

The Blockchain Revolution: New Opportunities in Equity Markets

By

Mélodie Lamarque

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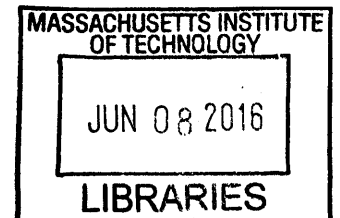
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ABSTRACT

The technological revolution of digital and online computing combined with the information revolution paved the way for the emergence of innovations to reshape existing industries and the way we think about traditional services. Even one of the most traditional industries, the financial sector, is being actively disrupted through fintech and the sharing economy. Innovations such as mobile banking, peer-to-peer lending or crowdfunding are challenging existing models and practices.

This paper aims to show that blockchain technology has the potential to transform equity markets by offering valuable opportunities to create new products to overcome existing inefficiencies and frictions. The blockchain was first introduced as the technology behind the bitcoin cryptocurrency, and is a trustless, decentralized and secure ledger. It provides an unprecedented way to monitor and execute transactions with no need for intermediaries, and to keep a tamper-proof record of these transactions. This breakthrough technology has gradually gained traction and is now being explored far beyond the scope of bitcoin projects. Even traditional big players in the financial industry are looking for ways to benefit from the blockchain: Nasdaq launched Nasdaq Linq, a blockchain-based equity platform for private companies, and 42 international banks came together to join the R3 consortium to explore blockchain's opportunities.

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1. Introduction

1.1 Financial industry disruption and blockchain technology

In the 2014 J.P. Morgan annual report, the Chairman and CEO Jamie Dimon writes in his letter to shareholders: “Silicon Valley is coming. There are hundreds of startups with a lot of brains and money working on various alternatives to traditional banking”. Indeed, over the past few years, the financial industry has been increasingly challenged by the emergence of financial technology, or “fintech”, startups in many different segments of their traditional business. A recent press release from KPMG and CB Insights (2016) reports that 2015 investments in fintech companies reached \$19.1 billion globally, its highest level ever. Of this amount, \$13.8 billion were directed to VC-backed fintech ventures, more than twice the 2014 total, and more than six times the 2011 total. In addition, KPMG and CB Insights count nineteen unicorns (companies with a valuation over \$1 billion) in the fintech industry, with fourteen in the lending or payments sectors. And in this disruptive wave, blockchain technology is considered as one of the most promising opportunities. However, it is still in the early days of its development. In early 2016, cumulated venture capital investments in blockchain and bitcoin related startups exceeded a \$1 billion threshold, according to CoinDesk.

Blockchain was first introduced as the technology behind bitcoin, but different versions of the network have been created since. Because it is decentralized and bypasses the need for middlemen, the technology is sometimes considered as a revolutionary means to change the way financial services operate, a step further in the lineage of the sharing economy, which includes equity crowdfunding or peer-to-peer lending. According to CoinDesk, “Blockchain is just one of a number of technological innovations such as machine learning/AI, multi-tenant cloud architectures, and Big Database platforms, that have the potential to liberate markets from incumbent players and start the process of real – not phantom – liquidity generation away from market makers and investment banks and toward the infrastructure of the market itself” (Amin, 2016).

1.2 Applications in equity markets

Recently, many publications have been covering various topics about blockchain technology, to understand what it offers and how it could change existing systems. In the financial industry only, there is a wide array of potential applications for the technology. At the moment, a majority of industry players are focused on applications in capital markets. Those players are not limited to startups but also include large incumbent financial institutions, exploring ways to exploit the technology to improve existing market structures. For instance, in November 2015, Goldman Sachs filed a patent application entitled “Cryptographic Currency For Securities Settlement”. Nasdaq describes it as “a settlement system for securities market based on cryptographic currency protocol, which introduces its own cryptographic currency - the ‘SETLcoin’” (Bajpai, 2015). The system is designed as a way to execute transactions more effectively via a peer-to-peer network and replace clearing and settlement functions.

As a matter of fact, blockchain could prove to be a real game-changer for equity markets, both public and private, as a new infrastructure to issue, trade, record and manage stock. This paper aims to understand how the technology applies to equity markets and how it can be implemented. Can blockchain technology make equity markets more efficient? Who will be the actors driving innovation?

1.3 Paper structure

In order to answer these questions, this paper gives a detailed overview of the technology’s potential and limitations in equity markets, as well as a sense of the current market applications and main players. The first part of the second chapter will be focused on describing the technology, its different features and the applications stemming from it. Then, the second part will introduce the opportunities for blockchain technology’s adoption in equity markets. The third chapter provides a framework of the technology’s relative advantages and drawbacks, in order to help overcome some of the market’s frictions. In chapter four, I will focus on four case studies both in private and public

equity settings, to give a more detailed and concrete overview of existing applications for blockchain technology. Finally, in chapter 5, I will give a perspective on the technology's potential impact on equity markets, and on its implementation in the financial industry.

2. A closer look at the blockchain and its potential in equity markets






2.1 More on the blockchain

2.1.1 Introduction to bitcoin

First and foremost, it is important not to reduce blockchain technology to bitcoin. The underlying technology's capabilities go far beyond the transactions of cryptocurrencies. Yet, it is important to understand bitcoin as the first application built on top of the blockchain. In 2008, the mysterious Satoshi Nakamoto introduced bitcoin to the world in a blog post: "I've been working on a new electronic cash system that's fully peer-to-peer, with no trusted third party". In the accompanying whitepaper *Bitcoin: A Peer-to-Peer Electronic Cash System* (Nakamoto, 2008), he describes the features of what is both the first decentralized cryptocurrency and a peer-to-peer payment network. Cryptocurrencies are used to store and exchange value through encrypted digital information. The network is secured by multiple individual miners¹ who verify transactions. Once it has been verified, a transaction is non-reversible and is added to the chain of previous transactions, recorded on a distributed public ledger. This system enables to make payments directly between individuals worldwide with no need for trusted intermediaries, such as banks and clearing houses, and therefore with fewer frictions.

Bitcoin remains the most widely known and used cryptocurrency, but since its creation, a large number of other cryptocurrencies called altcoins have been developed, with the purpose to overcome some of bitcoin's limitations with new or improved features. Below is an overview of key metrics for the digital currencies with the five highest market capitalizations, showing bitcoin as the undisputed leader in this respect, but behind Ethereum in terms of available coin supply:

¹ Miners support the blockchain network by devoting computing power to validate transactions.

#	Name	Market Cap	Price	Available Supply
1	 Bitcoin	\$6,339,367,930	\$414.42	15.3m BTC
2	 Ethereum	\$836,784,774	\$10.78	77.6m ETH
3	 Ripple	\$274,798,431	\$0.01	34.1b XRP
4	 Litecoin	\$146,990,558	\$3.28	44.8m LTC
5	 MaidSafeCoin	\$49,678,941	\$0.11	452.6m MAID

Source: <http://coinmarketcap.com/> as of March 9, 2016

However, at first, Bitcoin was confined to a small community, insufficient to provide enough scale to fulfill its purpose: with no products to spend your bitcoins on, their utility is extremely limited. One of the main obstacles is that there was no central authority to oversee its expansion. This component was at the core of Nakamoto’s invention. Yet, according to Vigna and Casey (2015, p.93) “as much as a decentralized community can have no central ledger, to grow it still needs individuals to take the lead”. Even with the promotion of early adopters and bitcoin “evangelists” the adoption of bitcoin by the wider public suffered many hurdles. Because of its high volatility and the scandals it provoked, bitcoin was regarded mainly with incomprehension and skepticism. The most famous scandals are probably the bust of the Silk Road website and the collapse of Mt. Gox. Silk Road was a notorious dark web marketplace, relying on the anonymity feature of bitcoin to complete illegal trades – mostly drug trafficking – and was finally seized by the FBI in 2013. Less than a year later, Bloomberg reports that Mt. Gox, the largest bitcoin exchange platform, declared bankruptcy after several hick-ups and the appalling loss of \$480m worth of bitcoins (Dougherty & Huang, 2014). These scandals have been extensively covered in the press, and critics of bitcoin have repeatedly echoed in people’s minds. Next critic in line was bitcoin’s extremely high volatility, which made it appear more like a speculative instrument than a store of value. In the Harvard Business Review, Wan and Hoblitzell (2014) argue the following:

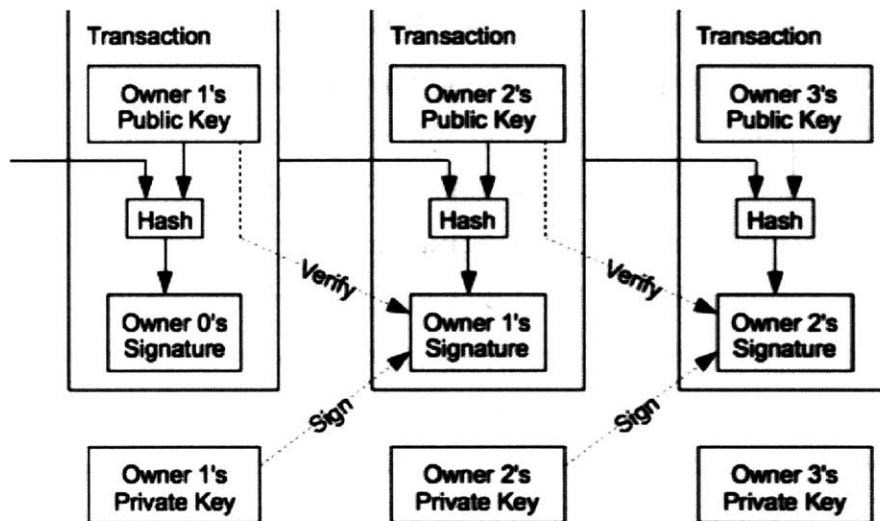
Digital currencies like Bitcoin have captured the attention of the media, entrepreneurs, and regulators. The coverage has described exchange

meltdowns, price volatility, and government crackdowns. However, the focus on Bitcoin as a currency may distract businesses and governments from its disruptive impact: as a technology.

2.1.2 Introduction to the blockchain

So what exactly is the blockchain? Different blockchains have emerged after bitcoin, with their own infrastructures and functionalities. Below is an explanation focused on the bitcoin blockchain, the technology behind bitcoin.

The blockchain is a fully decentralized public ledger. It is composed of a distributed network of computers called nodes. The ledger keeps a transparent and incorruptible record of all the transactions that have been made on the network while keeping private identities anonymous. The way this is possible is by using a cryptographic protocol: transactions are secured by encrypted messages, or identifiers called hash. In order to properly understand how the technology works, let's go through the process of a bitcoin transaction between two individuals. To make a transaction, the owner of a coin submits a digital message to the network, including the public key of the receiver, the amount of the transaction, and a cryptographic digital signature to certify its authenticity.



Source: Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System", 2008, p.2

The transaction information is then broadcasted to the nodes of the network. Once they have validated the message, the receiver uses his private key to prove he is the valid beneficiary. The digital signature is recorded on each bitcoin, proving that the owner

wants to transfer its record of ownership to the receiver. This means that it is possible to trace each bitcoin's chain of ownership by verifying all the signatures information it contains.

But there is an issue with replicating digital assets: how can we make sure that the bitcoins in questions have not been already spent? In order to avoid this double-spending risk, transactions have to be verified. Trusted third parties traditionally assume this function by tracking all transactions. For the blockchain to be fully decentralized and bypass central authorities, it needs a mechanism to replace this function efficiently, a proof that the funds required for a specific transaction are available and spent only once. The solution proposed by blockchain technology is to broadcast transactions publicly to the network and to certify their validity by keeping a chronological record of all transactions, what Nakamoto (2008, p.2) called a "timestamp server".

Basically, the network nodes authenticate transactions by decrypting the digital signatures and verifying that there are valid (no double-spending). The authenticated transactions arriving around the same time on the network are then combined in blocks. For a block to be validated and incorporated to the existing chain of blocks, it needs a majority consensus on the network amongst miners. This distributed consensus can be based on different validation techniques depending on the blockchain; such as "proof-of-stake", requiring users to prove that they hold sufficient funds for a transaction; or in the bitcoin blockchain's case, on "proof-of-work", requiring multiple miners in the network to invest computational power to solve difficulty-adapting mathematical puzzles. Once a miner has solved the proof-of-work for a block, the solution is transmitted to the entire network and the block is added to the ever-growing chain of transaction records. Moreover, each block contains the hash identifier of the previous block, which provides a single public source of truth based on the longest chain in the network. The reason for this is explained by Nakamoto (2008, p.3): "To modify a past block, an attacker would have to redo the proof-of-work of the block and all blocks after it and then catch up with and surpass the work of the honest nodes". Therefore, all blocks are linked to one another in a chronological fashion.

But miners need incentives to maintain the system and verify transactions. In the case of the bitcoin blockchain, incentives are set up in two stages. The first stage, from its inception until now is based on bitcoin rewards. Miners are awarded a number of coins, decreasing over time, when they validate a block by successfully solving the mathematical puzzle. This process gives nodes rewards for supporting the network and is also a way to issue coins with no central authority involved. The limit of total bitcoins in circulation was set at 21 million by Nakamoto. When this amount is reached, a second-stage incentive system based on low transaction fees will be put in place.

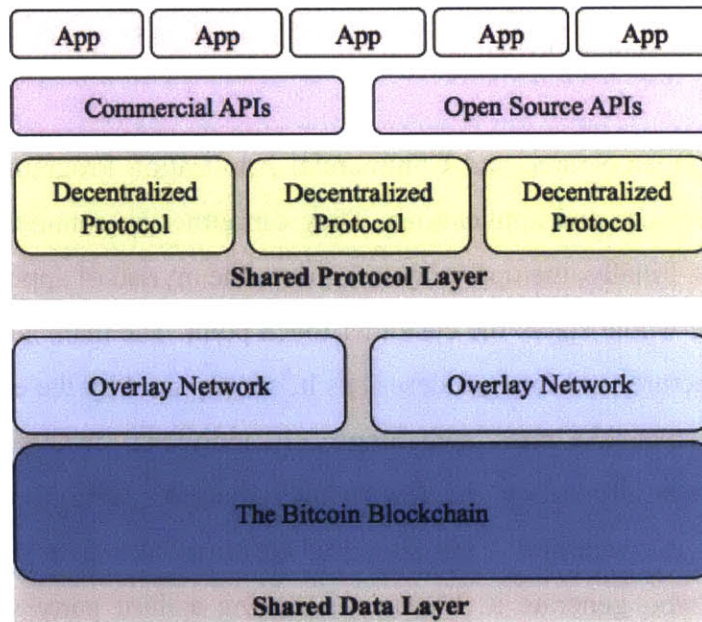
Vigna and Casey (2015, p.27) argue that the technology has the “capacity to rearrange the rules of trust around which society manages exchanges of value”. And indeed, the blockchain offers extremely valuable features. It is decentralized and therefore bypasses the need for central authorities. It is trustless because it is based on a distributed consensus and thus removes the necessity for intermediaries. Since there isn’t one central point susceptible to failure, the network is also durable and better protected from attacks, as well as a guarantor of integrity (Needham, 2015, p.10). The blockchain ledger is transparent and publicly available while preserving anonymity. It is also secure because it can’t be tampered with. Finally, the database is automatically and infinitely updated and therefore reliable, as long as miners are supporting it. Blockchain’s obvious advantages sparked curiosity and triggered the exploration of the numerous potential applications to build on top of it.

2.1.3 Blockchain applications overview

The blockchain can be used as an infrastructure to support many innovations, and has a much broader scope of applications than payments. According to Wan and Hoblitzell (2014) “Bitcoin could disrupt other systems that rely on intermediaries with a similarly open, peer-to-peer system, including property, contracts, and identity management. Anywhere a transaction between two parties has traditionally required third party validation, Bitcoin may be applicable”.

2.1.3.1 The Blockchain Application Stack

The best analogy to understand the blockchain is probably to compare it to the HTTP decentralized protocol, on top of which services and applications are built as customer interfaces. Monegro (2015), from Union Square Ventures, gives a very clear description of how applications are built on top of the blockchain, as shown below:



Source: Monegro, J. *The Blockchain Application Stack*. 2015.

The Shared Data Layer and the Shared Protocol Layer are decentralized and open-source. They are accessible to everyone and not controlled by any central authority. For bitcoin, the blockchain is the Shared Data Layer, on top of which the decentralized bitcoin protocol (similar to a software program) is built, setting the rules for computers to run on the network. Monegro shows in this illustration that “the Shared Data and Protocol Layers cover about 80% of the entire stack” whereas, for Internet, TCP/IP and HTTP decentralized platforms would only account for around 15% of the application stack, and private centralized applications on top would make up the most part. Then, overlay networks are constructed to fulfill different purposes than the bitcoin cryptocurrency, but still relying on the blockchain infrastructure and its features, such as proof-of-work or timestamps. They contain complementary or additional functions to the original network. On top of this are decentralized protocols, which allow peer-to-peer exchanges and access to fully open data sets. They constitute a real disruption for business models such

as Facebook or Uber who greatly rely and benefit from the use of the private data they collect. Indeed, as Monegro claims “decentralized protocols on top of the blockchain have the potential to undo every single part of the stacks that make these services valuable to consumers and investors”. This doesn’t mean that business models like Uber’s will disappear, but that new ones will be created, such as La’Zooz, a decentralized platform providing “smart transportation” services based on “realtime ridesharing” according to their whitepaper (2015).

