



Analysing the Deployment of Blockchain and Distributed Ledger Technologies in the Financial Sector

Final Report

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Table of Contents

1. Executive Summary	4
2. Market Delineation	9
1.1 Sectorial Scoping	9
1.2 Blockchain and Distributed Ledger Technologies (BDLTs)	11
1.3 Key Application Areas.....	15
3. Assessing the Impact of ICT on Growth through Financial Services	22
4. Drivers and Obstacles for BDLT Adoption and Deployment	24
3.1. Drivers	24
3.2 Obstacles	26
5. Policy	29
6. Quantification	32
5.1 Quantifying the Effects of BDLT implementation	32
5.2 Assessment of BDLT implementation impacts on segments of the European financial sector.....	33
5.3 Assessment of BDLT-driven shifts in financial development	37
5.4 Impact of BDLT implementation on GDP growth.....	38
5.5. Key risks.....	39
5.6 Differences of BDLT effects and risks across European countries	40
7. BDLT Deployment in practice: Case Study Analysis	42
6.1 Approach	42
6.2 Live BDLT Applications	43
6.3 Deploying BDLT to the Financial Sector	56
8. Concluding Remarks	63
7.1 Still at an early stage, non-crypto BDLT's are now Deploying.....	63
7.2 BDLT show Strong Impact Prospects for the Financial Sector and Beyond	63
7.3 Uptake Hampered by Critical Factors	64
9. Bibliography	65

1. Executive Summary

The financial sector has pioneered the deployment of Blockchain and Distributed Ledger Technologies (BDLTs) since the launch of bitcoin in 2008. The technology has been touted to possibly have the most disruptive impact on the financial industry for decades. “DLT’s critical innovation in the context of digital currencies is that it provides a cryptographic solution for providing security and protecting system integrity in a decentralized ledger that is maintained by a network of anonymous participants without any need for trust across one or more institutions”. (World Bank, 2017). Beyond finance, however, BDLTs are considered a possible breakthrough for a broad range of industrial sectors. The technologies introduce new notions such as disintermediation and efficiency gains that could be key to industry.

This document provides an early assessment of the effect of BDLTs on the competitiveness and growth of the European financial sector with extensions for the rest of the economy. In the process, the document discusses the drivers and obstacles to BDLT deployment across Europe. The analysis has been based on three diverse sources of information:

- An extensive review of the academic and popular literature as well as of policy directives and initiatives across the continent.
- A tentative quantification of the effects of BDLT technology adoption in the European financial sector based on three sources of data: (i) the replies of a number experts to a detailed questionnaire on the effects of BDLT implementation (adoption) in segments of the financial sector and the associated risks; (ii) estimates of parameters of financial sector and gross domestic product (GDP) growth from the academic literature; and (iii) data from the Bank of International Settlements (BIS) and the World Bank. The impact of BDLT implementation (adoption) on the European financial sector and its contribution to the economic growth of the EU as a whole are estimated. The risks of BDLT implementation in each segment of the financial sector are also assessed.
- Five case studies of European companies currently piloting new BDLT-based products, drawing on deep interviews and the (open) business literature.

Wide range of BDLT applications in the financial sector

Examples of BDLT application areas in the financial sector include functions such as:

1. Payments and remittance: Cross-border payments are usually intermediated by clearing firms. Payments are in that sense usually subject to intermediation costs in multiple layers that induce operational complexity and counterparty risks. In contrast, BDLTs allow for direct peer-to-peer transactions that limit the need for intermediaries.
2. Credit and lending: The use of smart contracts presents potential benefits that could make lending safe and prevent crises. BDLTs are also used to raise capital through crowdfunding and other means and have the potential to impact classic and new financial intermediaries. Examples encompass blockchain-based tokens and Initial Coin Offerings (ICOs).
3. Trading and settlement: The use of BDLTs can lead to near real-time clearing and settlement, reducing risks related to duplicated records and associated time lags.

4. Compliance: BDLTs show great potential for financial reporting and compliance issues. Despite the lack of use cases, BDLT could allow for recording players and actions in a transparent, streamlined fashion and in line with regulatory requirements.
5. Asset management.

Extensive prospective benefits from adopting BLTD but also challenges hindering widespread deployment

The alleged strengths of BLTD systems include a long list of factors that enhance efficiency and security while decreasing transaction costs. Private and social benefits become possible due to the special features of the technology whereby transactions are registered and stored on various servers and a copy of the database exists in every node. Strengths arguably include:

1. Information (transparency and traceability)
2. Network security/resilience
3. Efficiency and cost savings
4. Scale and network effects
5. Trust
6. Flexibility
7. Automation and programmability
8. Social inclusion

Financial applications of BDLT, however, currently face numerous challenges hindering adoption and full-scale deployment. Such challenges primarily relate to the overall immaturity of the technology and various external factors, including:

1. Speed / slow pace of transactions in large networks / scalability (throughput issues)
2. Cost of processing / high energy consumption
3. Operational and cybersecurity issues
4. Transparency vs privacy issues
5. Legal settlement (liability) issues / dispute and recourse frameworks
6. Human capital shortages
7. Network effects (critical mass)
8. Regulation complications
9. Technology maturity: latency and transaction speed; scalability; resilience
10. Coordination effort associated with multi-asset management
11. Systems integration / interoperability / standards
12. Access issues (permissionless networks)
13. Suboptimal awareness of possibilities (demand and supply sides)
14. Reluctance to change / migration costs to new technology

Significant role for public sector authorities in early market creation

Reflecting the current state of flux in the technology and its prospective applications, but also reacting to high expectations for significant societal returns, governments and regulators around the world have gone into high gear. Policy measures are multiple but not necessarily well orchestrated and coherent. A large number of initiatives piloting blockchain are reported around the world, also including the World Bank's Blockchain Lab. More than a user, however, the public sector plays a critical role as regulator. The World Bank (2017) has pointed at several legal and regulatory challenges, including:

- 1) Regulatory vetting and industry standards;
- 2) Legal clarity over ownership and jurisdiction;
- 3) Know-your-customer, customer due diligence, anti-money laundering, combating the financing of terrorism;
- 4) Recourse mechanisms for dispute resolution and liability over possible losses.

In Europe, both the European Commission (EC) and national governments are moving towards addressing the new technologies. The EC formalized its interest in BDLTs in 2013 under Horizon 2020 with an estimated expense of €340 million on blockchain technologies by the end of 2020. The EC also supports the European Blockchain Partnership established in 2018, has initiated the EU Blockchain Observatory and Forum, launched projects such as Blockpool.eu, facilitates contacts with the International Association for Trusted Blockchain Applications, has triggered the formation of an EU BDLT industry-driven community (starting with the EU Blockchain Industry Roundtable held in 2018), has engaged into the #Blockchain4EU initiative touching upon Blockchain for industrial transformations, and has launched the “*Blockchains for Social Good*” challenge and associated prize. Beyond the Commission, both the European Council and the European Parliament have been sensitized to the new technologies and have passed several related resolutions.

Regulatory frameworks in place at the EU level are also under consideration. They mainly include:

- The EU Payment Service Directive (PSD2)
- The General Data Protection Regulation (GDPR)
- The EU Markets in Financial Instruments Directive (MiFID II)
- The Know Your Customer (KYC) and Anti-Money Laundering (AML) regulation

The regulatory agencies key to the financial sector have produced reports and recommendations on BDLT, highlighting the diversity of possible cases and the care needed when considering the role of BDLT in the financial sector. They include the European Insurance and Occupational Pensions Authority (EIOPA), the European Banking Authority (EBA), the European Securities and Markets Authority (ESMA), and the European Central Bank (ECP).

Last but not least, national policy frameworks are key. The predominance of national frameworks across the 28 EU countries remains an important factor to bear in mind. Some challenges are induced by the cross-border nature of BDLT transactions which can cut across jurisdictions, implying for instance the development of VAT standards and protocols which could be empowered by artificial intelligence and smart contracts. Policy initiatives are being fostered across Europe, ranging from the French Parliamentary debates around Blockchain to the UK research orientation toward addressing BDLT technical limitations. It would be fair to say, however, that policy initiatives are still in flux reflecting the novelty (fluidity) of the technology and deep uncertainties about its potential impacts.

While too early to quantify the effects of BDLT implementation, it is already obvious that the impact will vary widely across market segments and across countries

The effects of BDLT implementation were assessed by experts for the following segments of European financial sector: payments; retail banking; corporate banking; financial markets; investments; insurance. According to these experts the cost reduction due to BDLT implementation varies from 20% to almost 70% depending on the segment. Cost reduction is expected to increase the frequency and number of transactions and hence provide an equivalent

range of growth of markets for BDLT based financial services in real terms. Financial inclusion and the appearance of new BDLT enabled services will demonstrate significantly different effects in Western and Eastern European countries. Inclusion will have a modest effect on financial market mainly in Eastern European countries such as Romania and Hungary but insignificant effects in the west due to the very well developed financial sectors. Due to a number of significant risks experts indicate that adoption of BDLT will not go extremely fast and may reach 50% only in early 2030s.

Early estimates of overall BDLT implementation effects indicate 15% increase in financial depth and more than 20% increase in financial leverage of European economies. Combined with rising electronic payments penetration and faster financial market turnover, these may increase economic growth and provide additional 6% to European GDP by 2030.

In-depth case studies and interviews indicate that BDLT are deploying now, thus being subject to the typical uncertainties, technological fluidity, lack of dominant product designs, evolving business models, rapid entry and exit, core roles of small firms, and possibly significant shakeouts in the future as technologies mature.

The case studies focused on non-cryptocurrency applications. They illustrate the momentum of BDLT deployment: while the financial sector as a whole is still a slow adopter, European companies are now deploying new financial applications and some of them already demonstrate the impact potential of BDLT.

