. NDA has been a member of the R3 Consortium since 2015, and, as previously mentioned, the bank recently joined We.trade as a founding partner. The head of DLT and blockchain at NDA, Mr. Ville Sointy, has stated (NDA press release, 5 December 2017) that "In the current broad landscape of blockchain technology based initiatives in trade finance we see We.trade as a standout in its focus and realistic execution strategy. We are looking forward to providing a Nordic perspective to the future of trade finance".

Over the past two years, NDA has been testing different DLT technologies in back-office areas, particularly within the bank's Know Your Customer (KYC) processes. In 2016, NDA presented the outcome of a KYC pilot, with the objective of improving the client experience and increasing efficiency in the process. The project was executed in cooperation with Nordic peer banks and financial institutions. NDA's approach is driven by practical considerations, and the bank highlights that likely areas of use for blockchain-related technologies are: simplifying KYC, trade finance processes, streamlining clearing and settlement and regulatory reporting.

Lastly, Southern European banks are also making steady progress in blockchain technology. The We.trade platform already involves SAN and UCG. ISP also stated in its 2016 Annual Report that it is part of a "consortium to assess the application of blockchain technology in accordance with the regulatory and functional requirements typical of the traditional financial world". ISP, UCG, SAN and BBVA are also part of the SWIFT project previously described. In a report from 30 November 2017, the Bank of Italy stated: "*Blockchain is expected to deliver efficiency gains: according to its proponents, some of these gains will come from easier diffusion of information and have the potential of altering the payment systems landscape. However, the extent of its impact is still uncertain, as many aspects of its practical implementation are yet unknown."* With regards to cryptocurrencies, UCG has said that acceptance amongst banks is still far off: not from a IT perspective, but from a regulatory and reputational angle.

Exchanges

Major opportunity, but hurdles underestimated

Research Analysts

Martin Price
44 20 7883 7516
martin.price@credit-suisse.com

Tom Mills
44 20 7888 8204
tom.mills@credit-suisse.com

Michalis Onisiforou
44 20 7883 1386
michalis.onisiforou@credit-suisse.com

Blockchain offers a new approach to data management and sharing, which has potential to change the way securities markets function, making them cheaper and more resilient. We think the technology is particularly well suited to the issuance, settlement and custody of financial instruments, but could also help facilitate regulatory reporting and transaction monitoring. Many exchanges are exploring small-scale PoC and small-scale applications, although these have focused on niche product areas to date. ASX has announced plans to replace the system that underpins post-trade processes of Australia's cash equities market, known as CHESS, although the Day 1 functional scope of the replacement system is still being defined and a go-live date is yet to be confirmed.

Overall, we remain of the view that the hurdles to implementing distributed ledger technology are often underestimated, with some of the challenges including interoperability with legacy infrastructure and agreeing legal claims on assets that are held within a globally distributed ledger (different bankruptcy rules present just one such challenge). We also believe the ASX project illustrates that existing providers are likely to be best placed to apply the technology and see low risk of disintermediation. Disruptors in other industries (e.g. Uber/Airbnb) have often adopted an 'act first, work through the issues with regulators later' approach, but innovations in financial markets will require full regulatory approval before implementation.

We also believe that some of the benefits of distributed ledger applications are achievable with existing technologies, or no significant IT enhancement. For instance, in many cases, adoption of blockchain technology is reliant on aligning industry standards for business processes and associated legal documentation which is hard to achieve, particularly on a cross-border basis. Regardless of new technology innovation, greater standardisation could improve efficiency and cut costs using existing market practices and infrastructure.

Who wins and who loses?

The efficiencies delivered by blockchain should benefit the market by enhancing efficiency and lowering costs. Lower processing costs can result in increased volumes, which would benefit exchanges with significant equities & derivatives trading businesses, such as BME, Deutsche Boerse and Euronext in Europe, or clearing flow such as LSE.

Shorter and more efficient settlement cycles could reduce NII generated by custodians, which is typically derived from funds deposited in advance of a scheduled settlement obligation, although the impact may be offset, at least partly, by lower operating costs. We do not expect central securities depositories to be disintermediated but think they are likely to perform similar functions as they do today but more efficiently. While theoretically the core functions of a CSD could be 'outsourced' to a permissioned distributed ledger, we believe regulators have a preference for regulating a central authority.

The European exchanges generate very little income from settlement, partly as a result of cash equities settlement functions being outsourced to the ECB's Target2Securities platform, which is being operated as a utility. Deutsche Boerse has greatest exposure to custody services at c.18% of group revenue in ‘17E, although we do not expect this to disappear.

Distributed ledgers poorly suited to trading

Whilst we think there is potential to use distributed ledger technology in certain post-trade processes, it is too slow for adoption for standard trading applications. A bitcoin transaction takes several minutes to be confirmed, while exchanges routinely match orders in microseconds. Decentralised systems such as blockchain require significant computing and storage resources because all nodes must perform validation checks and store the ledger data, which in turn slows the system down. Blockchain might be more suitable for trading in less liquid instruments (e.g. syndicated debt).

Settlement & custody – more suitable use-cases

Blockchain is potentially best suited to payment functions such as settlement and asset ownership/servicing functions including registration and custody. For instance, blockchain could provide a secure, consistent "source of truth" of the ownership of assets to other market infrastructure providers such as custodians, central securities depositories and beneficial owners.

The success of bitcoin as a mechanism for transferring value with finality of execution on a common ledger demonstrates that for a simple case, the delivery vs. payment settlement can be programmable and managed in near real time. The application of distributed ledger technology to shorten settlement cycles could lower risk, by reducing exposure to trade settlement failures (e.g. dealers have less time to be exposed to counterparty risk) and lowering clearing fund requirements. In cash equities markets, trades typically settle on a T+2 basis (i.e. trades are settled two days after a trade was executed). Although the existing market infrastructure is capable of operating on a shorter timetable, there is little appetite to change things with the delay often imposed by market convention, laws and regulation rather than because of technical capability. For example, instantaneous settlement would increase liquidity requirements and reduce capital efficiency because every transaction would need to be settled, while currently market participants can just settle their net end-of-day exposure. In the US, for example, over 97% of daily equity trades are settled through netting and only 3% go through the full settlement mechanism according to the DTCC.

Registration & custody

The core function of a depository is to maintain a register of who owns what and to keep this updated as part of the settlement process. While existing applications generally work well, registration processes can be complex, inefficient and prone to error. Blockchain could help to solve many of these issues by making the register of owners available on a near real-time basis to permissioned entities such as clearing houses, custodians and agent banks.

Typically asset owners interact with central securities depositories via agent banks and custodians. A distributed ledger could cut costs by allowing custodians to interact directly with asset owners and CSDs via a permissioned distributed ledger.

While blockchain could change the way custodians work, we do not believe it removes some of their core functions (e.g. we see a continued need for entities with responsibility for asset safekeeping and management of corporate actions on behalf of asset owners).

Clearing houses still have a role to play

There is an ongoing debate about whether the blockchain will disintermediate the novation function provided by central counterparty clearing houses (CCPs), but we do not believe this will be the case. We think CCPs will continue to perform a key role in mitigating risks for buyers and sellers by guaranteeing trade completion even if one side defaults. CCPs also support brokers and other agents by connecting buyers and sellers that do not have liquidity to settle trades themselves.

While technically it may be possible to by-pass the novation function provided by a CCP, this would require the market to revert to sending and receiving payments bilaterally with margin payments triggered by smart contracts which interact with cash accounts at commercial or central banks held off-ledger. This would require a fundamental redesign of the existing central clearing model where counterparties log a portfolio of trades against a CCP and make payments on a net basis, to one where each contract is independently accounted for and identifiable. We do not believe this would represent an improvement on the existing market structure or result in obvious cost savings, an enhanced level of transparency.

Australia could be the testing ground for blockchain technology

We think Australia is likely to provide a good testing ground for blockchain applications that are most relevant to financial exchanges. Australia's market infrastructure is considered world class and is large enough to be a meaningful test environment, yet is also less complicated than the US or European operating environments.

In Australia, the market structure is relatively simple compared to the US and Europe with only a single exchange and clearinghouse (albeit two trading platforms – ASX and Chi-X), has transparent share ownership rules (unlike the US street and non-street system) and has a concentrated ownership structure with ASX owning the trading, clearing and settlement functions across both equity and futures markets. In addition there is a willingness of industry participants to invest (e.g. ASX, Computershare, Government) in blockchain and other distributed ledger technology.

In December 2017, ASX announced plans to push ahead with the replacement of its legacy cash equity post trade infrastructure with a new solution based on distributed ledger technology. ASX intends to launch a public consultation at the end of March 2018 that will outline the proposed Day 1 scope and implementation plan, including a 'window' for the live date of the new system.

London Stock Exchange (LSE.L)

FOCUS LIST STOCK

Blockchain – more opportunity than threat

Rating	**OUTPERFORM**
Price (08 Jan 18, p)	3744.00
Target price (p)	4150.00
Market Cap (£ m)	12,981.8
Enterprise value (£ m)	12,985.3

Target price is for 12 months.

Research Analysts

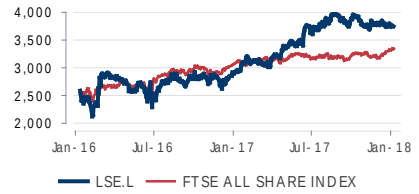
Martin Price
44 20 7883 7516
martin.price@credit-suisse.com

Tom Mills
44 20 7888 8204
tom.mills@credit-suisse.com

Michalis Onisiforou
44 20 7883 1386
michalis.onisiforou@credit-suisse.com

- **Low risk of disintermediation:** Blockchain has scope to change the way that markets work, potentially making them cheaper and more resilient. We believe the technology is likely to be best suited to settlement and custody, although LSE's exposure to these functions is low at c.3% of '18E total income. We also believe that existing market infrastructure providers are best placed to apply the technology and see little risk of disintermediation.
- **Execution and CCP services unlikely to be disrupted:** Decentralised applications like blockchain require significant computing resources which slow transactions down. A bitcoin transaction takes several minutes to be confirmed which is too slow for application in exchanges which match trades in microseconds. We believe central counterparty clearing (CCP) and novation services are poorly suited to blockchain usage and expect third party owned CCPs to retain a key role in guaranteeing trade completion in a blockchain environment. CCP services and NII make up c.32% of LSE '18E total income.
- **Potential revenue upside from other initiatives:** LSE has partnered with IBM to build a blockchain solution to digitally issue private securities of SMEs in Italy. The platform's goal is to help simply track and manage shareholder information by storing it on a distributed ledger, potentially opening up new opportunities for trading and investing. LSE also continues to explore additional use cases for distributed ledger and other emerging technologies (e.g. AI).
- **Reiterate Outperform rating (TP 4150p):** On c21x '18E P/E, LSE trades on a modest premium to the global diversified exchanges (20x), but we think this looks undemanding given much stronger EPS growth on our estimates (18% CAGR 16A-19E vs. 10% for peers). Given upside to company EBITDA margin targets vs. consensus forecasts for '19E, debt headroom for accretive bolt-on deals and optionality on transformational M&A, we reiterate our Outperform rating.

Share price performance



The price relative chart measures performance against the FTSE ALL SHARE INDEX which closed at 4244.8 on 08/01/18
On 08/01/18 the spot exchange rate was £.88/Eu 1.-Eu.84/US$1

Performance	1M	3M	12M
Absolute (%)	-1.2	-4.5	28.0
Relative (%)	-5.7	-7.2	19.9

Financial and valuation metrics

Year	12/16A	12/17E	12/18E	12/19E
Revenue (£ m)	1657.1	1936.9	2152.1	2314.3
EBITDA (£ m)	770.83	935.97	1098.61	1210.76
Pre-tax profit adjusted (£ m)	623.13	784.83	930.61	1035.56
CS EPS (adj.) (p)	124.72	152.13	182.78	202.52
Prev. EPS (p)	-	-	-	-
ROIC (%)	14.64	17.52	20.74	22.99
P/E (adj.) (x)	30.02	24.61	20.48	18.49
P/E rel. (%)	163.5	161.2	143.1	138.5
EV/EBITDA (x)	16.9	13.9	11.6	10.3

Dividend (12/17E, p)	45.6	IC (12/17E, £ m)	3,643.0
Dividend yield (12/17E, %)	1.2	EV/IC (12/17E, (x)	3.6
Net debt (12/17E, £ m)	3.5	Current WACC (%)	
Net debt/equity (12/17E, %)	0.1	Free float (%)	97.7
BV/share (12/17E, £)	9.0	Number of shares (m)	346.7

Source: Company data, Thomson Reuters, Credit Suisse estimates

London Stock Exchange (LSE.L)

Price (08 Jan 2018): **3744.00p**; Rating: **OUTPERFORM**; Target Price: **4150.00**; Analyst: **Martin Price**

Income statement (£ m)	12/16A	12/17E	12/18E	12/19E
Revenue	**1,657**	**1,937**	**2,152**	**2,314**
EBITDA	**771**	**936**	**1,099**	**1,211**
Depr & amort	(85)	(96)	(105)	(109)
EBIT	**686**	**840**	**994**	**1,102**
Net interest exp.	(63)	(55)	(63)	(67)
Associates	-	-	-	-
PBT	**623**	**785**	**931**	**1,036**
Income taxes	(140)	(188)	(223)	(249)
Profit after tax	483	596	707	787
Minorities	(48)	(72)	(81)	(93)
Preferred dividends	-	-	-	-
Associates & other	(95)	(144)	(161)	(185)
Net profit	**435**	**524**	**627**	**694**
Other NPAT adjustments	**0**	**0**	**0**	**0**
Reported net income	**435**	**524**	**627**	**694**

Cash flow (£ m)	12/16A	12/17E	12/18E	12/19E
EBIT	686	840	994	1,102
Net interest	(63)	(55)	(63)	(67)
Cash taxes paid	(316)	(188)	(223)	(249)
Change in working capital	30,223	0	0	0
Other cash & non-cash items	(30,310)	24	104	109
Cash flow from operations	**221**	**620**	**812**	**896**
CAPEX	(34)	(97)	(36)	(37)
Free cashflow to the firm	**187**	**523**	**776**	**858**
Acquisitions	-	-	-	-
Divestments	0	5	25	25
Other investment/(outflows)	277	(675)	(280)	(311)
Cash flow from investments	**243**	**(768)**	**(292)**	**(324)**
net share issue/(repurchase)	3	(357)	0	0
Dividends paid	(133)	(175)	(204)	(271)
Issuance (retirement) of debt	(547)	831	0	0
Cash flow from financing	**(47)**	**159**	**(228)**	**(296)**
Changes in net cash/debt	**417**	**12**	**292**	**276**
Net debt at start	433	15	4	(289)
Changes in net cash/debt	**(417)**	**(12)**	**(292)**	**(276)**
Net debt at end	15	4	(289)	(565)

Balance sheet (£ m)	12/16A	12/17E	12/18E	12/19E
Assets				
Total current assets	**560,375**	**591,934**	**592,263**	**592,577**
Total assets	**564,796**	**596,463**	**596,756**	**597,032**
Liabilities				
Total current liability	559,761	591,439	591,439	591,439
Total liabilities	**561,182**	**592,824**	**592,824**	**592,824**
Total equity and liabilities	**564,796**	**596,463**	**596,756**	**597,032**

