Blockchain / Distributed Ledger Technology (DLT): What Impact on the Financial Sector?

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Abstract: Blockchain technology, along with distributed ledger technology (DLT), has caused quite a stir over the last year as many experts now consider that it has the potential for facilitating multiple bursts of creativity and catalysing an exceptional level of digital innovation not seen since the advent of the Internet. Of all sectors, the financial one in particular is very likely to be the most impacted by the technology's potential for disruption. In this article, we first present the essential aspects of the new transactional model that DLT brings about. We then outline what we estimate to be the main areas of applications of DLT to finance, whether for capital markets or corporates. Last but not least, we attempt to evaluate the likely impact of DLT on financial markets, with a particular focus on the post-trade infrastructure for which DLT seems particularly promising.

Key words: blockchain, distributed ledger technology (DLT), financial markets, corporate finance and governance, disintermediation, post-trade infrastructure.

Information technology has played a key role in the development of modern financial services. As underlined by SHILLER (2003), it is the development of information technology that has made possible the proliferation of many, if not all, contemporary financial services. Improvements in information infrastructure have been essential for modern finance as they allowed the transformation of countless stacks of paper, hard to classify and archive, into electronic data. Because they are now capable of better managing data and information, banks have been able to expand their product offerings, improve their processes and keep track of the

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increasing number of transactions. And today financial institutions heavily rely on large information systems and databases to conduct their business, whichever the field - securitization, derivatives, or just plain commercial banking to name a few.

Blockchain technology has been holding many promises for both the financial sector, in particular its financial markets infrastructure, and the insurance industry. At the heart of this enthusiasm for DLT lies the new decentralized transactional model that the technology permits, whose principles are based upon Satoshi NAKAMOTO'S white paper (2008). Indeed, one of the key drivers of the blockchain wave of innovation is the transition it should facilitate from centralized and proprietary ecosystems to their decentralized and mutualized equivalents. For financial actors, banks in particular, this should mean increased risks of disintermediation and a potential threat to some of their activities, especially those for which banks had acted until now as the central coordinator. But the increasing interest of financial institutions for DLT is not limited to possible fears of further disintermediation, but seems to spring from a growing understanding that the technology could facilitate a wave of transformations and innovations beneficial to both financial institutions themselves and their clients – whether individuals or corporates. This is why we will attempt, in the second part of this article, to establish a brief inventory of DLT's many potential applications in finance, focusing in the third and last part on its likely impact on financial markets, especially post-trade infrastructure.

■ A new decentralized transactional model

One of the essential features of blockchain technology is that it allows a deep transition from a centralized transactional model, which until today has prevailed, to a decentralized one. In technological terms, this can be more or less assimilated to a transition from a centralized informational architecture, of the client/server type, to a distributed and decentralized one, such as the one found in peer-to-peer networks.

In fact weaknesses and corruption risks associated with the standard centralized model were criticized very early on by pioneers of decentralized crypto-currencies such as Nick SZABO for whom "trusted third party is a nice-sounding synonym for a wide-open security hole that a designer chooses to overlook" (SZABO, 2001).

And the Bitcoin original paper is explicitly critical of any centralized solution for digital currencies as it notes that "the problem with this solution is that the fate of the entire money system depends on the company running the mint, with every transaction having to go through them, just like a bank" (NAKAMOTO, 2008).

Overall this early aspiration to finding a viable decentralized model originates from a safety paradigm shared by many computer scientists that a distributed system should turn out to be a more robust and reliable solution than is usually provided by a centralized authority to its stakeholders – such as a government to its citizens.

Without going over all of Bitcoin's essential concepts, and the way the protocol solves the double-spending problem, an issue which all previous attempts of a decentralized cryptocurrency had collided with, we sum up below the key differences between the standard transactional model (so far quasi-unique and certainly prevalent) and the decentralized approach that DLT provides (the so-called blockchain transactional model).