Five cases were explored in greater depth:

- 1) **Komgo** is a BDLT-based platform to digitize finance along the commodity trade value chain. The lead success is the digitization of letters of credit – shrinking the process from days to minutes while ensuring a secured transaction.
- 2) **SatoshiPay** provides micro-payment solutions (in cents or fraction of cents) to access digital content. Tens of thousands of transactions are currently being performed on this middleware with a growing user base.
- 3) **SettleMint** offers a middleware and a range of complementary services allowing for the full digitization and tokenization of activities in areas such as financial and supply chains. Besides being used by one of the world's largest retailer, it has also been used to digitize Islamic Development Bank subsidies, leading to an estimated \$150 million impact.
- 4) **SmartValor** went live at the very moment of the study. It provides a token (including securities) exchange allowing for alternative investment. The exchange has created strong traction right passed commercialization, deploying a high level of transactions.
- 5) **Centrifuge** also went live at the time of the study and proposes a decentralized Operating System dedicated to the digitization of the financial supply chain. It raised funds through several rounds and is considered a leading player in its segment.

The cases illustrate the fact that BDLTs are currently deploying to the market. In other words, we are looking here at a technological transformation during the very early stages of development with the concomitant uncertainties, fast rates of transformation, large numbers of small entrants, relative reluctance of large incumbents to join, and wildly varying expectations about benefits and costs. Various technologies are evolving rapidly with adopters moving from one to another after testing rounds and reaching a certain level of maturity in product development. Business models are also evolving rapidly; new ones are emerging such as Security Token Offerings through which securities can be tokenized and made more liquid.

Company growth and supporting investments are very much linked to the way they anticipate the evolution of their revenue generation model.

Disintermediation leads to a reduction of costs and length of the financial transactions along the value chains, ranging from the commodity trade market to micro-payments. Estimates of operational cost savings reach 30% in the commodity trade case, for instance. The impact potential of BDLT deployment can therefore be quite significant, although it is too early at the moment to see real impacts of BDLT deployment at industry level (with the exception perhaps of the market creation occasioned by the raise of cryptocurrencies).

Once again, the role of policy decision-makers can (will) be instrumental

An exploration of the challenges to BDLT deployment in lays the ground for policy issues that deserve attention. The following list is not exhaustive but covers priority areas:

- 1) **Ease Regulatory Compliance for SMEs.** Compliance adds length and costs to the deployment of most applications at stake. SMEs do not have enough resources to face such burden. The lack of common framework appears to be a hampering factor in many areas (from the portability of e-documents to checks implied by Know-Your-Customer regulation). This is not about questioning the ground for regulation protecting EU customers and citizens; rather it is about bearing the burden of compliance processes.
- 2) **Facilitate the involvement of lead-users** and unlocking the confidence of large customers. This is a challenge for many new entrants that need to take on-board large corporate clients to ensure a clean take-off.
- 3) **Support technological development** is key to overcome technical constraints such as scalability (seen as a real, alas temporary, issue) and interoperability.
- 4) **Foster the cultural acceptance of BDLT.** Perception and cultural factors have historically affected adoption of new technologies. BDLTs are not an exception. The cultural reluctance embedded into larger organisations was often mentioned in our cases.
- 5) **Address information asymmetries.** Confusion regarding the nature of BDLTs as a technology and their narrow identification with cryptocurrencies (a specific applications of BDLT) lead to a volatility in BDLT traction. Information asymmetry is strengthened by the complexity of the technology which is not widely known and understood.
- 6) **Setting the right incentive models** such as funding and financing to enable the capacity increase in smaller entities deploying or adopting BDLT. Mobilizing/fostering demand for BDLT's could also stimulate deployment and further innovation.

We conclude with a word of caution. A recently produced report (Rauchs et al., 2019) makes a strong point of the opaque terminology and marketing hype that have contributed to the “*blockchain meme*”. The first part of our report essentially indicates that this also applies to the whole BDLT family. This set of technologies is currently at such an early stage of development with fluid markets and a lot of regular business risks as well as uncertainties that it would be unwise to hang one's hat on any early estimate of impact. Students of technological advancement have learned long ago to respect the power of the markets and of unforeseen phenomena in determining the final outcomes of radical innovation.

Introductory Note

Since the launch of Bitcoin in 2008, the **Financial Sector** has always been perceived as the leading area where **Blockchain** and *Distributed Ledger Technologies (BDLTs)* are deployed, opening innovation tracks through decentralisation and transactional innovations.

BDLTs are now considered a prospective breakthrough that could disrupt a broad range of economic activities. They introduce new notions such as disintermediation and potential security and efficiency gains that could be key to industry. Presently, however, the technology is “hyped up” by investor and developer enthusiasm and its net impact is being **questioned**.

This report **aims** to:

1. Provide an early assessment of the effect of BDLTs on the competitiveness and growth of European economies with a particular emphasis on the financial sector;
2. Analyse the drivers and obstacles to BDLT deployment across Europe.

2. Market Delineation

1.1 Sectorial Scoping

1.1.1 Financial Services

Eurostat (2008) stands as the reference for sectorial classification in Europe and combines financial and insurance activities in section K in **NACE Rev 2**. Financial service activities consist of monetary intermediation including central banking, activities of holding companies, trust funds and similar financial entities, insurance, reinsurance, and pension funding. K section also covers activities auxiliary to financial services and insurance activities which are distributed across the type of financial transaction or funding served.

S&P (2018) uses the global industry classification standard which is comparable with NACE Rev 2. Three categories of **financial institutions** are considered: banks, diversified financials (including multi-sector holding, consumer finance, capital markets, mortgage real estate investment trusts) and insurance. This definition was further refined by FTSE Russell (2019) defining **financial services** as covering banks, finance and credit services, investment banking and brokerage services, mortgage real estate investment trusts, equity and non-equity investment instruments, life and non-life insurance.

Banks are key stakeholders in this system. The leading position of banks as a financial intermediary is also supported by McKinsey in its Global Banking Annual Review (Dietz et al, 2018). To identify key banking activities, McKinsey analyzed revenue streams of the global financial intermediation system. The mapping of revenue distribution across the global financial intermediation system shows that retail banking together with commercial banking are key elements of the current global financial system: in 2018 they accounted for 35% and 30% of total financial intermediation revenues respectively. At the same time, the document highlighted the growing importance of newcomers which affected incumbent’s market share.

Functions remain a key angle to approach the financial sector. The World Economic Forum, for instance, in collaboration with Deloitte (2015) employs a classification of financial services based on their core functions, including market provisioning, investment management, capital raising,

deposits & lending, payments, insurance. Among these, WEF (2015) specifies 11 clusters for financial innovation by starting from a shift in customer preferences to identifying emerging payment rails and new market platforms. Such functions were affected by new changes in the financial system, such as the growth of alternative finance. Ziegler et al. (2018) systemized in that sense a variety of platform-based activities across European **Alternative Finance** – excluding the UK data – listing 14 main alternative finance models¹.

Another way to classify financial services is to incorporate the impact of disruptive technologies like fintech on financial services. In this vein, He et al. (2018) divided financial services into 7 groups: regulation, currency and payments attributed to central banks; back-office operations, currency and payments, lending, insurance, savings, and advice by financial institutions. Fintech firms were assumed to disrupt all types of financial services. In addition, He et al. (2018) suggested which financial services were expected to be transformed due to particular technologies adopted in finance such as Artificial Intelligence and Big Data, Distributed Computing, Cryptography, and Mobile Internet Access. Carmona et al. (2018) followed a more application-driven approach, identifying 8 categories of **fintech services**: deposits, lending and equity represented banking services, payments, transfers and forex, digital currencies, wealth and asset management, personal financial management, IsurTech, enabling technologies and infrastructure.

1.1.1 Financial Technologies

The driving role of technology in the modern financial sector is at the core of our study. Technology adoption is regularly associated in the economic literature to its **benefits**. The IMF (2017) for example systemized cases illustrating how technology might encourage efficiency gains for contestability – the extent to which the entry of newcomers can lead to a more competitive market environment – changing the behavior of market players. For example:

- The automation of credit scoring systems allows financial institutions to monitor information asymmetry;
- The adaptation of online payments tends to decrease transaction costs;
- Peer-to-peer lending facilitates precise matching of savers and borrowers.

Buchak et al. (2018) studied the difference in **technological advantages** between fintech-lenders over non-fintech firms and traditional intermediaries. They expected fintech firms to be more innovative in selecting approaches to set interest rates for online lending – bringing up the issue of big data. The authors emphasised that these intermediaries provided mortgages at higher interest rates compared to non-fintech ones, since consumers might be satisfied by service convenience, including the short time to deliver the financial service. Finally, they estimated that about 60% of shadow bank growth (provided by fintech and non-fintech firms) was due to US tough regulation further strengthened after 2010; the rest was due to advances in technology.

Another angle on **technological impact** over the financial sector was highlighted by Fuster et al. (2018) focusing on the acceleration of mortgage application processes enabled by technology. Rather than a decrease in intermediation costs driven by advances in financial technology, Philippon (2018) looked at **benefits** such as loan accessibility. As an example, Bartlett et al. (2018)

¹ Including P2P Consumer Lending, P2P Business Lending, Invoice Trading, Equity-based Crowdfunding, Reward-based Crowdfunding, Real Estate Crowdfunding, P2P Property Lending, Balance Sheet Business Lending, Donation-based Crowdfunding, Debt-based Securities, Balance Sheet Consumer Lending, Mini-Bonds, Profit Sharing and Balance Sheet Property Lending (Source: Ziegler et al., 2018)

pointed out that fairer pricing was mostly observed for these lenders which appeared to shift their service provision to borrowers from more loan restricted areas such as Africa and Latin America.

1.2 Blockchain and Distributed Ledger Technologies (BDLTs)

1.2.1 Delineation of the technological area

Setting the stage. Considered by some “*the most disruptive invention since the Internet itself*”², BDLTs “*are expected to provide huge improvements in efficiency, generating potential savings of \$16–20 billion a year*”³. Recent estimates foresee a European Blockchain spending led by the financial sector to reach \$1.8B by 2021⁴. While the technology remains at an early stage of development (World Bank, 2017), it is rapidly leading to the creation of new profitable markets (e.g. the cryptocurrency market⁵) and could well be a disruptive technology with application potential across all sectors of the economy. BDLTs “*could have the most disruptive impact on the financial industry for decades*” (PwC, 2017), finance being the sector where most of the current BDLT applications are observed (Hileman and Rauchs, 2017). CBINSIGHTS (2019) reported the first Hyperledger’s Fabric supply chain use case (end of 2017) and first applications of non-fungible tokens to the Gaming sector, suggesting a slow take-off of BDLT in non-financial sectors. The technological landscape is progressively structuring with the emergence of a growing number of start-ups: a sampling survey from Hileman and Rauchs (2017) estimated for instance that in the total population under study (200 entities in total from 49 countries) “*DLT start-ups employ approximately 2,000 people fulltime; established corporations also have several thousand employees working on DLT-based activities*”; they found that a majority were infrastructure (who have “*twice the median number of full-time employees as app developers and operators*”) providers and that most companies were newly founded.