Per share	12/16A	12/17E	12/18E	12/19E
No. of shares (wtd avg.) (m)	348.90	344.75	342.90	342.90
CS EPS (adj.) (p)	**124.72**	**152.13**	**182.78**	**202.52**
Prev. EPS (p)	-	-	-	-
Dividend (p)	37.19	45.60	59.36	79.04
Operating CFPS (p)	63.34	179.98	236.73	261.22

Earnings	12/16A	12/17E	12/18E	12/19E
Growth/margins (%)				
Sales	-	-	-	-
EBIT	17.2	22.5	18.4	10.9
Net income	21.1	20.5	19.5	10.8
EPS	20.5	22.0	20.1	10.8
EBITDA margin	-	-	-	-
EBIT margin	-	-	-	-
Pretax margin	-	-	-	-
Net margin	-	-	-	-

Valuation	12/16A	12/17E	12/18E	12/19E
EV/Sales (x)	-	-	-	-
EV/EBITDA (x)	16.9	13.9	11.6	10.3
EV/EBIT (x)	19.0	15.5	12.8	11.3
P/E (x)	30.0	24.6	20.5	18.5
Price to book (x)	4.2	4.2	3.8	3.5

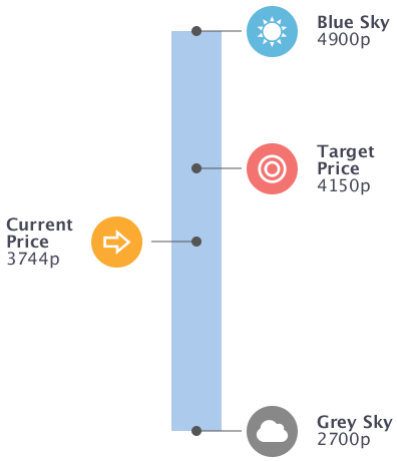
Gearing	12/16A	12/17E	12/18E	12/19E
Net debt/equity (%)	0.4	0.1	(7.3)	(13.4)
Net Debt to EBITDA (x)	0.0	0.0	(0.3)	(0.5)
Interest coverage ratio (X)	10.9	15.2	15.7	16.6

Source: FTI, Company data, Thomson Reuters, Credit Suisse Securities (EUROPE) LTD. Estimates

Company Background

London Stock Exchange Group is engaged in services including the admission of securities for trading, clearing & settlement, trading in securities and information services.

Blue/Grey Sky Scenario



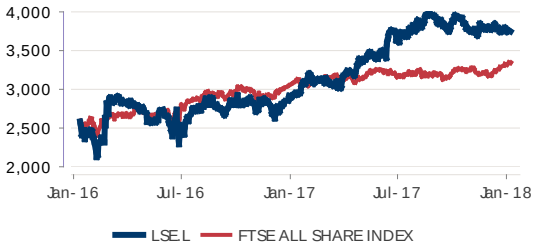
Our Blue Sky Scenario (p) 4900.00

In our blue sky scenario, our DCF model assumes an organic PBT growth rate of 9% over the period 2018-26E, vs. 8% in our base case, and 4% terminal growth rate. Our DCF derived blue sky scenario would be 4900p per share and implies a multiple of 27x our 2018E EPS estimate.

Our Grey Sky Scenario (p) 2700.00

In our grey sky scenario, our DCF model assumes an organic PBT growth rate of 3.0% over the period 2018-26E, vs. 8% in our base case, and 2.5% terminal growth rate, in line with long term UK GDP growth trends. Our DCF derived grey sky scenario would be 2700p per share and implies a multiple of 15x our 2018E EPS estimate.

Share price performance



The price relative chart measures performance against the FTSE ALL SHARE INDEX which closed at 4244.8 on 08/01/18

On 08/01/18 the spot exchange rate was £.88/Eu 1.- Eu.84/US$1

ASX (ASX.AX / ASX AU)

Rating	**UNDERPERFORM**
Price (09-Jan,A$)	55.93
Target Price (A$)	51.00
Target price ESG risk (%)	NA
Market cap (A$mn)	10,827.8
Yr avg. mthly trading (A$mn)	384.1
Projected return:	
Capital gain (%)	-8.8
Dividend yield (net %)	3.8
Total return (%)	-5.0

Target price is for 12 months.

Research Analysts

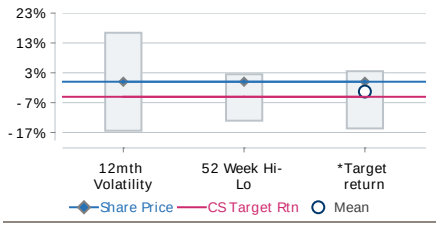
Andrew Adams
61 2 8205 4106
andrew.adams@credit-suisse.com

James Cordukes, CFA
61 2 8205 4858
james.cordukes@credit-suisse.com

Shift to DLT may not necessarily be accretive

- **ASX is proceeding with distributed ledger technology (DLT) for its cash equities post-trade service.** In December 2017, following a 2+ year scoping study, ASX announced it would replace CHESS with Digital Asset's permissioned private distributed ledger. ASX will have exclusivity over Digital Asset's system in Australia and New Zealand. ASX is yet to finalise the scope of the Day 1 functionality with plans to provide an update at the end of March 2018 on the proposed timing, transition period and Day 1 functionality. The new system will also be developed to facilitate competition in both trading and clearing and settlement markets.
- **The impact of DLT remains uncertain.** The financial outcome of ASX's DLT-based settlement service is difficult to determine with pricing yet to be agreed with clients and fees payable to Digital Asset also unknown. Given the potential threat of new entrants and the regulator's new focus on ensuring ASX's returns are commensurate with its business risk, we struggle to see ASX making EBITDA margins as high as it did on its fully depreciated CHESS system (which were ~75%). As a partial offset, we see scope for higher pricing of the new service given the value proposition to ASX's clients. For example, stockbrokers should see substantial efficiencies in the form of streamlined / eliminated back-office functions. We have discussed the full consideration of ASX's new system in *ASX: Pending DLT decision may not necessarily be positive; Maintain Underperform* (28 November 2017).
- **Underperform.** ASX bears more uncertainty over the future of its post-trade business than its high multiple might imply with the DLT not necessarily an earnings accretive investment (as is the consensus view). With ASX trading on a ~40% premium to the market (well above its historical range) and offering only 2-3% EPS growth p.a. we see limited valuation support despite the high quality and defensive nature of its earnings and business.

Total return forecast in perspective



Source: Company data, Thomson Reuters, IBES, Credit Suisse estimates

Performance	1M	3M	12M
Absolute (%)	-0.569	4.68	8.92
Relative (%)	-2.93	-1.62	3.27

Financial and valuation metrics

Year	6/17A	6/18E	6/19E	6/20E
Revenue (A$ mn)	764	806	829	863
EBITDA (A$ mn)	583	610	622	643
EBIT (A$ mn)	537	560	569	587
Net Income (Adj.) (A$ mn)	434	450	459	474
EPS (Adj.) (A$)	2.24	2.32	2.37	2.45
Change from previous EPS (%)	n.a.	0.0	0.0	0.0
EPS growth (%)	1.9	3.5	2.0	3.3
P/E (x)	24.9	24.1	23.6	22.9
Dividend (A$)	2.02	2.09	2.13	2.20
Dividend yield (%)	3.6	3.7	3.8	3.9
Price/Book (x)	2.8	2.7	2.7	2.7
Net debt/equity (%)	Net Cash	Net Cash	Net Cash	Net Cash

Source: Company data, Thomson Reuters, Credit Suisse estimates

ASX (ASX.AX / ASX AU)

Price (09 Jan 2018): **A$55.93**; Rating: **UNDERPERFORM**; Target Price: **A$51**; Analyst: **Andrew Adams**

Income Statement	6/17A	6/18E	6/19E	6/20E
Revenue	**764**	**806**	**829**	**863**
EBITDA	**583**	**610**	**622**	**643**
Depr. & Amort.	(46)	(50)	(53)	(56)
EBIT	**537**	**560**	**569**	**587**
Associates	-	-	-	-
Net interest exp.	65	65	68	71
Other	14	15	15	16
Profit before tax	**616**	**640**	**653**	**674**
Income tax	(182)	(190)	(194)	(200)
Profit after tax	**434**	**450**	**459**	**474**
Minorities	-0	-0	-0	-0
Preferred dividends	-	-	-	-
Associates & Other	0	0	0	0
Normalised NPAT	**434**	**450**	**459**	**474**
Unusual item after tax	0	0	0	0
Net profit (Reported)	**434**	**450**	**459**	**474**

Balance Sheet	6/17A	6/18E	6/19E	6/20E
Cash & equivalents	5,684	5,771	5,862	5,956
Inventories	0	0	0	0
Receivables	1,125	1,125	1,125	1,125
Other current assets	3,418	3,418	3,418	3,418
Current assets	**10,227**	**10,314**	**10,405**	**10,499**
Property, plant & equip.	47	47	47	47
Intangibles	2,439	2,404	2,367	2,327
Other non-current assets	499	499	499	499
Non-current assets	**2,985**	**2,950**	**2,912**	**2,873**
Total assets	13,212	13,264	13,318	13,372
Payables	8,977	8,977	8,977	8,977
Interest bearing debt	0	0	0	0
Other liabilities	327	327	327	327
Total liabilities	**9,304**	**9,304**	**9,304**	**9,304**
Net assets	**3,908**	**3,960**	**4,014**	**4,068**
Ordinary equity	3,908	3,960	4,014	4,068
Minority interests	0	0	0	0
Preferred capital	-	-	-	-
Net assets	**3,908**	**3,960**	**4,014**	**4,068**
Net Debt	(5,684)	(5,771)	(5,862)	(5,956)

Cash Flow	6/17A	6/18E	6/19E	6/20E
EBIT	537	560	569	587
Net Interest	67	65	68	71
Depr & Amort	46	50	53	56
Tax Paid	(175)	(190)	(194)	(200)
Change in Working capital	1,995	-0	-0	-0
Other cash and non-cash items	(1,987)	15	15	16
Operating cash flow	**484**	**500**	**512**	**530**
Capex	(61)	(50)	(50)	(50)
Capex - expansionary	-	-	-	-
Capex - Maintenance	-	-	-	-
Acquisitions & Invest	(16)	0	0	0
Asset sale proceeds	-	-	-	-
Other	-	-	-	-
Investing cash flow	**(77)**	**(15)**	**(16)**	**(17)**
Dividends paid	(389)	(398)	(405)	(419)
Equity raised	0	0	0	0
Net borrowings	0	0	0	0
Other financing cash in/(outflows)	0	0	0	0
Financing cash flow	**(389)**	**(398)**	**(405)**	**(419)**
Total cash flow	**18**	**87**	**91**	**94**
Adjustments	-	-	-	-
Movement in cash/equivalents	**18**	**87**	**91**	**94**

Source: Company Data, Credit Suisse Estimates, MSCI ESG Research

Earnings	6/17A	6/18E	6/19E	6/20E
Equiv. FPO (period avg)	193	194	194	194
EPS (CS adj.) (c)	224.4	232.2	237.0	244.7
EPS growth (%)	1.9	3.5	2.0	3.3
DPS (c)	201.8	209.0	213.3	220.2
Dividend Payout (%)	89.9	90.0	90.0	90.0
Free CFPS (c)	218.5	232.2	238.5	247.9

Valuation	6/17A	6/18E	6/19E	6/20E
P/E (CS) (x)	24.9	24.1	23.6	22.9
EV/EBIT (x)	9.6	9.2	9.0	8.8
EV/EBITDA (x)	8.8	8.4	8.3	8.0
Dividend Yield (%)	3.6	3.7	3.8	3.9
FCF Yield (%)	3.9	4.2	4.3	4.4
Price to book (x)	2.8	2.7	2.7	2.7

Returns	6/17A	6/18E	6/19E	6/20E
Return on Equity (%)	11.1	11.4	11.4	11.6
Profit Margin (%)	56.8	55.8	55.3	54.9
Asset Turnover (x)	0.1	0.1	0.1	0.1
Equity Multiplier (x)	3.4	3.3	3.3	3.3
Return on Assets (%)	3.3	3.4	3.4	3.5
Return on Invested Cap.	(21.3)	(21.7)	(21.7)	(21.9)

Gearing	6/17A	6/18E	6/19E	6/20E
ND/ND+E (%)	320.1	318.7	317.2	315.5
Net Debt to EBITDA (x)	Net	Net	Net	Net
Int Cover (EBITDA) (x)	na	na	na	na
Int Cover (EBIT) (x)	na	na	na	na
Capex to Sales (%)	8.0	6.2	6.0	5.8
Capex to Depr (%)	445.3	336.0	316.7	298.5

Share price performance

On 09-Jan-2018 the S&P ASX 200 Index closed at 6135.8
On 09-Jan-2018 the spot exchange rate was A$1.27/US$1

Business Services

Organisations must take notice now

Research Analysts

Karl Green
44 20 7888 2629
karl.green@credit-suisse.com

Andy Grobler, CFA
44 20 7883 5943
andy.grobler@credit-suisse.com

Daniel Hobden
44 20 7883 3290
daniel.hobden@credit-suisse.com

UK Business Process Outsourcing service providers

Summary: We continue to see immense potential for blockchain technology to improve efficiency and reduce friction across a broad range of private and public sector administrative processes over the long term. However, as the debate has migrated from the theoretical to the practical, we believe that the roll-out of blockchain applications is likely to be slower and more complicated than initially envisaged.

Due to Brexit, the prospect of widespread adoption in the UK public sector in the foreseeable future seems remote. However, internationally, there is clear evidence of public sector bodies embracing blockchain solutions we think due to the high importance attached to the improvement of trust, security and fraud-prevention, as well as rational economics. On this basis, it seems more likely that skills and templates are imported to, rather than exported from, the UK. We see Equiniti as well-positioned over the long-term (though we rate the shares Underperform on unrelated concerns) and believe that Capita (rated Neutral and currently in a state of great flux) needs to articulate a clear blockchain strategy once its new CEO has stabilized the business and prioritized growth avenues.

To recap, in our *Blockchain: The Trust Disrupter* report in August 2016, we focused on the applications of blockchain in three keys areas with most relevance to the UK-based Business Process Outsourcing (BPO) service providers, as follows:

- **Share registration**: We concluded that (1) the application of blockchain technology to the UK share registration market was at least 5 years away; (2) that full dematerialisation (the eradication of physical share certificates) needs to happen before full adoption can happen; and (3) there will still be a critical permissioned 'gatekeeping' function for the incumbent registrars to ensure that all entries onto the chain and reconciliations of data being pulled from the chain are accurate. Thus we saw the threat of disintermediation as a relatively low probability risk.

- **Payments**: We concluded that he potential for blockchain to remove significant layers of cost from the current 'byzantine' UK payments architecture over the longer term could deliver significant cost savings for BPO operators, namely Capita and Equiniti who handle £bns of pension administration payments transactions every year.