The layer above is Open Source and Commercial Application Programming Interface: tools for building services and applications. They can either be commercial services or open-source projects. Finally, the upper layer regroups the myriad of applications that can be built on top of the whole stack: the customer touch point. The main advantages of this decentralized architecture, as Monegro describes it, are captured by the end-user because of “lower or nonexistent take rates, switching costs, individual ownership of data, and consumer market power”. In theory, the new business models arising from the distributed ledger technology – if successful – are supposed to bring back data ownership in the hands of the users who generate it. Instead of trusting a third party website to store personal data and have access to it, the network holds the data, and the user has control over it. As Kaminska (2015a) puts it in the Financial Times: “The potential of the blockchain is tied to organising the world’s data in a way that can unshackle society from its dependency on big data behemoths such as Google and Facebook”.

2.1.3.2 Blockchains

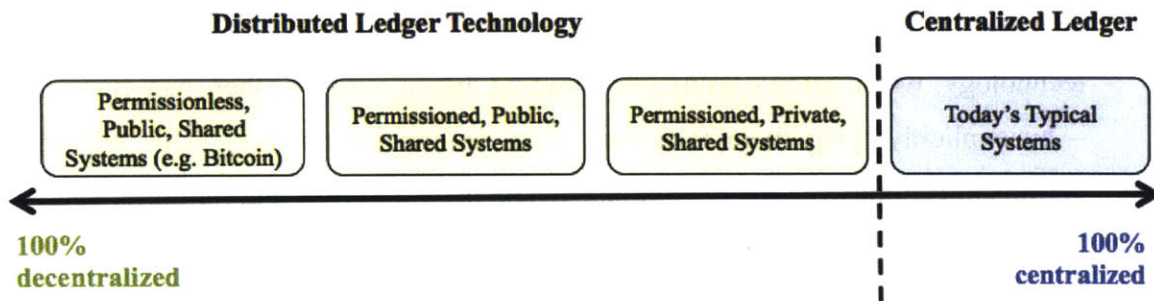
However, the bitcoin blockchain is not the only way to build on the technology. Adaptations to the initial network and entirely new blockchains have been created since 2009. They can be complementary or compete with one another. Those new networks are completely separate from the bitcoin blockchain and seek to improve or add features to the original technology, such as “faster settlement times, larger transaction sizes, different consensus methods, varying degrees of anonymity/pseudonymity, more advanced functionality, permissioning features etc.” (Needham, 2015, p.6).

- The first option to exploit the technology is to build applications on top of the bitcoin blockchain, and to use the ability of the network to convey and securely store information by simply using very small amounts of bitcoin necessary for an exchange to take place. One way to do this is to use the “Colored Coins” technology, which allows issuing and trading digital assets – other than currency – by explicitly tying them to a very small amount of bitcoins¹. This solution permits to benefit from the bitcoin blockchain network effect and liquidity, and to leverage the global, solid and reputable network capabilities.
- The second option is to create another blockchain, not focused on cryptocurrency and hence more adapted to different purposes. One example of such blockchain is Ethereum; a decentralized platform specialized in smart contracts. Their own blockchain includes components that make it particularly suitable for the execution of smart contracts; not focused on the transfer of value, but on the transfer of property ownership. This solution can be very valuable in the sense that it allows to build a system adapted to the particular needs of a service and to shape fitted functionalities and incentive models. Also, there is a question about the bitcoin blockchain’s flexibility and capacity to handle all the additional workload created on top of it.
- The last option is a mix of the two above, called sidechains. They are “alternative blockchains that are linked to the Bitcoin blockchain via two-way peg – thus allowing users to seamlessly transition between the alternative blockchain and the Bitcoin blockchain” (Needham, 2015, p.8). The Needham report also argues that this solution, if working, seems optimal since it would combine both the flexibility to adapt the underlying infrastructure to specific requirements and the huge network effect benefits of the bitcoin blockchain.

Regarding the different types of blockchains and their singularities, there is yet another major distinction to be made: their degree of centralization and openness.

¹ Retrieved from <http://coloredcoins.org/>

The UK Government Office for Science (2016) presents a quick overview of the different models that exist in that regard, exposed below.



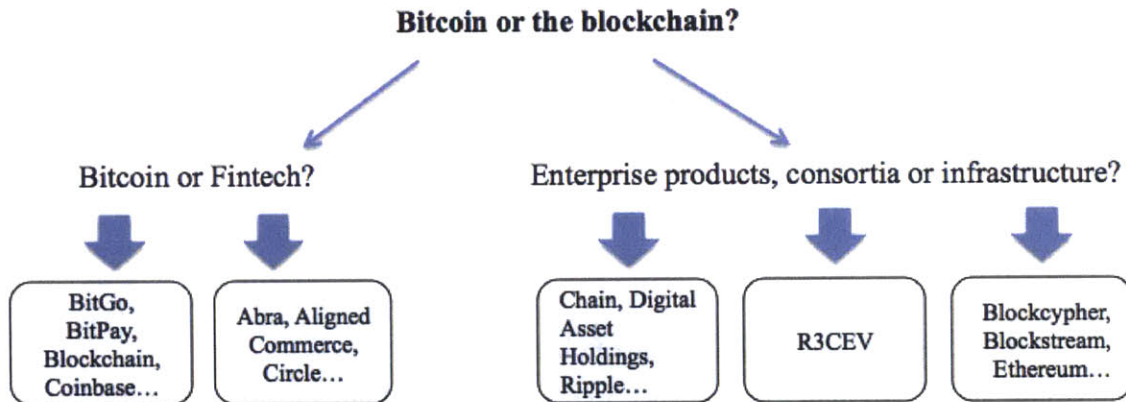
Source: UK Government Office for Science, "Distributed Ledger Technology: Beyond Block Chain", 2016, p.35

The main difference is between permissionless and permissioned systems. A permissionless ledger (such as the bitcoin or the Ethereum network) is public: everyone can access it globally and join the network by committing computing power and thus become validators. The nodes composing and supporting the network, which validate transactions, are fully decentralized and anonymous. Those networks are public and accessible, and are secured through cryptographic verification by distributed consensus systems such as proof-of-work or proof-of-stake. On top of permissionless ledgers, applications can be either private or open access. In a permissioned ledger on the other hand, also called consortium or private ledger, validators can only be trusted, pre-selected nodes. Hence participating to such networks requires authorization, and they are mainly used at an enterprise level. The access rights to read permissioned blockchains can then be either public (partially decentralized) or private, restricted to approved parties. Some of the main advantages of a permissioned ledger over a permissionless include cheaper and faster transactions and more privacy.

In substance, pursuing the Internet analogy, the bitcoin blockchain or similar permissionless and public networks can be compared to the Internet, whereas permissioned ledgers would be the equivalent of Intranets.

2.1.3.3 Current applications

Whether it is through bitcoin or the blockchain, there are many possible ways to approach the technology and to build on it. In a recent Forbes article, Shin (2016) presents the five main strategies that companies are pursuing in the space, mapped in the decision tree below.

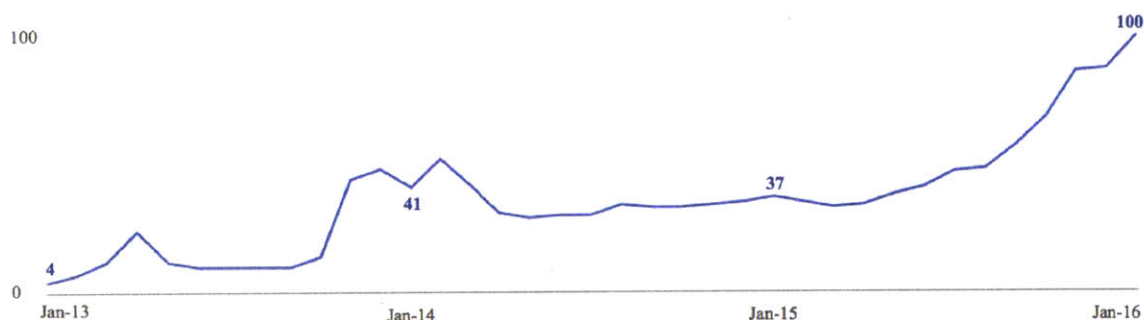


Source: Shin "How Will Bitcoin Technology Go Mainstream? An Analysis Of 5 Strategies", Forbes, 2016

The technological opportunities of the bitcoin blockchain can thus be explored in many different ways. This taxonomy is not exclusive since many companies in the space actually target more than one segment in their activity span. At first, applications based on bitcoin gained the most traction. This step was essential for the blockchain to expand and become a valuable technology since it relies on network effects to be robust and secure. But then, and mostly since 2015, a growing number of companies have been tapping on the broader potential of the distributed ledger technology to disrupt various industries, processes, and business models. One of the main use cases for the technology lies in the improvement of the financial system, by providing a faster and cheaper way to make transactions in a secure and transparent fashion. Furthermore, the blockchain enables us to digitize and trade virtually any asset: the potential impact is substantive. There is a multitude of potential innovative applications other than in financial services, such as digital property titles in real estate or identity issuance.

2.1.4 A growing interest in the technology

Since its creation, the blockchain has made its way to a much larger audience than the initial enthusiasts. People are getting more and more interested in the technology and started to gaze at the opportunities it offers, as shown by the tremendous growth of Google searches for “blockchain” between January 2013 and January 2016 below (+170% between January 2015 and 2016 only).



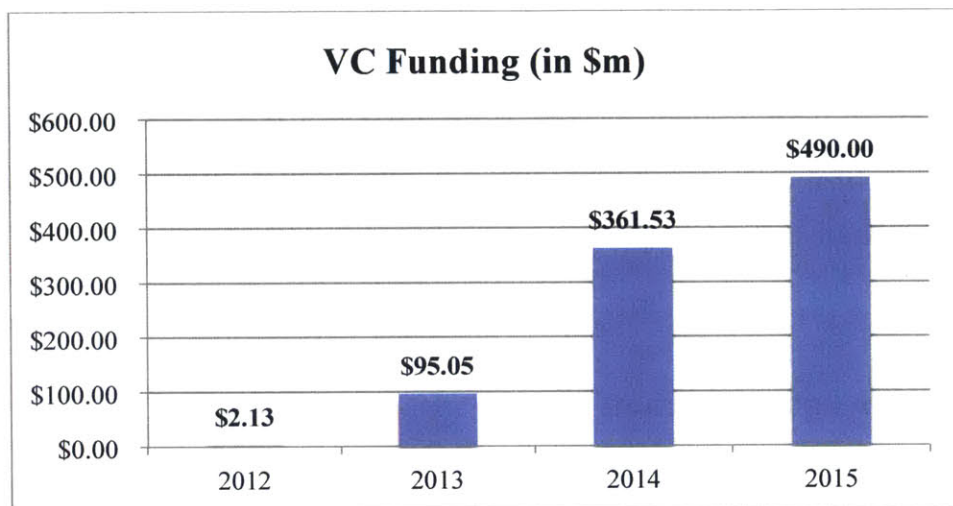
Source: Google Trends between January 2013 and 2016

Many argue that 2016 will be the year when the technology reaches a tipping point towards becoming truly mainstream: “Emerging trends in the industry, such as early enterprise adoption, usage trends, R&D expenditure and venture capital activity, suggest that blockchain technology is approaching an inflection point toward greater mainstream and enterprise adoption” (Needham, 2015, p.1).

Investments in blockchain technology have certainly boomed, in the past year especially, whether they are investments in start-ups by venture capital funds or investments for in-house development by companies, mainly from big players in the financial industry. The World Economic Forum survey report *Deep Shift - Technology Tipping Points and Societal Impact* (2015a, p.24) gives an estimate of the tipping point for bitcoin and the blockchain. At the time of the report in September 2015, “the total worth of bitcoin in the blockchain is around \$20 billion, or about 0.025% of global GDP of around \$80 trillion”. However, they expect 10% of global gross domestic product to be stored on blockchain technology by 2027. What’s more: 58% of the survey respondents believe that this tipping point will be reached by 2025¹.

¹ The survey was conducted by the Global Agenda Council on the Future of Software & Society to ask their view on when 21 technology “tipping points” would occur to executives and experts from the information and communications technology sector. 816 responses were recorded.

From 2012 to 2015, bitcoin (and related) venture capital funding has been multiplied by 230x, and from 2014 to 2015, investments grew by 36%, as shown below.



Source: <http://www.coindesk.com/bitcoin-venture-capital/>

All-time funding exceeded \$1 billion in early 2016 with over \$163 million investment since the beginning of the year (as of April 21, 2016). Investments in ventures in the blockchain space have strongly accelerated over the past two years and have reached meaningful round sizes.

Here is an overview of the largest investment rounds in blockchain technology and bitcoin startups by venture capital funds:

#	Name	Date	Round Size (\$m)	Round	Cumulative Funding (\$m)
1	21 Inc	Mar-15	\$116	Series A	\$121
2	Coinbase	Jan-15	\$75	Third	\$106
3	DAH ¹	Jan-16	\$60	N/A	\$60
4	Blockstream	Feb-16	\$55	Series A	\$76
5	Circle	Apr-15	\$50	Third	\$76

Source: <http://www.coindesk.com/bitcoin-venture-capital/>

¹ DAH: Digital Asset Holdings

The Needham report (2015, p.27) suggests that investments have been primarily directed towards companies that would benefit the most from mainstream adoption of blockchain technology. They are mostly focused on digital currency, in sectors such as transaction processing services, wallets, exchange platforms or payment systems. The second step, according to the report, comprises investments focused on broader applications, such as developer platforms and commercial APIs. Finally, the third investment step is essentially directed to end-user applications.

2.2 Potential in equity markets

2.2.1 Deregulation of equity markets

2.2.1.1 Regulation A+

In March 2015, the SEC published a press release stating that they “adopted final rules to facilitate smaller companies’ access to capital. The new rules provide investors with more investment choices”. More specifically, those rules are exposed in the Title IV (Regulation A) of the Jumpstart Our Business Startups (JOBS) Act. The JOBS Act was signed by Obama in 2012, as a mean to broaden entrepreneurs’ access to capital by allowing them to raise capital from the crowd, meaning from non-accredited investors. The purpose is to expand and generalize exemptions from the registration requirements of the 1933 Securities Act. This historic SEC ruling shifted the principles of early-stage financing towards further deregulation; it is an eloquent illustration of the changes taking place in financial services. Regulation A is a major step towards easing small companies’ public access to capital since virtually anyone can participate versus the 2% wealthiest Americans – accredited investors¹ – prior to the reform, according to SeedInvest (“Raising Capital using a Regulation A+ Mini-IPO”, n.d.).

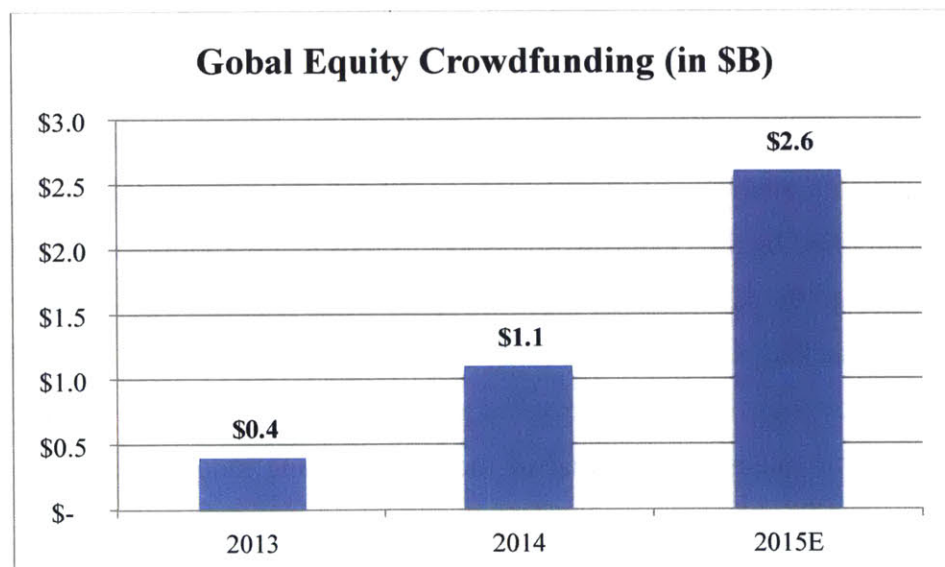
Regulation A+ (referring to the final rules) allows unregistered companies to raise up to \$50 million in capital via a public offering in a 12-month period. Conditions include

¹ Accredited investors, as defined by the SEC, include people with a net worth of over \$1 million or earnings exceeding \$200,000 yearly.

disclosure and reporting obligations in order to protect investors. There are two tier options for the aforementioned offerings with different regulatory constraints. Tier 1 maximum offering is \$20 million; it only requires reviewed financials for most states and no ongoing public financial reporting. Tier 2 maximum offering is \$50 million and it necessitates audited financials, and annual and semi-annual public reporting including audits. Regulation A+ lays ground for new ways to get funding for small companies by allowing them to launch equity crowdfunding campaigns or “mini-IPOs” (as described by SeedInvest), hereby giving birth to a new kind of peer-to-peer equity investment. Companies now have a new quick and efficient way to raise funding and to “tap into an eager and engaged source of capital” (SeedInvest, n.d.). Indeed, investments can now take place online and benefit from network effects by reaching a much larger and specific investor base at the same time. It can be a way to reward and incentivize early adopters who want to participate in a firm’s success and even turn them into active promoters. This equity crowdfunding model allows backers to benefit from the startup’s potential upside. This gives an alternative to traditional crowdfunding and solves one of its main criticisms, exemplified by the Oculus Rift episode. Oculus Rift – a virtual reality headset maker – raised up to \$2.4 million on the crowdfunding platform Kickstarter, in September 2012. Backers received the promise for an early-release headset for pledging a certain amount. However, less than two years later, Facebook bought the startup for \$2 billion, which led to intense questioning of the crowdfunding model, according to the Guardian (Hern, 2014).