Origin of BDLTs. BDLTs are rooted in Nakamoto’s 2008 *Bitcoin White Paper*⁶ which laid the ground for blockchain as well as for a broader technological group: distributed ledger technologies. With the release of the first Bitcoin in 2009, Nakamoto⁷ initiated a shift from trust to “*cryptographic proof*”, with the ambition to create a system where asset double-spending would not be prevented by a single organisation but a peer-to-peer network (Nakamoto, 2008). The technology supporting the Bitcoin – also known as “*blockchain*” – allowed for data never to be stored in a single device and decision-making to be decentralised and secure thanks to crypted transactions (Miraz and Ali, 2018).

“DLT’s critical innovation in the context of digital currencies is that it provides a cryptographic solution for providing security and protecting system integrity in a decentralized ledger that is maintained by a network of anonymous participants without any need for trust across one or more institutions.” (World Bank, 2017)

² Martin Hiesboeck (2016), “*Blockchain is the most disruptive invention since the Internet itself - not just in finance*”, accessible on <https://www.digitaldoughnut.com/articles/2016/april/blockchain-is-the-most-disruptive-invention-since>

³ Rosati and Čuk (2019), reference to Santander 2015 and Capgemini 2016

⁴ See IDC (2018) at <https://www.idc.com/getdoc.jsp?containerId=prEMEA43543718>

⁵ On 16/02/2019, Bitcoin (BTC) was valued at \$3.586,20 (Coinbase, <https://www.coinbase.com/price/bitcoin>)

⁶ Satoshi Nakamoto (2008), “*Bitcoin: A Peer-to-Peer Electronic Cash System*” – www.bitcoin.org

⁷ Whose real identity remains unknown and is suspected to be either an individual or a group under pseudonym

More than a decade since Nakamoto's breakthrough, BDLT application potential covers a range scope far beyond cryptocurrencies (Peters and Panayi, 2016).

Terminology. The technical concepts associated to BDLTs have made its accessibility to a wider audience more difficult than other more “*tangible*” Industry 4.0 technologies (such as 3D-Printing or robotic systems which can arguably be pitched more easily). Research remains subject to “*ambiguities, oversights, and even misconceptions*” (Zhao et al., 2016). *Box 1* below defines a few critical terms that are key to understanding the foundations of BDLTs.

Box 1: Terminology

- 1. Distributed Ledger Technology:** distributed database or “*ledger*” replicated across the nodes of a network. In such digital system, data can be recorded and shared across the distributed ledger which adjusts in each node. Consensus between the nodes is required for the ledger to be adjusted. To validate the addition of a new data line to the ledger (such as a transaction between two nodes), cryptographic techniques and protocols are in place to support the action and its broadcasting across the network.
- 2. Blockchain:** while often used interchangeably, Blockchain and DLTs should not be confused, the former being a subgroup of the latter. Blockchain is a type of DLT where information is consolidated into “*blocks*” linked in an “*append-only*” fashion, adding close-to-immutable⁸ information layers to the ledger – one after the other. That way, the need for trust is reduced.
- 3. Smart Contracts:** software programmes embedded in a distributed ledger and triggered by specific data patterns which can enforce⁹ rules and functions across the ledger. Smart contracts appear in each and every distributed ledger.
- 4. Protocols:** they define the rules of a BDLT network, such as for instance reward mechanisms or cryptographic requirements. They can be viewed as the architecture of the network, delineating the possibilities and limitations of the network and apps built upon this network.
- 5. Token:** “*a representation of a digital asset*”¹⁰ usually associated to the asset value. Besides cryptocurrencies, generated tokens can represent company shares, utilities (services), etc.
- 6. Consensus mechanism:** proof-checking mechanism that allows decisions and potential transactions to be validated and implemented¹¹. Each type of consensus mechanism can be associated to a rationale (“*Mining*” for PoW, “*Sealing*” for PoA, and “*Minting*” for PoS): for example, while mining implies that a node has to solve a complex algorithmic puzzle to unlock a transaction of tokens, minting will allow such transaction based on the recognition of ownership.

Source: N-ABLE, 2019

BDLT Business Performance: optimistic claims BDLTs show a great deal of promise highlighted by many corporate reports¹². Still, evidence over the real impact of BDLT over the economy remains scattered: it mainly consists in single business cases put forward by interested organisations, non-exhaustive surveys with limited samples, or qualitative analyses that tend to highlight the opportunity represented by BDLT. While monetisation seems to primarily take place at higher stack levels (not in infrastructure but more in app development) and network deployment

⁸ Clarifications were recently brought to “*blockchain myths*” such as concerning the so-called “*immutable*” and “*trust-free*” nature of blockchain (see Hileman and Rauchs, 2017; or Carson et al., 2018)

⁹ Source: Dorfleitner & al., 2017

¹⁰ Source: World Bank, 2017

¹¹ They mainly consist of the following types: Proof-of-Work (PoW), Proof-of-Stake (PoS), Delegated Proof-of-Stake (DPoS) Proof-of-Authority (PoA), Practical Byzantine Fault Tolerance (PBFT), Proof of Bandwidth (PoB), Proof of Elapsed Time (PoET).- see also Li et al. (2017)

¹² See for instance IBM Use Cases on <https://www.ibm.com/blockchain/use-cases/> - consulted on 29/03/2019

would be lagging behind, app developers seem to be going down the value chain – (Hileman and Rauchs, 2017). Some estimates were however made on specific aspects of BDLT impacts over the economy. Casey et al. (2018) for instance claimed that “*for the top ten banks alone, blockchain technology could reduce infrastructure costs by 30%, translating into savings of between \$8 and \$12 billion*”; they based their claims possible impacts such as the mitigation of the cost of trust; as well as disintermediation effects (lowering costs induced by financial intermediaries), efficiency gains (in duplicative and time-consuming post-trade processes for instance). An assessment operated by Accenture and Aon (2017) showed that with the current cost structure of investment banking, BDLT could lead to “*initial savings of \$8 billion on a cost base of \$30 billion*”¹³.

A more nuanced picture. However, Casey et al. (2018) highlight that these figures “*only estimated expenditures on back-office functions, [and] did not incorporate the opportunity cost that is incurred by institutions that must lock up capital for long periods of time – ranging from two days to weeks, depending on asset class – until trades are settled*”. Although highly positive assumptions were made about the potential impact of the technology, current reality is that there is still little on the ground. A few examples can be listed:

- Despite having expressed an interest and evaluated BDLT adoption, no central bank had an operational BDLT-based system due to remaining challenges (Del Rio, 2017).
- Gartner’s 2018 CIO Survey shows that 77% of CIOs declared having no interest in BDLTs and no action planned to investigate or develop it¹⁴.
- BDLTs are still going through the so-called Gartner “*Hype Cycle*”, having hit the “*disillusionment*” phase¹⁵ following the high end of the hype curve¹⁶ - Blockchain was in 2017 ranked 2nd most popular technology/solution on online media channels between cybersecurity (N°1) and artificial intelligence comes (N°3)¹⁷.

A wide range of influencing factors play a role in that context. Li and Wang (2017) confirmed for instance the relevance of both technology and economic factors to crypto-currency exchange rates.

1.2.2 Technical features: Selected Insights

Basic structure. BDLTs can be understood “*layer by layer*”. The complexity of BDLTs has led to a great deal of confusion. DLT can be considered as made of different layers, one building upon the other. One could indeed consider that while an app is the product we physically access on a computer, cell phone etc., each app is based on a network which runs on the basis of an architecture and associated rules, or “*protocol*” (Hileman and Rauchs, 2017– based on Platt, 2016).

¹³ Listed as follows: 70% potential cost savings on central finance reporting; 30-50% potential cost savings on compliance; 50% potential cost savings on centralised operations; and 50% potential cost savings on business operations

¹⁴ See <https://www.gartner.com/newsroom/id/3810968>

¹⁵ See for instance Coinbase (2018), “*Blockchain Enters ‘Trough of Disillusionment’ on Gartner’s Hype Scale*”, accessible at <https://www.coindesk.com/blockchain-enters-trough-of-disillusionment-on-gartners-hype-scale> ; and CBINSIGHTS, 2018

¹⁶ Higginson et al. (2019) for instance highlighted the unbalance perceived between BDLT investments and results observed so far, reminding that start-ups venture capital funding “*reached \$1 billion in 2017*” and that numerous investments are made (e.g. “*IBM invested more than \$200 million in a blockchain-powered data-sharing solution for the Internet of Things (...) the financial industry spends around \$1.7 billion annually on experimentation*”)

¹⁷ Digital Transformation Scoreboard 2018, see <https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTS%202018.pdf>

Common ground. BDLTs usually share 4 characteristics¹⁸:

- 1) *Distributed networks*: BDLTs are distributed settings with no or limited need for intermediary players to handle transactions or manage the access to the network.
- 2) *Consensus*: for an information to be recorded, several nodes from the network should validate its existence and reliability through proof-checking mechanisms.
- 3) *Cryptography*: BDLTs rely on record “*hashing*” and cryptographic mechanisms. The use of signatures based on a “*Public Key Infrastructure*” – or *PKI* – model allows for transactions enabled by multiple keys (one public, one private): a user can in that way open a transaction with a private key while referring to the target’s public key.
- 4) *Timestamp*: timestamps are key to certify the validity of a given data.