- **Public sector administration**: We observed that the UK government had published a prescient paper, 'Distributed Ledger Technology: beyond block chain' which noted that, "*The UK Government Digital Service is developing a digital platform for government to deliver its services and distributed ledgers could be at the heart of this*". We concluded that this could eventually create a multi-decade opportunity for blockchain transition and integration specialists, though Capita and Equiniti would likely to have to partner and acquire independent fintech entities to build the necessary skills.

Whereas other blockchain applications have tangibly evolved over the past 12 months, there has been only limited development of the technology which directly impacts the three areas above in the UK to the extent that we think that the pace of change has altered. We identified at the time that Equiniti was being particularly proactive in its approach to blockchain R&D which, as we go on to discuss, has remained the case.

By contrast, in response to multifarious operational challenges and associated balance sheet stress, Capita sold its share registration unit to Link Administration Holdings in mid-2017. Thus the debate around share registration opportunities and challenges is limited to EQN in the UK (and to Computershare and Link, the two Sydney-listed competitors who represent the other two major players in this market).

"Organisations must take notice now"

As part of its Share Registration Conference 2017 in September, EQN asked the audience of company secretaries to vote on when they thought blockchain technology might enter the UK financial markets infrastructure. The results were evenly split with 49% expecting it to happen within the next 5 years, whereas 51% were of the opinion that it will take longer. However, as Angus Scott, Head of Product Strategy and Innovation at Euroclear Group and one of the blockchain panelists at the conference, observed, "*There's not suddenly going to be a point at which the world shifts to blockchain. As it evolves, it will become pervasive and you probably won't even notice it because it's just a better way of sharing data in certain environments".*

Whilst the longer-term benefits of blockchain applications remain compelling in terms of data integrity, trust and huge reductions in administrative and transactional friction, the insights provided by the EQN conference into the practicalities of blockchain implementation confirm our belief that the real-world application to the UK share registration mark (and, in our view, particularly UK public sector administration) is at least 5 years away. Key obstacles to overcome were identified, as follows:

- Despite the ultimate achievement of economies of scale, the set-up of blockchain solutions will be expensive.
- It will be time consuming to reorganise existing systems and databases in a way that makes adoption possible.
- Organisations around the world operate on different rhythms and investment cycles, potentially complicating synchronization further.
- From a legal and regulatory perspective, complex issues still need to be resolved around the ownership of processes and data, accountability, resolution mechanisms in the event of errors and disputes, the nature of governance and regulatory structure.
- Additionally, Accenture has observed that "expertise in the technology remains minimal" and that it is likely to be some time before there is a strong pool of talent trained in blockchain which can overcome the skills and resources shortage.

Of course, there is no suggestion that any of the above issues is insurmountable and history tells us that public and private-sector entities have been able to migrate from paper-based records to digital records over time, with all of the duplication and double-running costs that has entailed. Rather, the four (non-exhaustive) points above suggest that the pace of migration is likely to be slower than theory/optimism suggests.

From a UK perspective, in the public sector particularly, we see a significant extra impediment to blockchain adoption and rollout which is resource diversion resulting from Brexit. There is clear evidence in the public sector that Brexit has caused a sharp drop in the number of complex/transformational BPO and technical services initiatives being designed, commissioned or sought by most central government departments and many local government entities. On this basis, what are likely to be deemed relatively high-risk, potentially expensive data migration programmes are, in our view, likely to be deprioritized.

We believe that Brexit is less likely to impede blockchain adoption in the private sector, although some sectors which may ultimately be burdened with complex modifications to cross border trading/customs IT platforms, subject to the final Brexit settlement, may also see a de-prioritisation of non-essential transformative data projects.

Notable developments in public sector blockchain applications

Whilst examples of the UK government's blockchain vision being developed upon have been few and far between since our last report on the subject, some departments, prompted by the Cabinet Office, are reportedly exploring specific applications, according to btcmanager.com, including:

- The Justice system (police, courts and prisons), to deliver improved record keeping, offering improved outcomes for victims, witnesses, defendants and offenders.
- Distribution, monitoring and control of governmental financial grants.
- Tracking student debts and development aid.

However, given the UK Government's more pressing priorities around Brexit, we are less convinced than we were that the UK will be at the *avant garde* of blockchain applications to public sector administration. Instead, we observe greater progress and apparent ambition internationally, the templates and experience of which we think could be imported to the UK, albeit recognising that the implementation challenges are likely to be unique on a country-by-country, department-by-department basis depending on the scale and complexity of legacy systems. We would note the following developments internationally (all according to McKinsey.com, "Using blockchain to improve data management in the public sector", February 2017, unless otherwise stated):

- **Sweden**: The national land registry authority, Lantmäteriet, is exploring ways to digitize the currently onerous process of **real estate transactions**. It is prototyping a mobile app that would provide a blockchain-based transaction interchange for sellers, buyers, real-estate agents and banks, recording detailed information about both properties and each step in the transaction process. Reportedly, "paper documentation – typically hundreds of pages long – would become superfluous" with the app expected to reduce the time needed to complete a sale from 3-6 months to just a few days and possibly as little as just a few hours. (Elsewhere, the Republic of Georgia is also reported to have indicated that it will test a similar technology.
- **US**: The State of Delaware is reported to be in the early stages of creating **incorporation services** based on blockchain records and smart contracts rather than the current paper-based system. McKinsey notes that this digital approach would likely benefit the growing number of private companies with complicated equity structures where different shareholders have different rights and obligations which could be codified within 'smart contracts' embedded in a blockchain. Such a solution could then be used to automate voting procedures or ensure compliance around share sale protocols. We see this innovation as particularly relevant to share registry businesses which could, over time, migrate existing registers to a blockchain and create significant administration savings via automation (some/most of which we would ultimately expect to be shared with customers).

- **Dubai**: According to Forbes.com ("Dubai Sets Its Sights on Becoming the World's First Blockchain-Powered Government", 18th December 2017), Dubai wants all **visa applications, bill payments and license renewals**, representing >100m documents per annum, to be transacted digitally using blockchain. The Smart Dubai initiative estimates that the strategy could save $1.5bn per annum or 25 million man hours through the move to paperless government. As in Sweden, the Dubai Land Department launched a blockchain powered system in October to help secure financial transactions, **record all real estate contracts** and connect homeowners/tenants to key utilities such as water, electricity and telecoms providers. The DLD sees blockchain as a key tool in fraud prevention and improving transparency.

In our view, beyond the limited examples such as Estonia that we discussed in the initial report, despite having a clear vision as to the theoretical potential of blockchain-enhanced public sector administration, the UK has not moved much beyond the stage of hypothesizing about blockchain, whereas other nations across multiple continents are taking much more tangible action to harness the potential of the technology. In this respect, it seems less likely that the UK will be the birthplace of an international market leader in public sector blockchain technology. Rather, the UK private sector, if at all, will have to be the engine of adoption.

Equiniti (EQN.L)

Rating	**UNDERPERFORM**
Price (08 Jan 18, p)	273.50
Target price (p)	270.00
Market Cap (£ m)	996.7
Enterprise value (£ m)	1,246.1

Target price is for 12 months.

Research Analysts

Karl Green
44 20 7888 2629
karl.green@credit-suisse.com

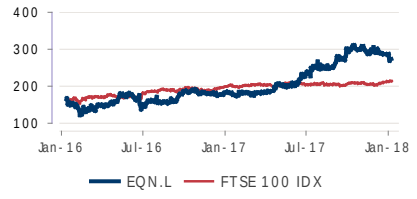
Andy Grobler, CFA
44 20 7883 5943
andy.grobler@credit-suisse.com

Daniel Hobden
44 20 7883 3290
daniel.hobden@credit-suisse.com

Blockchain update

- **Reiterate Underperform on a 12-month view, despite blockchain preparedness:** We recently downgraded EQN to Underperform on concerns around slowing organic growth and a significant relative re-rating of the shares. However, over the longer term we continue to see limited risk of disintermediation in the core share registry business and the opportunity for EQN to enjoy significant cost savings as blockchain is adopted through its ecosystem. EQN's R&D into blockchain applications seems to be well ahead of BPO peers and this could open up new markets (especially in the private sector) in the longer term.
- **Slowing organic growth the key near-term concern:** The acquisition of WFSS in the US, expected to complete in Q118, represents a major milestone for the company and we continue to regard the deal as a strong diversification platform with significant longer-term cross-selling potential. However, we are cognisant that the likely slowing of group organic growth to a little over flat in FY18 could weigh on the shares. The key drivers of this are the insourcing of a lower-margin element of the NHS pension administration contract and heightened competition in the space more broadly, which is likely to result in high-single-digit £m organic growth declines in FY18, even though divisional profits are likely to be more stable. In addition, after a strong year for high-margin corporate actions, FY18E faces a tough comp.
- **Catalysts and Risks:** EQN is due to report FY17 results on 7th Mar '18. Key upside risks: (1) Greater-than-expected revenue and cost synergies from WFSS; (2) incremental bolt-on M&A; (3) stronger-than-forecast organic revenue momentum in Investment & Intelligent Solutions.
- **Valuation:** EQN materially re-rated in FY17 to c16x FY18E P/E and c10x EV/EBITDA as the US growth opportunity has improved longer-term sustainability of growth. However, we see the rating as vulnerable to mild compression as organic growth momentum deteriorates in the near term.

Share price performance



The price relative chart measures performance against the FTSE 100 IDX which closed at 7723.7 on 08/01/18
On 08/01/18 the spot exchange rate was £.88/Eu 1.-Eu.84/US$1

Performance	1M	3M	12M
Absolute (%)	-9.2	-9.1	50.0
Relative (%)	-13.6	-11.6	43.3

Financial and valuation metrics

Year	12/16A	12/17E	12/18E	12/19E
Revenue (£ m)	382.6	394.2	478.5	505.3
EBITDA (£ m)	92.4	97.4	119.8	128.0
Pre-tax profit adjusted (£ m)	58.80	62.03	79.07	85.89
CS EPS (adj.) (p)	14.71	15.63	17.06	18.19
Prev. EPS (p)	-	-	-	-
ROIC (%)	8.7	9.5	9.1	10.0
P/E (adj.) (x)	18.6	17.5	16.0	15.0
P/E rel. (%)	101.3	114.6	112.0	112.6
EV/EBITDA (x)	13.5	12.8	10.4	9.3
Dividend (12/17E, £)	5.08	Net debt/equity (12/17E,%)		65.2
Dividend yield (12/17E,%)	1.9	Net debt (12/17E, £ m)		249.4
BV/share (12/17E, £)	1.2	IC (12/17E, £ m)		631.6
Free float (%)	96.0	EV/IC (12/17E, (x)		2.0

Source: Company data, Thomson Reuters, Credit Suisse estimates

Equiniti (EQN.L)

Price (08 Jan 2018): **273.50p**; Rating: **UNDERPERFORM**; Target Price: **270.00**; Analyst: **Karl Green**

Income statement (£ m)	12/16A	12/17E	12/18E	12/19E
Revenue	383	394	478	505
EBITDA	**92**	**97**	**120**	**128**
Depr. & amort.	(21)	(23)	(28)	(30)
EBIT	**71**	**75**	**92**	**98**
Net interest exp.	(12)	(13)	(13)	(12)
Associates	-	-	-	-
PBT	**59**	**62**	**79**	**86**
Income taxes	(12)	(12)	(15)	(16)
Profit after tax	**47**	**50**	**64**	**70**
Minorities	(3)	(3)	(3)	(3)
Preferred dividends	-	-	-	-
Associates & other	0	0	0	0
Net profit	**44**	**47**	**61**	**66**
Other NPAT adjustments	0	0	0	0
Reported net income	**44**	**47**	**61**	**66**

Cash flow (£ m)	12/16A	12/17E	12/18E	12/19E
EBIT	71	75	92	98
Net interest	(10)	(9)	(10)	(9)
Cash taxes paid	(2)	(3)	(7)	(8)
Change in working capital	(23)	(3)	(4)	(2)
Other cash and non-cash items	27	23	44	47
Cash flow from operations	**64**	**81**	**116**	**126**
CAPEX	(28)	(28)	(30)	(32)
Free cashflow to the firm	**21**	**38**	**66**	**73**
Acquisitions	(12)	0	(169)	0
Divestments	0	0	0	0
Other investment/(outflows)	(0)	0	0	0
Cash flow from investments	**(40)**	**(28)**	**(199)**	**(32)**
Net share issue/(repurchase)	0	0	122	0
Dividends paid	(7)	(15)	(17)	(20)
Issuance (retirement) of debt	3	1	0	0
Cashflow from financing	**(17)**	**(26)**	**92**	**(33)**
Changes in net cash/debt	(3)	2	1	53
Net debt at start	248	251	249	249
Change in net debt	**3**	**(2)**	**(1)**	**(53)**
Net debt at end	251	249	249	196

Balance sheet (£ m)	12/16A	12/17E	12/18E	12/19E
Assets				
Total current assets	**148**	**150**	**169**	**177**
Total assets	**872**	**851**	**1,055**	**1,034**
Liabilities				
Total current liabilities	**124**	**123**	**138**	**143**
Total liabilities	**470**	**468**	**484**	**438**
Total equity and liabilities	**872**	**851**	**1,055**	**1,034**

Per share	12/16A	12/17E	12/18E	12/19E
No. of shares (wtd avg.) (mn)	300	300	356	364
CS EPS (adj.) (p)	**14.71**	**15.63**	**17.06**	**18.19**
Prev. EPS (p)	**-**	**-**	**-**	**-**
Dividend (p)	**4.75**	**5.08**	**5.44**	**5.82**
Free cash flow per share (p)	6.93	12.50	18.62	20.10

Key ratios and valuation	12/16A	12/17E	12/18E	12/19E
Growth/Margin (%)				
Sales growth (%)	3.7	3.0	21.4	5.6
EBIT growth (%)	14.3	5.0	23.1	6.9
Net income growth (%)	25.0	6.2	29.7	9.0
EPS growth (%)	25.0	6.2	9.2	6.6
EBITDA margin (%)	24.2	24.7	25.0	25.3
EBIT margin (%)	18.6	18.9	19.2	19.4
Pretax profit margin (%)	15.4	15.7	16.5	17.0
Net income margin (%)	11.5	11.9	12.7	13.1

Valuation	12/16A	12/17E	12/18E	12/19E
EV/Sales (x)	3.3	3.2	2.6	2.4
EV/EBITDA (x)	13.5	12.8	10.4	9.3
EV/EBIT (x)	17.6	16.7	13.6	12.2
Dividend yield (%)	1.74	1.86	1.99	2.13
P/E (x)	18.6	17.5	16.0	15.0

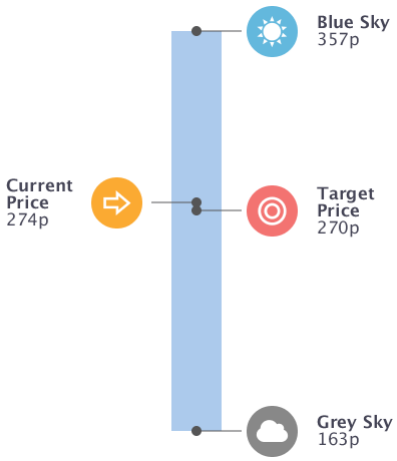
Credit ratios (%)	12/16A	12/17E	12/18E	12/19E
Net debt/equity (%)	62.5	65.2	43.5	32.8
Net debt to EBITDA (x)	2.7	2.6	2.1	1.5
Interest coverage ratio (x)	5.8	6.0	7.2	8.0

Source: FTI, Company data, Thomson Reuters, Credit Suisse Securities (EUROPE) LTD. Estimates

Company Background

Equiniti is a UK-domiciled business focusing on business process outsourcing (BPO) solutions for complex and regulated processes.