Standard vs. blockchain-based transactional models

Standard	MODEL	Blockchain
Trusted third-party / central coordinator	Paradigm	Trustless system / pseudonymous participants
Centralized server / many clients	Architecture	Peer-to-peer network
Single copy	Database	Multiple copies
Controlled access / firewalls	Security	Cryptography
Intermediation	Price / Cost	Consensus / proof-of-work
PRIVATE	⟷	PUBLIC

Beyond the simple safety issue, indeed a priority, proponents of DLT and blockchain technology usually put forward three potential deficiencies of centralized ledgers controlled by a trusted third-party: (i) the trust depository may not really be trustworthy and may be subject to bribery and other forms of corruption; (ii) the controller of the centralized ledger may censor or reject

certain market participants on subjective and/or discriminatory grounds; (iii) centralized ledgers are not immune to loss of records. The Blockchain, with its decentralized consensus-reaching mechanism, its open-source approach, and multiple copies available for all to see, is capable of addressing all these concerns.

Continuous rise of banking desintermediation

The emergence of DLT comes in the wake of a rising trend of disintermediation, of which one sympton is the growing market share of shadow banking within global finance, a trend which has even prompted a few to call for the "end of banking" (MCMILLAN, 2014). This trend, far from abating, has probably accelerated over the past years with the steady development of new forms of digital finance, such as crowdfunding and peer-to-peer (P2P) lending, whereby lenders and borrowers can directly transact with each other without having to resort to banking intermediation (COLLOMB, 2015).

DLT's impact on digital economy and e-commerce

Blockchain technology is very likely to have a very strong impact on the digital economy and global e-commerce, precisely because of this decentralized transactional model that it facilitates. And indeed, even if the share of e-commerce has been steadily rising since the age of the Internet, essentially over the last score of years, it remains that the main transactional paradigm is centralized. Today's global e-commerce is essentially driven by centralized platforms, such as Amazon's or eBay's. And even if we look at more recent heavyweights of the digital age, the so-called unicorns[1] such as Airbnb or Uber, their services are still based upon proprietary and centralized platforms.

[1] "Unicorns" are privately held companies valued at more than US$ 1 billion. The term "unicorn" was first used by venture capitalist Aileen LEE on November 2, 2013, in a Techcrunch article titled "Welcome to the Unicorn Club: Learning from Billion-Dollar Startups." Aileen LEE used the term "unicorn" to show how rare the phenomenon was. Aileen LEE was doing due diligence research on the tech sector in order to check that there were no bubbles when she came up with this now standard term.
http://www.ibtimes.com/real-reason-everyone-calls-billion-dollar-startups-unicorns-2079596

Along comes blockchain technology, and suddenly the potential for "uberizing Uber" appears, that is the possibilty of foresaking the standard centralized transactional model for a distributed one, where the trust provided by a central third-party would be replaced by the safety of a distributed protocol running over a P2P network. And various examples already exist to test this change of transactional paradigm, beginning with initiatives such as Arcade City in the US or La`Zooz in Israel for transportation services and carsharing. Similarly, when it comes to e-commerce, OpenBazaar[2] ambitions to become a completely distributed competitor to eBay, and Overstock.com is working closely with start-up CounterParty on developing Medici, a blockchain-based stock exchange.

Why DLT is almost impossible to ignore

From a strategic point of view, it seems clear that it would be very risky for financial institutions and key e-commerce players to ignore blockchain technology. Going back to PORTER'S work on competitive forces, DLT can be considered interchangeably as both a threat on established situations, but also as an opportunity for greater efficiency (PORTER, 1979). Either way, financial institutions need to anticipate, to adjust and preferably to spearhead, in terms of new services for instance, what some experts assess as a powerful tsunami of both new technological and business opportunities. And in this dual vision of threat and opportunity, it seems that it is the latter that is mobilizing the enthusiasm of many financial institutions, all the more as the perspective of significant cost savings looms. In their recent paper with Oliver WYMAN and Anthemis Group, Santander InnoVenture claims that blockchain technology could reduce banks' infrastructural costs by $15-20bn a year by 2022[3].

From the Bitcoin protocol to blockchain technology

It is essential in our view to take into account that the growing interest in DLT has very much nurtured itself from the "pole of innovation" (SCHUMPETER, 1934) that the technology was able to bring into existence.