Public VS Private. A key distinction must be made between permissioned and permissionless BDLT networks. The principle is simple: a public network makes information and transactions accessible to all, while a private network restricts network usage (Rosati and Čuk, 2019). This classification is helpful in understanding the setting for network consensus: while public BDLT networks can be considered more decentralised and are usually associated to cryptoassets (incl. utility and security tokens) and cryptocurrencies, private models are often mobilised to build BDLT solutions such as in internal company projects (see CBINSIGHTS, 2018). Connected to this binary approach, “*Ledger permission*” has been a way to operate the distinction between different types of BDLTs as explained in *Box 2*.

Box 2: Ledger Permission

A fundamental distinction can be made between *permissioned* and *permissionless* networks: while in the former one or more central point(s) should grant access to a new user, the latter network is open to all new users. Simply put:

- *Permissioned* distributed ledgers rely on one or more administrators/access control points who pre-select participants, often implying that newcomers’ identities are known, leading to trust and greater volumes of transactions which can be processed faster;
- *Permissionless* distributed ledgers imply transparency but also more complex mechanisms and proofing protocols to ensure consensus, leading to lower transaction pace and volumes (World Bank, 2017).

Source: N-ABLE, 2019

¹⁸ Source: Rosati and Čuk, 2019 and World Bank, 2017

Multiple technologies. Various protocols will offer distinct values often rooted (among others) in this type of characteristic. Other features related for instance to security or performance will complement the picture. Figure 1 below provides five popular examples of BDLT protocols¹⁹:

Figure 1: Examples of Permissioned and Permissionless Distributed Ledger Technologies

Examples of DLs	
Bitcoin	<ul style="list-style-type: none"> • Open/Permissionless • First and largest public blockchain • Records transactions of cryptocurrency Bitcoin • View transactions live here: https://blockchain.info/
Ethereum	<ul style="list-style-type: none"> • Open/Permissionless • Most popular blockchain for smart contracts (see section 8). Ethereum allows for a scripting language to exist on top of a blockchain, which enables construction of smart contracts. • The DAO used Ethereum (see Annex)
Ripple	<ul style="list-style-type: none"> • Permissioned • Focused on commercial cross-border and inter-bank payments • Offers alternative to correspondent banking • Raised \$55 million in Series B funding in Q3 2016
Fabric (Hyperledger Project)	<ul style="list-style-type: none"> • Permissioned • Open-source • Focused on helping financial institutions mitigate settlement risk and lower reconciliation costs • Collaboration between the Linux Foundation and over 80 financial and technological companies including IBM, DTCC, JP Morgan, Accenture, CISCO
Corda (R3 CEV)	<ul style="list-style-type: none"> • Permissioned • Created by R3, a consortium of over 70 financial institutions • Open-source • Focus on financial applications

Source: World Bank, 2017

1.3 Key Application Areas

1.3.1 The Financial Sector, BDLT Pioneer

The financial sector has pioneered BDLTs. From the launch of the Bitcoin to the deployment of asset, utility and payment tokens (Casey et al., 2018), the financial sector has been seen as the primary user of BDLTs. Financial service companies were early investors (CBINSIGHTS reported that “more than 50 of the world’s major financial services institutions have invested in the sector” between 2014 and 2017²⁰). One should note that the financial sector has also been the main investor in BDLT development: related Venture Capital rounds have sky-rocketed in 2017 and 2018, kicking off from 103,8M\$ in 2016 to 496,7M\$ in 2017 and 637,7M\$ in 2018 (through June 15)²¹. Based on Pitchbook data, Diar pointed at a raise of BDLT capital investment of “nearly 3.9Bn through traditional VC” in the first three quarters of 2018, a 280% increase compared to 2017²².

¹⁹ It is to be noticed that a wide range of BDLTs have been and still are being developed.

²⁰ Source: CBINSIGHTS, <https://www.cbinsights.com/research/report/blockchain-trends-opportunities/>, consulted on 22/02/2019

²¹ Source: Crunchbase and Crypto Fund research (2018)

²² Source: Diar, “Venture Capital Firms Go Deep and Wide with Blockchain Investments”, available at <https://diar.co/volume-2-issue-39/>, consulted on 22/02/2019

Beyond venture capital deals²³, large banks show a great deal of equity investment and consortia involvement in the BDLT area (see for instance CBINSIGHTS, 2018). The largest global banks are involved in BDLT projects and/or consortia, including European players such as the BNP Paribas, Crédit Agricole, ING, and HSBC. The forefront players remain multinational companies located in the United States where a major part of BDLT start-ups see the day.

1.3.2 Further Application Areas

Beyond “Crypto”. The fragmentation and immaturity of BDLTs are associated to a “*lack of clarity around roles and positioning of enterprise DLT actors*” as well as to the high share of prototyping and pilot testing compared to full-scale commercial implementation (Hileman and Rauchs, 2017). Delineating clear segments is therefore often difficult. Given their nature as “*transactional*” technologies, BDLTs have been mainly associated to payments and cryptocurrencies²⁴ - such as Bitcoin and 1000+ other cryptocurrencies. But the potential of BDLT is far more outreaching as “*DLT could have applications in cross-border payments, financial markets infrastructure in the securities markets, and in collateral registries*” (World bank, 2017). Use also in crowdfunding has been noted (Tsilidou and Foroglou, 2015).

Multiple angles. There is multiplicity of angles and views on what areas are or will be impacted by BDLTs. He et al. (2018) complemented Mills et al. (2016) by listing security settlements and payments, B2B transactions, back-office functions and recording, digital currencies.

Box 3: Linking the “who” to the “what”

Out of 132 use cases, Hileman and Rauchs (2017) found that DLT service providers targeted Capital Markets (70%), insurance (61%), trade finance (59%), payments (57%), regulatory compliance and audit (57%), and digital identity (57%). The top-5 users of BDLT were from the financial sphere and included:

- 1) Banks (72%)
- 2) Non-DLT FinTech companies (56%)
- 3) Insurance companies (47%)
- 4) Custodians (42%)
- 5) Exchanges (42%)

The identification of BDLT applications in the financial sectors and classifications hitherto tend to mix **1) Financial Functions**, **2) Financial Players** and **3) Technological aspects**. A relevant approach in that respect was proposed by the World Bank (2017) which distinguished between various cases across the areas of Money & Payments, Financial Services and Infrastructure (beyond payment), Collateral registries and ownership registers, as well as Internal systems of financial service providers.

5 Examples of BDLT Application areas in the financial sector. The following examples of recurring BDLT application areas in the financial sector aim to provide some insights on the

²³ See Coindesk Blockchain Venture Capital, available at <https://www.coindesk.com/bitcoin-venture-capital> consulted on 22/02/2019

²⁴ See Dorfleitner & al., 2017

prospective implementation range of the technology. Many descriptions remain based on principles and proof of concept (PoC) more than live examples:

6. *Payments and remittance:*

Cross-border payments are usually intermediated by clearing firms. Payments are in that sense usually subject to intermediation costs in multiple layers *that induce “operational complexity and counterparty risks”* (Casey et al., 2018). In contrast, BDLTs allow for direct peer-to-peer transactions that limit the need for intermediaries. Cryptocurrencies have been a breakthrough in this area, starting from the founding of Bitcoin up to the recent growth of stablecoins²⁵. The driving factors remain technical and challenges to the development of BDLT-based payment systems encompass *“speed, capacity, cryptocurrency-to-fiat currency price volatility and transaction costs”* (Casey et al., 2018).

7. *Credit and lending*

The use of smart contracts presents potential benefits that could make lending safe and prevent crises. BDLTs are also used to raise capital through crowdfunding but other means and have the potential to impact classic and new financial intermediaries. Examples encompass blockchain-based tokens and Initial Coin Offerings (ICOs) which were closely associated to crowdfunding and peer-to-peer models. ESMA (2019) concluded that while the sector remains modest and associated to risks, it offers opportunities linked to the tokenisation of assets. Other areas encompass credit scoring and data market places. In the primary securities market, the issuance of securities can be secured by the fact that all parties have a shared record and made efficient thanks to automation (Casey et al., 2018).

8. *Trading and settlement*

BDLT have the potential to streamline securities settlement (Santander, 2015). Post-trade transactions and reporting for complex products subject to long timelines – such as derivatives – are associated with different BDLT pilots (Casey et al., 2018). The use of BDLTs could lead to near real-time clearing and settlement, reducing risks related to duplicated records and associated time lags (Casey et al., 2018). Key barriers to BDLTs becoming mainstream in the clearing and settlement area remain nonetheless: physical/digital world interactions (such as legacy assets held by custodians), legal and regulatory limitations, and technological immaturity linked for instance to the current scalability and throughput limitations of the technology (Rosati and Čuk, 2019).

9. *Compliance*²⁶

At the edge of Fintech and RegTech, BDLT show great potential for financial reporting and compliance issues. Despite the lack of use cases, BDLT could allow for recording players and actions in a transparent, streamlined fashion and in line with regulatory requirements imposed by regulatory frameworks such as MIFID, KYC, AML, etc. Benefits could possibly reside in zero-knowledge proofs that allow for privacy, real-time data that facilitates control, and the immutability of a transparent record (Rosati and Čuk, 2019). Know Your Customer (KYC) is one of the key functions pursued by BDLT in the financial sector. They allow for less duplication and offer solid proof of identification to be operated, sometimes allowing for identification with no direct access thanks to zero-knowledge proof protocols (Casey et al., 2018).

²⁵ See for instance “*Fedcoin: A Central Bank-issues Cryptocurrency*” by JP Koning, R3 Reports (Corda)

²⁶ Source: Rosati and Čuk, 2019

10. Asset Management

Multiple use cases can be identified in the area of asset management²⁷. The initiative FundChain for instance developed a pilot with an emphasis on the fund distribution value chain and the development of a SMART Transfer Agent. FundChain observed 4 main megatrends (demographics, technology, environment as well as social values, behaviour and ethics) driving the future of fund distribution (see also PwC, 2017).

Other cases could also be observed, such as in the insurance sector or claims processing. *Table 1* provides an illustration of use cases in other financial areas where BDLTs are being piloted and/or deployed.