Blue/Grey Sky Scenario



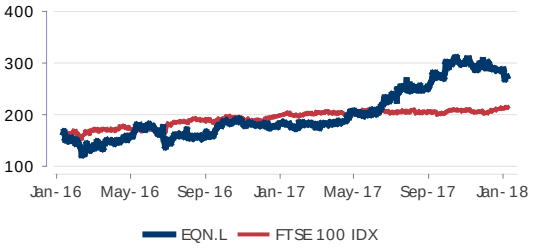
Our Blue Sky Scenario (p) 357.00

(1) Revenue growth 3-4% higher than core in FY18-21E due to better organic performance & M&A; (2) EBITA margin +150bps higher than core by 2021E (at 22.2%); cash tax rate used to calculate EPS rather than notional UK tax rate; (4) 20x sustainable P/E in 2021E, discounted back at WACC.

Our Grey Sky Scenario (p) 163.00

(1) Revenue growth 2% lower in FY18-21E due to weaker organic performance; (2) EBITA margin 150ps lower than core by 2021E (at 17.5%) due to higher IT/software costs; (3) tax rate in line with core assumptions; (4) 14x sustainable P/E in 2021E, discounted back at WACC.

Share price performance



The price relative chart measures performance against the FTSE 100 IDX which closed at 7723.7 on 08/01/18

On 08/01/18 the spot exchange rate was £.88/Eu 1.- Eu.84/US$1

Experian (EXPN.L)

FOCUS LIST STOCK

Blockchain – not a significant near term issue

Rating	**OUTPERFORM**
Price (08 Jan 18, p)	1650.00
Target price (p)	1900.00
Market Cap (£ m)	15,176.8
Enterprise value (£ m)	17,494.8

Target price is for 12 months.

Research Analysts

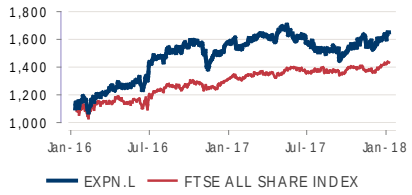
Andy Grobler, CFA
44 20 7883 5943
andy.grobler@credit-suisse.com

Karl Green
44 20 7888 2629
karl.green@credit-suisse.com

Daniel Hobden
44 20 7883 3290
daniel.hobden@credit-suisse.com

- **Bureau:** Credit bureaus play a key role in the current functioning of consumer credit based economies. The collection, analysis and distribution of data across multiple vertical markets enables the risk adjusted flow of credit through the economy. At the core of these businesses are vast databases containing the credit history of hundreds of millions of consumers.
- **Two potential risks:** 1) Following the Equifax breach in September 2017 affecting over 140m consumers worldwide, there were suggestions that the bureaus should be replaced by decentralized blockchain technology. 2) Financial institutions build a shared ledger on a common system that allows these institutions to access a spectrum of data independently of the bureau.
- **Only part of the value proposition:** Credit bureaus offer more than the collection and redistribution of data from financial services. Data series are significantly broader, historical data has tangible value, the analysis and the implementation of analytical systems are important and, potentially most critically, Experian is an objective third-party custodian of data. This has value to both consumers (its objectivity) and potentially to the consortium given data provided to a bureau is not accessible to competitors – in a blockchain register, all information is accessible**.**
- **Our view:** While the development of blockchain could potentially be disruptive both the time scale of creating a unified register with sufficient history to offer a viable alternative to elements of a bureau offering (we estimate 10 years (5 years to create and 5 years to build), plus the value of having regulated third-party entities at the heart of the credit economy, suggests to us that the existing approach will be maintained. The risks have, however, risen following the Equifax breach which highlighted the vulnerability of mass centralized databases. If there were to be another breach in one of the other major bureaus (eg, Experian or Transunion) this could encourage greater effort/investment into blockchain-backed alternatives.

Share price performance



The price relative chart measures performance against the FTSE ALL SHARE INDEX which closed at 4232.0 on 08/01/18
On 08/01/18 the spot exchange rate was £.88/Eu 1.-Eu.84/US$1

Performance	1M	3M	12M
Absolute (%)	6.7	6.8	5.8
Relative (%)	2.8	4.2	-2.0

Financial and valuation metrics

Year	3/17A	3/18E	3/19E	3/20E
Revenue (US$ m)	4,335.0	4,613.7	4,971.9	5,268.9
EBITDA (US$ m)	1,510.6	1,624.6	1,771.1	1,899.3
Pre-tax profit adjusted (US$ m)	1,113.60	1,191.16	1,297.23	1,384.20
CS EPS (adj.) (US$)	0.87	0.96	1.07	1.17
Prev. EPS (US$)	-	-	-	-
ROIC (%)	14.6	15.5	17.1	18.5
P/E (adj.) (x)	25.6	23.4	21.0	19.2
P/E rel. (%)	139.7	153.5	146.7	143.9
EV/EBITDA (x)	15.7	14.6	13.4	12.4

Dividend (03/18E, US$)	0.44	Net debt/equity (03/18E,%)	121.0
Dividend yield (03/18E,%)	1.9	Net debt (03/18E, US$ m)	3,116.7
BV/share (03/18E, US$)	2.8	IC (03/18E, US$ m)	5,692.3
Free float (%)	100.0	EV/IC (03/18E, (x)	4.2

Source: Company data, Thomson Reuters, Credit Suisse estimates

Experian (EXPN.L)

Price (08 Jan 2018): **1650.00p**; Rating: **OUTPERFORM**; Target Price: **1900.00**; Analyst: **Andrew Grobler**

Income statement (US$ m)	3/17A	3/18E	3/19E	3/20E
Revenue	4,335	4,614	4,972	5,269
EBITDA	**1,511**	**1,625**	**1,771**	**1,899**
Depr. & amort.	(426)	(483)	(524)	(565)
EBIT	**1,085**	**1,141**	**1,248**	**1,334**
Net interest exp.	(75)	(85)	(85)	(85)
Associates	0	5	5	5
PBT	**1,114**	**1,191**	**1,297**	**1,384**
Income taxes	(259)	(268)	(292)	(314)
Profit after tax	**855**	**923**	**1,005**	**1,071**
Minorities	1	(0)	(0)	(0)
Preferred dividends	-	-	-	-
Associates & other	(35)	(47)	(52)	(53)
Net profit	**821**	**875**	**953**	**1,017**
Other NPAT adjustments	(18)	(71)	(78)	(77)
Reported net income	**803**	**805**	**875**	**941**

Cash flow (US$ m)	3/17A	3/18E	3/19E	3/20E
EBIT	1,085	1,141	1,248	1,334
Net interest	(70)	(82)	(82)	(82)
Cash taxes paid	(144)	(171)	(225)	(267)
Change in working capital	(39)	(111)	(65)	(59)
Other cash and non-cash items	513	554	595	636
Cash flow from operations	**1,345**	**1,332**	**1,470**	**1,562**
CAPEX	(399)	(438)	(472)	(501)
Free cashflow to the firm	**946**	**893**	**998**	**1,062**
Acquisitions	(410)	(210)	0	0
Divestments	11	200	0	0
Other investment/(outflows)	21	0	0	0
Cash flow from investments	**(777)**	**(448)**	**(472)**	**(501)**
Net share issue/(repurchase)	(365)	(547)	(545)	(599)
Dividends paid	(383)	(392)	(400)	(435)
Issuance (retirement) of debt	(76)	156	0	0
Cashflow from financing	**(826)**	**(782)**	**(945)**	**(1,034)**
Changes in net cash/debt	(29)	(54)	53	28
Net debt at start	3,034	3,063	3,117	3,063
Change in net debt	**29**	**54**	**(53)**	**(28)**
Net debt at end	3,063	3,117	3,063	3,036

Balance sheet (US$ m)	3/17A	3/18E	3/19E	3/20E
Assets				
Total current assets	**1,397**	**1,229**	**1,404**	**1,516**
Total assets	**7,691**	**7,846**	**7,970**	**8,017**
Liabilities				
Total current liabilities	**2,141**	**2,119**	**2,176**	**2,201**
Total liabilities	**5,040**	**5,270**	**5,395**	**5,466**
Total equity and liabilities	**7,691**	**7,846**	**7,970**	**8,017**

Per share	3/17A	3/18E	3/19E	3/20E
No. of shares (wtd avg.) (mn)	940	917	895	873
CS EPS (adj.) (US$)	**0.87**	**0.96**	**1.07**	**1.17**
Prev. EPS (US$)	**-**	**-**	**-**	**-**
Dividend (US$)	**0.42**	**0.44**	**0.48**	**0.52**
Free cash flow per share (US$)	1.01	0.97	1.12	1.22

Key ratios and valuation	3/17A	3/18E	3/19E	3/20E
Growth/Margin (%)				
Sales growth (%)	(3.1)	6.4	7.8	6.0
EBIT growth (%)	1.4	5.2	9.3	6.9
Net income growth (%)	(1.5)	6.7	8.9	6.7
EPS growth (%)	0.4	9.4	11.6	9.3
EBITDA margin (%)	34.8	35.2	35.6	36.0
EBIT margin (%)	25.0	24.7	25.1	25.3
Pretax profit margin (%)	25.7	25.8	26.1	26.3
Net income margin (%)	18.9	19.0	19.2	19.3

Valuation	3/17A	3/18E	3/19E	3/20E
EV/Sales (x)	5.5	5.1	4.8	4.5
EV/EBITDA (x)	15.7	14.6	13.4	12.4
EV/EBIT (x)	21.8	20.8	19.0	17.7
Dividend yield (%)	1.85	1.94	2.14	2.32
P/E (x)	25.6	23.4	21.0	19.2

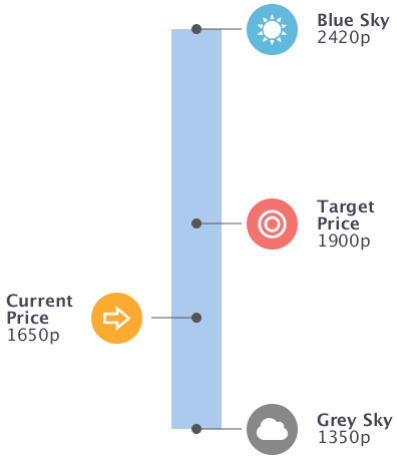
Credit ratios (%)	3/17A	3/18E	3/19E	3/20E
Net debt/equity (%)	115.5	121.0	119.0	119.0
Net debt to EBITDA (x)	2.0	1.9	1.7	1.6
Interest coverage ratio (x)	14.5	13.4	14.6	15.7

Source: FTI, Company data, Thomson Reuters, Credit Suisse Securities (EUROPE) LTD. Estimates

Company Background

Experian plc is an information services company. They provide data & analytical tools to a range of organizations & consumers across the world. Clients use these to manage credit risk, prevent fraud, target marketing offers & automate decision making

Blue/Grey Sky Scenario



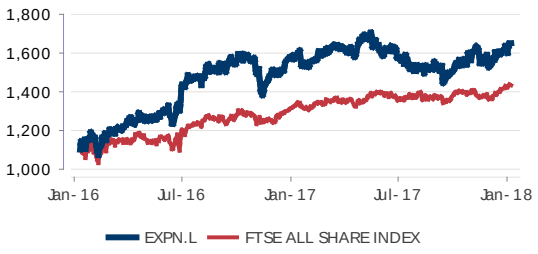
Our Blue Sky Scenario (p) 2420.00

We assume 1) a faster recovery in the US consumer division 2) structural drivers in Latam drive growth 3) the adoption of positive data in Brazil drives incremental growth and margin accretion 4) health continues to grow at mid-double digit levels. We value at average relative PE

Our Grey Sky Scenario (p) 1350.00

We assume 1) the US consumer division faces structural headwinds as competition grows and revenues decline year on year 2) structural drivers in Latam does not offset cyclical weakness and 4) health slows to high single digit 5) credit conditions in the US weaken. We value it at a 10% premium to the market

Share price performance



The price relative chart measures performance against the FTSE ALL SHARE INDEX which closed at 4232.0 on 08/01/18
On 08/01/18 the spot exchange rate was £.88/Eu 1.- Eu.84/US$1

Travel & Leisure

Casinos and gaming stand to benefit

Research Analysts

Tal Grant, CFA
44 20 7883 4910
tal.grant@credit-suisse.com

Tim Ramskill, CFA
44 20 7883 7361
tim.ramskill@credit-suisse.com

Julia Pennington
44 20 7888 0157
julia.pennington@credit-suisse.com

We largely view blockchain technology and cryptocurrencies as a way of driving increased adoption of online gambling, rather than as representing a significant threat to incumbent players.

We list four key reasons why entrepreneurs have found the world of gaming to be such fertile soil for the implementation of blockchain technology. We believe the first three reasons will appeal to users who would not be the primary targets of the companies under our coverage: i.e. users who do not currently participate in online gambling due to a lack of anonymity, high fees, or regulatory uncertainty.

The application of smart contracts to online gambling (the fourth reason we list) could represent a risk to incumbent technology platforms, but we do not believe that either a) trust in online gaming companies under our coverage is sufficiently low or b) consumers are sufficiently savvy for smart contracts to be a game changer.

1. **Anonymity** – Demand for anonymous gambling is evident in the relatively high usage of pre-paid cards – such as the *paysafecard* – on gambling websites and in consumer behaviour surveys. Gambling with cryptocurrencies – as opposed to fiat money – can currently be conducted without the need to provide identification documents, or in some cases, without the need to create an account.
2. **Lower transaction costs** – As well as anonymity, the existing infrastructure of blockchain networks offers users the opportunity to carry out (near-instant) deposits and withdrawals at very low transaction costs. In more sensitive regulatory environments, this can be a key driver of adoption. For example, one current ICO seeks to provide a method to reduce transaction costs in the credit junket business in Macau.
3. **Regulatory uncertainty** – Cryptocurrencies are not recognized as legal currency by many countries and most jurisdictions do not have explicit regulation either approving or banning casinos built on blockchain technology. As such, many online forums appear to consider bitcoin casinos in the US (a black market for online gaming outside of the few states in which it is regulated) as “grey”, driving adoption.
4. **'Provably fair'** – Existing online casino games are largely executed on private servers using black box codes and require a level of trust to be built between player and casino operator. Smart contracts, however, are fully decentralized and in theory 'provably fair', giving the player total insight into the code that determined her bet’s success or failure.

Playtech (PTEC.L)

Rating	**OUTPERFORM**
Price (08 Jan 18, p)	875.00
Target price (p)	980.00
Market Cap (£ m)	2,776.8
Enterprise value (£ m)	2,773.4

Target price is for 12 months.