Furthermore, the capitalization table consequent to an offering under Regulation A+ is likely to be highly fragmented; hence ownership will be less concentrated. This leaves the founding team with more control over their company, as there will be no requirements for control or board seats for example, like it is usually the case for private equity or venture capital funding rounds. However, there are significant drawbacks to having a fragmented shareholder base (such as more difficulties to raise later stage funding or for shareholder management), and having VC members on the board can actually prove to be really beneficial for the company.

The Crowdfunder expects that “by 2020, the JOBS Act – and the equity crowdfunding opportunities it unlocks – will create \$50 billion of available capital” (“The Guide to Equity Crowdfunding”, n.d.). In the US only, there are 28 million small businesses (+49% since 1982), according to the U.S. Small Business Administration (“Small Business Trends”, n.d.), and start-ups and small businesses account for 50% of US GDP production (SeedInvest, “Equity Crowdfunding by the Numbers”, 2015, p.2). Regulatory evolution and technological innovations allow them and new ventures to have easier access to capital and to a larger funding pool at a lower cost than ever before. The crowdfunding industry has been growing sharply over the past few years, as shown below, and since the regulation passed there has been a clear momentum for equity crowdfunding, which is not expected to fade in the near term.



Source: SeedInvest, “Equity Crowdfunding by the Numbers”, 2015, p.10

Massolution (2015) estimates the crowdfunding industry aggregate funding volume at \$34.4 billion for 2015 worldwide¹ (as reported by Forbes²). Equity crowdfunding therefore accounts for only 7.4% of the total for the year 2015. The report expects that by

¹ Massolution’s numbers for the crowdfunding industry include the following models: donation, reward, lending, equity, royalty and hybrid.

² Numbers from Massolution report retrieved from Forbes article: “Trends Show Crowdfunding To Surpass VC In 2016” (Barnett, C., 2015). Retrieved from <http://www.forbes.com/sites/chancebarnett/2015/06/09/trends-show-crowdfunding-to-surpass-vc-in-2016/#1b9734e1444b>

2016, capital raised by the entire crowdfunding industry will surpass venture capital funding. The World Bank report *Crowdfunding's Potential for the Developing World* (2013, p.43) assesses the market potential for crowdfunding expansion in developing economies. It corroborates Massolution's anticipation, by estimating that the total potential of the industry would amount to \$90-96 billion per year by 2025. It is undeniably one of the strong emerging forces disrupting traditional equity markets and challenging incumbent actors: "We are in a new environment – and it was Crowdfunding which laid the groundwork and foundations for fintech and wider 'disruption'" (James, 2016).

2.2.1.2 Stock issuance via blockchain technology

The next major regulatory change in equity markets took place in 2015 when the SEC approved the plan of online retailer Overstock to issue shares using the bitcoin blockchain. This marked an important milestone for the technology, since this was the first time that the SEC allowed issuance and trading of securities on a blockchain-based marketplace, thus opening the door to a multitude of opportunities. Overstock was among the first few large companies to accept bitcoin as a means of payment and even more importantly, the first one to issue a crypto security in the form of a crypto bond based on its blockchain platform tØ.com. tØ is an alternative trading system (ATS), powered by blockchain technology and subject to SEC regulation and approval – like all ATSS. Early 2015, Overstock filed a prospectus with the SEC indicating its intention to issue securities through tØ and its plan to raise \$500 million in crypto securities, as disclosed by Wired (Metz, 2015a). Wired also reported that the SEC approved an amended version of Overstock's Form S-3, allowing the issuance of public shares on their tØ platform, amongst other securities (Metz, 2015b). In December 2015, tØ became the first blockchain-powered stock-trading platform endorsed by the SEC.

This set a precedent that could enhance many innovations in security markets. Furthermore, Overstock has stated its wish to expand the activities of tØ and offer its services to other companies so they can use the technology to issue and exchange securities as well. Metz (2015b) adds that tØ's tools are "designed to remove the

traditional middlemen overseeing the \$954 billion stock loan market in the US – and close the kind of stock settlement loophole that allows traders to “naked short sell” shares they hadn’t actually borrowed”: a compelling promise.

2.2.2 New solutions for equity markets

SEC recent rulings have paved the way for a profound disruption of equity markets both in private and public equity settings, exceeding equity crowdfunding opportunities. It is a major step forward for the development of blockchain technology in the financial industry, by recognizing the use of “cryptoequity” to issue or trade securities. The terms crypto-equity and cryptoequity are different. According to Swarm (“What is Cryptoequity?”, 2014), crypto-equity designates “an equity equivalent that is issued on a cryptographic ledger” which will be the main focus of this paper; whereas cryptoequity is an umbrella term that Swarm¹ divides into the following categories:

- (1) Product presales in which the token serves as a coupon redeemable for a real world good (i.e. the Comic Book sale done via Swarm²)
- (2) Product sales in which the token is redeemable for some service in a decentralized network (i.e. Storj³ or Ethereum⁴)
- (3) Product sales which serve as a “subscription” or membership to some decentralized network (i.e. Swarm¹)

¹ Swarm is the first online distributed crowdfunding platform built on the bitcoin blockchain, launched in June 2014. Startups can raise funds by issuing their own coin, representing crypto-equity in the company. The platform’s own crowdsale worked the following way: “Holders of Swarm’s own coin (SwarmCoin) will receive a percentage of these new coins as a reward for their support of the Swarm community. This means by investing in Swarm you will be rewarded with additional coins from successful campaigns” according to the Bitcoin Magazine (“Swarm Redefines Crowdfunding”, Hofman, A., 2014) retrieved from <https://bitcoinmagazine.com/articles/swarm-redefines-crowdfunding-1401991272>

² In July 2014, the comic book “The Hunt for Satoshi” was the first crowdfunding project on the platform, through the comiccoin tokens. They are redeemable and entitle owners to perks (like special editions), have voting rights, but they are not equity claims.

³ According to Storj’s Crowdsale terms: “Storj has decided to hold a crowdsale to aid in development and to offer early adopters a chance to experience our software before anyone else. The goal of the Storj team is to raise up to 9,800 BTC”, retrieved from Storj website, <https://storj.io/CrowdsaleTerms.pdf>

⁴ Ethereum CEO, Vitalik Buterin announced a 42-day presale for the platform’s coin Ether in July 2014, and reminded that: “Ether is a product, NOT a security or investment offering. Ether is simply a token useful for paying transaction fees or building or purchasing decentralized application services on the Ethereum platform” retrieved from Ethereum website, <https://blog.ethereum.org/2014/07/22/launching-the-ether-sale/>

(4) Token which serves as a license to use some type of intellectual property, potentially with an attached legal contract (i.e. sales being conducted in the Swarm 5th of November launch¹)

(5) “Shares” serving as stock equivalent for organizations that have no legal entity (i.e. BitShares²)

(6) Shares serving as stock for legal entities (i.e. Overstock/Medici)

Essentially the term cryptoequity regroups many possible applications using cryptocurrencies to represent assets, services or equity shares of a business – in the same way that bitcoins are considered like shares in the bitcoin payment system – through registration by smart contracts. Vigna and Casey (2015, p.227) further describe such coins as digital vehicles created to perform decentralized actions such as the exchange of digital assets or execute smart contracts, rather than currencies. They are similar to digital tokens and can be issued at very low costs and easily transferred. However, there are two intrinsically different categories among them. Shares serving as stock (6, above) are legally binding. They are investment vehicles similar to the ones trading on traditional markets, and the “same set of legal rights, privileges and protections will be associated with it and the company itself will be subject to the same laws and regulations” (Walsh, 2015). The other cryptoequity category includes tokens that can also track the company’s performance and reward the digital asset bearers on this basis, but they are not legally binding.

Companies such as Next, Ripple, Mastercoin, Ethereum, BitShares, Counterparty and Stellar have platforms on top of which it is possible to issue and trade digitized assets and to create peer-to-peer contracts in a decentralized way. These platforms have many advantages over the traditional financial system, which will be further discussed later on, such as streamlining equity transactions and mitigating risks. But more importantly, they lay the foundations for a parallel system to the existing one, such as alternative trading systems (like tØ described above). MPEX is one of the first of this kind. It became live in

¹ On November 5, 2014, Swarm chose 5 projects from a pool of applicants to launch a crowdsale.

² BitShares is a peer-to-peer trading platform allowing to “trade in Gold, Silver, Gas, and Oil in addition to your national currency and cryptocurrencies. [...] The BitShares exchange can support assets that can track stocks, bonds, indexes, or inflation. Companies can issue their own stock on the BitShares network and allow easy, low-cost trading”, retrieved from <https://bitshares.org/technology/decentralized-asset-exchange/>

2012, as the first securities exchange platform to trade digitized assets quoted in digital currencies, including stocks, bonds, and options. The platform hosted the first large bitcoin-only acquisition operation: in 2013, the online gambling site SatoshiDice was sold for 126,315 bitcoins (equivalent to \$11.47 million at the time) to an undisclosed buyer, as reported by VentureBeat (Ludwig, 2013). Prior, SatoshiDice was listed on MPEX, with shareholders buying equity in bitcoin on the exchange platform. One conclusion to draw from this illustration is that the span of the opportunities offered by blockchain technology is not constrained to private equity markets, but has a broader innovative potential.

Indeed, startups designed to provide alternative solutions to the current system have been booming. The World Economic Forum's executive summary of the report *Future of Financial Services 2015* (2015b) argues that "because they are many in number and work in parallel, they can iterate and test potential solutions at a rate that traditional institutions simply cannot hope to compete with". Such ventures are very flexible and targeted, which makes them a lot more efficient. Looking at online crowdfunding platforms for example, current intermediaries in the financial system – like venture capital funds – are facing acute competition in deal sourcing since the emergence of AngelList and their syndicate model.

Even traditional services performed in equity markets such as rating functions have found substitutes: in 2014, Coinist beta version was launched. Its purpose is to rate the companies, digital assets and cryptocurrencies of the blockchain ecosystem. The function the company performs is fundamentally the same as rating agencies such as Moody's or Standard and Poor's – that is to say, to assess risk – but in a specific space and industry. Equity markets are being re-thought by new services treading on incumbent's toes: equity crowdfunding or new stock-trading platforms bypass their long-established control. This can also be seen as a healthy and much-needed competition, forcing financial services to redesign themselves and to get rid of their inefficiencies.

2.2.3 Applications in the traditional financial system

Blockchain technology has indeed empowered new actors to create innovative solutions that challenge the way the current financial system operates. But it wouldn't be fair or accurate to consider that incumbents are simply not reacting. The growing interest in the technology actually comes primarily from existing financial institutions. They have invested extensively to explore the potential of the technology; not only to integrate it to their existing systems, but they have also backed blockchain-focused financial startups and entered partnerships with them. Here is a segmentation of the strategies financial institutions have pursued to exploit the technology (Evry, 2015, p.43):

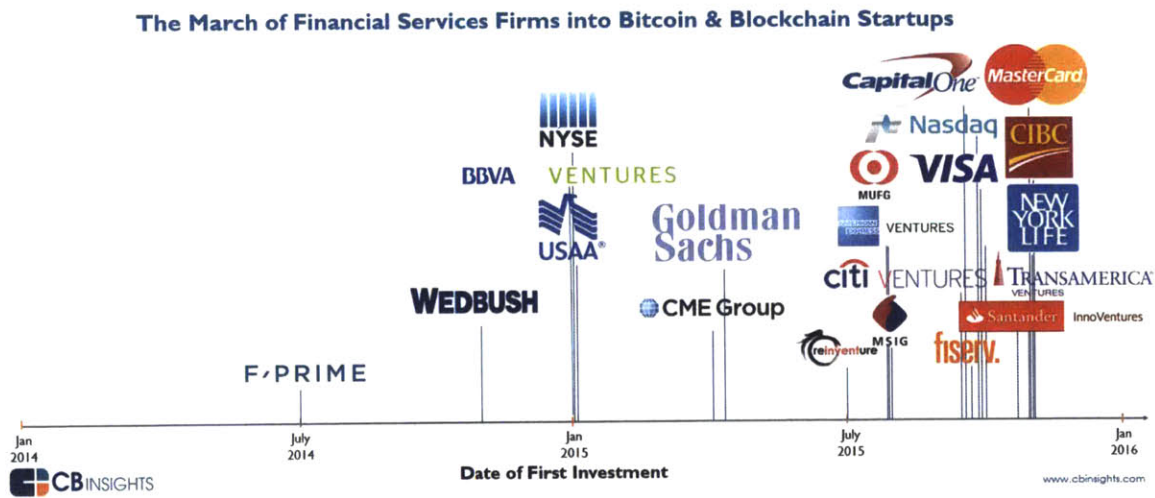
- **Investment:** powerful incumbents have decided to participate in the promising future of blockchain-based ventures. First in line, Goldman Sachs acting as a venture capital investor, poured \$50 million in a fundraising round for the payment and wallet platform Circle in 2015. Santander also invested \$32 million in the transaction platform Ripple and set up a \$100 million fund, InnoVentures, focusing on fintech and mostly blockchain opportunities. Visa, Nasdaq, and Citi among others formed a syndicate to invest \$30 million in Chain, a service designed to help institutions build and develop blockchain platforms.
- **Partnership:** some financial institutions chose to enter partnerships with innovative ventures – which could be seen as a way to outsource research and development in the technology. For instance, in 2015, UBS and Clearmatics agreed to cooperate to build a global securities settlement system. In the same year, Barclays partnered up with the Swedish startup Safello in order to explore a proof-of-concept based on the blockchain.
- **In-House development:** finally, some incumbents are also looking into how to integrate the technology into their current practices. Nasdaq launched Linq in 2015, an issuance and exchange platform for private equity based on the blockchain. And large banks such as Citibank and RBS have been developing and testing their own internal cryptocurrencies over the past months.

Finally, one last strategy should be added:

- **Consortium:** other institutions allied their forces to get the best out of the opportunities offered by blockchain. The largest consortium is R3CEV, founded in

2014, composed of 42 banks (called the Distributed Ledger Group) to “design and deliver advanced distributed ledger technologies to the global financial markets”¹.

Whatever the strategy they chose to pursue, the pace of investments by financial institutions has rapidly increased over the past year (as shown below) and indicates that blockchain technology has gained momentum.

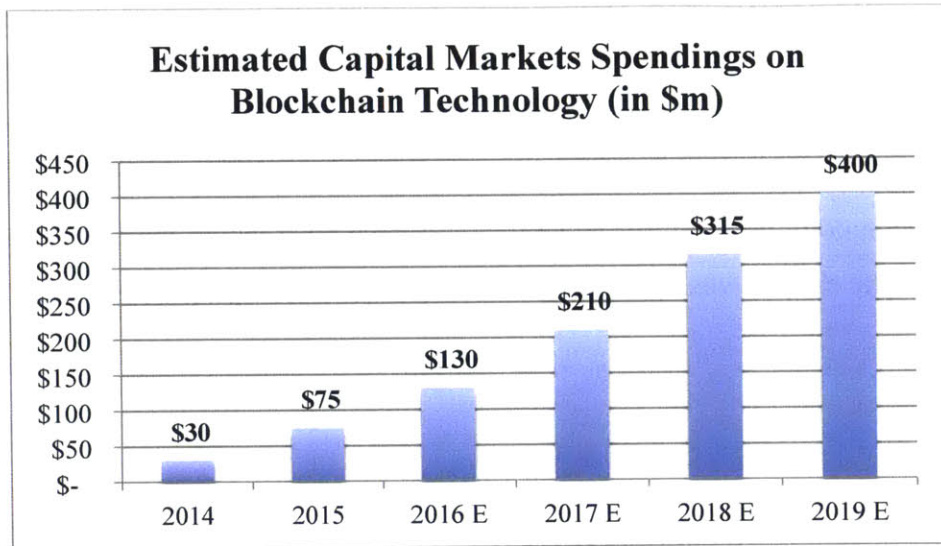


Source: CB Insights, “The March Of Financial Services Giants Into Bitcoin And Blockchain Startups In One Chart”, 2015²

What’s more: momentum is not expected to fade. Aite Group “sees a steady increase of capital markets’ IT spending in blockchain technology over the next five years” (Lee & Wang, 2015). According to them, financial institutions have invested \$75 million in the blockchain in 2015 only (+150% versus 2014), and they are expected to invest around \$400 million in 2019 (equivalent to an impressive 52% compound annual growth rate between 2015 and 2019), as shown below.

¹ Retrieved from R3 website <http://r3cev.com/about/>

² Retrieved from <https://www.cbinsights.com/blog/financial-services-corporate-blockchain-investments/>



Source: Lee & Wang, "Demystifying Blockchain in Capital Markets: Innovation or Disruption?", Aite Group, 2015

Financial institutions are investing and experimenting with a large array of applications. They have grasped the technology's potential to save costs, create efficient products and services and disintermediate the market by eliminating the need for middlemen, streamlining operations and increasing transparency. The White & Case report (2015, p.5-8) presents some of the major areas of applications for the technology in financial services:

- Trade execution and settlement: the ledger stores the change of ownership record automatically and thus settlement of trades is cheaper and faster.
- Asset exchange: virtually any asset (both tangible and intangible) can be digitized and securely traded through the use of digital tokens.
- Cash reserve management: by allowing faster transaction execution and fewer intermediaries involved, settlement risks for financial institutions would decrease, and less collateral would be needed to cover these risks.
- Smart contracts: they would allow transactions and complex contracts to be automatically executed on the blockchain, thus bypassing counterparties and intermediaries.
- Algorithmic regulation: regulation in the financial system can also benefit from the blockchain by creating algorithms to identify patterns related to fraud. Banks will be able to access a transparent, traceable and incorruptible history of their transactions.

To conclude, traditional financial institutions have visibly understood the disruptive potential of blockchain technology and are exploring the ways they can benefit from it. Blythe Masters, CEO of blockchain company Digital Asset Holdings and former J.P. Morgan executive, told Bloomberg in a much talked-about interview “You should be taking this technology as seriously as you should have been taking the development of the Internet in the early 1990s, it’s analogous to e-mail for money” (Robinson & Leising, 2015).