²⁷ Such as Alphapoint, Polymath, Smart Varlor and Harbor (source: <https://medium.com/bitfwd/top-5-most-compelling-use-cases-for-blockchain-technology-d198e500e3d3>, consulted on 29/03/2019)

Table 1: Selected examples of BDLT Use Cases across Application Areas

Examples of Practical BDLT Use Cases in the Financial Industry (non-representative selection)			
Players involved	Description	Application area	Source
HSBC	<i>“HSBC Securities Services is trialling DLT on proxy voting services with a number of end investors, including major sovereign wealth funds and pension funds. The approach has been small-scale and controlled. Using DLT in proxy voting can help accentuate transparency and reduce the number of intermediaries in the process, delivering efficiencies to the end investor”</i>	Settlement	HSBC ²⁸ , consulted on 16/02/2019
ECV	<i>“European Central Bank and the Central Bank of Japan have already conducted a first study to evaluate the possibility of using blockchain for real-time gross settlements that are crucial in conducting monetary policy”</i>	Assessment	ECB, 2017
FundChain	<i>“it consists in a distributed database”</i>	Fund Distribution/Asset Management	See PwC, 2017
SWIFT	<i>“SWIFT recently completed a proof of concept with 34 banks, incorporating DLT – specifically, Hyperledger Fabric – into its own architecture. The SWIFT pilot was designed to streamline Nostro account reconciliation, eliminating one of the largest delays in cross-border payments, and to provide more transparent payment tracking and up-front pricing.”</i>	Cross-border Payments	Casey et al., 2018
ASX	<i>“Last year, the Australian Stock Exchange (ASX) announced that it would replace its entire clearing and settlement infrastructure with a permissioned distributed ledger-based solution developed by Digital Asset Holdings. The announcement followed a two-year period in which ASX consulted with the broad public on the best way to update their core systems (called ‘CHESS’) for clearing, settlement and post trade services”</i>	Clearing and settlement	Casey et al., 2018
NASDAQ	<i>“Nasdaq is experimenting with blockchain for clearing and settlement on its private securities market, partnering with blockchain startup</i>	Clearing and settlement	Casey et al., 2018

²⁸ <https://www.gbm.hsbc.com/insights/securities-services/distributed-ledger-technology-in-fund-administration>



Examples of Practical BDLT Use Cases in the Financial Industry (non-representative selection)

Players involved	Description	Application area	Source
	<i>Chain to facilitate faster clearing and settlement of normally cumbersome private securities transactions for non-listed companies.”</i>		
NASDAQ	<i>“NASDAQ is using its ‘Linq Blockchain’ to record its private securities transactions”</i>	Clearing and settlement	Miraz and Ali, 2018
DTCC	<i>“IBM is working with the DTCC to provide a blockchain framework for their Trade Information Warehouse, which automates record-keeping, lifecycle events and payment management for more than \$11 trillion of cleared and bilateral credit derivatives”</i>	Clearing and settlement (derivatives)	Casey et al., 2018
DTCC	<i>“the Depository Trust & Clearing Corporation (DTCC, USA) is working with Axoni in implementing financial settlement services such as post-trade matters and swaps.”</i>	Clearing and settlement	Miraz and Ali, 2018
ISDA	<i>“International Swaps and Derivatives Association (ISDA) is working with Regnosys to produce a digital version of ISDA’s Common Domain Model for the numerous swap transaction and life cycle processes.”</i>	Clearing and settlement (derivatives)	Casey et al., 2018
Barclays	<i>“Barclays teamed up with Irish cheese-maker Ornuu to process the guarantees and financing assurance for a transaction selling a shipment of cheese to the Seychelles in September 2016”</i>	Trade	Casey et al., 2018
Foxconn	<i>“A somewhat different approach to the same problem has been developed by electronics giant Foxconn, which taps thousands of sometimes very small suppliers to provide the parts it needs to make everything from Apple iPhones to Hewlett Packard printers. Foxconn, whose venture arm has invested in a number of US-based blockchain start-ups, is encouraging its suppliers to submit data to a blockchain ledger of transactions so as to improve coordination of production schedules and availability of parts. In return, the company is shortening the payment terms or providing internal loans on its own account – in effect, boosting its suppliers’ working capital and bypassing the role of banks altogether”</i>	Trade	Casey et al., 2018
IADB	<i>“Inter-American Development Bank, the MIT Digital Currency Initiative is working on a blockchain-based trade finance solution known as b_verify.²⁹ This project is a new protocol for issuing and transacting</i>	Trade	Casey et al., 2018



Examples of Practical BDLT Use Cases in the Financial Industry (non-representative selection)

Players involved	Description	Application area	Source
	<i>in verifiable records using a public blockchain.”</i>		
HKMA	<i>“Developments since then include proofs of concept developed by Standard Chartered in Singapore and by Deloitte and the Hong Kong Monetary Authority in Hong Kong to record shipping documents in a blockchain so as to give lenders greater confidence in the veracity of exporter claims and make letters of credit more available”</i>	Trade	Casey et al., 2018
Securitize	<i>“Securitize hopes to develop the frameworks necessary to tokenize companies. Trading of security tokens will take place on exchanges like Coinbase (an investor in Securitize). Indeed, Coinbase received approval in July to list security tokens on its exchange, after the company’s purchase of registered broker-dealer Keystone Capital. SELECT INVESTORS: Blockchain Capital, Coinbase Ventures, Ripple, Global Brain”</i>	Trade	CBINSIGHTS, 2018
Overstock	<i>“Overstock’s CEO, Patrick Byrne, has made repeated bets on blockchain technology, often via blockchain venture arm (and subsidiary of Overstock) Medici Ventures. Among them is tZero, which hopes to be platform to track and trade security tokens representing traditional assets (e.g. stocks and bonds). WhiltZero has yet to launch commercially, it raised \$134M in its own security token offering”</i>	Trade	CBINSIGHTS, 2018
Circle	<i>“Circle’s acquisition of registered broker-dealer and crowdfunding player, SeedInvest, positions the company to help businesses (1) raise capital in security token offerings, and then (2) exchange those securities through its trading arms.”</i>	Trade	CBINSIGHTS, 2018
Harbor	<i>“Harbor offers a compliant platform to tokenize securities, with a focus on “illiquid assets” –like real estate. In November, the company announced its first tokenized investment, the \$100M Hub at Columbia REIT (part of the University of South Carolina).”</i>	Trade	CBINSIGHTS, 2018

Source: illustrative compilation by N-ABLE, 2019



3. Assessing the Impact of ICT on Growth through Financial Services

At a more aggregate level, there has been a long stream of literature on the effect of information and communication technologies on the financial sector and on growth. Just to mention a few examples:

Finance and growth. Goldsmith (1969) first reported a positive relationship between the size of the financial system and economic growth in the long-run. He emphasized financial intermediation as a driver of efficiency instead of the growth in investments. This was further supported by Greenwood and Jovanovich (1990) as well as Bencivenga and Smith (1991). In the early 1990s, the focus shifted to testing causal links between finance and growth. Researchers explained economic growth through financial depth (King and Levine, 1993); others predicted this growth through the angle of stock market liquidity (Levine and Zervos, 1998). Further studies (Rajan and Zingales, 1998; Levine et al., 2000; Beck et al., 2000) claimed a causal relation linking finance and economic growth. Such a view was however not statistically supported in countries with double-digit inflation (Rousseau and Wachtel, 2002) and others with poor institutions (Demetriades and Law, 2006).

Functions of the financial sector. Although Merton (1995) and Levine (2005) identified various functions for financial institutions and the financial market in developed economies, Beck et al. (2014) distinguished between two roles finance plays in a modern market economy. The first reflects intermediation activities in the financial system such as mobilizing funds and distributing them efficiently across households and enterprises, delivering payment and settlement services safely, precisely and properly – positioning the financial system as a facilitator. The second considers the financial system a growth sector which provides other non-intermediation activities.

Testing the finance-growth relationship. Research has illustrated the role of the financial sector in the economy by changing the size of traditional intermediation activities. For instance, Rioja and Valev (2004) emphasized the differentiation of financial development levels in 74 countries. They concluded that a higher level of financial development leads to a positive influence of the financial systems over economic growth; the largest effect was found in intermediate regions. By testing the finance-growth relationship on a sample of 48 countries, Shen and Lee (2006) additionally demonstrated that the development of the stock market leads to positive effects on economic growth. The overall conclusion was that financial liberalization, high-income levels, and good shareholder protection could reduce the harmful impact of banking on the real performance of market-based economies. Taken together these empirical papers suggest that there exists nonlinearity in the finance-growth relationship.

Hybridisation and intermediation. However, a tremendous shift in traditional and non-traditional activities mix can be observed across financial institutions. These institutions have been highly engaged into short-term non-deposit funding strategies (Demirgüç-Kunt and Huizinga, 2010) and non-interest income bearing transactions like trading, market-making, financial advisory services and insurance (Beck et al., 2014). Relying on a sample of 77 countries for the period 1980–2007, Beck et al. (2014) argued that economic growth was only driven by intermediation activities (no impact of non-traditional intermediation activities on the real economy was observed), which also helped increase stability in the long run, particularly in the medium run for low-income countries. A higher level of volatility might be observed in high-income countries for shorter periods of time as a response to a large growth of the financial system.

Financial depth. Another literature stream has argued that high levels of financial depth do not bring additional benefits to economy – with a mitigation effect over economic growth. For

example, De Gregorio and Guidotti (1995) found that in high-income countries financial depth affected economic growth differently: during the 1960–1985 period it had a positive effect on the economy, whereas during the 1970–1985 period the effect appeared to be negative. For the 1965–2004 timeline, Rousseau and Wachtel (2011) also did not observe a statistically significant effect of credit to the private sector on GDP growth. Arcand et al. (2015) who studied the 1960-2010 period empirically supported the view that the threshold of 80-100% set for the ratio of credit granted to the private sector to GDP was a critical one above which the financial depth becomes negative for economic growth.

While relevant as contextual background to the quantitative analysis presented in Section 5 below, closer examination of this literature falls outside the remit of this report.