Research Analysts

Tal Grant, CFA
44 20 7883 4910
tal.grant@credit-suisse.com

Tim Ramskill, CFA
44 20 7883 7361
tim.ramskill@credit-suisse.com

Julia Pennington
44 20 7888 0157
julia.pennington@credit-suisse.com

Best placed in Gaming sub-sector to benefit from blockchain technology and cryptocurrency interest

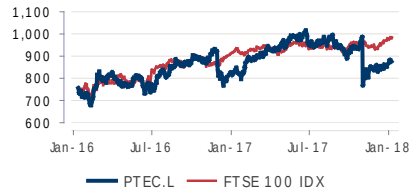
- **As far as we are aware, Playtech is the only listed European gaming company making money out of blockchain technology and cryptocurrencies.** It does this in two ways:

  (1) **Markets.com (c5% of sales)** – Playtech's B2C Contracts for Difference (CFD) trading website – allows users to trade the spreads on 11 different cryptocurrency pairs (thus Playtech benefits not from its own usage of blockchain technology but from the success of and interest in cryptocurrencies). Competitor (and Playtech equity investment) Plus500 highlighted trading in cryptocurrencies as driving its outperformance relative to market expectations in 2017, in a trading update released on 3rd January 2018; and

  (2) Playtech's bread and butter business is to supply casino gaming content to gaming operators. None of its content is built on blockchain, as far as we are aware, but it **supplies to casinos which accept cryptocurrencies**. For example, Playtech's Quickspin supplies to bitcoin casino Megadice.com.

- **Investment Overview:** Playtech is a top-quality provider of gaming software, holding long-term contracts with its largest customers. We see the possibility for double digit earnings growth to 2020E, likely bolstered by M&A and new contract announcements.
- **Catalysts and Risks:** We expect Playtech to report H2 17 results in February 2018. The key risk to our thesis is a change in the Chinese regulatory landscape. We addressed this risk in a recent report, *Asian channel checks come back OK* (5 December).
- **Valuation:** Our 980p price target is based on a sum-of-the-parts model. Playtech currently trades at c12.6x P/E (on 12-month forward consensus expectations), a 12% discount to its five-year average.

Share price performance



The price relative chart measures performance against the FTSE 100 IDX which closed at 7723.7 on 08/01/18
On 08/01/18 the spot exchange rate was £.88/Eu 1.-Eu.84/US$1

Performance	1M	3M	12M
Absolute (%)	4.9	-6.3	5.6
Relative (%)	0.4	-8.8	-1.1

Financial and valuation metrics

Year	12/16A	12/17E	12/18E	12/19E
Revenue (€ m)	708.6	827.8	886.1	933.1
EBITDA (€ m)	302.2	318.9	342.4	366.6
Pre-tax profit adjusted (€ m)	213.52	253.78	286.12	308.68
CS EPS (adj.) (€)	0.60	0.70	0.78	0.84
Prev. EPS (€)	-	-	-	-
ROIC (%)	23.8	18.9	19.5	19.5
P/E (adj.) (x)	16.6	14.2	12.7	11.9
P/E rel. (%)	90.4	92.9	88.8	89.0
EV/EBITDA (x)	10.2	9.9	8.9	7.4

Dividend (12/17E, €)	0.38	Net debt/equity (12/17E,%)	-0.3
Dividend yield (12/17E,%)	3.9	Net debt (12/17E, € m)	-3.9
BV/share (12/17E, €)	4.2	IC (12/17E, € m)	1,332.3
Free float (%)	90.8	EV/IC (12/17E, (x)	2.4

Source: Company data, Thomson Reuters, Credit Suisse estimates

Playtech (PTEC.L)

Price (08 Jan 2018): **875.00p**; Rating: **OUTPERFORM**; Target Price: **980.00**; Analyst: **Tal Grant**

Income statement (€ m)	12/16A	12/17E	12/18E	12/19E
Revenue	709	828	886	933
EBITDA	**302**	**319**	**342**	**367**
Depr. & amort.	(51)	(55)	(60)	(63)
EBIT	**251**	**264**	**283**	**304**
Net interest exp.	(37)	(10)	3	4
Associates	-	-	-	-
PBT	**214**	**254**	**286**	**309**
Income taxes	(6)	(9)	(11)	(14)
Profit after tax	**207**	**245**	**275**	**295**
Minorities	(1)	(3)	(3)	(4)
Preferred dividends	-	-	-	-
Associates & other	0	0	0	0
Net profit	**206**	**242**	**271**	**291**
Other NPAT adjustments	(13)	(53)	(52)	(52)
Reported net income	**193**	**190**	**219**	**239**

Cash flow (€ m)	12/16A	12/17E	12/18E	12/19E
EBIT	251	264	283	304
Net interest	(5)	(3)	2	3
Cash taxes paid	(10)	(9)	(11)	(14)
Change in working capital	61	(13)	(14)	(15)
Other cash and non-cash items	(51)	55	60	63
Cash flow from operations	**247**	**294**	**319**	**341**
CAPEX	(78)	(88)	(90)	(91)
Free cashflow to the firm	**169**	**206**	**229**	**250**
Acquisitions	-	-	-	-
Divestments	-	-	-	-
Other investment/(outflows)	(186)	26	(4)	(46)
Cash flow from investments	**(264)**	**(61)**	**(94)**	**(137)**
Net share issue/(repurchase)	-	-	-	-
Dividends paid	(246)	(112)	(128)	(140)
Issuance (retirement) of debt	-	-	-	-
Cashflow from financing	**(295)**	**(307)**	**(128)**	**(140)**
Changes in net cash/debt	(323)	(75)	97	330
Net debt at start	(401)	(79)	(4)	(101)
Change in net debt	**323**	**75**	**(97)**	**(330)**
Net debt at end	(79)	(4)	(101)	(431)

Balance sheet (€ m)	12/16A	12/17E	12/18E	12/19E
Assets				
Total current assets	**693**	**631**	**745**	**824**
Total assets	**2,076**	**1,979**	**2,129**	**2,243**
Liabilities				
Total current liabilities	**260**	**65**	**68**	**70**
Total liabilities	**977**	**642**	**646**	**339**
Total equity and liabilities	**2,076**	**1,979**	**2,129**	**2,243**

Per share	12/16A	12/17E	12/18E	12/19E
No. of shares (wtd avg.) (mn)	348	349	350	351
CS EPS (adj.) (€)	**0.60**	**0.70**	**0.78**	**0.84**
Prev. EPS (€)	**-**	**-**	**-**	**-**
Dividend (€)	**0.33**	**0.38**	**0.43**	**0.44**
Free cash flow per share (€)	0.49	0.59	0.66	0.71

Key ratios and valuation	12/16A	12/17E	12/18E	12/19E
Growth/Margin (%)				
Sales growth (%)	12.5	16.8	7.0	5.3
EBIT growth (%)	20.7	4.9	7.3	7.4
Net income growth (%)	0.2	17.5	12.0	7.3
EPS growth (%)	(2.6)	17.0	11.6	7.0
EBITDA margin (%)	42.7	38.5	38.6	39.3
EBIT margin (%)	35.5	31.8	31.9	32.6
Pretax profit margin (%)	30.1	30.7	32.3	33.1
Net income margin (%)	29.1	29.3	30.6	31.2

Valuation	12/16A	12/17E	12/18E	12/19E
EV/Sales (x)	4.3	3.8	3.4	2.9
EV/EBITDA (x)	10.2	9.9	8.9	7.4
EV/EBIT (x)	12.2	11.9	10.8	8.9
Dividend yield (%)	3.30	3.86	4.31	4.39
P/E (x)	16.6	14.2	12.7	11.9

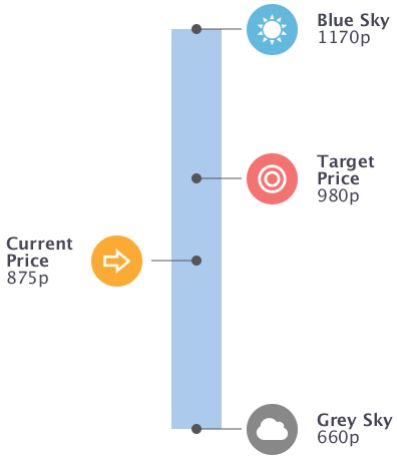
Credit ratios (%)	12/16A	12/17E	12/18E	12/19E
Net debt/equity (%)	(7.1)	(0.3)	(6.8)	(22.6)
Net debt to EBITDA (x)	(0.3)	(0.0)	(0.3)	(1.2)
Interest coverage ratio (x)	6.8	27.1	(99.3)	(79.0)

Source: FTI, Company data, Thomson Reuters, Credit Suisse Securities (EUROPE) LTD. Estimates

Company Background

Playtech is a software supplier to the gambling industry. Founded in 1999, the company derives c40% of its revenue from operators licensed in the Philippines and c30% from UK-based operators. It also has a small CFD trading business (c5% of profits).

Blue/Grey Sky Scenario



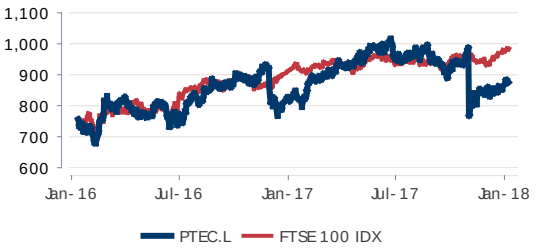
Our Blue Sky Scenario (p) 1170.00

In our Blue Sky scenario, we assume: (1) Malaysian revenue returns to a normalised level by the start of 2018E (c€40m revenue); (2) New large live casino customer and medium-sized sports-betting customer (c€10-20m revenue); (3) Outperformance of existing licencees versus our assumptions (c€10-20m revenue).

Our Grey Sky Scenario (p) 660.00

Our Grey Sky price is driven by our assumption of a closure of the Chinese market at the start of 2018E. In our Grey Sky scenario, we assume: (1) All profits derived from end-consumers playing in China coming to an end on 1st January 2018E; (2) Half of UK land-based revenue disappearing in 2018E on the back of regulatory changes to B2 gaming machines.

Share price performance



The price relative chart measures performance against the FTSE 100 IDX which closed at 7723.7 on 08/01/18

On 08/01/18 the spot exchange rate was £.88/Eu 1.- Eu.84/US$1

Housing

Research Analysts

Susan Maklari
212 325 3134
susan.maklari@credit-suisse.com

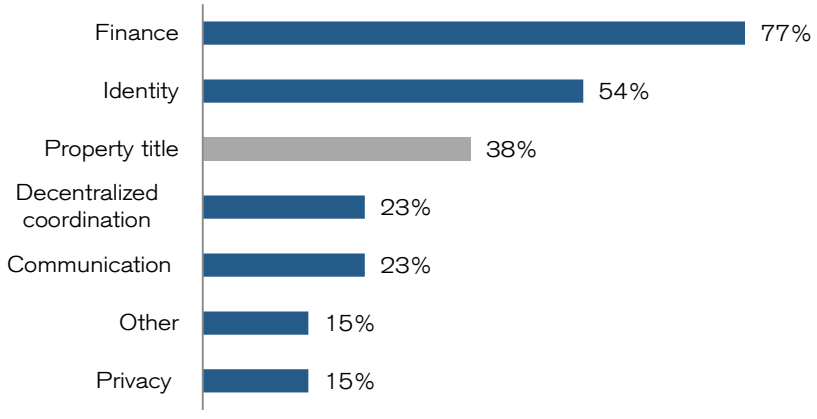
Christopher Kalata
212 325 6654
christopher.kalata@credit-suisse.com

Amanda Luper
212 325 2690
amanda.luper@credit-suisse.com

Blockchain a real estate game-changer

- **What's the Next Frontier? A Primer on Developing Technologies:** Blockchain technology continues to evolve and is becoming a greater focus for governments and companies including those in residential and non-residential real estate. Among the areas this development could revolutionize are: 1) property ownership, 2) increased transparency (including asset prices), and 3) the rising use of smart contracts. Given its ability to reduce costs, remove information asymmetry and increase operational efficiency, we seek to define and better understand what it could mean for the industry. Although we acknowledge that blockchain won't change the course of near-term events, we believe it will play a greater role over time.
- **Real Estate and Blockchain—What Makes them a Good Fit:** Among the ways this technology differs from legacy processes is that it is tamper resistant and based on peer-to-peer connections. This, in turn, makes it especially impactful in areas where trust is paramount and deals are more complex and expensive as a result of the number of individuals involved in a given transaction. Over time, blockchain could streamline the purchase and sale of land and buildings as it eliminates human error, prevents data loss, and modernizes an otherwise slow-moving industry. Areas we expect could benefit from its advent include: title registry, land pricing, mortgage payments, and escrow processes.
- **Starting to Put the Blocks in Place:** This report provides investors with an overview of this technology and its ability to transform the real estate sector. We believe it captures the most salient points of the broader blockchain discussion and will help frame the potential impacts it can have.
- **Credit Suisse Real Estate Blockchain Seminar:** With this backdrop, we will be hosting a seminar on January 16th on the topic in conjunction with MIT's Center for Real Estate. The event will take place at our New York office at 11 Madison Avenue. Discussions will include: 1) an analysis of blockchain fundamentals, 2) current issues and inefficiencies in property titles, 3) government and legal issues associated with distributed ledger innovation, and 4) new start-up players in tokens and smart contracts.

Figure 62: Blockchain Thought Leaders' Expectations for Impact - 2016

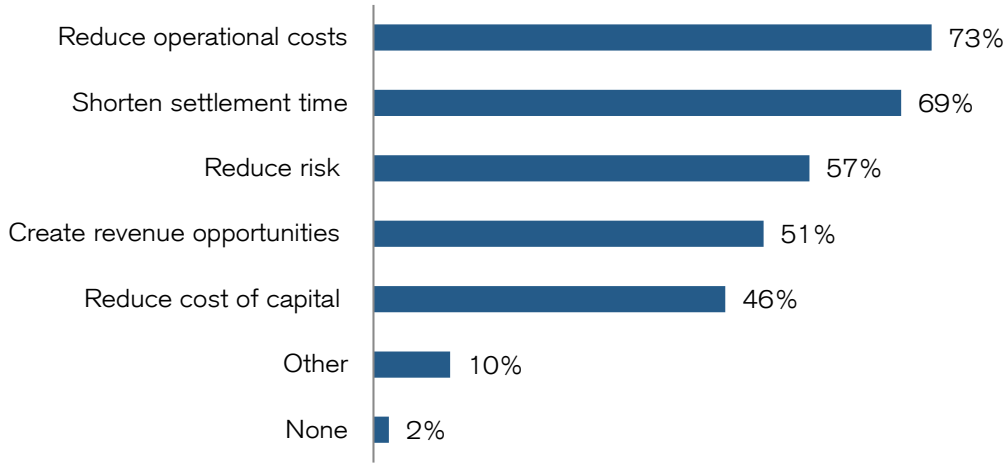


Source: Coindesk – 2016 Bitcoin and Blockchain Thought Leaders Annual Survey, Credit Suisse research

Blockchain and Real Estate

Applying these factors to real estate—an industry that has undergone relatively little change to date—suggests significant new ways of operating could be on the horizon. Although we readily acknowledge that this won't change the course of near-term events (and adaptions within residential construction are likely to come even later), we believe blockchain will play a greater role over time. Our view is formed by the need for businesses to adjust for higher land and input costs as well as to adapt to secular shifts in the construction labor force, notably in specialized trades where an aging workforce is most apparent.