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2 http://www.coindesk.com/openbazaar-live-version-bitcoin-market/

3 "The FinTech 2.0 Paper: rebooting financial services". https://www.finextra.com/finextra-downloads/newsdocs/the%20fintech%202%200%20paper.pdf

In the wake of the original Bitcoin protocol and Blockchain, multiple improvements and innovations have been made, ranging from colored coins, sidechains, and smart contracts to name a few. The emergence of this pole of innovation has reinforced the general perception that DLT had an extremely promising potential for innovative applications, which in turn reinforced the general interest in the technology and seems to have created a virtuous circle of research and development.

The smart contract eldorado

One DLT concept has resonated particularly well with technologists: smart contracts. We will not dwell here on the many automated applications that they could foster, and how they are likely to be deeply embedded in the development of connected objects and the Internet of Things. We simply mention some of the new organizational forms smart contracts make possible, such as the concept of distributed autonomous organization (DAO) which is reminiscent of HAYEK'S theory of spontaneous order (ZACKLAD & SOK, 2015). Despite the recent hacking of the Ethereum-based DAO, and the uncertainty it has created, the concept of a global virtual machine, upon which decentralized smart contracts are running, retains a powerful appeal. We will not risk ourselves at this juncture into predicting the future of Ethereum or other similar decentralized platforms. However we believe that the concept of smart contracts, and the "expansion of a new subset of law" they create, termed "Lex Cryptographia" by WRIGHT & De FILIPPI (2015), is there to stay and flourish – whichever platforms end up dominant in the future. And recent initiatives such as the Lightning Network (POON & DRYJA, 2016), Rootstock[4], or the very many solutions developed by Blockstream for sidechains[5], all seem to confirm the atomic role of smart contracts, while also underlining the central role Bitcoin and the Blockchain are very likely to continue to play in this pole of innovation, and as a means (or common denominator) of interoperability between different and newer blockchains.

It is worth noticing that this feverish interest in DLT, almost an effervescence of enthusiasm, appears to range broadly across the economy, and possibly with a grain of irony, across providers of trust of last resort,

4 http://www.rsk.co/

5 https://blockstream.com/

such as governments, regulators and central banks. Today, almost all institutions seem tuned in to the latest wobbles of the technology and its many promising applications. It is now its potential for financial applications that we would like to further scrutinize.

■ Blockchain technology and its mutli-faceted potential for financial applications

Over the past year, Blockchain technology has become one of the focal points of many financial practitioners eager to understand how it could impact, and possibly alter, their ways of doing business. We outline below our prospective analysis of where we think blockchain technology is likely to matter most when it comes to financial applications.

Payment systems

It seems fair to say that it all started there – for finding a cheap and reliable way to make decentralized payments. Satoshi NAKAMOTO'S white paper and the first implementation of the Bitcoin protocol generated growing interest because bitcoin payments worked – and this despite the setbacks and negative publicity due to the Silk Road or the Mount Gox demises. It has been hailed as an effective means of making international transfers and paying remittances, with lower transaction costs than standard banking fees and a much speedier settlement – about ten minutes for the first confirmation as opposed to a couple of days for an international bank transfer. And blockchain technology has been the subject of growing interest and various experiments as a payment solution. Visa has tested the Blockchain[6] while the Korean KB Kookmin Bank[7] has been developing a DLT-based solution for its fund transfers, currently done on SWIFT[8].

One of the key questions is whether the Bitcoin network, or any other DLT-like network using a consensus mechanism, will be able to achieve transaction throughput comparable to major payment networks such as Visa

6 http://www.coindesk.com/visa-europe-remittances-bitcoin-blockchain/

7 http://www.coindesk.com/korean-bank-developing-blockchain-solution-foreign-exchange/

8 SWIFT (Society for Worldwide Interbank Financial Telecommunication) is a global provider of secure financial messaging services. https://www.swift.com

or Mastercard. And this scalability issue has sometimes set off passionate debates on the technological adjustments that would be needed – such as whether the block size should be increased or not. There has also been a lot of discussion as to what types of payments should be conducted on blockchains. For instance, many think that the Bitcoin blockchain should not be used for trivial payments but that its bandwidth should be saved for authenticating and storing key consolidated information – such as daily net balances of sidechains dedicated to certain types of micropayments.