3. Framework of benefits and difficulties of using blockchain technology in equity markets

“It lets you create a version of Wall Street that nobody can cheat. A whole category of mischief that’s occurred on Wall Street for decades is eliminated on this system”¹. Patrick Byrne, CEO of Overstock and long-time detractor of Wall Street vigorously denounces the excessive costs borne by current financial processes and abusive practices, arguing that blockchain-based systems have the solution. Interesting fact: in the same year, one of the biggest financial crises in history unfolded and Nakamoto published his whitepaper, introducing bitcoin.

3.1 Frictions in existing markets

3.1.1 Trust issues

The financial system has been tremendously challenged and criticized since the 2008 financial crisis, which had dramatic and durable repercussions globally. Vigna and Casey (2015, p.64) describe the appalling state of the financial industry after this breakdown:

Nobody trusted asset valuations, nobody trusted price quotes. Nobody trusted the banks’ balance sheets. The entire machinery of the global capital markets seized up, coming to a grinding, smashing, disastrous halt, because nobody trusted anyone anymore.

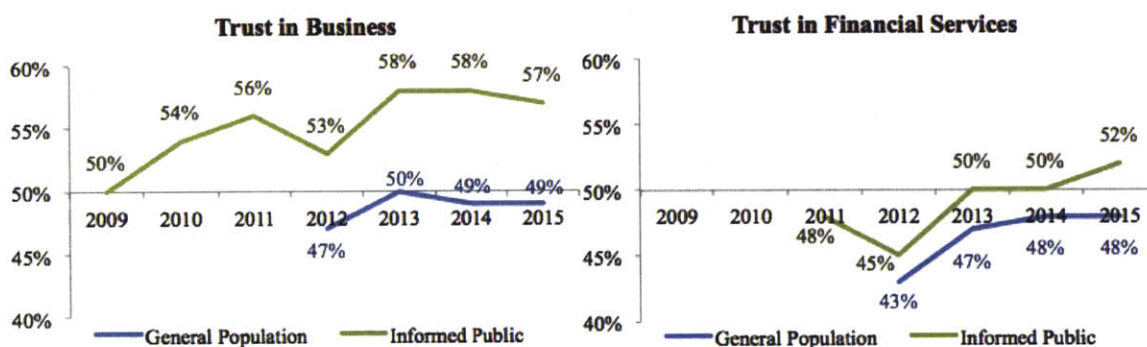
Indeed, one of the most disastrous consequences of the crisis was undermining trust in the financial system. Financial institutions broke the trust people placed in them and on which they rely to assume their functions. Evidence of illegal practices and abuses were widely exposed in the press and led to a vendetta against banks and the entire financial system. These trust issues deeply affected equity markets as argue Zingales and Sapienza in the City Journal (2009): “As trust declines, so does Americans’ willingness to invest their money in the financial system. Our data show that trust in the stock market affects

¹ Citation retrieved from Motherboard article, “Overstock Wants To Fix Wall Street By Trading Brokers for the Blockchain”, (Pearson, J., 2015), <http://motherboard.vice.com/read/overstock-wants-to-fix-wall-street-by-trading-brokers-for-the-blockchain>

people’s intention to buy stocks, even after accounting for expectations of future stock-market performance”. Trust is the foundation of financial services and an essential requirement for the entire system to create growth.

Hence, the crisis led to a call for change: people were looking for a real overhaul. The Edelman Trust Barometer measured the mistrust towards the financial industry. Results are based on surveys which evaluate people’s trust level across different countries and industries. In 2015, they surveyed 33,000 people in 27 countries. In particular, the trust level analysis across industries showed that financial institutions and banks rank almost last among the 15 industry sectors represented (Edelman, Annual Global Study, 2015a, p.11). Below is the evolution of the trust barometer in Financial Services compared to Business in general over the past years for general population and informed public¹:

Long-term trend: recovery has stalled



Source: Edelman, Annual Global Study, 2015 Edelman Trust Barometer Financial Services, 2015a, p.12

The first conclusion is that people trust general business more than financial services, and this gap is not really shrinking. After the drop in general trust in 2012, businesses have been re-gaining trust at a much faster rate than financial services, which still trigger very skeptical responses. It looks like the bitter taste left by the financial meltdown in 2008 didn’t entirely go away, even if there is evidence of recovery. Significant regulatory reforms were undertaken to straighten up the existing system and restore trust. Requirements for banks, for example, were hardened with Basel III agreements, through larger capital requirements, risk coverage and management, and market discipline rules. Moreover, the international system agreed to implement global liquidity standards and

¹ Informed public meets four criteria: age 25-64; college-educated; household income in the top quartile for their age in their country; significant media consumption and engagement in business news weekly.

supervisory monitoring, as explained by the Bank for International Settlements¹. Yet, some issues remain and need to be tackled. The Edelman report actually states that 2/3rds of surveyed countries want more regulation in the financial industry (Edelman, 2015a, p.24). In addition to the mistrust due to fraudulent practices, cyber-attacks create further anxiety around the weakness of the financial system. Most financial institutions' IT systems are currently incapable of dealing with large-scale cyber-attacks, especially for big firms, with very complex and global infrastructures to manage. Plus, networks are so interconnected globally that a single point of failure could result in dramatic consequences for the whole system.

This climate of mistrust largely encouraged the emergence of alternative models and solutions to the traditional ones, in the shape of fintech companies and applications of new technologies. As a matter of fact, people tend to confide a lot more in fintech startups rather than in the old system. For instance, while trust in the financial industry overall is 54%, trust in electronic payments is as high as 62%, according to Edelman (2015b). Even more striking: it is the “only innovation story that scores better than its respective industry overall” (Edelman, 2015b). Therefore, new solutions brought by innovative technologies can help restore part of the trust that was lost in the financial industry.

3.1.2 Cost frictions and information issues

Nasdaq defines friction costs as the following: “costs, both implied and direct, associated with a transaction. Such costs include time, effort, money, and associated tax effects of gathering information and making a transaction”². Such frictions are prevalent in the current structure of public equity markets. As a matter of fact, private equity markets also bear a lot of underlying frictions for share issuance and trading.

First, let's focus on the machinery behind transactions in public stock markets. Rather than having a simultaneous peer-to-peer exchange of cash versus shares between a buyer and a seller, the current system involves many more intricacies and intermediaries. Throughout their evolution, marketplaces and exchanges became increasingly complex

¹ Retrieved from Bank for International Settlements website <http://www.bis.org/bcbs/basel3.htm>

² Retrieved from Nasdaq website <http://www.nasdaq.com/investing/glossary/f/friction-costs>

during their maturation process. A multitude of new kinds of assets was created, and different layers of trusted third parties appeared, responsible for holding and managing assets for others. Risks of fraud and abuse entailed by this system – combined to the subsequent crises they triggered – generated the need for additional parties, rules and infrastructure to control transactions and mitigate risks. In reality, many intermediaries and processes are involved for a simple trade to take place in the market.

Basically, there are three major steps in a stock trade: execution, clearing, and settlement. First, the buyer and the seller of the security agree to the transfer on the market. These orders are sent to stockbrokers or dealers who execute them. Then, third parties are responsible for clearing the transaction. They record it and make sure it is valid, meaning that both the seller and the buyer have the asset or cash counterparty required for the exchange. The final stage is the settlement, where the title of the security is delivered to the buyer and the corresponding cash counterpart is transferred to the seller. One last important actor is the custodian, in charge of safekeeping and managing assets for buyers and sellers. Together, these agencies perform essential functions to keep the system honest and running. But it is a lengthy process – currently, it takes around three days to be completed in the US stock market, “T+3”– involving fees, and multiple risk and information transfers. Risks are also considerably augmented due to the length of the process. DTCC¹ (2014, p.2) argues that: “Shortening the settlement cycle mitigates operational and systemic risk by reducing counterparty exposure, procyclicality and liquidity risk from both a clearing agency and member perspective.”

The complex transaction structure bears another huge pain-point: information reconciliation. First, the registration process used to record, transfer and deliver titles of ownership is costly and cumbersome. Then, the system is susceptible to account for multiple versions of the truth, since information is siloed within the different layers of the transaction’s process, and there is very little standardization globally to facilitate information transfers. Reconciliation of the truth requires banks to maintain large and costly libraries of codes for this purpose (DTCC, *Embracing Disruption*, 2016, p.7). There can also be inexactitudes in the instructions given to the custodian by the broker,

¹ DTCC: Depository Trust & Clearing Corporation. DTCC is an American financial services corporation, operating clearing and settlement functions in financial markets.

for example, or mistakes in the registration of titles of ownership, considering all the participants involved. The Euroclear and Wyman report (2016, p.9) argues the following:

Storing and agreeing datasets of financial obligations and ownership forms the basic core of capital markets operations. The current methods are highly complex, utilize fragmented IT and data architectures and suffer from a lack of common standards. This creates the continual need to reconcile data with massive systems and process duplication, leading to high costs and protracted time to execute tasks.

Yet, reconciliation is not the only source of vulnerability and costs. As a result of the multiple-layer transaction structure, the middlemen involved in a transaction are given access to information and private data, and currently, there is no control over this. Finally, multiple marketplaces and service agencies are performing these tasks internationally, leading to a discrepancy in standards, thus making global integration challenging. But, the overall system is rather efficient.

However, there are considerable costs entangled in this process. First of all, each of the intermediaries involved in the transaction is paid a fee for its service. Autonomous Research (2016, p.5) assesses the annual costs of back-office at \$54 billion globally, accounting for roughly a third of the \$163 billion total costs of sales and trading. Back-office includes clearing, settlement and custody functions, and other costs related to transactions such as “financing books and records, reference data, reconciliations, corporate actions, tax and regulatory reporting”. There are also costs linked the very nature of the transaction: how can we verify that the counterparty has the assets it claims? Intermediaries processing the transaction need to reduce this risk, called counterparty risk. In order to do so, they have to hold a portion of the transaction amount as part of their capital requirements. Autonomous Research (2016, p.7) also estimates that the thirteen biggest capital market players in the US and Europe on their own hold \$120 billion in capital requirements dedicated to mitigating counterparty risks.

In addition to public equity markets, issuing, trading and keeping track of private equity also bears significant costs and inefficiencies. Similar to the above transaction process,

issuing equity in an IPO requires many intermediaries and thus incurs frictions. Investment banks run the process – called underwriting – and receive large fees for doing so. First, in order not to bear all the risk of the transaction, the lead bank can form a syndicate of underwriters with other investment banks. When this step is completed, the underwriter has to put together a registration statement for the SEC, which in turn investigates the company and sets a date for the IPO. Once the prospectus is issued, the underwriters go on a road show and present the investment opportunity to prospective buyers, who can order shares. Commitments are combined to form an order book. Then the underwriter allocates shares to the investors before the listing. In addition to a fixed fee for underwriting, banks typically make more money because they buy the shares before they are listed on a stock exchange, and make a profit on the difference between this initial price and the public offer price. There are huge costs linked to banks handling the process, added to marketing costs and registration burdens. This operation overall incurs a lot of frictions; the process is cumbersome to manage and also very lengthy. As for a large private placement, even though securities do not have to be registered, hiring an intermediary to execute it is also costly and takes time. Even when raising capital through equity crowdfunding platforms, there are usually fees for using them. Platforms are used as trusted third parties responsible for selecting worthy projects, putting investors and ventures in contact, providing tools for marketing campaigns and a secure way to transfer pledges.

Moreover, holding private equity is costly because of their illiquidity and to the time horizon of the investment. Trading private equity is neither common nor easy. In most cases, an investor has the opportunity to exit his/her investment only when a liquidity event occurs (IPO, M&A or sale of the company). That means that there are important opportunity costs for investors, and thus, private shares' prices usually bear significant discounts called illiquidity discount. Damodaran, in his paper *Estimating Illiquidity Discounts*, gives a rule of thumb to estimate the typical illiquidity discount: around 20-30%, which does not vary much across private firms. The last, very important pain-point is data related. It is very complicated to track information on non-listed stocks and access it easily. Hence, this leads to transparency and accountability issues for both investors and management teams. Furthermore, companies now tend to stay private longer than

before. Forbes reports that the average time for a startup until IPO was five years in 1994, six years in 2004 and eight years in 2014 (TrueBridge Capital, 2015). This means that later funding rounds are becoming a lot larger – sometimes referred to as private IPOs – and that investors require more liquidity and transparency.

3.1.3 Technical limitations and abuses

The existing market infrastructure also bears technical limitations resulting in inefficiencies and vulnerabilities. The main one is a consequence of the multi-layer structure of the transaction process: it multiplies potential points of failure and adds delays and vulnerability to the entire network. The second risk of failure lies in the centralization of the existing system. Central Counterparty Clearing Houses around the globe, for example, have a critical importance to ensure the financial stability of the markets, and a breakdown would rattle the entire system. DTCC (2016, p.7) evokes two additional limitations:

- Vulnerability to technology threats: hackers and cyber-terrorists are developing very powerful tools to access markets' secure networks, which could result in data compromises. Current systems are not capable of sustaining this kind of cyber-attacks.
- Market processing time: unlike a lot of today's services globally, transactions are not being processed 24/7/365, which results in further delays and lost opportunities.

Finally, the current setup of the financial system allows the existence of many abusive practices. Lee (2016) exposes some of the irregular practices in stock markets that could find a solution thanks to blockchain technology: issues with stockbrokers, high frequency trading, and naked short-selling.

Stockbrokers and dealers are one layer in the transaction process described above. They are the intermediaries through whom orders necessarily go in order to be completed. They decide how they want your trade to be executed. Although this process appears to be seamless, it takes time to reach the market, and, under current SEC rules¹, there is no minimum time requirement for execution imposed on brokerage firms. Therefore, since

¹ Retrieved from SEC website, <https://www.sec.gov/investor/pubs/tradexec.htm>

quoted prices on the market are only viable for a limited number of shares and in a limited period of time, there can be large discrepancies in stock prices between the moment a buyer puts an order in and the moment it reaches the market. Broker-dealers obviously get a fee for their service, but the problem is that they can take advantage of their intermediary position for fraudulent purposes. For instance, they can maximize their commissions through “churning”, that is to say, trade at an excessive frequency with the intent of making personal gains, as defined by the Securities Fraud and Investor Protection Resource Center¹. Another common abuse is insider trading: the use of privileged information to make a gain on stock markets.

Other abusive practices that could potentially be resolved using blockchain technology in security markets include high frequency trading and naked short selling. High frequency trading (HFT) refers to computers trading based on algorithms dealing with large financial data sets and trading rules. They produce high speed and high volume trades which can lead to very sharp ups and downs in the market in intervals as short as several minutes. Spoofing is an illegal practice defined by the SEC as follows: “The trader places orders with no intention of having them executed but rather to trick others into buying or selling a stock at an artificial price driven by the orders that the trader later cancels” (2012). Short selling is a legal practice, occurring when a seller sells a stock in the market that he himself has borrowed, hoping the price will drop and he will buy it back cheaper. Naked short selling designates the same practice with the only distinction that the seller hasn’t actually borrowed the stock he is selling and has no intention to do so within the T+3 settlement period of the trade. If the seller doesn’t deliver at all, this is considered as a “fail” and Lee (2016) states that “settlement failures, whether purposeful or accidental, account for approximately 20% of total trades”.

¹ Retrieved from Securities Fraud and Investor Protection Resource Center website
<http://www.securitieslaw.com/information/causes-of-action.asp>

3.2 Advantages of the blockchain

Maybe some of the issues in equity markets mentioned above could find a solution in blockchain technology. The blockchain has many advantageous features that can massively benefit equity markets by proposing improved structures for transactions, share issuance, and recordkeeping.

3.2.1 Disintermediated and secure

The first major contribution of blockchain technology to equity markets is that it would enhance trust dramatically while at the same time streamlining processes.

As we have seen previously, blockchain technology is based on a decentralized network and distributed consensus. These features remove the need for a central authority to oversee transactions and for trusted third parties to assume the role of middlemen and risk bearers. It is a trustless system in the sense that the network can assume and replace the functions of some of the intermediaries involved in transaction processes. Indeed, when a transaction takes place on the blockchain, the sender and the buyer enter in a direct digital agreement. The transaction is immediately broadcasted to the entire network, which in turn takes care of validating it and transferring the corresponding assets. The multiple miners composing the distributed network are responsible for validating the transaction and as such, are guarantors of the accuracy and the security of the system. Vigna and Casey argue in that sense: “Many decided it was better to trust this inviolable-algorithm-based system than the errors and fraud prone human beings that run the large institutions at the center of the old monetary system” (2015, p.66). Any transaction that has taken place on a blockchain, whether it was a trade or stock issuance, is being recorded on a single, transparent and incorruptible ledger. Whether this ledger is made public or not (depending on the type of blockchain in question), it is almost impossible to be tampered with¹.

¹ The proof-of-work system makes it virtually impossible to change a past transaction versus a proof-of-stake system. Buterin explains it as follows: for proof-of-work, “the incentive is to support the chain that everyone else supports, forcing rapid convergence, and preventing successful attacks provided that at least 51% of the network is not colluding”. On the other hand, for proof-of-stake systems, “there is nothing at stake” meaning that “the optimal strategy is to mine on any fork that you can find. Thus, in order to launch

Those benefits can be applied to the process of stock trades in equity markets. The White & Case report (2016, p.4) asserts the following:

Blockchain technology revolutionizes the transaction process by dispersing control and providing total transparency, obviating the need for the type of middlemen or centralized authorities that traditionally conduct, authorize or verify transactions.