Figure 63: Main Benefits of Blockchain Technology



Source: Greenwich Associates 2016 Blockchain Adoption Study, Credit Suisse research

With this backdrop, researchers at MIT's Center for Real Estate have identified several ways blockchain is poised to revolutionize real estate:

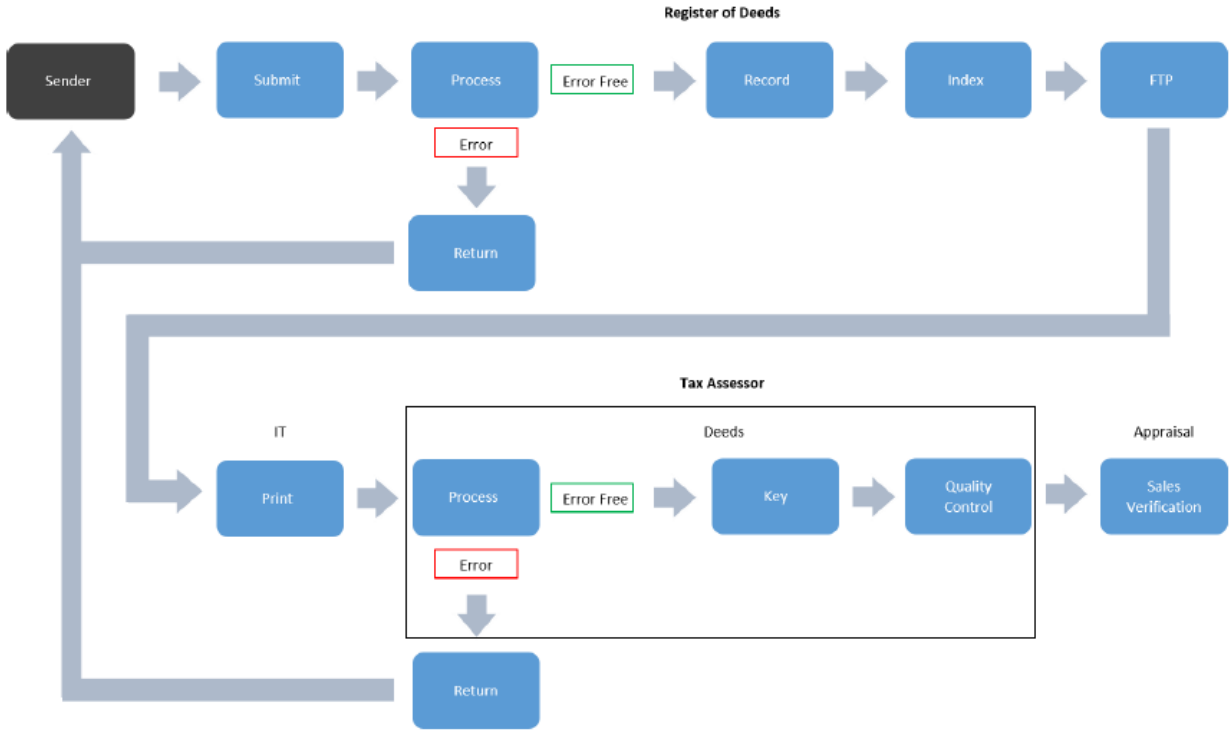
- **Property ownership**—Data can be easily discovered and verified, helping to eliminate information asymmetry. It can also provide greater assurance around transfers, deeds, and liens and removes the need for redundant databases.
- **Increased transparency**—We view this as one of the most important changes, as this technology can break through today's very opaque markets. In turn, asset prices—including land—as well as title registrars can become clearer, resulting in smoother and more trustworthy transactions.
- **Smart contracts**—Allows for the elimination of contractual clauses by facilitating, verifying and enforcing performance of agreed upon actions. In turn, things like escrow processes can be automated, reducing costs, time and risk, while also providing greater assurance. Put differently, these can be considered "if-then" type situations, with an action automatically taken once certain conditions are met and recorded in the blockchain. Certain obligations are easily replicable, meaning possible uses could be extended, in time, to things like mortgage payments.

Applications are on the Rise

Given the potential benefits, in September 2016 the Illinois Office of the Cook County Recorder of Deeds (CCRD) along with several partners (including the International Blockchain Real Estate Association) announced a pilot program to better understand how it could implement blockchain technology into current law and practice. More specifically, it was designed to study how the department could address problems and inefficiencies related to property records, such as:

- **Complexity of transactions**—The acquisition of a commercial or residential real estate title requires the involvement of a buyer, seller, lawyer for each party, appraiser, lender and counsel, and title insurer. Following the housing market crash in 2008-2009, the federal government enacted additional regulations intended to protect consumers prior to closing but which also increase a purchasers' dependency on experts to sift through the complexities. As such, the high cost of title insurance premiums reflects the number of employees involved in the process rather than actuarial risk.
- **Human error**—Recording and indexing transactions at the CCRD requires manual employee labor, specifically the examination and retyping of information found on a scanned image. Mistakes in this process, or in the original submission, can render a document, which represents a valid claim to property, useless and impossible to search for in the public record.
- **Loss of data**—Not all Recorder of Deeds Offices possess the resources to back up their databases. Fires, natural disasters and direct database failures can cause the loss of entire recorded title claim histories. Further, as cyberattacks grow in number and severity, the real estate sector faces mounting security pressures. Altered or stolen records could potentially erode trust in the government system.
- **Technological stagnancy**—Many counties across the country still operate on a paper-only recording system. The most advanced offices have adopted a hybrid system that combines handwritten material and paper documents with image scanning and typing of information. These operating models are often inefficient and have failed to keep pace with modern times.

Figure 64: Sample Current Workflow for Recording Titles at a Recorder of Deeds Office



Source: Avi Spielman - "Blockchain: Digitally Rebuilding the Real Estate Industry"

Although it remains early, the CCRD has been able to successfully use elements of this technology to streamline the property records system and will continue to work to implement it into a new land records system being put in place. Blockchain forms a secure and immutable transaction history on a decentralized database, allowing for disaster recovery and eliminating human error through transaction consensus.

Other cities and states, including those with top 20 housing markets, are also in various stages of passing, implementing, or studying blockchain laws. Among them are:

- **Arizona**—In March, the governor signed a ground-breaking bill (HB 2417) aimed at clarifying some of the enforceability issues associated with blockchain and smart contracts, especially as it relates to the sale or transfer of goods, leases, and some documents of title. Said differently, it establishes blockchain as a usable format for smart contacts. The legislation allows local municipalities to use this technology in place of conventional methods for recording property ownership and sales.
- **Nevada**—Similar to Arizona, this state passed a law in June recognizing blockchain technology as a type of electronic record.
- **Vermont**—The state enacted a law last year allowing for the authentication of a blockchain real-estate transaction. Local towns are now exploring ways to incorporate this into their operations.

Other states are also doing work on the subject in a range of areas and ways. In turn, this could place the traditionally slow-moving real estate industry at the forefront of innovation and efficiency.

CS & MIT Real Estate Blockchain Seminar

On January 16, we will be hosting a half-day Real Estate Blockchain Seminar along with MIT's Center for Real Estate at our New York office at 11 Madison Avenue, providing insights to the practical applications of this technology. Our line-up includes practitioners, innovators and thought leaders:

- **Avi Spielman**—Mr. Spielman is an author and frequent lecturer specializing in the evolution of blockchain technologies and their applications for the real estate industry, including the white paper Blockchain: Digitally Rebuilding the Real Estate Industry. He also serves as an advisor to Ubitquity LLC., the first blockchain platform intended for real estate recordkeeping. Currently, he oversees development and property management interests in middle Tennessee as the Founder of Joon Properties. He holds a bachelor's in Philosophy from Vanderbilt University and a Master's of Science in Real Estate Development from the Massachusetts Institute of Technology.
- **Sandy Selman**—Mr. Selman is the co-founder of CryptoProperties LLC (CPROP) which has a stated long-term of goal of using blockchain to end transactional inefficiencies, improve the title documentation process, and reduce risks associated with inaccurate or fraudulent mortgage related documents. In addition, he is the co-founder and CEO of Sanus Connect Inc. which uses disruptive cloud-based technology to enhance the operating efficiency of large, multi-tenant properties. He holds a bachelor's in Mechanical Engineering from Worcester Polytechnic Institute and an MBA in Finance & Investments from The George Washington University.
- **Lewis Cohen**—A Partner at Hogan Lovells LLP, Mr. Cohen concentrates on International Structured Finance as well as disruptive technologies including blockchain, distributed ledgers, smart contracts and cryptocurrencies. He provides unique insights on the legal issues domestic and foreign government's stand to face as blockchain is more widely adopted. Mr. Cohen holds a bachelor's in Philosophy from Clark University and a JD from the Cardozo School of Law.
- **Drew Hinkes**—Mr. Hinkes is a Partner at Berger Singerman on the Dispute Resolution Team, an adjunct Professor at New York University, and a cited authority on Virtual Currency issues. He has written more than 20 articles on blockchain and associated technologies, including Blockchain and Title: The Distant Frontier for the American Land Title Association. He is also a member of Blockchain Beach, a non-profit focused on cultivating entrepreneurial attention to bitcoin and blockchain. He holds a degree in History from Washington University in St. Louis and a JD from the University of Miami.
- **Steve Weikal**—As the Head of Industry Relations at the MIT Center for Real Estate, Mr. Weikal is responsible for managing relationships between the Center and its network of industry partners and nearly 1100 alumni across 43 countries. He is a lecturer and researcher on innovative real estate technology as well as the founder of MIT Real Disruption, a series of conferences discussing the impact of emerging technology on the industry. He holds a Master's of Science in Real Estate Development and a Master's in City Planning from MIT, along with a JD from Suffolk University. Mr. Weikal is a licensed attorney and real estate broker as well as an advisory board member of three real estate tech start-ups.
- **Emmanuel Aidoo**—As a Director in the Global Markets Division at Credit Suisse, Mr. Aidoo leads the Blockchain and Distributed Ledger Practice. In his 18 years of experience at the bank, Mr. Aidoo has established himself as an intrapreneur capable of building a variety of complex platforms. His prior roles include Global Head of Debt Capital Markets Technology, Global Head of Leverage Finance Technology and Global Head of Fixed Income Solutions Delivery. He holds a Computer Science degree from Brunel University in London.

ConsenSys Interview

Insights from a leading blockchain venture production studio

Research Analysts

Brad Zelnick
212 325-6118
brad.zelnick@credit-suisse.com

Kevin Ma
212 325 2694
kevin.ma@credit-suisse.com

Syed Talha Saleem, CFA
212 538 1428
syedtalha.saleem.2@credit-suisse.com

Figure 65: ConsenSys Company and Experts Profile

Griffin Anderson, Founder, Balanc3
Maxwell Stein, Blockchain Business Architect

CONSENSYS

What is ConsenSys?

ConsenSys is the world's largest blockchain venture production studio, consisting of 450+ blockchain experts, entrepreneurs, computer scientists, designers, engineers, consultants, and business leaders with delivery experience across 5 continents. ConsenSys builds decentralized applications and infrastructure tools and provides enterprise consulting and educational resources in addition to maintaining a venture investment arm focusing on the emerging Blockchain ecosystem.

Who are the Experts?

Griffin Anderson is an entrepreneur and founder of several startups, and he spent the last five years building, designing, and growing fintech and social media companies. At ConsenSys, Griffin architects and develops accounting and financial applications utilizing the blockchain.

Maxwell Stein first started work with ConsenSys in the summer of 2016, where he worked with the enterprise delivery teams and helped launch the Accounting Blockchain Coalition. Today, Maxwell leads business development for the Balanc3 blockchain accounting spoke and serves as an advisor to various decentralized applications and crypto funds.

Source: Company data

ConsenSys is a venture production studio building decentralized applications and various developer and end-user tools for Blockchain ecosystems—primarily Ethereum. We conducted an interview over phone and email in November with two experts from ConsenSys regarding their projects and recent developments in Ethereum and blockchain in general:

Q: A debate rages (often between bitcoin maximalists and the rest) as to whether one protocol will eventually have primacy over others. Structurally, do you believe it makes sense for 'one chain to rule them all'? If you do, which protocol today has the best chance of becoming that standard, and why (technical, scale or perhaps other advantages)?

A: Critical to the success of a blockchain protocol is the ecosystem built on top of it, and the size of its community. Ethereum has incredible momentum and a quickly growing network, however, it remains an evolving project that does face multiple challenges. Ethereum is in agile development with many protocol enhancements on the roadmap. As more advances in the technology are discovered (perhaps from alternative new blockchain protocols) they can be effectively implemented into Ethereum.

In the development of new blockchains, a focus on interoperability with existing chains will maximize adoption and interactivity. Structurally it makes sense to ensure seamless cryptographic data migration between protocols. While the blockchain with the largest community will likely dominate, side chains for niche purposes and specific use cases will add value to the broader ecosystems.

Q: Scalability and identity are problems that seem unsolved but represent some of the largest barriers to the more widespread application of Blockchain protocols. Do you agree these are the key impediments? If not, what are? Do you have a view as to the timeframe to solve them?

A: Scalability is a barrier for certain types of adoption. There are many ongoing research and development initiatives in the Ethereum ecosystem which are attempting to address scalability through proof of stake and sharding. Outside of the Ethereum ecosystem, there are many alternative blockchain protocols that are also experimenting with innovative solutions that could also be shared across blockchains. Even before these solutions are integrated, it takes around 10 minutes to transfer and confirm the transfer of digital tokens on a decentralized exchange. Besides the stock market, there are many legacy financial transfers like corporate bonds, private equity and real estate that take hours—or even days or years—to transfer.

Identity is a significant barrier to the existing financial system and offers an incredible opportunity to leverage blockchain as a solution. It could also advance the mainstream adoption of blockchain technology. The billions of people lacking an official identity and the incredibly inefficient AML and KYC process just scrape the surface of areas where blockchain identity platforms can revolutionize worldwide identity problems. ConsenSys's largest development team of 30 is working on an application called uPort, a self-sovereign identity platform.

Q: The WEF has famously predicted that 10% of global GDP will be stored on blockchain protocols by 2025. The explosion in the value of crypto assets has certainly brought this closer, but the question remains how long do you believe it will take before blockchain technology becomes truly mainstream? (Defined as disrupting traditional consumer/enterprise practices on a widespread scale.)

A: There are a lot of variables that will need to align for that blockchain technology to become truly mainstream so it's very difficult to speculate. However, the market cap of digital assets is on its way to approaching 1% of global GDP, which may be a more challenging accomplishment than reaching 10%.

Q: Some say we already know what the 'killer app' for blockchain is, others say it is yet to emerge. Upon which side of this debate do you fall and why? What do you think the 'killer app' is likely going to be (or already is) for Enterprise, and for Consumer?