It is still too early to know where these technological chips will end up falling but it is important to bear in mind that what is particularly interesting with DLT is its transactional generality: not only can it be used for payments but it can be used for many other applications such as storing digital assets or digital certificates and proof-of-existence information[9].

Corporate finance and governance

DLT is full of promises when it comes to corporate finance. This is mainly due to the fact that it could be used as a firm's new informational backbone. Blockchain technology resonates particularly well with chief financial officers and treasurers because of the ownership traceability it could provide. Indeed, a firm's ownership is not always easy to trace. Surely, publicly-traded companies have to know their significant shareholders, and regulations force shareholders to disclose ownership when crossing certain thresholds. However minority shareholders are often difficult to trace, so much so that in certain situations such as a corporate takeover, a firm's management may have a difficult time reaching out to them. DLT could bring about significant improvements to these fuzzy situations where management is unsure of "who has what?". And DLT could also turn out to be very useful for corporate governance, facilitating shareholder consultation at annual general meetings through secure electronic voting. This more granular tracking of a firm's stakeholders should also greatly facilitate dividend payouts to shareholders or coupon payments to bondholders.

9 https://www.proofofexistence.com/

Financial accounting, trade finance and supply chain management

There again hopes in DLT are essentially based on high expectations that a quasi-exhaustive recording of all (financial) transactions involving a corporation could do marvels for its management, not just its chief financial officer or treasurer, but also its chief accountant, legal counsel or purchasing manager. Just as some observers hope that corporate governance should become more inclusive, financial accounting and management could become more precise with quasi-real-time updates of a firm's balance sheet, income or cash flow statements. Similarly trade finance, which to this day still involves letters of credit and fax-based paperwork, could benefit from blockchain technology. And already various DLT-based initiatives for facilitating B2B commerce, and its financing, have emerged such as Skuchain[10] that is working on fostering a smart-contract solution to "govern all phases of a typical trade agreement from order, shipment and invoice to final payment". Clearly, there again one needs to differentiate between wishful thinking and what the reality will turn out to be in five or ten years; but at the minimum, blockchain technology is likely to force a firm's managers to reassess their various administrative and management processes.

Financial reporting and compliance

DLT seems also very promising for automating financial reporting and enforcing compliance procedures. Indeed as a comprehensive and immutable repository of a firm's past transactions, it should facilitate an auditor's work, and even a regulator's monitoring of a firm's activities. For banks, and financial institutions in general, this feature seems particularly relevant. Indeed, the 2008 global financial crisis has triggered new and more stringent prudential regulations under Basel III for banks or Solvency II for insurers. One could hope that enforcing the capital or liquidity requirements embedded in these directives should be facilitated by a shared blockchain infrastructure. As of today, this vision of leveraging DLT for automating compliance procedures still seems futuristic but since the technology is getting a lot of attention from regulators and audit firms alike, DLT is fuelling innovative thoughts on how to improve and simplify compliance procedures by redesigning reporting channels and automating financial reports.

10 http://www.skuchain.com

Crowdfunding and peer-to-peer (P2P) lending

DLT's ability to track ownership in a distributed and immutable way has been appealing to both issuers and investors, as the Nasdaq Linq initiative seems to confirm. Hence it should not be surprising that some crowdfunding platforms have started to investigate using blockchain technology to provide their investors with investment e-certificates[11]. But just as we mentioned before that DLT may turn out a potent means of disintermediating centralized platforms, its attractiveness for crowdfunding and P2P lending goes beyond its traceability advantages. And some start-ups such as Waves have offered their users to run crowdfunding campaigns with fiat currencies, Bitcoin or the start-up's native tokens, thus leaving customers free to choose their way of investing[12].

We will now focus on the likely impact of DLT on capital markets, particularly the post-trade infrastructure which seems the first concerned.

■ Is blockchain likely to reshape post-trade infrastructure?