4. Drivers and Obstacles for BDLT Adoption and Deployment

3.1. Drivers

Driver	Explanation	Sources (selection)
1. Information and network security	From network breach coverage to data integrity, BDLTs show great strengths in security matters. Transactions are registered and stored on various servers ²⁹ and a copy of the database exists in every node. Various features (append-only approach, time-stamps, multiple keys, etc.) offer a great deal of security for networks that are both difficult to hack and where any failure can be contained in a sub-section of the overall network. Such value proposition is key compared to centralised systems where the failure of a single central entity can greatly affect intermediated actors.	Dorfleitner & al., 2017 and Rosati and Čuk, 2019 (references to Grinberg 2011; Böhme et al. 2015), Casey et al. (2018), Xu (2016), Kshetri (2017), Peters and Panayi (2016)
2. Resilience	While centralised systems also centralise risks, distributed systems rely on a variety of access points and safeguards (no concentration of information in one node).	Rosati and Čuk (2019), World Bank (2017), Peters and Panayi (2016)
3. Efficiency and cost savings	The reduction of coordination and transaction costs led to economies of scale and a higher pace. Besides disintermediation, the use of smart contracts also led to cost savings: besides the costs of being handled by financial intermediaries, financial transactions are associated to bookkeeping, transactions and balance reconciliations across financial intermediaries can imply long and time-consuming efforts that can be associated with delays and additional costs. In the trading and settlement area, a reduction of reconciliation and data management costs can be achieved thanks to the simplification and (clearing) automation of most post-trading processes.	Rosati and Čuk, 2019 (also reference to Benos et al., 2017), World Bank (2017), Casey et al. (2018), Mills et al. (2016), Zhao et al. (2016)
4. Scale and network effects	Network effects and the prospect of reaching higher scales in BDLT implementation are key, for instance in terms of diffusion effects across a same network. The long-term expectation of some specialists positions the future network effects of BDLTs at the level of the ones generated by the internet ³⁰ .	Casey et al. (2018)

²⁹ Source: Dorfleitner & al., 2017

³⁰ See for instance <https://btcmanager.com/network-effects-and-blockchain-two-parallels-merging-to-form-web-3-0/>, consulted on 16/04/2019

Driver	Explanation	Sources (selection)
5. Trust	Information is available to all network participants and the system is distributed, leveraging “ <i>cryptography and peer validation of transactions to ensure data integrity and record immutability</i> ” ³¹	Rosati and Čuk (2019), Xu (2016)
6. Social inclusion	“DLT holds potential to expand financial inclusion by addressing the following barriers to access to finance, in specific country contexts: • Affordability of financial products and services • Lack of robust, verifiable ID systems for KYC and other eligibility and due diligence requirements • Deficient payment and credit infrastructures • Incomplete secured transaction frameworks and collateral registries • Impact of de-risking on international remittances. Selected examples of applications of DLT that could lead to greater financial access and inclusion for underserved populations are: • Cross-border Payments and Remittances • Digital Identity Systems • Asset Registries • Digital Currencies” (Source: World Bank, 2017)	World Bank (2017), Larios-Hernández (2017)
7. Transparency and traceability	The information is transparent, accessible and immutable, offering for instance the possibility to facilitate risk assessments in a credit/lending context (strengthening credit scoring), leading to more efficient capital allocation and more growth opportunities caught. With blockchain, the “ <i>additive</i> ” layers of data also allow for greater traceability (a transaction being linked to the previous one) because each data added to the ledger is immutable and time-stamped. Another aspect lies in the ownership and more specifically shareholder rights associated to traded securities: direct ownership would allow for transparent peer-to-peer trading with no intermediation in that respect.	Rosati and Čuk (2019), World Bank (2017)
8. Real-time	While the timing of settlement processes is linked to currency value fluctuations (and therefore subject to market rules), BDLTs offer the possibility for peer-to-peer real-time settlements	Rosati and Čuk (2019)
9. Privacy	BDLTs are distributed and cryptography but also the use of pseudonyms. Blockchain in particular allows for an anonymous activity across the distributed network.	Rosati and Čuk (2019), Casey et al. (2018), Peters and Panayi (2016)
10. Flexibility	Settlement times can be made flexible thanks to smart contracts,	Rosati and Čuk,(2019)

³¹ Rosati and Čuk, 2019



Driver	Explanation	Sources (selection)
11. Automation and programmability	Smart contracts (protocol or pre-programmed rules and conditions) are the key to automation	World Bank (2017)

3.2 Obstacles

Financial applications of BDLT also face many challenges, some of which relate to the overall immaturity of the technology as well as to external factors hindering adoption and full-scale deployment (Carson et al., 2018).

Obstacle	Explanation	Sources (selection)
1. Speed	Particularly related to blockchain (as opposed to DLTs), the speed often relates to the pace of transactions in large networks where validation processes are mobilising more nodes and involve heavier timeframes.	DelRio (2017)
2. Cost of processing	Processing costs, often referred to in a Blockchain context, are often associated to the use of energy which can be massive.	DelRio (2017)
3. Operational and Cyber-Security (incl. identity verification)	Financial institutions handle sensitive consumer data and should be regulatory compliant. Besides, risks apply that can be linked to the quasi-immutability of information. Cryptoassets are for instance subject to risks such as possible data losses, balance mix-ups, etc.	DelRio (2017), Rosati and Čuk (2019), World bank (2017), Peters and Panayi (2016)
4. Transparency and privacy	Transparency and privacy are two antagonist notions. While users and investors would often favour privacy over transparency, financial processes are rather oriented toward record and identity transparency. Zero-knowledge proof systems are an opportunity to address this issue beyond the simple pseudonymisation of BDLT users in search of privacy.	DelRio (2017), World Bank (2017), Rosati and Čuk (2019), Hileman and Rauchs (2017), Casey et al. (2018)
5. Legal settlement finality	Legal boundaries are blurred with blockchain, impacting liability issues (who is legally responsible of what in case of conflict – the users, the network, etc.?)	DelRio (2017)
6. Human capital and skills	While it is not often referred to in the literature, practitioners referred to the challenge of encountering a skilled workforce with appropriate competences but also an adapted mindset for what BDLT have to offer.	Interviews, World Bank (2017)



Obstacle	Explanation	Sources (selection)
7. Security	Malicious users could open failures in the network – mainly in open/public chains. The risk of a “51% Attack” points in that respect at the risk of having a malicious user reaching an ownership of 51% of the network nodes, which – <i>although hypothetical</i> – remains a risk for any open ledger. Successful hacks were observed in the cryptocurrency area and are possible at both system/record levels. Double-spending and identity theft are also risks to bear in mind as are the different types of illegal activities usually addressed by AML regulations, all being possibly addressed with defensive and preventive measures. Security can also be jeopardized by weaknesses in the smart contracts and in the very design of the system.	World Bank (2017), Casey et al. (2018), Xu (2016), Zhao et al. (2016), Li et al. (2017)
8. Environmental costs	BDLT is energy-consuming because of the range of computing power needed to operate ledger updates.	World Bank, 2017
9. Scalability	Often associated with permissionless ledgers and PoW consensus mechanisms, scalability is a critical issue as the multiplication of nodes and transactions might slow down the performance of the network and increase transaction time.	DelRio (2017), Rosati and Čuk (2019), World Bank (2017), McConaghy et al. (2016)
10. Network effects	Network effects require a critical mass of participants/users to a BDLT network. The expected snowball effect constitutes a barrier for entry hampering the constitution of the lead-user groups needed for a proper take-off.	DelRio, 2017
11. Regulation	General Data Protection Regulation (GDPR) compliance is a challenge as it requires consent for information use The distributed nature of BDLTs can imply multiple jurisdiction, with responsibilities that would be decentralised as are participants.	Rosati and Čuk (2019), World bank (2017), Hileman and Rauchs (2017), Casey et al. (2018)
12. Technology maturity: Latency and transaction speed	Mainly linked to permissionless BDLT, the issue of maturity is often concerned with the pace and latency associated to transactions. This is a main hurdle for the full deployment of BDLT at a large scale.	Rosati and Čuk (2019), Casey et al. (2018)
13. Coordination effort associated to multi-asset management	When a digital asset is for instance associated to an old version or parallel asset – the example of crypto-currency showing examples of multi-currency (old/new) management costs.	Presthuis and O’Malley (2017)

Obstacle	Explanation	Sources (selection)
14. Dispute and recourse frameworks	The availability of an infrastructure to handle possible disputes is currently missing and goes together with the legal blanks in national and supra-national legislations with respect to liability in a BDLT context.	World bank (2017)
15. Technology maturity: Scalability	Scalability is seen by a constraint over permissionless networks, but permissioned networks are also concerned with this obstacle, for example in the retail and corporate banking sub-sectors.	World bank (2017) and interviews
16. Technology maturity: resilience	Cybersecurity resilience is mainly seen as a challenge that would come with scale of BDLT networks and the volume of transactions.	World bank (2017), Hileman and Rauchs (2017)
17. Throughput	Mainly permissionless, very much related to the pace issue	
18. Systems integration (interoperability)	At this stage, the lack of standards makes interoperability limited to a very limited number of BDLT systems and underlying protocols. It therefore often requires the mobilisation of a third party. “Fork” risks (when decisions in a single chain lead it to splits into two or more divergent pathways)	Rosati and Čuk (2019), World Bank (2017), Hileman and Rauchs (2017), Casey et al. (2018),
19. Access	Permissionless public blockchain difficult to control who accesses the chain	Rosati and Čuk (2019)
20. Energy consumption	BDLT call upon the use of large amounts of energy to power the chain of nodes and support the numerous transactions operated across the network.	Casey et al. (2018)
21. Sub-optimal awareness of the supply side (on user adoption)	The lack of awareness on the real pros and cons of BDLTs is a barrier to the adoption and deployment of BDLTs, which are associated to a “Hype” and appear to be difficult to understand for many.	Rosati and Čuk (2019)
22. Lack of standards	Emerging standards are seen as a key to set the ground for BDLT development and deployment. This effort is only nascent and requires more live cases as well as a consensus across a very diverse technological area.	World Bank (2017), CEN-CENELEC (2018)
23. Reluctance to change	Cultural factors and conservatism were spotted in different cases. They are usual obstacles to new technology adoption.	Hileman and Rauchs (2017)
24. Sub-optimal awareness of the demand side (on possible benefits/value generation)	In the context of an over-flow of information on BDLTs, unclarities remain on the pros and cons of BDLT adoption.	Hileman and Rauchs (2017),
25. Migration costs	Shifting toward new IT, operational and institutional structures is an entry barrier for many organisations which have well-established systems	World Bank (2017), Presthus and O’Malley (2017)



5. Policy

Public sector approach to BDLTs. A broad range of public sector entities are piloting blockchain (see for instance Hileman and Rauchs, 2017). The OECD recently spotted an increase from 117 initiatives in 26 countries in 2017 to 202 in 45 countries to 2018 (OECD, 2018). For example:

- The World Bank Group itself launched its Blockchain Lab in 2017 to help fight against poverty³² and issued \$79 Million Bond on permissioned blockchain³³.
- The European Commission recently completed a Proof of Concept (PoC) and kicked-off its European Financial Transparency Gateway (EFTG): the EFTG links national databases containing the financial information of companies listed on EU regulated markets to foster cross-border investment³⁴.