A: Initially, the killer app for blockchains was a decentralized peer to peer payments platform. Going forward I think real world asset and infrastructure tokenization will become more widespread as blockchain offers clear economic efficiencies. the "killer app" may be the solution that bridges the gap between physical, or off-chain assets, and scarce digital representations of them.

Q: It has been argued that compared to the internet protocol, Blockchain creates greater value at the protocol level, as opposed to application level (to which the majority of the internet's value accrued, see here (http://www.usv.com/blog/fat-protocols)). Do you believe this reversed relationship between protocols and applications can sustain? Or does it commoditize at some point?

A: The value of a protocol is very connected to the size of the community and ecosystem built on top of it. As a public protocol can always be forked and altered, in the long run, the cost will be driven down if founders impose fees that are above normal profit. Traditional methods of value extraction will need to be innovated in the blockchain space.

Q: Can you introduce us to ConsenSys, perhaps take us through the history of your founding, what problems you are setting out to solve and how are you structured to achieve your goals?

A: ConsenSys was founded by Joe Lubin who was a co-founder of Ethereum. After working with the Ethereum Foundation, he decided to leave and start ConSensys in order to prove the huge range of use cases for Ethereum, proliferate the Ethereum ecosystem. In order to accomplish this goal, we are working on 30+ blockchain applications, infrastructure/ developer tools, Fortune 100 enterprise consulting, education, capital management, as well as spearheading trade organizations such as the Enterprise Ethereum Alliance (EEA), and the Accounting Blockchain Coalition (ABC).

Q: Are there any metrics or soft data points you can share with us, perhaps some customer examples, so we can get a quantitative or qualitative perspective of your success so far?

A: ConsenSys has grown to nearly 500 employees across 5 continents, with offices in Brooklyn, San Francisco, Toronto, Washington, London, and Dubai.

Consensys has over 30+ Blockchain applications in development across every industry and vertical.

In terms of applications in production, Infura, a scalable blockchain infrastructure tool, gets over 2 billion read requests per day; Metamask, which allows users to interact with Ethereum dApps through their web browser, has over 250,000 daily active users.

Consensys Academy received 1,200 applications for their inaugural Developer Program and graduated 100 new blockchain developers this October.

Consensys Ventures has launched a $50m fund to invest in external blockchain companies.

Q: WEF has said evidence suggests that a growing number of organizations are looking down the wrong end of the telescope at DLTs: instead of bringing their problems to the table and assessing whether DLTs might help, they are bringing DLTs to the table and looking for problems to which the technology might be applied. Do you agree? How is Consensys deciding what to focus on and invest in, given the commitment of time and money each 'spoke' requires?

A: The enterprise consulting arm of ConsenSys works with Fortune 100 companies to help them solve critical problems with blockchain solutions. Through education to proof of concept to the scalable implementation, we gain valuable insights into real-world frictions that can be smoothed with blockchain solutions. These insights inform our spoke prioritization and validation. Should spokes need additional investments or staffing, we have an internal resource allocation committee.

Q: Could you give us an idea as to what share of your 'spokes' are at the ideation phase vs. proof-of-concept vs. productization? And also broadly what share are Consumer vs Enterprise facing?

A: 10% are in ideation, 75% in proof of concept/development, and 15% have been productized.

Q: It would be great to hear about some of your most promising spokes that might now be moving from PoC to prototype/pilot phases. Similarly have there been any recent light bulb moments that have made it to ideation stage? We would love to hear about both Enterprise and Consumer spokes.

A: While most spokes are still in development and PoC stages, the following spokes are a sample of what we now have in pilot or production phases:

- BlockApps is an enterprise blockchain-as-a-service
- Gnosis is a crowdsourced prediction market
- Uport is a decentralized identity platform
- GRID+ is a decentralized energy market
- Virtue Poker, a provably fair consumer poker platform
- Variabl is a blockchain derivatives trading platform
- UJO - digital music management and payments platform
- GovernX is a decentralized voting and governance platform
- AirSwap is a peer to peer token trading platform

Our newest spokes that are currently still in ideation are in blockchain-based supply chain systems, tokenized real estate, and decentralized data platforms.

Q: You had mentioned in a previous conversation that large Enterprise Software vendors like Oracle and SAP are in your sights in the long-run. Perhaps you can explain why blockchain-based applications or infrastructure is better suited to solving enterprise problems.

A: For internal enterprise resource planning purposes, the blockchain offers incredible economic and technological superiority to the legacy ERP systems through built-in security, data integrity, data migration, traceability, and accountability.

Where the bigger opportunity for enterprise solutions is in the shared data layer the blockchain can provide to industries, in order to facilitate seamless multi-firm collaboration. One potential is to have hundreds of firms operating together with the efficiencies of a vertically integrated monopoly, but with the market price of perfect competition.

As digital assets continue to become more widely held, there will also be more widespread enterprise acceptance. Whether for the efficiencies they offer or for the marketing appeal, digital assets will enter the mainstream economy. These firms will need to use blockchain native systems to track these new digital assets. Initially this will represent a small segment of overall operations, however, the cost savings, efficiency, and superiority of the blockchain systems will spill into every aspect of the enterprise.

Q: We would love to hear more about Balance: what stage you are at? How is blockchain protocol used to do the actual accounting process? Where, and how large, is the revenue opportunity? What incumbents can be displaced by this technology?

A: The blockchain's decentralized record of unchangeable truth lends itself very well to accounting. Balanc3 will leverage the blockchain technology to build accounting systems that can create verifiably accurate financial statements that can update in real-time.

The first use case for our technology is firms currently operating or accepting digital assets: token sales, crypto exchanges, miners, and crypto funds.

We have built the foundation level general ledger, which has a very open framework. Currently in development are the business processes and audit tools that interact with this foundation.

We see a world where all assets are tokenized, and business can seamlessly operate on the blockchain. So while the current market of firms operating with digital assets is relatively small, we expect it to grow exponentially. This will lead to incredible investor protections and a new transparent financial ecosystem.

Q: Can you give us some more color on where ConsenSys is with the decentralized identity projects—such as UPort. What kind of products and use cases could you offer through self-sovereign identity platforms?

A: When you go to a bar and are asked to prove you're over 21, why should you have to reveal your home address to the bouncer? When you apply for an apartment, why should you have to reveal your exact salary and credit score? A decentralized identity platform allows for selective disclosures, such as "over 21" or "salary over $70,000." KYC and AML procedures could be conducted instantly and without error. The big picture is giving identity to the 2.5bn people currently lacking one, in order to actualize greater economic participation.

Q: You mentioned that your Consulting division is working closely with many governments and companies on blockchain – especially those in the Software/Service space. Are you working with any hardware companies at this stage? Do you have any thoughts on how blockchain might change the hardware space?

A: ConsenSys has explored engagements with hardware companies on a number of locations. By connecting the blockchain to the IOT via cryptographically secure communication channels, we can enable smart contracts to affect the physical world in an amazing way. Think smart batteries that signal a smart contract when they are fully charged, generating a token that can then be traded on an open market, and then eventual consumed by the end user—triggering the battery to release the energy into the grid. There is also lots of development into smart locks that can provide access to cars, homes, safes, and more if a user sends a predetermined amount to a smart contract. In the long run, it will be interesting to see how robotics and blockchain integrate to create autonomous machines.

Q: With the funding and regulatory environment having changed beyond recognition in the last six months, what would you say are the two main obstacles currently on the horizon for developing a more comprehensive blockchain architecture?

A: A lack of regulatory clarity and guidance for token-based business models is one obstacle that the industry is coping with. The need for more user-friendly UI/UX for interacting with blockchain applications is another big challenge.

Companies Mentioned *(Price as of 08-Jan-2018)*

ABN AMRO Group N.V. (ABNd.AS, €27.42)
ASX (ASX.AX, A$56.13, UNDERPERFORM, TP A$51.0)
Accenture Plc (ACN.N, $158.93)
Advanced Micro Devices, Inc. (AMD.OQ, $12.28)
Airbnb (Unlisted)
Alphabet (GOOGL.OQ, $1114.21)
Amazon com Inc. (AMZN.OQ, $1246.87)
B&M European Retail (BMEB.L, 409.7p)
BBVA (BBVA.MC, €7.24)
BNP Paribas (BNPP.PA, €64.5)
Barclays PLC (BARC.L, 200.1p)
Bitmain (Unlisted)
Bolsas Y Mercados Espanoles (BME.MC, €27.28)
CA Inc. (CA.OQ, $33.87)
CME Group Inc. (CME.OQ, $151.73)
Capita (CPI.L, 408.3p)
Check Point Software Technologies Ltd. (CHKP.OQ, $103.6)
Chi-X Japan (Unlisted)
Citrix Systems Inc. (CTXS.OQ, $90.97)
Computershare (CPU.AX, A$16.35)
Dell Tech (DVMT.N, $85.38)
Deutsche Bank (DBKGn.F, €15.32)
Deutsche Boerse (DB1Gn.F, €99.7)
Equifax Inc. (EFX.N, $121.99)
Equiniti (EQN.L, 273.5p, UNDERPERFORM, TP 270.0p)
Euronext NV (ENX.PA, €53.4)
European Eqty Fd (EEA.N, $10.1)
Experian (EXPN.L, 1650.0p, OUTPERFORM, TP 1900.0p)
Facebook Inc. (FB.OQ, $188.28)
Gartner Inc (IT.N, $130.31)
Goldman Sachs Group, Inc. (GS.N, $251.81)
HSBC (0005.HK, HK$80.5)
HSBC (HSBA.L, 758.0p)
Hortonworks, Inc. (HDP.OQ, $19.97)
Intel Corp. (INTC.OQ, $44.74)
International Business Machines Corp. (IBM.N, $163.47)
Intesa-Sanpaolo (ISP.MI, €2.81)
JPMorgan Chase & Co. (JPM.N, $108.5)
KBC Group N.V. (KBC.BR, €72.94)
Link Administration Holdings Limited (LNK.AX, A$8.62)
Link REIT (0823.HK, HK$73.4)
London Stock Exchange (LSE.L, 3744.0p, OUTPERFORM, TP 4150.0p)
MasterCard Inc. (MA.N, $159.27)
Microsoft (MSFT.OQ, $88.28)
NVIDIA Corporation (NVDA.OQ, $222.0)
NXP Semiconductors N.V. (NXPI.OQ, $118.28)
Natixis (CNAT.PA, €6.9)
Nordea Bank (NDA1V.HE, €10.24)
Online (OBC.L, 139.0p)
Oracle Corporation (ORCL.N, $48.98)
Overstock com (OSTK.OQ, $86.9)
PayPal Holdings, Inc. (PYPL.OQ, $79.05)
Playtech (PTEC.L, 875.0p, OUTPERFORM, TP 980.0p)
Plus500 (PLUSP.L, 1139.0p)
RSA Insurance Group PLC (RSA.L, 620.6p)
Red Hat, Inc. (RHT.N, $125.21)
Riot Blockchain (RIOT.OQ, $23.42)
Royal Bank of Scotland (RBS.L, 278.7p)
SAP (SAPG.F, €96.16)
Santander (SAN.MC, €5.69)
Societe Generale (SOGN.PA, €45.14)
Sophos Group PLC (SOPH.L, 634.5p, OUTPERFORM, TP 700.0p)
Square, Inc. (SQ.N, $40.76, NEUTRAL[V], TP $37.0)
Standard Chartered (2888.HK, HK$84.25)
Standard Chartered (STAN.L, 795.4p)
Starbucks (SBUX.OQ, $59.31)
T-Mobile US Inc (TMUS.OQ, $65.1)
Target Corporation (TGT.N, $67.18)
Thomson Reuters Corporation (TRI.N, $44.03)
Uber (Unlisted)
UniCredit (UCGP.WA, zł67.92)
VMware Inc. (VMW.N, $130.9)
Visa Inc. (V.N, $119.34)
Volkswagen (VOWG_p.DE, €179.84)

Disclosure Appendix

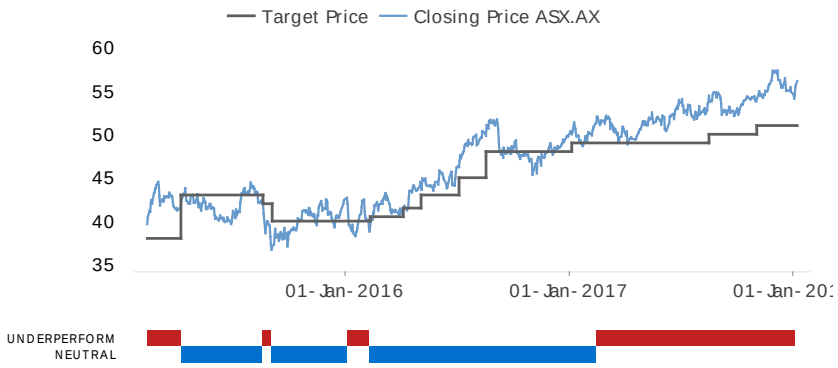
Analyst Certification

Charles Brennan CFA and Brad Zelnick each certify, with respect to the companies or securities that the individual analyzes, that (1) the views expressed in this report accurately reflect his or her personal views about all of the subject companies and securities and (2) no part of his or her compensation was, is or will be directly or indirectly related to the specific recommendations or views expressed in this report.