Financial market infrastructure is commonly divided into three main value chain components: (i) pre-trade, (ii) trade and (iii) post-trade processes. Its building has evolved slowly and gradually over time, and its current functioning still relies on various legacy systems.

The competitive advantage of DLT for pre-trade and trade activities, versus existing processes, is not that obvious as the technology has not been originally conceived for conducting negotiations or constructing an order book. However the advantages of the technology for post-trade clearing and settlement seem natural.

When trade becomes settlement

Indeed a delivery-versus-payment (DVP) settlement system is designed to ensure that delivery will take place only when the due payment occurs.

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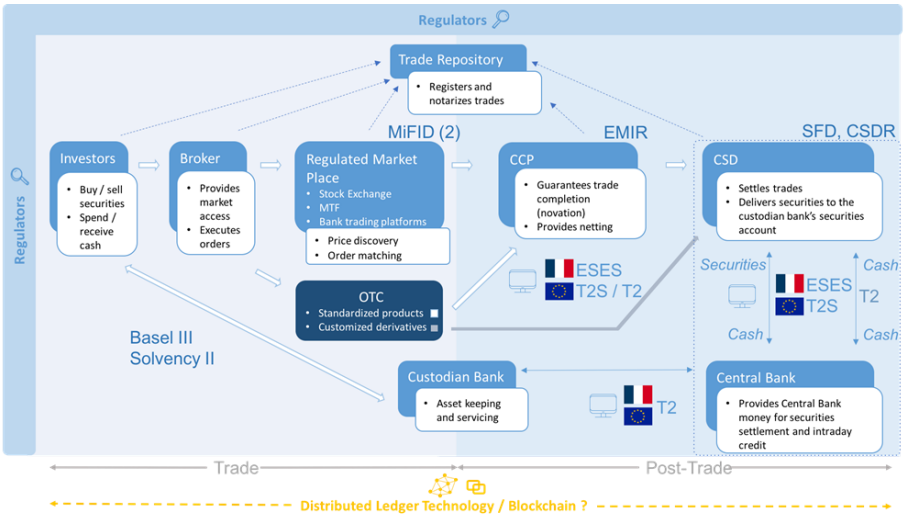
11 An example is the blockchain-centric partnership between BNP Securities Services and the SmartAngels crowdfunding platform, announced in April of this year.

12 http://forklog.net/blockchain-platform-waves-to-create-kickstarters-killer/

This system acts as a link between a funds transfer system and a securities transfer system. It needs to check that the buyer has the cash to pay for the purchase of the security, and that the seller indeed owns the security sold and is able to deliver it. Proper settlement will also need to ensure that the rightful change of securities ownership is recorded in a safe and reliable ledger. Today DVP settlement is not instantaneous and can take a few days; for instance, a "T+2" settlement system will refer to the fact that settlement must be done within 2 days of the trade date. And completing this settlement process will require executing a few operations in the post-trade infrastructure (see below the capital markets overview) in the relevant cash and securities accounts. And precisely because of the time taken by current settlement procedures, the smooth functioning of capital markets requires clearing mechanisms, usually performed by a clearing house, to insure either party against the other's potential default. To do so, the clearing house interposes itself between buyer and seller and takes on the selling liability due to the buyer, and conversely the buying obligation due to the seller; this transfer of liabilities to the clearing house through its interposition between buyer and seller is called novation.

Overview of capital markets



Blochain technology, where "trade is settlement", may have a profound impact on the way post-trade currently works. More precisely a DVP-based trade could only be allowed if quasi-instantaneously authorized: it should be possible to immediately check if the buyer has the available cash to proceed

with the due payment in his/her cash account, and if the seller indeed owns the sold security and has it ready for delivery in his/her securities account. To sum it up, DLT makes it possible to have on the same digital data infrastructure both cash and securities accounts, two types of accounts that until now were dealt with separately.