Essentially, the need for brokers, clearing houses or settlement firms could be suppressed altogether. The central exchange itself would be irrelevant since transactions could take place on the decentralized ledger. In theory, there wouldn't be any need for brokers to execute transactions since they are automatically broadcasted to the network. The network will also verify that each party involved in the transaction holds the assets it claims and that they have not been spent already (removing double-spending risks): this step is immediate and verified by multiple parties. Therefore, that eliminates the necessity of clearing, supervision and IT infrastructure related. Finally, when the transaction has been validated thanks to a distributed consensus (such as a proof-of-work in the case of the bitcoin blockchain), the transfer of the stock and the corresponding cash is immediately taken care of within the network through the execution of a "smart contract" – a protocol read by the network of computers enabling them to verify and enforce contracts. This final functionality also removes the need for settlement functions. In addition, all restrictions and requirements linked to a specific asset can be coded on top of a digital asset, using a technology like Colored Coins: "Unregistered securities can be coded as unregistered, shares with restrictions on resell can be coded with the exact resell restrictions so that there is no confusion on when the shareholder may sell the shares" (Lee, 2016, p.52). Some banks have already been testing the advantages of the technology. The startup Ripple, for instance, has created a global exchange platform based on a distributed ledger, allowing banks to transact between themselves in real time with no central authority or intermediary, saving them a lot of cost and time. 10 of the

a successful attack, an attacker need only overpower all of the altruists who are willing to vote only on the correct chain", retrieved from <https://blog.ethereum.org/2014/07/05/stake/>

25 top banks work with Ripple, and 116 million exchanges have already been processed on the network¹.

Blockchain technology also has strong implications for private equity markets, as a simple and revolutionary means to issue, transfer and keep track of non-listed stocks. Access to funding for private companies can be a complicated process, bearing significant costs: the blockchain would allow streamlining equity offerings and trading (if need be). Blockchain-powered platforms dedicated to private stock, such as Nasdaq's Linq platform, enable companies to easily issue stock with fewer frictions than in the existing system, by removing intermediaries and letting the issuer lead its own offering, and largely facilitating the registration process. Furthermore, such platforms can also propose a secondary market for trading private stock, if the company chooses liquidity features for their shares. In the case of equity crowdfunding, the technology offers startups the possibility to bypass the central marketplace and lead their campaign themselves, directly, as we will see later on. Pledges from investors are received directly by the company and in turn, investors are issued digital assets and ownership titles through the use of smart contracts. Finally, there are a lot of cumbersome processes to manage for a private company, such as implementing milestones to incentivize investors when raising funds or executing contractual clauses in a liquidity event. Smart contracts could permit to perform some of these actions automatically, quickly and without any mistakes or fraud. For instance, smart contracts can guarantee that funds raised by investors would be released to the founder only if he/she reaches predetermined milestones, or that if the venture doesn't reach specific goals, the funds are returned.

3.2.2 Cheaper and faster

Since blockchain technology bypasses some intermediaries, their cuts on each transaction would be eliminated. The same goes for the high costs associated with information reconciliation and bookkeeping for titles ownership, which will be discussed below. The Autonomous Research (2016, p.5) estimates that between 20% and 30% (more likely) of the \$54 billion costs in annual clearing and settlement globally could be reduced by

¹ Retrieved from Ripple website <https://ripple.com/>

blockchain technology by 2021. This is equivalent to \$11-\$16 billion savings annually for the industry overall, on middlemen's fees and reconciliation processes by eliminating the costs of running a back-office. Furthermore, as mentioned above there is substantial capital tied up in the current transaction structure in order to mitigate transaction's default risk, accounting for as much as 9% of banks' capital requirements (Autonomous Research, 2016, p.7). The report expects that the blockchain could free up 5% of total counterparty risk collateral requirements – the major part still being required for over-the-counter derivatives trading. This somewhat small contribution would still free up \$6 billion (of \$120 total requirement) for the biggest thirteen capital market players in the US and Europe alone.

Another major contribution of blockchain technology to existing systems is the speed of the network processing. On the bitcoin blockchain, it generally takes about 10 minutes for a block to be immutably added to the blockchain, from the moment the transaction is made to settlement and recording. On the Ripple blockchain network, transactions only take between three to five seconds to be confirmed through validation consensus. This would allow transactions to be nearly instantaneous and go from T+3 to T+0. Reducing the time of settlement would have huge costs benefits since the volume of transactions in the pipeline could be multiplied and settlement risk would be infinitely smaller due to smaller time exposure. Nasdaq claims that, by using blockchain technology, “settlement risk exposure can be reduced by over 99 percent, dramatically lowering capital costs and systemic risk” (2015). Lee (2016, p.52) also adds that the very short time period needed to verify and execute the transaction will enable better clarity of ownership, and eliminate the window used by traders to exploit the system through practices such as spoofing or naked short selling.

All these benefits combined represent substantial savings for incumbent financial institutions. Santander, Wyman and Anthemis Group (2015, p.15) estimate that the “distributed ledger technology could reduce banks' infrastructure costs attributable to cross-border payments, securities trading and regulatory compliance by between \$15-20 billion per annum by 2022”.

As for private equity markets, the technology would entail significant cost and time benefits as well. Blockchain-powered platforms enable issuing, trading and executing transactions, with fewer frictions compared to existing systems. In theory, companies could execute private placements or IPO without banks handling the underwriting process. Bank fees for IPO underwriting are set as a percentage of the total amount raised, typically ranging from 3% to 7%, but it can be much higher depending on the size of the company (Lee, n.d.). As for private placements, removing third party agencies would also incur significant savings, since their fees are usually about 2% to 5% of the total amount raised, according to VC Experts (Bartlett, n.d.). In both processes, the blockchain infrastructure would save a considerable amount of time. As for equity crowdfunding platforms, they usually charge fees on investors in the form of a carry. For instance, on the AngelList platform, individual investment carry is 20% of which the lead recoups 15% and AngelList 5%¹.

In addition, the opportunity to trade private shares on blockchain-powered exchanges would lead to a substantial reduction in the illiquidity discount associated with holding non-listed shares, and thus to an increase in company valuation. The final cost reduction would come from the application of smart contracts, allowing more efficient and less costly investor management and equity bookkeeping.

3.3.3 Transparent and reliable

The last valuable benefit brought by blockchain technology lies in the transparency of its infrastructure. Records of all past transactions, titles and ownership are stored on a tamper-proof ledger. The technology allows the multiple parties involved to share the same ledger and benefit from a unique data source, hence providing automatic reconciliation. The data is securely stored and public at the same time.

This feature is a huge advantage for equity trading. Whenever a transaction occurs, the corresponding information is broadcasted on one shared platform in real time and not kept in silos by the different participants. Therefore, it provides a unique source of truth, synchronized and accessible at any time by all parties. This solves the burdensome reconciliation issues and recordkeeping traditionally undertaken by back-office services.

¹ Retrieved from <https://angel.co/help/syndicates>

The technology “could remove the need for data enrichment (such as aligning trade data with settlement data), reconciliations and disputes amongst counterparties” Euroclear and Wyman (2016, p.7). A. Zinder (personal communication, March 6, 2016) also claims that even if traditional participants in a trade, such as brokers, are still used on the platform, at least they will all work on the same ledger, therefore removing the risk of reconciliation errors and providing a tool for perfect auditability.

However, potential implications are not limited to stock trades. Benefits also apply to share issuance and non-listed shares trading: any change in ownership is immediately and indefinitely recorded on the blockchain. Since historical records of transactions are easily accessible, they can be effectively monitored and audited by the relevant authorities. The ledger also provides more transparency to private equity markets. It allows companies to have access to the entire history of transactions and ownership of their stock and therefore to be able to better control and monitor their equity. For example, Nasdaq’s ledger for private equity Linq offers these advantages. The interface enables entrepreneurs to have a simple and complete overview of the current and historic state of equity ownership and other key valuation metrics. In addition, on a blockchain-based network, propriety titles would be immediately and automatically registered, and their transfer would be executed by smart contracts, which saves substantial time and costs in recordkeeping. In conclusion, streamlining the issuance and trading processes would lead to more transparent, less complex and more reliable systems, independent of a central repository or multiple middlemen.

3.3. Disadvantages of the blockchain

3.3.1. Regulatory uncertainty

In June 2014, Erik Voorhes was fined \$50,000 by the SEC for issuing shares of SatoshiDice and FeedZeBirds through unregistered offerings in 2012. Andrew J. Ceresney, director of the SEC's Division of Enforcement, commented: "All issuers selling securities to the public must comply with the registration provisions of the securities laws, including issuers who seek to raise funds using Bitcoin" (SEC, 2014). Voorhes solicited investors through bitcoin-related websites and even published a prospectus on the Internet, but didn't file for an IPO with the SEC. Around a year later, in December 2015, Overstock's platform tØ gets SEC approval to issue shares using the blockchain. Regulation is indeed evolving towards including the technology in financial services and especially in equity markets frameworks, but substantial uncertainty remains. First of all, regulatory approval is essential for blockchain to become mainstream, as explained in the Euroclear and Wyman report (2016, p.14):

Disrupters in other industries (such as Airbnb and Uber) have adopted an 'act first, seek forgiveness later' approach to regulation. Innovations in financial markets, however, require the explicit blessing of regulators well ahead of time. New regulatory principles may be needed where blockchain technologies become an integral part of the market infrastructure, and where consensus protocols are run through an international network of nodes.

The regulatory focus for the past years was on bitcoin, mainly targeting the illegal activities it supported, and not on the blockchain. However, with all the recent traction gained by the technology, more regulation is on its way. Yet, blockchain is a complex technology and regulators need to fully grasp it before they can create a regulatory framework around it. Autonomous Research (2016, p.10) considers that a vast majority of regulators are currently in this first stage, except for the Bank of England and the Bank of Canada, which are already in a second stage: exploring the risks and opportunities of the technology. Stage 3 is the step when they will work on designing actual rules, but no one is there yet. Currently, Autonomous Research believes that "regulation of blockchain

still feels relatively hands-off as the regulators themselves get up to speed on the technology. We think this will change at some point over the next two to five years – putting a temporary brake on the speed of development” (2016, p.10).

The main issue at this stage is the lack of legal and jurisdictional clarity on the technology. Interestingly, blockchain can also prove to be a valuable tool for regulators as a mean to track transactions and monitor financial institutions’ activities. However, there are legal requirements which are incompatible with the technology. Complications especially arise when a transaction needs to be amended, after the settlement of a legal dispute for example, since transactions on the blockchain are irreversible. Another problem with regulation is that it is not at all harmonized, neither in the US nor internationally. This creates regulatory arbitrage opportunities, favoring some lenient countries such as Switzerland or other Central and Eastern European countries.

In addition to regulation uncertainty, there is fear in the industry that the regulation will come too soon and be too strong to allow for the blockchain to grow to its potential. Deloitte (2015, p.2) claims that history has proven that revolutionary technologies which had a transformative impact on society required time to evolve before being confronted with heavy regulatory supervision, and that “serious efforts to regulate disruptive technologies have traditionally been a function of the technology achieving mass adoption”. For instance, the Internet was invented in 1969 and strong regulatory focus only took place over the recent years, more than 40 years into its development. It took 37 years for the telephone, 35 years for airplanes, 20 years for the radio and 24 years for mobile phones (Deloitte, 2015, p.4). The concern for equity markets – and more broadly, for the financial industry – is that too much regulation would hinder the creation of valuable applications. CFTC¹ Commissioner J.C. Giancarlo made a Special Address Before the Depository Trust & Clearing Corporation in 2016 in that sense, alluding to the last breakthrough technology, the Internet:

It is time again to remind regulators to ‘do no harm’. [...] I believe that innovators and investors should not have to seek government’s

¹ CFTC: Commodity Futures Trading Commission

permission, only its forbearance, to develop DLT¹ so they can do the work necessary to address the increased operational complexity and capital consumption of modern financial market regulation.

3.3.2. Adoption hurdles

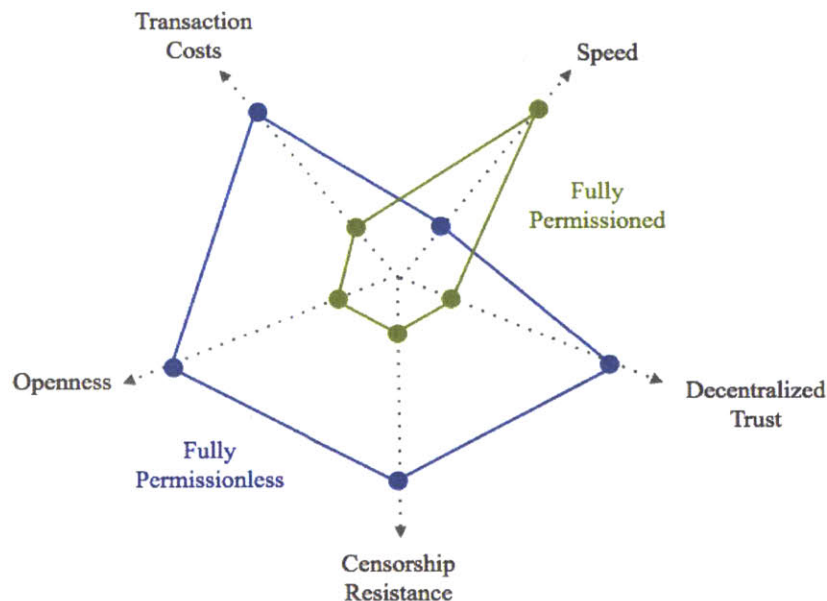
Although companies are building on the blockchain's potential at the moment, there are diverging views on how to do so, and implementation hurdles.

The main divergence lies in the fundamental view of the technology: should it be kept open and decentralized or in some way controlled? Both approaches are possible respectively by using permissionless and permissioned networks. The initial purpose of the technology – as Satoshi Nakamoto and his early evangelists see it – is to disintermediate processes and put control back in the hands of users. Nevertheless, the vast majority of traditional financial institutions is exploring permissioned blockchains, which basically means that they would use the distributed ledger technology but only sharing it with vetted actors, thereby reaping the benefits and centralizing the technology amongst themselves. There are two ways to do that: build a private blockchain, or build a permissioned application on top of a permissionless blockchain (such as Bitcoin or Ethereum) using technology like Colored Coins. One example of the former technique is Ripple, which aims at using blockchain technology for interbank exchanges, through the use of its own ledger and cryptocurrency XRP². The Ripple network was theoretically intended to be permissionless, like the bitcoin blockchain, but in reality, it works more like a permissioned network, as Swanson (2015, p.58) explains, since the nodes have to be registered and acknowledged as trusted parties by the network in order to participate. Thus, the network (and the applications on top of it) is permissioned: the same institutions that use it undertake the validation task by freely allocating computing power to the network. Ripple wasn't meant to compete with the existing system, but to improve it by providing immediate and bilateral clearing and settlement between actors in the financial industry. Ripple provides a faster, cheaper and more secure way of transacting.

¹ DLT: Distributed Ledger Technology.

² XRP is a token, conveying information in the network as well as store of value for participants.

No system between permissioned and permissionless is intrinsically better than the other. Yet, there are trade-offs between both options simplified in the chart below. Swanson (2015, p.6) argues that “due to their gated approach, permissioned systems as a whole are capable of clearing and settling assets faster and are cheaper to maintain than capital-intensive permissionless systems.”



Source: Ghalim, “Why we should drop the whole “Bitcoin vs blockchain” discussion”, 2015

Indeed, fully decentralized trust, and censorship resistant features are very valuable but they come at the cost of speed and cost. On the other hand, Ghalim (2015) argues that “permissionless blockchains are far more disruptive and transformative” and bear no single point of failure, whereas permissioned ledgers are a very efficient way to improve current systems amongst existing actors.

Another risk of permissioned networks, feared mainly by the cryptocurrency enthusiasts is explained by Vigna and Casey (2015, p.237): “The hope is that those who issue a cryptocurrency won’t exploit the unique power of that role that they won’t engage in the same seigniorage practices as traditional central banks and make money for themselves simply by making currency”. At the forefront of the skeptics is Patrick Byrne, CEO of Overstock, warning the blockchain community against the risk of seeing existing financial institutions reap the benefits of the blockchain. He mainly targets R3, the banks consortium exploring the technology opportunities: “What’s happening is Wall Street is

trying to slow us down while they come up with their own version, and that's, I think, R3 [...] and then they're going to outlaw [the competition]"¹.

In addition to the skepticism and conflicting views on how to implement the technology, there are also immediate hurdles in the widespread adoption of the technology. First, all structures can't be suddenly entirely disintermediated. Intermediaries play an essential role in all segments of equity markets. Let's take equity crowdfunding for example; blockchain can enable founders to raise money on their own with no central platform. But platforms play fundamental roles for both startups and backers: they certify and curate deals. They also allow founders to reach a large enough investor base and to market a fundraising campaign. In addition, syndicates have proven to be extremely valuable on AngelList: "Overall, syndicates enhance economic growth by reducing market failures and allocating capital more efficiently" (Agrawal, Catalini & Goldfarb, 2015, p.10). As for private placements or IPOs, underwriters are also crucial in the process: they are the ones who do the due diligence, pitch the opportunity to investors, advise the issuer and bring their financial expertise. The same goes for some parts of public equity markets. In stock trading, for example, not all traders are experienced enough to trade without a broker. As Lee (2016, p.55) explains it, traders can make peer-to-peer transactions on the blockchain by directly finding a counterparty for a trade. However, matching might be very hard to achieve without traditional intermediaries, namely exchanges, market makers and broker-dealers. Instead of a complete disappearance of third parties, new intermediaries are created within the blockchain space. The Financial Times Alphaville strongly argues in that sense: "Look at the bitcoin eco-system closely and you realise it represents anything but the death of the middleman. If anything bitcoin has provided the middleman with a new *raison d'être*. He is flourishing because there is a new demand for his intermediary services" (Kaminska, 2014).