Besides its role as possible adopter, the public sector is also key in setting up regulatory conditions for the implementation of BDLT. The present section highlights policy considerations with respect to EU public action frameworks, initiatives and regulations impacting the development and deployment of BDLTs.

Regulatory challenges. Political decisions will be key to the future of BDLT (Miraz and Ali, 2018). The financial sector especially is tied to regulatory constraints that are currently seen as a major challenge for BDLT deployment across the globe (Guo and Liang, 2016). Regulatory frameworks such as Basel III/IV and consistency with key norms (e.g. IFRS) emerged early on as BDLT deployment challenges (Peters and Panayi, 2016).

The World Bank (2017) has pointed at several legal and regulatory challenges including:

- 5) *Regulatory Vetting and Industry Standards*, highlighting the need for broader implementation frameworks for BDLTs;
- 6) *Legal Clarity over Ownership and Jurisdiction*, an issue that is posed in a cross-jurisdictional context as well as the definition of “*point of finality*”;
- 7) *Know-Your-Customer (KYC), Customer Due Diligence (CDD) and Anti-Money Laundering/Combating the Financing of Terrorism (AML/CFT)*, most likely less problematic in a permissioned system whereas open ledgers allow for unverified identification and therefore possible transaction approval by un-vetted parties;
- 8) *Recourse mechanism*, as dispute resolution and liability over possible losses remain open questions that could be addressed through the use of smart contracts.

Such challenges are clearly related to the early life phase of BDLTs where standards are largely missing. Efforts have been initiated, nonetheless, expected to come in support of future European policy making (*Box 4*).

Box 4: Setting standards for BDLT

To date main norms were built upon known R&D projects carried out in key platforms (Ethereum, R3, Hyperledger, etc.). Official standardisation committees have recently also taken action. The EC facilitates the links between European stakeholders and the ISO Technical Committee 307 on BDLTs, as well as the ITU-T Focus Group on DLT). Its efforts were recently complemented by actions undertaken by European standardisation experts: the CEN-CENELEC

³² See <http://www.fao.org/in-action/agronoticias/detail/en/c/903647/>

³³ See <https://www.nasdaq.com/article/world-bank-issues-79-million-bond-on-permissioned-blockchain-cm1018611>

³⁴ [http://europa.eu/rapid/press-release MEMO-18-1406 en.htm](http://europa.eu/rapid/press-release_MEMO-18-1406_en.htm)

created in 2017 a joint Focus Group³⁵ (FG-Blockchain-DLT) dedicated to Blockchain and Distributed Ledger Technologies to define standards for a successful adoption of BDLTs. Its goal is to support the work of the ISO TC 307, sharing information on standardisation needs and facilitating the contribution of Europe to international normalisation discussions around BDLT in that context. The FG recently published a White Paper on BDLT³⁶ which listed a set of recommendations toward BDLT standardisation (see CEN-CENELEC, 2018).

General policy approach in Europe. The European Commission (EC) formalised its interest for BDLT in 2013 under the previous Research Framework Programme (FP). It is estimated that €340 million would have supported projects drawing on blockchain technologies by the end of 2020³⁷ - with a key contribution made under the “*Leadership in Enabling and Industrial Technologies*” (LEIT)³⁸ and “*Digital Society*”³⁹ priorities. The EC approach encompasses various action lines ranging from governance to supporting the emergence of an interoperability framework and strengthening of EU blockchain infrastructure and financing⁴⁰. Among others, the EC:

1. Supported the European Blockchain Partnership⁴¹, established in 2018, whose founding declaration was signed by 27 EU Member States and Norway in view of setting up a European Blockchain Services Infrastructure (EBSI) for cross-border digital public services;
2. Initiated the EU Blockchain Observatory and Forum⁴², an instrument aimed to map BDLT initiatives, share experiences and pool expertise on BDLT and challenges related to its development and deployment
3. Facilitates contacts with the International Association for Trusted Blockchain Applications (INATBA)⁴³;
4. Triggered the formation of an EU BDLT industry-driven community, starting with the EU Blockchain Industry Roundtable⁴⁴ held in 2018;
5. Engaged into the #Blockchain4EU initiative touching upon Blockchain for industrial transformations⁴⁵;
6. Launched the “*Blockchains for Social Good*” challenge and associated prize⁴⁶.

Other European institutions have also acknowledged the critical importance of BDLTs, starting with the 19 October 2017 conclusions from the European Council which qualified BDLTs as a “*key emerging trend*”⁴⁷ along with Artificial Intelligence (AI). This interest was matched across

³⁵ <https://www.cencenelec.eu/standards/Sectors/ICT/BlockchainLedgerTechnologies/Pages/default.aspx>

³⁶ https://www.cencenelec.eu/news/brief_news/Pages/TN-2018-085.aspx

³⁷ See http://europa.eu/rapid/press-release_IP-18-521_en.htm and <https://ec.europa.eu/digital-single-market/en/blockchain-technologies>

³⁸ See <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/leadership-enabling-and-industrial-technologies>

³⁹ <https://ec.europa.eu/digital-single-market/en/policies/creating-digital-society>

⁴⁰ See the factsheet, http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=49649

⁴¹ See <https://ec.europa.eu/digital-single-market/en/news/european-countries-join-blockchain-partnership>

⁴² <https://www.eublockchainforum.eu>

⁴³ See <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/leadership-enabling-and-industrial-technologies>

⁴⁴ See <https://ec.europa.eu/digital-single-market/en/news/eu-blockchain-roundtable-supports-efforts-deploy-blockchain-technologies-eu>

⁴⁵ See <https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/blockchain4eu-blockchain-industrial-transformations>

⁴⁶ Source: https://ec.europa.eu/research/eic/index.cfm?pg=prizes_blockchains

⁴⁷ See page 7, <http://data.consilium.europa.eu/doc/document/ST-14-2017-INIT/en/pdf>

European institutions and multiple reports were ordered to provide a clearer view on BDLT implications for Europe. A recent European Parliament (EP) motion for resolution highlighted the need to address “*regulatory hurdles to widespread blockchain implementation*” and recommended that the European Commission and Member States closely monitor BDLT developments in a supply chain context as well as “*feed in to ongoing international initiatives to develop standards and principles that underpin regulation for facilitating the use of blockchain*” (European Parliament, 2018a). The Resolution on distributed ledger technologies and blockchains: building trust with disintermediation (2017/2772(RSP))⁴⁸ was voted in October 2018, highlighting sectoral issues. It acknowledged the potential and challenges associated to the application of BDLTs in the financial sector, mainly calling upon informative actions to better understand the ins and outs of this recent development (European Parliament, 2018b).

BDLT Policy Framework – specifics of the EU financial sector. Significant ICO⁴⁹ activity has triggered many regulatory reviews and decisions – see, for instance, the European Parliament assessment undertaken by Houben and Snyers (2018) – with respect to cryptocurrencies and illegitimate activities (incl. money laundering, terrorist financing⁵⁰ and tax evasion⁵¹). The early influence of the Financial Action Task Force (2014) set the ground for a common understanding of virtual currencies which are now associated with multiple risks such as highlighted by a recent European Parliament ECON committee report (Lastra and Allen, 2018).

Policy concerns however go beyond crypto-currencies: policy frameworks impact and are impacted by the development of BDLT and their progressive deployment to the market beyond the monetary sphere (see for instance Boucher et al., 2017 – on behalf of the EP). The EC has for instance set up in 2018 its FinTech Action plan (European Commission, 2018) which addressed the deployment of BDLT in the financial sector, touching upon issues related to BDLT standardisation, the EU Blockchain initiative, etc.

Regulatory frameworks in place at the EU level are also under consideration. They mainly include:

- The EU Payment Service Directive (PSD2)⁵²
- The General Data Protection Regulation (GDPR)⁵³ – see also the recent assessment operated by the European Union blockchain observatory & forum (2018)
- The EU Markets in Financial Instruments Directive (MiFID II)⁵⁴
- The Know Your Customer (KYC) and Anti-Money Laundering (AML) regulation⁵⁵

The regulatory agencies key to the financial sector have produced reports and recommendations on BDLTs, highlighting the diversity of possible cases and the care needed when considering the role of BDLT in the financial sector:

⁴⁸ See <https://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P8-TA-2018-0373+0+DOC+XML+V0//EN&language=EN>

⁴⁹ Initial Coin Offering

⁵⁰ See also Keatinge et al., 2018

⁵¹ See also Xu, 2016

⁵² https://ec.europa.eu/info/law/payment-services-psd-2-directive-eu-2015-2366_en

⁵³ https://ec.europa.eu/commission/priorities/justice-and-fundamental-rights/data-protection/2018-reform-eu-data-protection-rules_en

⁵⁴ <https://www.esma.europa.eu/policy-rules/mifid-ii-and-mifir>

⁵⁵ https://ec.europa.eu/info/policies/justice-and-fundamental-rights/criminal-justice/anti-money-laundering-and-counter-terrorist-financing_en

- The *European Insurance and Occupational Pensions Authority* (EIOPA) established an InsurTech Task Force (ITF)⁵⁶. The 2017 EIOPA InsurTech Roundtable assessed the role of blockchain, smart contracts and associated use cases, concluding on the “*great potential*” of BDLT and exemplary target usages – “*parametrics insurance, catastrophe bonds or plane tickets cancellation*” (European Insurance and Occupational Pensions Authority, 2017);
- The *European Banking Authority* (EBA) recently issued its analysis and conclusions on crypto-assets (European Banking Authority, 2019), looking at BDLTs as an emerging area with no immediate implications for financial stability and recommending measures to further analyse the role of this technology group in the current development of the banking sector.
- The *European Securities and Markets Authority* (ESMA) highlighted the risks implied by the lack of maturity of BDLTs and the fact that the various applications of the technology should not occult the need for regulatory enforcement (European Securities and Markets Authority, 2017)
- The *European Central Bank* (ECP) addressed BDLT in 2016⁵⁷ and engaged into an assessment of the impact of BDLT market infrastructure and central bank roles, considering the triple helix “*cash-collateral-securities*” in close collaboration with the Bank of Japan (Bullmann and Kobayakawa, 2017). Its 2017 report formulated an assessment of BDLT potentialities but also recommended a careful (closed) piloting of potential initiatives in that respect (ECB, 2017).