Blockchain as a tool to track systemic risk

But beyond the perceived advantages of DLT for settling trades, it has a particular regulatory appeal, again due to its promise of immutable and comprehensive transactional traceability. Let us explain why market participants, in particular regulators, could be very keen to use the technology. The recent global financial crisis put the spotlight on the proliferation of over-the-counter (OTC) derivatives transactions, and the potential risk the latter represented for financial markets' stability. An instance of the potentially devastating effect of unchecked derivatives transactions could be found with the bankruptcy of AIG Financial Products (AIGFP) and the near collapse of its parent company, the insurer AIG, that had to be saved by the US federal government after the company was deemed of systematic importance. This rescue was conducted once public officials realized that letting AIG go bankrupt risked having a devastating and rippling domino effect across global financial markets: the fall of AIG was likely to drag along some of its major counterparties, especially those to whom it had significant liabilities in the credit default swap (CDS) market.

Since then in Europe, the European market and infrastructure regulation (EMIR) has required derivatives dealers to clear through a central counterparty clearing house (CCP) all OTC derivatives trades deemed to be liquid and standard enough by the European Securities and Markets Authority (ESMA). In fact EMIR has cast "CCPs as pillars of the new global financial architecture" (CONT, 2015).

In addition, among its various constraints, EMIR has imposed the establishment of trade repositories (TR) for centrally collecting and maintaining the records of derivatives. TR are dedicated to "[playing] a central role in enhancing the transparency of derivative markets and reducing risks to financial stability"[13]. With the establishment of TR, the spirit of EMIR is quite clear: if we want to avoid a repeat of the last financial crisis

13 https://www.esma.europa.eu/supervision/trade-repositories

and avoid situations where risks of devastating financial contagion are discovered at the last minute and at the worst possible time (when the financial crisis has started unfolding), regulators need to have a clear view of counterparties' exposures to all others - especially for systemically important financial institutions (SIFI). And to accomplish such a mapping of systemic and contagion risks, there needs to exist a comprehensive record of all derivatives trades. And there again DLT, with its distributed and immutable characteristics, could lend itself well for collecting and recording all these derivatives trades, all the more if major global financial institutions decided to use a common dedicated blockchain. And global initiatives such as R3[14], that has federated almost fifty banks, may allow for this.

Post-trade infrastructure and economic growth

The liquidity contraction and the deleveraging that followed Lehman's demise created acute funding needs for the European private sector. With the global turmoils of the financial crisis and the economic slump that ensued, particularly in Europe, the importance of fostering growth through efficient and stable capital markets was once again stressed, all the more so given that European financial markets seemed to lag behind their US counterparts in terms of financing the economy. Indeed, as underlined by the European Commission's "Action Plan on Building a Capital Markets Union" (September 2015)[15], "compared with the US, European small and medium-sized enterprises receive five times less funding from capital markets".

In this tight and difficult context, it was reminded to all that safe and efficient post-trade infrastructures were key to achieving secure and sustainable economic growth across Europe, and that this meant achieving a smooth cross-border integration of European financial markets. As stated in this same 2015 European Commission's action plan on building a capital markets union, "EU legislation, such as European Markets Infrastructure Regulation (EMIR), Central Securities Depositories Regulation (CSDR) and MiFID II, has removed many of the barriers to the cross-border clearing and settlement of securities". Harmonization efforts had been made in line with the Giovannini Group's recommendations (2001, 2003), through pan-European initiatives such as the European Post Trade Group (EPTG)

14 http://r3cev.com/

15 http://ec.europa.eu/finance/capital-markets-union/docs/building-cmu-action-plan_en.pdf

composed of the European Commission, the European Central Bank (ECB), the European Securities and Markets Authority (ESMA), and industry representatives, and these efforts were to be continued.

Recent evolutions in settlement systems

Continuous link settlement (CLS) and real-time gross settlement (RTGS) systems have been set up to replace deferred net settlement (DNS) procedures at the European level for both intraday payment and credit (TARGET2, or T2, the RTGS system operated by the Eurosystem replaced TARGET in November 2007) and most recently for securities settlement (TARGET2-Securities, or T2S, is currently being rolled out in the Eurosystem). RTGS systems use and rely on the SWIFT messaging system.

RTGS has generally been considered safer than DNS (HERVO, 2008) as each transaction is settled "as soon as it enters the system". Yet, "a side effect of settlement in RTGS mode is that the associated intraday liquidity needs required to settle an equivalent of underlying payment obligations are higher than in a DNS environment" while it also creates an increased need for "collateralization to support liquidity demand".