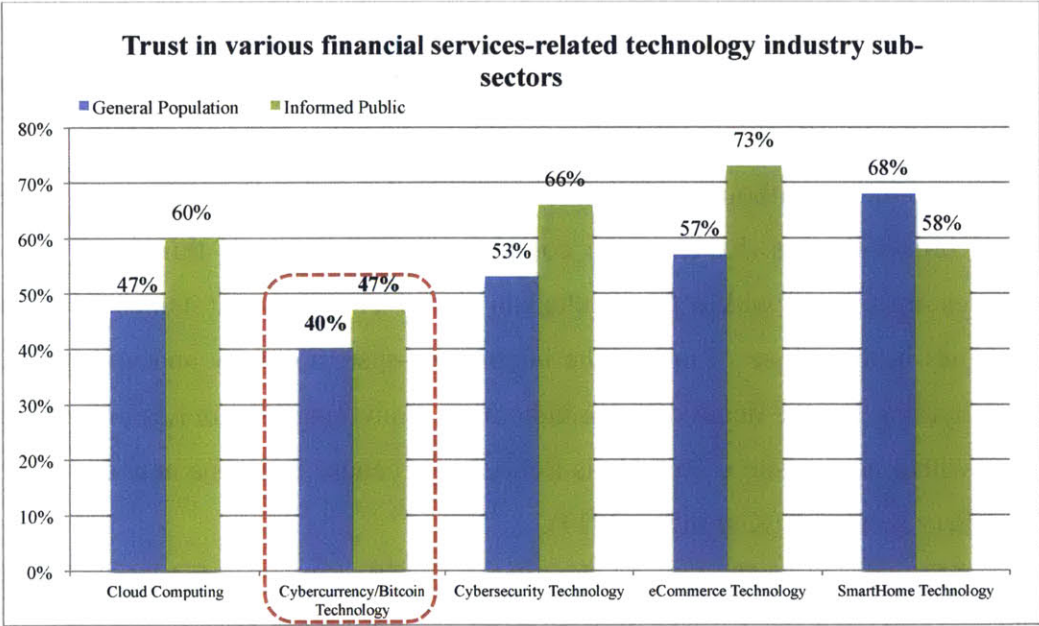
Finally, human interventions and decision settlements will still be needed in many cases. The problem is: blockchain doesn't allow exceptions to the rules. However, bankruptcy,

¹ Citation retrieved from Inside Bitcoin article, "Patrick Byrne Sees Bank Blockchain Consortium R3 as an Attempt at Regulatory Protectionism" (Torpey, K., 2015), <http://insidebitcoins.com/news/patrick-byrne-sees-bank-blockchain-consortium-r3-as-an-attempt-at-regulatory-protectionism/36264>

for instance, has proven to be a very useful tool to foster renewal and risk-taking (Vigna & Casey, 2015, p.242). Therefore, blockchain technology must adapt to create room for necessary judicial intervention, which is currently almost impossible with the immutable recordkeeping or automatic execution of smart contracts. Vigna and Casey (2015, p.242) further explain that adoption will only take place through compromise:

Hybrids, compromise, pragmatic solutions. There must be room for this kind of thinking if Blockchain 2.0 ideas are to break out of the hypothetical realm and into the real world. Some of the rigid ideological positions will have to be tampered.

One final impediment to mainstream adoption remains social wariness. The bitcoin-linked widely advertised scandals, the currency’s high volatility and the shady activities it supported, still echo in people’s minds. And the distinction between bitcoin and the blockchain isn’t all clear yet. The Edelman Trust Barometer compared cybercurrency and bitcoin technology trust level within the general population and an informed public to other financial service-related sectors. It remains by far the least trusted.



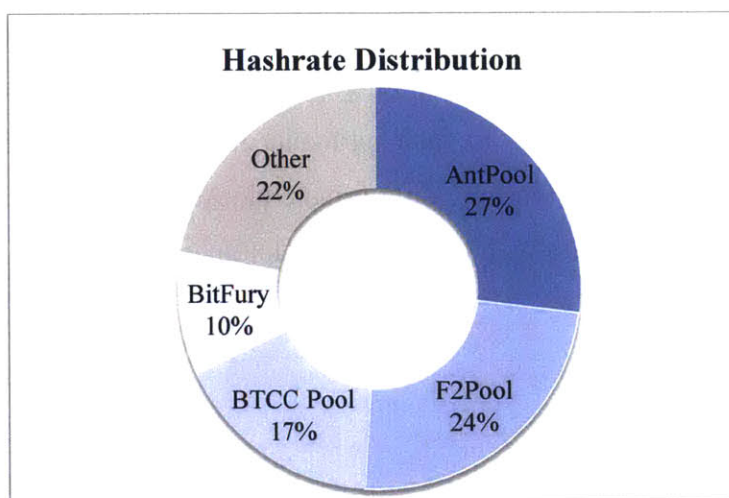
Source: Edelman, Annual Global Study, 2015 Edelman Trust Barometer Financial Services, 2015, p.21

The technology’s applications and benefits for the financial industry overall are not clearly understood by the large public for now.

3.3.3. Technology limitations

There are also risks and limitations to the technology itself, depending on the type of blockchain in question. Regarding the bitcoin blockchain, risks include the following:

- **Network protection:** the network is as good as the nodes composing it. Indeed, the bitcoin blockchain can only work if miners keep supporting it. If confidence or interest fades, so will the network.
- **Privacy:** there are some concerns from companies or individuals about publishing their information on a public ledger. Some companies might want to keep some information private, such as equity ownership data and transactions history for a private company. This will limit use cases for the bitcoin blockchain.
- **The 51% attack:** if a single mining source succeeds in capturing more than 50% of the entire network's hashing power, it would be able to reverse transactions history and hinder new transactions from being validated. And since the attacker would control the validation process, this would make double spending possible. The size of mining pools has been increasing. CoinDesk (*State of Bitcoin and Blockchain 2016*, 2016, p.22) reports that from 2014 to 2015, mining pools became more concentrated with unknown pools now accounting for 1% (versus 11%) of the total hashing power. Currently, the four main mining pools together hold a 78% share of the total hashing power.



Source: <https://blockchain.info/> average of last four days, as of April 22, 2016

- **Energy consumption:** the computing power necessary to solve the mathematical problems to validate blocks is increasing over time, requiring more and more energy. Since an equity-trading platform, for example, incurs very high transaction volumes, this would be a major handicap.
- **Capacity:** if the bitcoin blockchain has to support many more applications on top of its network, it definitely needs to be upgraded. In fact, there is a hard limit on the information that can be contained in a block for now: the capacity is capped to 1 megabyte (McKinsey, 2015, p.12).
- **Speed:** the main consequence of this capacity limit is speed restriction. The bitcoin blockchain can treat around 7 transactions per second compared to 10,000 for Visa at peak volumes, as stated in the Washington Post (Lee, 2013). And again, equity markets generate very high volumes of transactions: this speed cap constitutes a bottleneck for future expansion.

Therefore, the biggest technological question around the bitcoin blockchain is scalability, which includes computing power, speed, and capacity limitations. Scalability requires a trade-off between decentralization and low-cost. Using the underlying infrastructure to build equity trading platforms will require upgrading the technology at some point to keep up with transactions volumes. Moreover, the more applications unrelated to bitcoin emerge (such as exchange of assets or information through Colored Coins), the quicker this problem is going to arise. Some startups have been trying to overcome these problems by building their own blockchains, like Ripple, which can provide quicker transaction confirmation using less computing power. Financial institutions are also developing in-house blockchains to fit their particular needs and requirements, such as the Australian Stock Exchange, working on a private blockchain as a post-trade solution for equity markets, in partnership with Digital Asset Holdings¹.

¹ Digital Asset Holdings is a service provider helping financial institutions build blockchain-based settlement and ledger solutions.

In conclusion, blockchain technology has tangible potential to alleviate frictions in equity markets and to provide valuable improvements to financial transactions. Incumbent players in the financial industry are closely looking at it and new actors have emerged offering alternative solutions, such as the tØ platform. One big question remains (Amin, 2016):

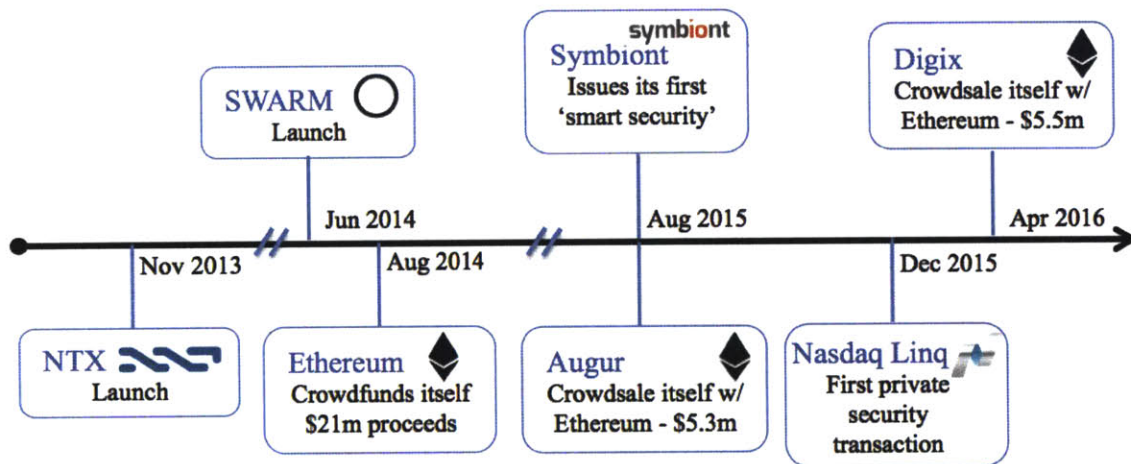
Will blockchain and its associated technologies be used to replicate existing oligopolies online or will they truly open up and enable all market participants to engage in a more democratic and open marketplace?

4. Hands-on with current applications

If 2015 was the year blockchain became notorious, 2016 will be the year of proof-of-concept explorations and trials for concrete applications in the financial industry.

4.1. Private equity markets

4.1.1. Overview of current applications



Blockchain technology has the potential to improve and transform private equity markets at each stage of their lifecycle, from early fundraising to private stock issuance (growth capital) and eventually, over-the-counter (OTC) trading.

The blockchain provides new solutions for early fundraising, in terms of access to funding, campaign management, and asset transferability. It gives startups the possibility to tailor their campaign and lead it themselves. One of the most successful examples of a self-crowdfunded campaign is Ethereum, a blockchain infrastructure provider dedicated to smart contracts. It was funded by the crowd as a nonprofit organization, in August 2014. According to Blockchain Agenda, Ethereum raised \$21 million in only a month, by selling their own coin “ether” (Jackson, 2014). But there are various blockchain-based solutions for crowdfunding. Here are the two main categories:

- **Do-It-Yourself:** startups use blockchain service providers, which help them create and launch their own crowdfunding campaign. Such providers include Ethereum, an

open-source protocol for companies to set-up their campaign using the network's altcoin ether.

- **Use blockchain-powered platforms:** they rely on a decentralized platform to connect founders and backers, and use the blockchain to issue and manage crypto-equity. This solution is by far the most commonly used. Applications include platforms such as SWARM, based on the bitcoin blockchain, which allows ventures to raise funding through the creation their own cryptocurrency, representing shares in their company¹. Another example is NXT, which enables startups to issue their own token to raise funds, and offers other flexible tools such as customized dividend payments or secure communication with backers. Yet, the main difference with NXT is that investors have in any case an exit possibility, by trading on the NTX exchange (ntxreporting.com).

Blockchain-based solutions are also being explored in order to facilitate the next stages of the private equity lifecycle: stock management, private placement, and stock trading. Indeed, the technology makes it easier to transfer and monitor private equity, and thus, in theory, to create more liquid secondary markets. The permissioned distributed ledger Symbiont for example – specialized in smart securities – proposes solutions for each stage²: from issuance to IPO and secondary market trading. And it is not the only company that foresaw the potential of blockchain to help overcome some of the main limitations of private equity markets: illiquidity and opacity. The arms race has started, as claimed by the Financial Technologies Forum (Grygo, 2016):

The rush to the first-mover status via Blockchain technology is heating up between Nasdaq and Symbiont, the maker of the Smart Securities platform for trading, clearing, settling and transferring financial instruments. These early adopters are vying for key milestones in securities operations that can be transformed by the Blockchain distributed ledger technology that underpins the Bitcoin cryptocurrency.

¹ SWARM was shut down in September 2015, and re-launched with a new “holonic” governance model, which is “a more general contract language and networking protocol” according to their blog post <https://medium.com/@Swarm/the-birth-of-holonic-governance-3ba9c5a80f0a#.irykablsp>

² Retrieved from Symbiont website <http://symbiont.io/solutions/>

Indeed, in 2015, both companies issued announcements stating that they completed their first cryptosecurity transaction on their newly operational exchange platforms, respectively Nasdaq Linq, and under the trademark Smart Securities for Symbiont. Both platforms are designed as digital securities trading platforms, but while Linq is currently focused on private equity trading and recordkeeping, Symbiont has a broader reach (including corporate debt, syndicated and corporate loans, and other asset classes). And they are not the only platforms using blockchain to issue and trade equity (others include BitShares, Equibit, Counterparty, Chroma, etc.).

At the same time, the frontier between private and public equity markets is becoming blurrier. Crowdfunding initiatives look like mini-IPOs, especially now, since there are more and more secondary markets to exchange private stock. This phenomenon is described by Kaminska (2015b) as the “demise of publicly-listed markets” due to a global oversupply of equity funding and over-the-counter exchanges for non-listed stock. The article explains that people traditionally invest in public equity markets not only for liquidity but also to be protected by regulation and by the theoretical absence of information asymmetry (through disclosures, due-diligence, and audits). However, being publicly traded imposes a lot of requirements and burdens on companies. With equity fund-raising platforms, access to long-term private funding, and a growing number of secondary markets, more companies tend to stay private as long as possible instead of doing an IPO. This way, ventures have access to long-term funding while incurring fewer regulatory requirements. However, the benefits for investors are not obvious since the burden of due-diligence falls on them, and they have access to less liquidity and information. Therefore, startups and financial institutions are looking to use blockchain technology to reduce these issues.

4.1.2. Ethereum case study



Ethereum's blockchain is currently the main challenger to the bitcoin blockchain (second in terms of market capitalization). It provides the underlying infrastructure on which one can easily build many applications. These applications can interact with one another seamlessly on the shared ledger, thus creating a "value ecosystem" (Evry, 2015, p.23). Ethereum's initial focus was to design an open platform running smart contracts, as the foundation stone of the ecosystem. The idea behind it was to offer a more flexible infrastructure than the bitcoin network, in order to provide an appropriate framework to support the multiple innovations of the Blockchain 2.0. Ethereum's CEO, Vitalik Buterin claims that they are "hoping to be like the Android of cryptocurrency" (as cited in Vigna & Casey, 2015, p.231), in reference to the open system of Android on which you can build virtually any application, compared to iOS' closed system, similar to the bitcoin network.

In the same open, decentralized and peer-to-peer perspective, Ethereum offers the possibility for founders to crowdfund their idea or project on their own, through the execution of smart contracts. In essence, it allows startups to launch their customized "crowdsale"¹ initiative while giving backers some protection insurance. For instance, the founder will set a funding goal and deadline, and if it is not met, all pledges will be returned to the investors. It is a "do-it-yourself" approach, entirely bypassing centralized platforms, and it is completely free. Ethereum seeks to solve two main issues: the management and recordkeeping of tokens, and investor's control over funds utilization. The distributed ledger will take care of tracking the tokens, the investments counterparty, and the utilization of funds can be monitored through the use of a decentralized organization. Buterin (2014) explains that: "Decentralized organization involves a set of humans interacting with each other according to a protocol specified in code, and enforced on the blockchain". For instance, the entire organization of a shareholder-owned

¹ Defined as "a new way to use cryptocurrency technology to issue tokens that can represent shares or equity in a company" by the website <http://crowdsale.co/>

company can be transferred to the blockchain, on which equity ownership titles and contracts will be recorded and enforced, and operations such as appointing boards members will be carried out. Anyone can build a campaign by following easy steps, and defining the terms of the contracts running it. The way to do so is to copy Ethereum crowdsale codes and enter campaign specifications like in the example below:

```
fundingGoal = fundingGoalInEthers * 1 ether;  
deadline = now + durationInMinutes * 1 minutes;  
price = etherCostOfEachToken * 1 ether;
```

Source: <https://www.ethereum.org/crowdsale>

Before deploying the contract, though, there is an inherent risk in decentralized applications. Since the crowdsale is entirely controlled by the token holders, if any party holds more than 50% of all tokens, this party will have control over the funds. There are a few solutions to overcome this threat, such as only selling half of the tokens, or distributing the other 50% to trusted organizations, as explained by Ethereum¹. Then, the only thing left to do is to invite people to participate. In the end, if the funding goal is achieved, the funds will be distributed under the terms of the contract.

Two very successful crowdsales already took place on the Ethereum blockchain and a third one is expected this year. Augur – a decentralized prediction market – raised more than \$5.3 million between August 17 and October 1, 2015². Very recently, Digix – a trading platform for gold-backed digital currency on Ethereum – raised \$5.5 million under 12 hours, “kicking off the race towards DAO³ Initial Coin Offerings (ICOs)” (Kalla, 2016). The way Digix DAO was set up enables token holders to make and vet proposals if they pledged more than \$15,000 in the crowdsale; and all token holders can vote to decide on how funds will be allocated, and on other strategic matters. Finally, other companies use the tools and infrastructure provided by Ethereum to set up decentralized crowdfunding platforms, such as WeiFund, which defines itself as “Kickstarter In a Box”, where all funds are raised in Ether.