3-Year Price and Rating History for ASX (ASX.AX)

ASX.AX	Closing Price	Target Price	
Date	(A$)	(A$)	Rating
12-Feb-15	39.65	38.00	U
08-Apr-15	41.61	43.00	N
20-Aug-15	42.35	42.00	U
04-Sep-15	37.07	40.00	N
06-Jan-16	41.03	40.00	U
11-Feb-16	39.53	40.50	N
05-Apr-16	41.40	41.50	
04-May-16	43.90	43.00	
05-Jul-16	46.21	45.00	
18-Aug-16	49.81	48.00	
05-Jan-17	50.01	49.00	
17-Feb-17	51.74	49.00	U
17-Aug-17	54.43	50.00	
03-Nov-17	54.05	51.00	

** Asterisk signifies initiation or assumption of coverage.*



3-Year Price and Rating History for Equiniti (EQN.L)

EQN.L	Closing Price	Target Price	
Date	(p)	(p)	Rating
07-Dec-15	172.00	196.30	O *
09-Jun-17	207.52	224.35	
14-Jul-17	243.04	280.43	
28-Jul-17	247.72	300.00	
03-Jan-18	274.50	270.00	U

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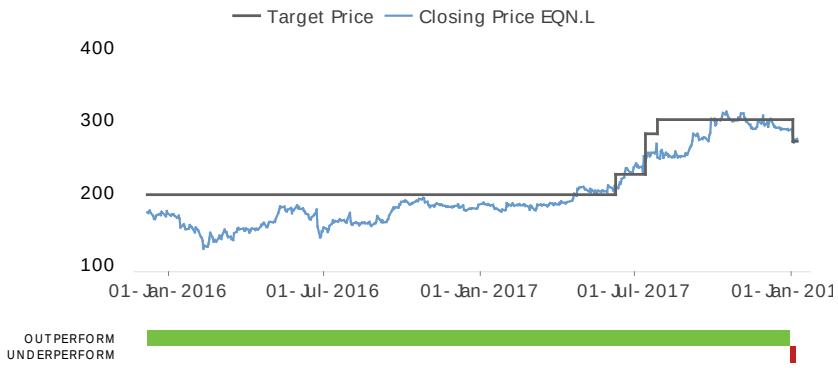
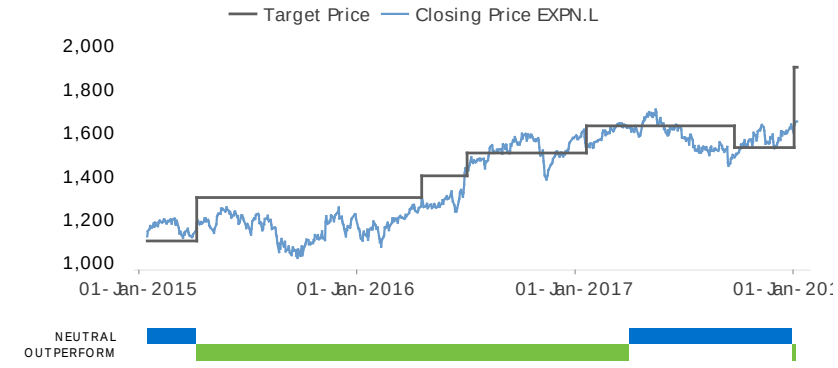


3-Year Price and Rating History for Experian (EXPN.L)

EXPN.L	Closing Price	Target Price	
Date	(p)	(p)	Rating
15-Jan-15	1121.00	1100.00	N
08-Apr-15	1181.00	1300.00	O
19-Apr-16	1290.00	1400.00	
04-Jul-16	1430.00	1505.00	
20-Jan-17	1539.00	1630.00	
05-Apr-17	1604.00	1630.00	N
25-Sep-17	1485.00	1530.00	
03-Jan-18	1635.50	1900.00	O

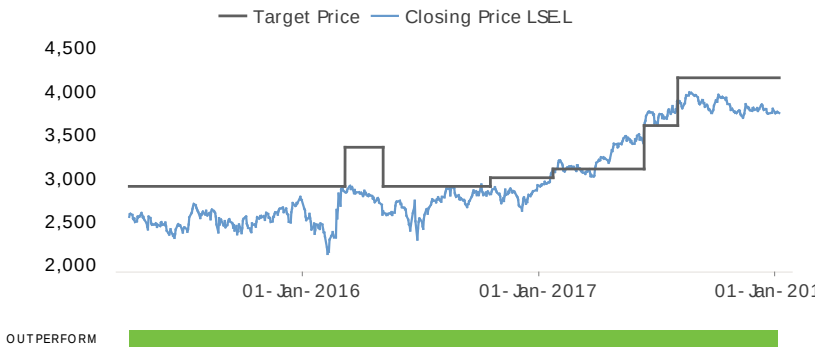
** Asterisk signifies initiation or assumption of coverage.*



3-Year Price and Rating History for London Stock Exchange (LSE.L)

LSE.L	Closing Price	Target Price	
Date	(p)	(p)	Rating
08-Apr-15	2550.00	2900.00	O *
07-Mar-16	2836.00	3350.00	
05-May-16	2614.00	2900.00	
18-Oct-16	2812.00	3000.00	
23-Jan-17	3097.00	3100.00	
13-Jun-17	3582.00	3600.00	
04-Aug-17	3892.00	4150.00	

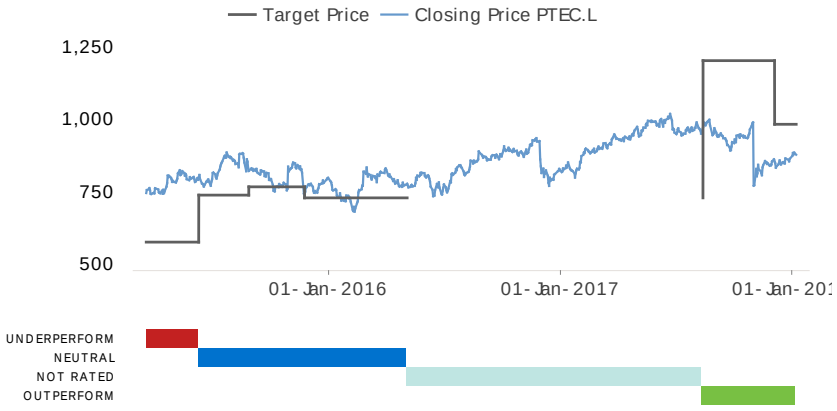
** Asterisk signifies initiation or assumption of coverage.*



3-Year Price and Rating History for Playtech (PTEC.L)

PTEC.L	Closing Price	Target Price	
Date	(p)	(p)	Rating
19-Mar-15	742.45	572.95	U
10-Jun-15	794.97	735.28	N
28-Aug-15	818.84	763.93	
24-Nov-15	734.81	725.73	
04-May-16	774.44		NR
14-Aug-17	969.00	1200.00	O *
05-Dec-17	851.00	980.00	

** Asterisk signifies initiation or assumption of coverage.*



3-Year Price and Rating History for Square, Inc. (SQ.N)

SQ.N	Closing Price	Target Price	
Date	(US$)	(US$)	Rating
19-Oct-16	11.30	12.00	N *
02-Nov-16	11.78	15.00	O
22-Feb-17	15.04	17.00	
04-May-17	19.90	20.00	
16-Jun-17	23.56	25.00	N
02-Aug-17	26.46	26.00	
08-Nov-17	36.71	31.00	
20-Nov-17	45.21	37.00	

** Asterisk signifies initiation or assumption of coverage.*

The analyst(s) responsible for preparing this research report received Compensation that is based upon various factors including Credit Suisse's total revenues, a portion of which are generated by Credit Suisse's investment banking activities

As of December 10, 2012 Analysts' stock rating are defined as follows:

Outperform (O) : The stock's total return is expected to outperform the relevant benchmark* over the next 12 months.
Neutral (N) : The stock's total return is expected to be in line with the relevant benchmark* over the next 12 months.
Underperform (U) : The stock's total return is expected to underperform the relevant benchmark* over the next 12 months.

**Relevant benchmark by region: As of 10th December 2012, Japanese ratings are based on a stock's total return relative to the analyst's coverage universe which consists of all companies covered by the analyst within the relevant sector, with Outperforms representing the most attractive, Neutrals the less attractive, and Underperforms the least attractive investment opportunities. As of 2nd October 2012, U.S. and Canadian as well as European ratings are based on a stock's total return relative to the analyst's coverage universe which consists of all companies covered by the analyst within the relevant sector, with Outperforms representing the most attractive, Neutrals the less attractive, and Underperforms the least attractive investment opportunities. For Latin American and Asia stocks (excluding Japan and Australia), ratings are based on a stock's total return relative to the average total return of the relevant country or regional benchmark (India - S&P BSE Sensex Index); prior to 2nd October 2012 U.S. and Canadian ratings were based on (1) a stock's absolute total return potential to its current share price and (2) the relative attractiveness of a stock's total return potential within an analyst's coverage universe. For Australian and New Zealand stocks, the expected total return (ETR)*

calculation includes 12-month rolling dividend yield. An Outperform rating is assigned where an ETR is greater than or equal to 7.5%; Underperform where an ETR less than or equal to 5%. A Neutral may be assigned where the ETR is between -5% and 15%. The overlapping rating range allows analysts to assign a rating that puts ETR in the context of associated risks. Prior to 18 May 2015, ETR ranges for Outperform and Underperform ratings did not overlap with Neutral thresholds between 15% and 7.5%, which was in operation from 7 July 2011.

Restricted (R) : In certain circumstances, Credit Suisse policy and/or applicable law and regulations preclude certain types of communications, including an investment recommendation, during the course of Credit Suisse's engagement in an investment banking transaction and in certain other circumstances.

Not Rated (NR) : Credit Suisse Equity Research does not have an investment rating or view on the stock or any other securities related to the company at this time.

Not Covered (NC) : Credit Suisse Equity Research does not provide ongoing coverage of the company or offer an investment rating or investment view on the equity security of the company or related products.

Volatility Indicator [V] : A stock is defined as volatile if the stock price has moved up or down by 20% or more in a month in at least 8 of the past 24 months or the analyst expects significant volatility going forward.

Analysts' sector weightings are distinct from analysts' stock ratings and are based on the analyst's expectations for the fundamentals and/or valuation of the sector* relative to the group's historic fundamentals and/or valuation:

Overweight : The analyst's expectation for the sector's fundamentals and/or valuation is favorable over the next 12 months.

Market Weight : The analyst's expectation for the sector's fundamentals and/or valuation is neutral over the next 12 months.

Underweight : The analyst's expectation for the sector's fundamentals and/or valuation is cautious over the next 12 months.

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Target Price and Rating
Valuation Methodology and Risks: (12 months) for ASX (ASX.AX)

Method: We set our target price of $51.00 for ASX using the average of our DCF (equity beta of 0.9, a risk free rate of 4.0%, a market risk premium of 6.0% and a terminal growth rate of 3.5%) and a PE relative (30% market premium). While ASX is a high quality business deserving of a P/E premium, we believe the current P/E premium is too large and so have an Underperform rating.

Risk: We consider main risks to ASX achieving our target price of $51.00 and Underperform rating to be : 1) sustained equity market weakness; 2) number and value of equity and derivative trades; 3) level of capital raisings/IPOs; 4) its ability to maintain strong cost control; 5) competition; 6) regulatory environment; and 7) potential upside risk from a takeover offer.

Target Price and Rating
Valuation Methodology and Risks: (12 months) for Equiniti (EQN.L)

Method: We reach our 270p target price using a DCF: we use a risk free rate of 1.5% and equity risk premium of 6.0%. DCF applies a 10-year competitive advantage period before fading RoNA towards teh WACC. Our Underperform rating reflects a forecasted slowdown in organic growth, principally due to the reduction in NHS contact centre work from FY18 onwards.

Risk: Upside risks to our 270p target price and Underperform rating include: Higher-than-expected cost and revenue synergies arising from the WFSS deal; an acceleration in the level of 'Corporate Actions' earnings; a material rise in UK interest rates; substantially higher levels of project work, especially in Pensions Solutions; strong trading in transactional revenues including retail share dealing. Downside risks include: Regulatory risks around the approval of the WFSS deal; misexecution of the WFSS integration; churn in the core Registration Services business away from retail investor-heavy registers; cost increases mandated by new regulations; longer term demographic shifts away from direct share ownership; higher-than-forecast short-term business development costs (e.g. into public sector BPO).

Target Price and Rating
Valuation Methodology and Risks: (12 months) for Experian (EXPN.L)

Method: Our target price of 1900p is based on our DCF methodology, in line with the rest of the sector. Our organic DCF uses a WACC of 6.0% in 2018 based on a risk free rate of 1.5% and 6.0% market risk premium. We use 5 years of explicit forecasts then reduce RoNA to sustainable mid-cycle levels for the subsequent 5 years. Thereafter we fade RoNA towards the WACC at 10% of the difference between RoNA and WACC per year. In addition we include the value of future acquisitions to reflect the company's M&A strategy. We rate Experian Outperform because we believe organic growth will accelerate and the company will benefit from macro conditions in Brazil and the on-going share buyback schemes.

Risk: Risk factors that could positively impact our 1900p price target and Outperform rating include: more operational gearing than we forecast in the cyclical segments of the business; value creative use of the balance sheet, benefits from expansion of product suite into the international business, recovery in Consumer Services and stronger growth in Latin America. Risk factors that could negatively impact our price target and rating include: legislation, data breach, prolonged weakness in the latin american division,competitive threats in the Consumer Services division and weakness in the UK during a period of macro and political uncertainty.

Target Price and Rating
Valuation Methodology and Risks: (12 months) for London Stock Exchange (LSE.L)

Method: We value LSE using a DCF model which incorporates our explicit forecasts until 2019, a medium term growth assumption of an average 6.0% and a long-term growth assumption of 3.0%. We discount cash flows using a WACC of 8.5% derived from a cost of equity of 8.9% which applies a 2.0% risk free rate, 7.0% equity risk premium & 6.0% long-term cost of debt. This results in a valuation of 4155p which we round down to derive our price target of 4150p. We rate the stock Outperform.

Risk: The risk factors that could impede achievement of our 4150p target price and cause us to lower our rating from Outperform are: (1) variation from our equities trading/OTC derivatives clearing volume growth forecasts; (2) regulatory change (e.g. large changes to CCP regulatory capital needs); (3) corporate restructuring; (4) unexpected senior management changes; and (5) development of an industry mutual index provider impairing growth potential at FTSE Russell.

Target Price and Rating
Valuation Methodology and Risks: (12 months) for Playtech (PTEC.L)

Method: Our target price of 980p is based on a sum of the parts (SOTP) model, where we separately value (i) the B2B regulated gaming business (16x EV/EBITDA - in-line with the peer group average); (ii) the B2B unregulated gaming business (4x EV/EBITDA - in-line with GVC's unregulated Turkish asset disposal); (iii) the Sun Bingo contract (at 0); and (iv) the Financials business (6.5x EV/EBITDA - in-line with Plus500). We rate the stock Outperform given the upside potential indicated by our target price.

Risk: We see the following as key risks to our 980p target price and Outperform rating: - Regulation - the company has material exposure to unregulated markets (54% of gaming revenue); - M&A execution risk - as well as future deals being value destructive; and - Loss of a major licensee.

Target Price and Rating
Valuation Methodology and Risks: (12 months) for Sophos Group PLC (SOPH.L)

Method: We value Sophos by valuing uFCF in FY20 on a 4% yield, consistent with industry bellwethers like SAP and Dassault. We adjust this FCF for a notional tax charge on the deferred revenues, leading to a target price of 700p. Given the significant upside potential implied by our target price, we rate the shares Outperform.

Risk: The biggest risk to our target price and Outperform rating is the ongoing debate between a P&L and cash flow view of valuation. In FY20 we believe cash EBITDA will be over 3 times larger than traditional EBITDA. The magnitude of this difference justifies the wide range between our blue sky and grey sky scenarios. Sophos accounts in USD and yet generates revenues in GBP and EUR – adverse FX moves could impact stated results. The fast-moving and competitive nature of IT security necessitates that vendors remain at the forefront of R&D; any slowdown could result in rapid loss of market share – as too could reputational damage from an unfit product or a poorly managed security incident.

Target Price and Rating
Valuation Methodology and Risks: (12 months) for Square, Inc. (SQ.N)

Method: Our $37 target price represents the average of 37x EV/EBITDA on our 2019 EBITDA forecast and 57x PE on our 2019 EPS forecast. Our Neutral rating stems from our view that Square is fully valued.

Risk: Risks to our $37 target price include an economic downturn or a negative credit event. Risks to our Neutral rating include pricing pressure, the inability to expand margins by increasing share of software and data product revenues, competition taking market share, the inability to sell Square Capital receivables to third party investors, and share dilution from Square's stock compensation plan.

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Credit Suisse International Charles Brennan CFA ; Mathew Yates ; Karl Green ; Andy Grobler, CFA ; Daniel Hobden ; Martin Price ; Tom Mills ; Michalis Onisiforou ; Tal Grant, CFA ; Tim Ramskill, CFA ; Julia Pennington
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