What this illustrates is that the design of any new DLT-based system should take into account this trade-off between (i) aiming to provide settlement as early as possible to decrease liquidity risks on the one hand (this should be quasi-instantaneous with DLT) and (ii) minimizing the collateral requirements which can be costly.

It is worth noting that liquidity-saving features have been introduced into RTGS systems in order to allow "bilateral or multilateral compensation with real-time settlement functionality (for instance, CHIPS in the United States, T2 in the EU)" and that other types of commands based on real-time information have been added in order to lower users' liquidity-related opportunity costs. For instance features were added to modify the order of a transaction in the backlog, the time at which it should settle or some credit limits controlling the amount of funding allowed to go out.

As for dealing with the increased collateralization generated by RTGS, adjustments have been made by central securities depositories (CSD) to introduce automated self-collateralization features. For example, Euroclear's ESES settlement system provides real-time delivery versus payment (DVP) services with embedded automated self-collateralization procedures

whereby securities "being purchased can be used as collateral for intra-day credit in order to fund the purchase" (HERVO 2008). T2S should provide similar features once roll-out is complete.

Lastly, it is worth observing that in order to increase security and trust, RTGS systems have prompted the dismantlement of revocable operational systems (in France, ESES began replacing Relit+ in 2007) in favor of irrevocable settlement systems for the delivery-versus-payment of securities[16].

All in all, we can see that some of the latest changes in European capital markets, such as the transition to real-time and irrevocable settlement systems bode well for the introduction of DLT. Surely, many other challenges would need to be answered such as dealing with increased needs for diversified collateral or with the growing use of commercial bank money instead of central bank money for multi-currency settlement. But one of the main hurdles that a blockchain-based architecture would need to overcome is the post-trade infrastructure scale of operations. In Europe, RTGS system T2S is still in test mode and therefore, no statistics related to its operations are yet available. According to the Banque de France[17], RTGS system T2, considered a Large Value Payment System (LVPS), treated on average 364,000 transactions per day, for a total amount of 1,935 billion euros in 2013. Interestingly enough, this is not that far off the Bitcoin blockchain's current daily throughput which has been hovering over 200k transactions per day, and almost reached the 250k mark in June. Hence, if it seems perfectly legitimate to wonder whether or not DLT could cope with the complexity and scale of post-trade infrastructure processes, one could also expect that a dedicated blockchain architecture with a tailored consensus mechanism could end up doing the trick in the future.

Latest initiatives and executive signals

Over the past two years, many partnerships between financial institutions and DLT start-ups have been launched and these announcements have shaken up the usually conservative perception of traditional banking.

16 https://www.banque-france.fr/stabilite-financiere/infrastructures-des-marches-financiers-et-moyens-de-paiement-scripturaux/infrastructures-des-marches-financiers/traitantlestitres.html

17 https://www.banque-france.fr/stabilite-financiere/infrastructures-des-marches-financiers-et-moyens-de-paiement-scripturaux/target2-banque-de-france.html

Whether these DLT start-ups end up reshaping the financial sector the way unicorns are transforming other sectors of the economy remains to be seen. But it is a very strong signal that these initiatives have usually enrolled household names in finance, and not just from the private sector. Just to name a few: Blythe MASTERS, former JP Morgan global head of commodities and also considered the creator of CDS, joined Digital Asset Holdings – a blockchain company providing asset and ledger services - as CEO in March 2015; Peter RANDALL, former CEO of multilateral trading facility Chi-X, launched the SETL system with the ambition to streamline post-trade infrastructures; David WALKER, former official of the Bank of England and chairman at various banks, was appointed SETL chairman in December 2015 and was recently joined on SETL board by Rachel LOMAX, former Deputy Governor of the Bank of England and Ed RICHARDS, former CEO of Ofcom[18]. This list is clearly not exhaustive and is getting longer month after month.