¹ Retrieved from <https://www.ethereum.org/crowdsale>

² Retrieved from <https://sale.augur.net/>

³ Decentralized Autonomous Organization, according to Buterin, “is an entity that lives on the Internet and exists autonomously, but also heavily relies on hiring individuals to perform certain tasks that the automation itself cannot do” (*DAOs, DACs, DAs and More: An Incomplete Terminology Guide*, 2014).

4.1.3. Nasdaq Linq case study



On December 30, 2015, Nasdaq published a press release entitled: “Nasdaq Linq Enables First-Ever Private Securities Issuance Documented With Blockchain Technology”. The blockchain infrastructure provider Chain¹ issued shares to a private investor and recorded the transaction using the blockchain-powered platform Linq. The two main advantages described by Nasdaq are: significant reduction in transaction settlement time, and minimization of manual handling and paper certificates through blockchain-managed digital ownership titles. Nasdaq Private Markets was launched in 2014, after several attempts, in order to enter the growing-demand segment for pre-IPO equity trading. A. Zinder, Director of Global Software Development at Nasdaq (MIT Bitcoin Expo, March 6, 2016), defined the three components of the Linq platform as follows:

- The underlying infrastructure: the blockchain-enabled ledger provides distributed, immutable data records and protection from double spending. The infrastructure (powered by Chain) is a permissioned network.
- The Linq API²: enables management of unregistered securities including issuance, allocations, corporate actions, auctions, transactions and settlement through integration with paying agent.
- The user features: provides an easy and transparent way to manage equity, through ledger visibility, contract management, investor communication and order management.

The purpose of Nasdaq Linq is to facilitate issuance and monitoring of private equity, but it is not an open marketplace: companies have control over their shares. At the moment, the platform didn't entirely remove intermediaries, as A. Zinder explains. The system is integrated with actors like clearing houses, and there are still broker-dealers in Linq private market. Plus, there are no peer-to-peer transactions yet.

¹ Chain partners with financial institutions to build blockchain-based solutions.

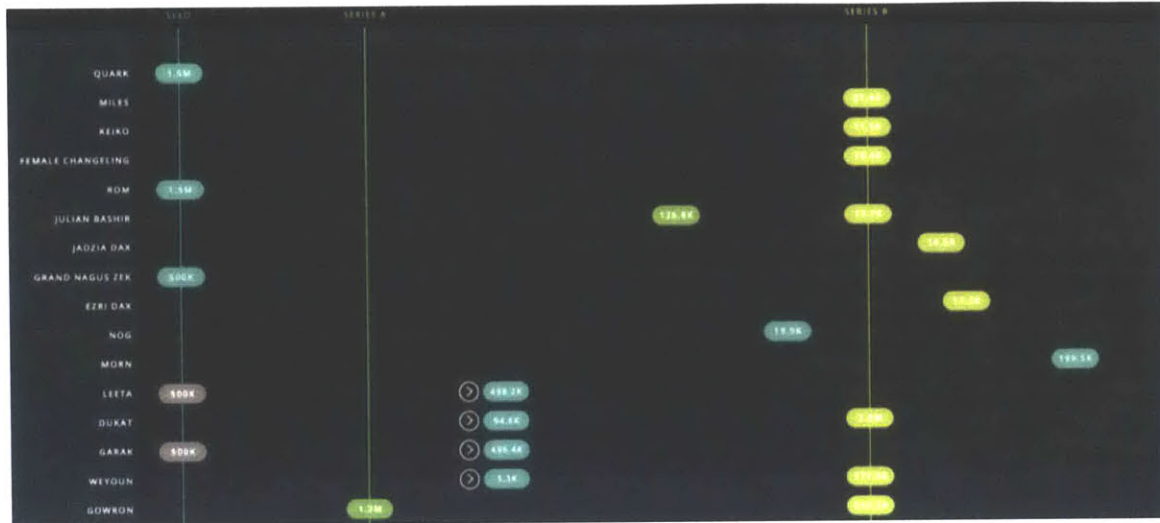
² API: Application Program Interface, is a set of routines, protocols, and tools for building software applications. Retrieved from Webopedia, <http://www.webopedia.com/TERM/A/API.html>

Coindesk gives a very detailed overview of how the platform works, summarized hereafter (Rizzo, 2015). The platform provides a clear user interface, enabling companies to have a thorough and easy glance at the current state of their capitalization table, and at the historic trail of transactions as well. The dashboard includes valuation, prices of shares issued at each round and stock options available, as shown in the example below.



Source: Coindesk, *Hands On With Linq, Nasdaq's Private Markets Blockchain Project, 2015*

Another intuitive tool is the “Equity Timeline View” (below), which presents current equity ownership of the company in colored blocks, visually accounting for different asset types (issuer, share class, round). Grey blocks represent the spent transactions and arrows show the transfer and division of shares. Linq also enables companies to access more detailed levels of information on their shares and investors. Plus, platform functionalities include the issuance of electronic ownership titles and registration, and recordkeeping of private securities. All these features empower pre-IPO startups to more effectively manage and keep track of their stock, instead of using manually updated spreadsheets, while at the same time preserving their privacy.



Source: Coindesk, *Hands On With Linq, Nasdaq's Private Markets Blockchain Project, 2015*

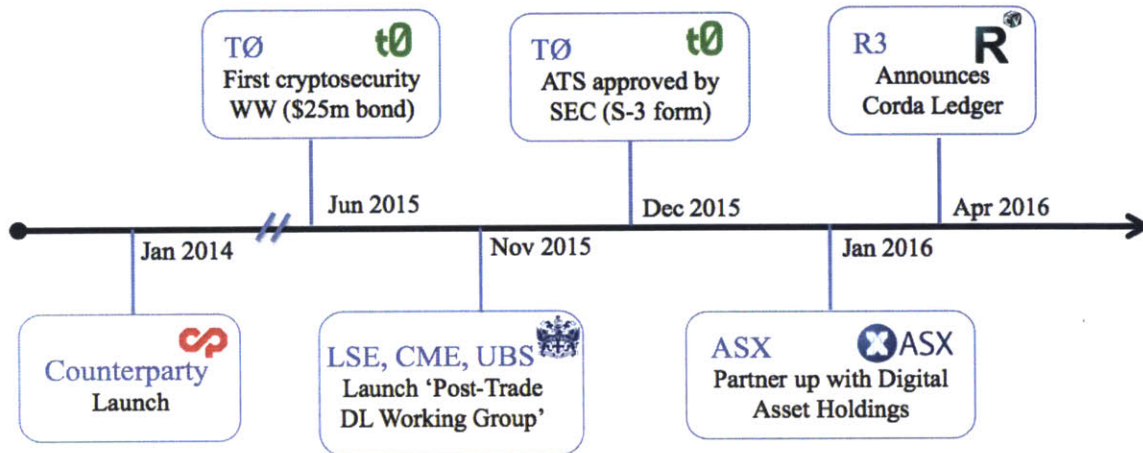
In addition, the Linq platform can support liquidity events – if a company decides to sell a percentage of its shares – and provides a complete audit trail and chain custody, as well as online certificates.

According to Coindesk, Linq is currently being trialed with six startups. Including more companies can be quite lengthy since each of them would first need to migrate their current equity ownership on the digital platform. In the future, Nasdaq Linq is looking to expand to other assets, after having used private markets as a proof-of-concept. James Angel, professor of finance at Georgetown University, sees Nasdaq Linq as the perfect gateway to public market applications, in order to test the technology first, and facilitate adoption: “This is the type of applications that makes a good test case” (as cited in Wired¹).

¹ Citation from Wired article, “Bitcoin May Never Make It to Wall Street, But Its Tech Will” (Metz, C., 2015). Retrieved from <http://www.wired.com/2015/05/nasdaq-bringing-bitcoin-closer-stock-market/>

4.2. Public equity markets

4.2.1. Overview of current applications



Blockchain technology can foster financial services overhaul. New players (tØ led by Patrick Byrne in the frontline) are trying to build credible alternatives to the existing financial system while incumbents are also extensively experimenting with the technology to improve their current models. Below are the main trends in the industry:

- **Building an alternative system:** one of the largest existing players is tØ – the first exchange to receive SEC’s approval to issue stock on a blockchain-powered platform – an Alternative Trading System, build on Counterparty protocol¹.
- **Improving the existing system:** incumbent players have been partnering up with blockchain service providers or developing in-house solutions to exploit blockchain technology in public capital markets. For instance, in 2015, a group formed of banks, exchanges and clearing houses (London Stock Exchange, LCH.Clearnet, Societe Generale, CME Group, UBS and Euroclear) launched the “Post-Trade Digital Ledger Working Group” in order to explore post-trade blockchain-enabled solutions.

The 42 banks consortium R3CEV is probably one of the most talked-about initiatives from financial institutions, aimed at leveraging the distributed ledger technology to

¹ Open-source protocol and peer-to-peer platform built on the top of the bitcoin blockchain to help companies design their own financial tools. The native currency of the protocol is XCP.

improve efficiency. K. Breitman, Strategy Associate at R3, explained that “the promise of distributed ledgers cannot be realized without the buy-in of major financial actors and a robust network effect” (MIT Bitcoin Expo, March 6, 2016). Their strategy is based on a three-pillar approach:

- “Financial Grade Ledger”: building financial transaction networks by partnering with technologists.
- “Global Collaborative Lab”: collaborating and testing among members.
- “Product Development”: creating software applications based on collaboration output.

K. Breitman added that the goal of the consortium is more political than technological: facilitating adoption and introducing network effects. On April 6, 2016, R3 introduced Corda, a ledger “specifically designed to manage financial agreements between regulated financial institutions” according to R3’s blog (Brown, 2016). The purpose was to create a new form of distributed ledger, closely fitted to financial institutions’ specific needs. It draws from existing blockchains but is not a blockchain per se. For instance: the data is not shared by all parties, consensus is not provided by the entire network and there is no native cryptocurrency. The focus of Corda is to reconcile the benefits of the technology with the necessary human intervention, from regulatory and legal standpoints.

Financial institutions are working closely with startups in the space to test the distributed ledger technology. According to the International Business Times, “beneath is a scrum of startups guarding their special sauces, vying for supremacy in the race to implement a protocol upgrade of the financial system” (Allison, 2015). Some of the leading actors, mostly focused on the financial industry, are Symbiont, Chain, and Digital Asset Holdings. Symbiont proposes a turnkey solution including a platform and smart contract protocols for different asset types. In March 2016, Symbiont entered a partnership with Ipreo – global provider of technology, data, and analytics for financial services, owned by Blackstone and Goldman Sachs – in order to reform the syndicated loan market by automating settlement and maintenance. Chain partners up with companies to build tools

customized to their specific needs, based on its APIs and SDKs¹. It has gained a lot of traction in the industry, and its investors include big incumbents such as Visa, Citi or Nasdaq. Finally, Digital Asset Holdings' main focus is to enable existing financial institutions to leverage blockchain technology to improve their processes. The team includes technology specialists and Wall Street connoisseurs, led by former J.P. Morgan executive Blythe Masters. The company relies on cryptography and blockchain and aims at reshaping financial infrastructures, primarily on the clearing and settlement side. Digital Asset Holdings builds tailored Business Applications through the use of their digital asset platform, which can work with any blockchain type². The company also benefits from significant media exposure, and recently completed a \$60 million investment round with participation of fifteen global leaders, including Accenture, BNP Paribas, Citi, J.P. Morgan, Santander, DTCC and Goldman Sachs (Digital Asset Holdings, 2016a). Finally, they contracted with large industry players such as the Australian Securities Exchange (case study below), or DTCC to build a blockchain-based clearing and settlement solution for U.S. repurchase agreement transactions (Digital Asset Holdings, 2016b).

4.2.2. tØ case study



As explained before, tØ became the first blockchain-powered alternative trading system (ATS) to be approved by the SEC. Overstock is a major online US retailer and one of the first worldwide to accept bitcoin as a means of payment, since January 2014. In July of the same year, the company published a web page named “How to issue a cryptosecurity”, describing a possible way to issue and exchange stocks globally on a computer network like the bitcoin blockchain, secured by the cryptographic algorithm. According to the Cointelegraph (Richards, 2015), the web page also mentioned the necessity to design cryptosecurities as similar as possible to existing ones, in order to facilitate adoption and regulatory consent. CEO Patrick Byrne led Overstock’s

¹ SDK: Software Development Kit

² Retrieved from <http://digitalasset.com/platform.html>

blockchain efforts, as a way to create an alternative to Wall Street's markets and practices. At the Inside Bitcoin Las Vegas Conference in October 2014, Byrne announced the Medici project, destined to create a platform for cryptosecurity issuance. In order to build the exchange, Overstock hired two of Counterparty's founders, after deciding to build the platform on the Counterparty protocol. They also hired the law firm Perkins Coie, to provide guidance on how to gain SEC's approval, since that would likely be the main hurdle in comparison to the technology itself. In 2014, Medici acquired a 24.9% stake in Pro Securities – a broker-dealer and operator of a registered ATS – in order to have a trading platform on which to incorporate blockchain technology. They acquired the remaining stake of Pro Securities in August 2015. Medici also took over SpeedRoute – a Wall Street broker-dealer firm – in August 2015, for \$30.3 million. Overstock says SpeedRoute moves approximately 2.5% of Wall Street equity trade flow (as cited in the New York Business Journal¹). Pursuing this effort, Medici bought an 80% stake in another brokerage firm, TraderField Securities.

tØ exchange uses Open Assets protocol (colored coins technology) to categorize securities and is currently based on the bitcoin blockchain. But, according to Byrne (as cited in Nasdaq article²), the system is “ledger-agnostic”: tØ could be easily integrated to other blockchains. In June 2015, Medici's first achievement was made public: Overstock issued a press release stating that they launched the offering of the first cryptosecurity worldwide on their newly operational platform tØ (referring to T+0 instead of T+3 settlement cycle). The security in question was a \$25 million Overstock digital private corporate bond. The press release claims that: “According to Byrne, issuing the TIGRcub³ bonds on the TØ.com platform proves that cryptotechnology can facilitate transparent and secure access to capital by emerging companies” (Overstock, 2015a). The first buyer was Byrne himself, for \$500,000, and FNY Capital followed in July, subscribing up to \$5 million worth of the cryptobond (Nasdaq Global Newswire, 2015).

¹ Citation from New York Business Journal article “Exclusive: \$30M Patrick Byrne deal bridges gap between bitcoin technology and Wall Street” (Castillo, M., 2015), retrieved from <http://www.bizjournals.com/newyork/news/2015/08/26/patrick-byrne-deal-overstock-bitcoin-wall-street.html>

² Citation from Nasdaq article “Overstock's t0: Reconciling Fiat Currency and the Bitcoin Blockchain” (Floyd, D., 2015), retrieved from <http://www.nasdaq.com/article/overstocks-t0-reconciling-fiat-currency-and-the-bitcoin-blockchain-cm555617>

³ TIGRcub: Top-Line Income Generation Rights Certificate

In December, Overstock was allowed to issue public stock via the tØ ATS, with the approval of their S-3 form by the SEC. This form is a simplified registration filing for issuing shares, destined to companies that have already achieved a certain degree of compliance with the SEC. The Form S-3 prospectus (2015b, p.1) states that Overstock can issue any combination of common stock, preferred stock, depositary shares, warrants, debts securities and units amounting to \$500 million, in “traditional certificated form or in uncertificated form, including as digital securities”. The prospectus defines the latter more specifically (2015b, p.4) as registered and uncertified securities, whose ownership titles and transaction records are listed on a proprietary ledger (private Pro Securities platform) and publicly distributed (underlying bitcoin blockchain). Furthermore, such securities will not be able to trade on National Market System (NMS) exchanges together with traditional instruments, and they will be issued in different asset classes than existing ones. Further details about the digital securities are given in the prospectus (2015b, p.34), including the following statements:

Digital securities have the same rights, preferences and privileges as traditional securities of the same class, but settle differently than traditional securities [...] Digital securities settle nearly instantaneously, as "the trade is the settlement." In addition, trades of digital securities do not require the involvement of a central depository, such as DTC's Cede & Co., which holds physical securities on behalf of record holders. Rather, digital securities will be directly held and traded by their beneficial owners on the proprietary ledger, which will be publicly published.

The abovementioned securities can only be exchanged on the Pro Securities market or future ATSs designated by Overstock, by the only broker-dealer licensed to access them to handle Overstock securities. Therefore, “underwriters of any offerings of our digital securities will be required to open brokerage accounts with such broker-dealer” (Overstock, 2015b, p.34-35). Regarding the recordkeeping of transactions: ownership information will be automatically and publicly inscribed on the proprietary ledger operated by the tØ software, and combined with personal identifiers provided by the unique broker-dealer. Finally, Overstock, Pro Securities ATS, and the broker-dealer in question will be entrusted with digital security owners’ private keys and will be entitled

to transfer the securities on the owners' behalf, as well as to block these transfers when necessary. The specific risks of digital securities are exposed in details in the prospectus (2015b, p.5-8) and include:

- **Platform risk:** digital securities will be exchanged only on the Pro Securities ATS, a closed trading system with one licensed broker-dealer, thus with limited trading volume and liquidity, and a potential risk of system failure. The platform has no listing requirements (such as minimum price). The use of the technology also bears a security risk (private keys from security holders can be stolen) and a privacy risk, since all records from the platform will be publicly available (even though encrypted) on the bitcoin blockchain.
- **Price risk:** the price of digital assets is not pegged to the value of the common stock traded on NMS exchanges. There is also a risk of stock manipulation, for instance: "There can be no assurance that a security holder will not be able to manipulate the stock price by opening multiple accounts and trading among those accounts" (Overstock, 2015b, p.7).
- **Novelty risk:** trading digital securities on the blockchain-based platform has not been tested yet. Specific risks are mainly technological (potential failure) and regulatory.

After this historic approval by the SEC, Overstock issued a press release on March 16, 2016, stating their intention to publicly offer preferred stock on either a traditional marketplace or on the tØ platform. The offering is "contemplated to be limited to Overstock.com shareholders of record as of a date to be determined, and will be of up to an aggregate of 1,000,000 shares of blockchain and traditional Series A preferred stock" as announced in the press release (Overstock, 2016). At this point, Overstock will have public stock trading on two different markets, potentially leading to discrepancies in prices and hence arbitrage opportunities for investors. In addition to Overstock's own equity offering, Wired reported that Overstock intends to open the tØ technology to other companies (Metz, 2015b). In this case, each of these companies would require separate approval from SEC.

4.2.3. Australian Stock Exchange case study



On January 22, 2016, ASX Limited, which operates the Australian Securities Exchange (the largest national stock exchange), issued a press release entitled “ASX selects Digital Asset to develop distributed ledger technology for the Australian equity market” (ASX, 2016a). It states that ASX invested A\$14.9m (equivalent to \$10.4m)¹ to buy a 5% stake in Digital Asset Holdings, “fund an initial phase of development, and acquire a warrant that will give ASX the right to purchase further equity and appoint a director to the board”. This investment follows the early 2015 decision of ASX to improve their trading and post-trade processes. The first step for Digital Asset Holdings and ASX in 2016 will be to work on a proof-of-concept, by building a platform based on the distributed ledger technology to replace the trading and risk management processes. The second step will be to apply the technology to the post-trade side of equity capital markets, especially in clearing and settlement services. In the meantime, the clearing and settlement firm operating on the Australian Securities Exchange, CHES², will carry on providing its services. The final call on whether or not to implement the technology is expected to take place in 2017, according to the press release. Along with the experimentation of the technology, a discussion with regulators and government agencies will be necessary to define an appropriate regulatory framework and to evaluate the implications of such a system for them. Finally, ASX’s press release (2016a) claims that the:

Adoption of Distributed Ledger Technology has the potential to stimulate greater innovation by ASX and third parties to develop new services for intermediaries, end-investors and listed companies. This would create a more competitive marketplace across a broad range of services.

In an interview with the Financial Times (Stafford, 2015), ASX’s previous CEO Elmer Funke Kupper explained that the Australian market was particularly suited to experiment with the technology compared to other exchanges, since the number of financial firms in the system is limited to 2,500 and the equity market is already entirely dematerialized (in digital form). Moreover, another relative advantage is their shareholder registration

¹ On January 22, 2016, the exchange rate was 1 USD = 1.426 AUD according to <https://www.oanda.com>

² CHES: Clearing House Electronic Subregister System

system, also digital and fully dematerialized, through CHES. Successful implementation of the distributed ledger technology would mean that clearing and settlement firms, in this case CHES, would not be required to intervene since the platform would automatically perform those tasks by confirming transactions in the peer-to-peer network, composed of vetted members. Indeed, in the press release regarding ASX partnership, Digital Asset Holdings addresses some of the technology-related concerns by specifying that the ledger will be based on a private, permissioned network. Lee and Hong (2016) describe implementation the following way:

The network (likely made up of brokers) will record the buyer and selling participants, the number of shares traded, price of shares, time of exchange and the exchange of funds. The ASX will still provide a centralized electronic exchange for participants to place orders, only the settlement or back office function will be sourced to the network.

This would have a beneficial impact on costs, by largely cutting back-office expenses, including post-trade settlement, auditing and recordkeeping functions. The other main benefit is to reduce settlement time to minutes, from the current T+2 settlement cycle for cash equities (which went down from T+3 in March 2016). These benefits combined would provide the Australian Securities Exchange users with more liquidity, and free up some capital.

In their half-year results (2016b, p.4) for the period ending December 31, 2015, ASX invested A\$18.7 million (equivalent to \$13.5 million¹) in capital expenditures versus A\$13.0 million (equivalent to \$9.4 million²) in the previous period. The financial statements add that the investments were essentially made for the implementation of blockchain technology in the trading and risk management platforms. However, on March 21, Kupper gave his resignation as ASX CEO, which cast doubt on the longevity of the blockchain project, since he was considered to be personally leading the initiative.

¹ For period June 30 to December 31, 2015, the average exchange rate was 1 USD = 1.383 AUD according to <https://www.oanda.com>

² For comparison purposes, the exchange rate applied was the same as period June 30-December 31, 2015

Two days later, ASX's Chairman Rick Holliday-Smith wrote a letter to ASX shareholders, reiterating the company's support for the project.

This is a large-scale test for blockchain technology in equity markets, and the results will be very important for its potential wider adoption. However, even if successful, we have to bear in mind that the Australian Securities Exchange is very particular: its relative advantages for blockchain experimentation are specific, and other financial exchanges may not be able to transpose their own system on the blockchain, or at least not easily.

5. Conclusion

5.1 Perspective on the technology

Blockchain technology has a real potential to disrupt equity markets, both private and public. By providing a secure and transparent way to execute, record and monitor transactions, the distributed ledger technology can deliver significant cost and efficiency benefits while reducing risks. Some of the intermediaries in the current system – such as clearing and settlement houses – and other back-office services designed to reconcile and record information could become obsolete by implementing blockchain-based systems. In addition, in public equity markets, the technology could also prove to be a valuable tool to eliminate some abusive practices and restore trust in the system. As for private equity markets, it could also foster greater transparency and accountability, as well as ease of management. Moreover, it can help reduce illiquidity and information asymmetry by providing adequate solutions for secondary markets. Finally, the distributed nature of the blockchain network can foster a redesign of markets' infrastructure, by eliminating the risk of having one central point of failure, which in case of breakdown would corrupt the entire system. Vigna and Casey (2015, p.6) go a step further to describe the potential of the technology by claiming that: “The public ledgers used by cryptocurrencies can bring into the open the inner workings of an economic-political system that was previously hidden within impenetrable, centralized institutions”.

However, even if blockchain technology can make equity markets more efficient, there are still limitations that the technology needs to overcome. Substantial technical uncertainties remain: the technology has to be extensively tested. In addition, a complete regulatory framework will need to be designed. Besides, adopting the distributed ledger technology doesn't mean entirely replacing existing systems. In the short-term at least, innovative structures will coexist with traditional systems. But even if the technology proves to be valuable and is widely implemented, existing players, intermediaries and central authorities will still have an essential role to play. Actually, interoperability between our current systems and blockchain-based ones will be a key factor for the

technology to have a concrete and meaningful impact. In that regard, we mentioned earlier the necessity to create room for regulatory and legal intervention, as a starting point. But equity markets' intermediaries such as banks executing underwriting processes, broker-dealers, traditional stock exchanges or equity crowdfunding platforms will not disappear. Lee (2016, p.53) applies this reasoning to public stock markets and argues that:

Just as there is still a need for people to use the post office to send traditional [mail] even though e-mail technology has been around for more than twenty years, it is unlikely that a cryptosecurities market will ever completely replace the traditional stock market.

However, tension prevails between views on how blockchain technology should be implemented and by whom. The technology, as per Nakamoto's intention, was created as a means to disintermediate existing processes and create transparent, open and peer-to-peer infrastructures. New industry players have emerged to build on this permissionless vision, like tØ or Symbiont, to propose alternative solutions to existing markets. However, financial institutions are also seeking ways to integrate the distributed ledger technology to their systems, through the use of permissioned networks. As powerful incumbents, they operate existing market infrastructures, and thus benefit from large network effects. If they decide to adopt the technology, they could probably end up being the sole benefactors of its advantages in equity markets. And indeed, they are actively exploring applications for the technology. There is substantive potential at stake, enough for incumbents to have strong incentives to participate. As Patrick Byrne explained at the Blockchain Agenda San Diego (as cited in the Inside Bitcoins¹), the technology creates a prisoner's dilemma in the financial industry. Considering banks, exchanges and settlement firms as the three main players in the game, Byrne explains that if one player starts to use blockchain technology, the other two will be negatively impacted by the disruption. He concludes by arguing that this is an "awfully appealing incentive to

¹ Citation from Inside Bitcoins article "Overstock CEO Patrick Byrne: Wall Street Has Strong Incentives to Join the Bitcoin Revolution" (Torpey, K., 2015). Retrieved from <http://insidebitcoins.com/news/overstock-ceo-patrick-byrne-wall-street-has-strong-incentives-to-join-the-bitcoin-revolution/36237>

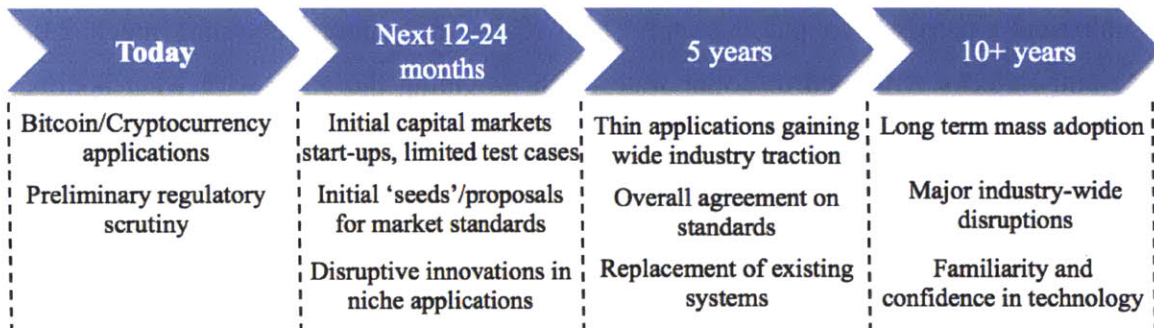
defect” from the existing system. Thus, financial institutions’ best response in this situation is to make the first move towards blockchain, especially since they are not the only players, and startups represent a fierce competition. Actually, the game could also be understood as a cooperation game between financial institutions and startups. Collaborating instead of competing might yield greater benefits for both, since they have relative strengths that complement each other. Santander, Wyman and Anthemis Group (2015, p.5) corroborate this view, by explaining that banks can allow fintech startups to scale and gain critical mass, while at the same time benefiting tremendously from their technological expertise. To put it simply: “To realise the opportunity of Fintech 2.0, banks and fintechs will need to collaborate, each providing the other with what it now lacks, be that data, brand, distribution or technical and regulatory expertise” (Santander, Wyman & Anthemis Group, 2015, p.5).

5.2 Adoption in the traditional financial industry

Is blockchain technology a threat to existing financial institutions? In the current context of fintech disruption, some incumbents might interpret the technology as a risk for their business, following the deep overhaul of payment systems. And all the more so since startups are flexible and numerous, and since shifting their current operations to blockchain-based solutions is very complex and lengthy for large financial firms. Some parts of banks’ traditional service portfolio are being actively challenged by fintech startups, in mobile banking, lending or payment. However, blockchain technology can be an opportunity for them to redesign practices and systems in a more efficient way. As a matter of fact, startups in the industry are proving to be valuable partners to explore and test these new solutions. Moreover, financial institutions are not only outsourcing their research and development to tech startups, but they are also building capabilities for themselves. Hence, instead of seeing blockchain technology as a threat, maybe it is worth looking at it as healthy competition, urging existing institutions to embrace change. The Euroclear and Wyman report (2016, p.3) further argues that:

It is up to major established players in the market to work with innovators to develop standards, while also preserving the existing strengths of the ecosystem, and navigating the complex worlds of regulation and legal oversight.

Euroclear and Wyman (2016) also give an estimate of the base case scenario for the adoption timeline of the technology (below), and envisage an ambitious case where the ten-year target would be reached in five years instead.



Source: Euroclear and Wyman, *Blockchain in Capital Markets*, 2016, p.19

Adoption of the technology by the existing financial system will take time. The first focus for financial institutions should be to build practical applications in small segments of their business, to test the technology and iterate. In fact, this is what Nasdaq seems to be doing with Linq by building a solution for their private market segment and experimenting, as a first step towards expanded implementation. Large-scale applications should be implemented over the course of the next five years, and more importantly, industry standards agreed upon.

Nevertheless, a widespread adoption of blockchain-based systems still faces important hurdles, as we have seen earlier. Incumbents suffer many regulatory burdens and compliance requirements, thus limiting the extent to which they can freely experiment with the technology. Implementation will require significant effort and collaboration from technologists, financial institutions, and regulatory authorities, to design a framework for distributed ledger technology applications. Also, common standards will have to be discussed and accepted by large institutions and regulators worldwide. Finally, on the technology side of things, one prerequisite for widespread adoption of the

technology is cooperation from financial institutions, in order to build consistent and interoperable networks. Indeed, in the case of a transaction based on a certain blockchain, compliance rules that are applied in one bank would need to be aligned with the ones of the bank on the other side of the transaction, and their technological systems would need to understand each other.

Furthermore, changing operational structures to adapt to the technology will also be very challenging. William Mougayar of Virtual Capital Ventures (2015, p.56) explains that 80% of the work for blockchain implementation is to be done on business processes, and only 20% on the technology side. This will require large financial institutions to operate a critical shift in their cultural norms and to provide extensive education to properly integrate the technology into their practices. Blockchain technology is still at an experimental stage, and Wall Street mentalities will definitely not change overnight. Basically, for successful and large-scale adoption, the entire financial ecosystem has to be rethought and then re-standardized.

5.3 Is it really a revolution?

“[Blockchain] is the biggest opportunity set we can think of over the next decade or so”, declared Nasdaq Chief Executive Bob Greifeld (as cited in Forbes¹). There is a big fuss in the financial industry about the “fintech revolution” and especially about the blockchain technology, sometimes referred to as the “Internet of Value”. The main segment targeted for experimentation at the moment is capital markets. And as far as they are concerned, blockchain technology has a real disruptive power, within the larger fintech disruption. “The scope for a more 'frictionless' trade lifecycle is definitely out there. Very little innovation has taken place in the post-trade clearing/settlement environment and even less when it comes to trading between counterparties”, reports CoinDesk (Amin, 2016).

¹ Citation from Forbes article “Bitcoin's Shared Ledger Technology: Money's New Operating System” (Shin, L., 2015). Retrieved from <http://www.forbes.com/sites/laurashin/2015/09/09/bitcoins-shared-ledger-technology-moneys-new-operating-system/#3763a901c4fc>

And indeed, only little innovation took place in the financial industry in the past decade, especially in transaction processes. However, it is still unclear whether the technology's disruptive power can lead to a revolutionary transformation of the financial industry and more broadly of how society operates. Among many others, the UK Government Office for Science's report (2016, p.56) foresees such potential:

DLTs represent an innovation towards the radical end of the change spectrum because of their potential to impact a broad extent of areas in the business model: from new products and services, through operating systems and organisational structures, to the sheer number of potential industries that could be affected. As such they form part of the interconnected and inter-related breakthroughs that form a technological revolution.

The report further explores the notion of revolution, by drawing on Schumpeter's "creative destruction" concept, and Perez' "technological revolutions" framework. The three common pillars in these revolutions are: "significantly lower costs, new communication methods, and changed infrastructure and logistics" (UK Government Office for Science, 2016, p.54), all of which blockchain technology could possibly achieve. The report explains that in the typical revolutionary innovation setting, the opportunity for significant cost savings generates tensions in the market (often in the form of financial bubbles and crashes) and in turn causes demand for a redesign of existing institutions. In order to truly provoke a profound change, the technology will need to be largely adopted, and strong inter-connected ecosystems will have to be formed around it, as the basis of a new "techno-economic paradigm" (UK Government Office for Science, 2016, p.55). The difference in this revolution compared to previous ones is that it could potentially alter our society's structure and organization, by challenging traditional hierarchical systems and replacing some intermediaries and trusted third parties. However, it is also very likely that the technology will change the modus operandi but not actually democratize all systems or weaken existing large players.

So, is all the excitement around blockchain creating a blockchain bubble? Some believe that there is indeed a fintech bubble, in some ways comparable to the dot-com bubble

following the widespread adoption of the Internet. The Wall Street Journal reports that: “Prominent venture capitalists in the red hot ‘fintech’ – or financial technology – sector say they are seeing overvaluation everywhere they look” (Demos & Rudegear, 2015). And among fintech sectors, blockchain is considered as the big investment opportunity. As we have seen previously, Venture Capital investments in the space exceeded \$1 billion in early 2016. Moreover, Magister Advisors survey (Q4, 2015) anticipates that at least five blockchain unicorns will emerge in 2016 (as cited in Blockchain News¹). However, there are still many uncertainties about the technology adoption and concrete potential. Plus, widespread implementation will take significant time. As a matter of fact, valuations for fintech startups were soaring until a recent contraction, as reported by Sammantics (2016) in January. The reasons the article gives include the large number of players working on financial applications for blockchain technology, ranging from startups to big banks. In addition, there are still doubts about the best strategy to implement the technology, through consortium or private chains for instance. Standards for the industry still need to be defined. But prior to committing a sizeable pool of capital to the technology, tangible applications and proof-of-concepts will have to be demonstrated. Sammantics (2016) argues in that sense: “There always comes a time when you batten down the hatches and build. Execution becomes the key and metrics begin to matter. It seems the time has come”.

Near-term outlook tends to confirm this direction: 2016 will see concrete implementations in the financial industry to experiment with the technology and gauge its true potential. William Mougayar gives a few anticipations for blockchain technology achievements in the current year, including VC funding for blockchain startups to exceed \$2.5 billion and \$1.5 billion of non-currency assets to be traded on the blockchain-powered platforms (2015, p.64). Blockchain technology conveys big promises for equity markets, and now, it is time to test them.

¹ Citation from Blockchain News article “Bitcoin's Shared Ledger Technology: Money's New Operating System” (Kastelein, R., 2015). Retrieved from <http://www.the-blockchain.com/2015/12/11/2016-will-see-the-emergence-of-five-blockchain-unicorns-1-billion-evaluation-says-magister-advisors/>

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