Going back to the scalability issue, SETL has in fact announced that they expect to be able to process as many as 100,000 transactions per second, numbers comparable to those of payment services provider Visa. SETL's stance is to "use computing to simplify processes" and they envision DLT as very promising on this front. "When we launched Chi-X, that worked because instead of taking a bunch of manual processes and computerizing them, we did it the other way round – we started with the computer, put that at the center and built the processes around it […] Reconciliation is traditionally very expensive – you end up having to reconcile multiple times due to differing systems. But the blockchain is a golden record that allows us to do it only once. The potential is enormous[19]".

Besides SETL, there are many other unfolding projects such as Clearmatics, which is working alongside Swiss banking giant UBS and is rumored to be making other significant advances[20], or implementations being tested by exchanges such as Nasdad's Linq to record private securities transactions[21] or the ASX's initiative to build a distributed ledger

18 Press release, 15 July 2016, https://setl.io/

19 http://www.bankingtech.com/348852/blockchain-based-setl-plans-to-revolutionise-payment-and-settlement/

20 http://www.bloomberg.com/news/articles/2015-11-18/ubs-blockchain-partner-clearmatics-raises-funds-for-digital-coin

21 http://ir.nasdaq.com/releasedetail.cfm?releaseid=948326

that could ultimately replace the clearing and settlement systems provided through its CHESS platform[22].

■ Conclusions and further research

We can draw a few conclusions from this brief study, along with key questions that in our view remain open at this juncture.

Firstly, we think that the new decentralized transactional model made possible by DLT is likely to impact e-commerce significantly over the next decade. If one of the original focal points of application of the technology was payments and international transfers, we see in the flurry of initiatives - and of household names joining them - a clear signal that DLT is likely to prosper and have a deep impact on the economy, not just payment services.

Secondly, we believe that DLT looks promising on paper for corporate finance, corporate governance, cash management and treasury applications, and more generally for many of a firm's management processes. But we also think it is important to separate what is specific to DLT from other IT improvements. For instance, blockchain-enabled innovations should not be confused with improved database management. And one should not forget that some key DLT concepts such as having a decentralized and hence hard-to-corrupt authentication mechanism can be lost in a private or a consortium setting. At least, one of the sure virtues of the blockchain-related technological debate is that it is forcing firms and institutions alike to think hard about their digital transformation, just like the Internet ended up doing in the late 90s.

Thirdly, it is still too early to see how its landscape will evolve, and how interoperability between different blockchains will be assured, and on what scale and with which bandwidth and throughput. There are different competing initiatives, whether public or private, but at the time of writing it seems fair to say that the Bitcoin blockchain remains both one of the most resilient and robust chains, and a central point of reference for new initiatives to be compatible with. When it comes to consortium or private blockchains – a contradiction for some, as the latter tend by design to be controlled by a

22 http://www.smh.com.au/business/banking-and-finance/asx-builds-blockchain-for-australian-equities-20160121-gmbic0.html

small number of permissioned participants – research still needs to be done on the appropriate consensus mechanisms, and the way for instance database immutability is guaranteed.

Last but not least, the issue for capital markets' adoption of DLT, and particularly for its integration in the current post-trade infrastructure, is that there is no margin for error. Capital markets cannot be paused... DLT integration seems relatively easy to do for peripheral or niche activities, such as a low-frequency private securities market, but are we ready yet to plug a major stock market into a blockchain for settling its trades? It may have been easier to start from scratch, but post-trade infrastructure is just the opposite: it has grown organically over the last decades, and ends up today being complex and filled with legacy systems. Governance, standards and interoperability are also key issues for an efficient large-scale DLT deployment in capital markets, let alone the regulatory adjustments that are likely to be needed to reflect any significant change in capital markets' infrastructure. We are doubtful at this point that a major and comprehensive overhaul of post-trade infrastructure could be jointly decided by key stakeholders such as financial institutions, central banks and regulators. We tend to believe that effective DLT integration is more likely to come from various initiatives, some of which have been mentioned above, of post-trade major players. But this will only succeed provided these major post-trade participants work out both the internal substitutions needed, over which they should have control, and the external interoperabilities required. As the DLT environment is changing very rapidly, assessing the techonology's impact on the financial sector is ongoing and exciting research.

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