National frameworks. Last but not least, national policy frameworks are key. As pointed by EBA in its recommendations to the EC on crypto-assets, “*significant portion of activities involving crypto-assets do not fall within the scope of current EU financial services law (but may fall within the scope of national laws)*” (European Banking Authority, 2019).

The predominance of national frameworks across the 28 EU countries thus remains an important factor to bear in mind. Some challenges are induced by the cross-border nature of BDLT transactions which can cut across jurisdictions, implying for instance the development of VAT standards and protocols which could be empowered by artificial intelligence and smart contracts (UK Government Chief Scientific Adviser, 2016). Policy initiatives are being fostered across Europe, ranging from the French Parliamentary debates around Blockchain⁵⁸ to the UK research orientation toward addressing BDLT technical limitations (UK Government Chief Scientific Adviser, 2016).

To conclude, the previous paragraphs in this Section indicate a state of flux for the public policy maker and for the regulator commensurate to the state of flux of the technology and its prospective applications summarized in earlier Sections of this report.

6. Quantification

5.1 Quantifying the Effects of BDLT implementation

This section presents an effort to quantify the effects of BDLT technology adoption in the European financial sector. It is based on three sources of data: (i) the replies of a number experts to a detailed questionnaire on the effects of BDLT implementation (adoption) in segments of the financial sector and the associated risks; (ii) estimates of parameters of financial sector and gross domestic product (GDP)

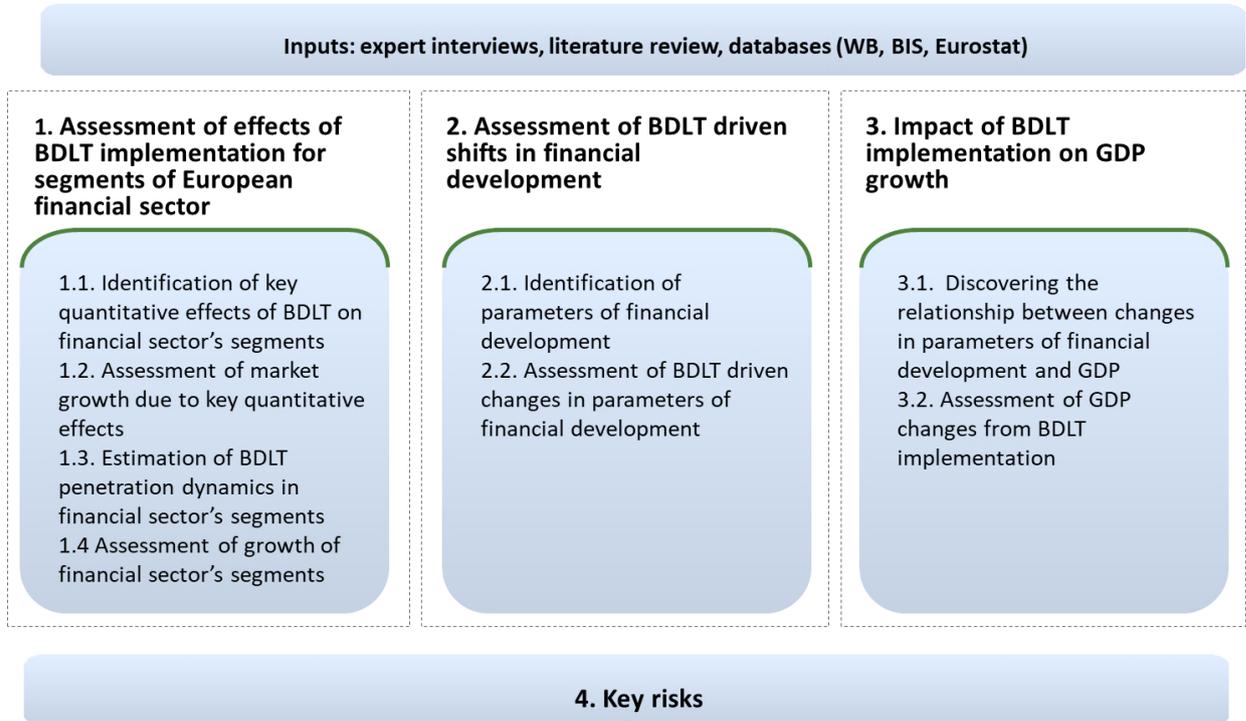
⁵⁶ <https://eiopa.europa.eu/Pages/Working%20Groups/InsurTech-Task-Force.aspx>

⁵⁷ See <https://www.ecb.europa.eu/pub/annual/special-features/2016/html/index.en.html>, consulted on 29/03/2019

⁵⁸ See https://www.lesechos.fr/12/12/2018/lesechos.fr/0600322757321_des-parlementaires-preconisent-d-investir-500-millions-dans-la-blockchain-en-trois-ans.htm, consulted on 29/03/2019

growth from the academic literature; and (iii) data from the Bank of International Settlements (BIS) and the World Bank. The impact of BDLT implementation (adoption) on the European financial sector and its contribution to the economic growth of the EU as a whole are estimated. The risks of BDLT implementation in each segment of the financial sector are also assessed. The overall schematic approach is presented in Figure 3.

Figure 3. Methodology of impact assessment of BDLT implementation



5.2 Assessment of BDLT implementation impacts on segments of the European financial sector

Six segments of European financial sector were considered in this analysis (NACE 2 codes in brackets):

- Payments and money transfer (64.19)
- Retail (consumer) banking: lending and deposits (64.19)
- Corporate banking, trade finance, leasing and etc (include central and interbanking activities) (64.9, 64.11)
- Financial markets (brokerages, securities clearing and settlement and etc) (66.1)
- Wealth management and Investments (investment banks and etc.) (66.3, 64.3, 64.2)
- Insurance (65, 66.2)

Moreover, the following effects of BDLT implementation were identified on the basis of our literature review and a set of expert interviews conducted early in the project:

- cost reduction (percent) for finsector customers (decrease of transaction costs, interest rate margins (spreads) for financial intermediates, insurance premiums, fees and commissions in segments of finsector)
- increase of the market for each segment due to new customers' groups (financial inclusion and new services)

- continuity and flexibility of transactions and business processes
- decreased financial and operational risks (including cyber risks)
- increased privacy
- improved transparency (KYC, AML and etc)
- increased speed of transactions

The first two effects above may directly impact the size of the corresponding markets through the changes in the frequency and volume of transactions, service fees and additional services for new customer groups. These two effects – cost reduction and new customers – are quantified in this Section through the estimation of changes in related market sizes. The remaining five effects mostly affect the business models and the quality characteristics of BDLT products and services and can be assessed only indirectly through the rate of adoption of BDLT.

The average estimates from different experts for cost reduction and the growth of the market for each segment due to new customers are shown in Table 1.

Table 1. Expert estimates of effect magnitude of BDLT implementation in the European financial sector

Segment of European finsector	Cost reduction	New customers (financial inclusion)
Payments	-43%	10%
Retail banking	-32%	5%
Corporate banking	-47%	0%
Financial markets	-53%	5%
Investments	-21%	10%
Insurance	-66%	10%

Note: Based on expert estimates

Overall the magnitude of the effect of financial inclusion is modest for the European financial sector due to highly developed financial institutions and low share of unbanked population in most European countries. A part of the corporate banking business may be disrupted and shift to peer-to-peer (P2P) lending BDLT platforms (investments segment). That is why most of experts estimated zero growth in corporate banking segment due to BDLT implementation.

Experts expect very significant cost decreases in case of successful BDLT implementation across all segments of European financial sector. BDLT based cryptocurrency payments systems may simplify and make cheaper transactions costs especially for cross-border payments which currently require longer settlement time and higher costs. Retail banking transition to BDLT based P2P platforms or to distributed internet banks which may reduce interest rate spreads (difference between deposit and loan interest rates). In corporate banking interest margins will decrease after transition to supply chain and leasing BDLT platforms. Broker and settlement commissions may be replaced with much smaller costs after transition of financial market services to BDLT based trading platforms. In wealth management and investments the cost reduction is expected to be less significant due to already relatively low management fees for mutual funds, exchange traded funds (ETFs) and the use of roboadvisors. For the wealth management segment BDLT-based solutions will increase the popularity of alternative investment instruments such as smart trust funds, tokenized SPVs, real estate and derivatives which may replace traditional investment instruments - stocks and bonds in investor’s portfolios. Finally, the insurance segment may be disrupted even more after transition to BDLT based P2P insurance platforms where insurance premiums may decrease by two thirds according to expert estimates.

Decrease in costs may increase the frequency of transactions, the amount of investments and loans, the turnover in financial markets and the value of insured assets. To estimate the increase in market share for each segment of the financial sector we used elasticities from published reports and research papers (Chiu, Hill, 2015; Martín-Oliver, 2011; Dick, 2007; Moody’s analytics report, 2016, European Commission, 2012). Applying the corresponding elasticities, the following increases in market size for each of six market segments were estimated (Table 2).

Table 2. Market growth due to cost reduction

Segment of European finsector	Market growth due to cost reduction
Payments	45%
Retail banking	39%
Corporate banking	50%
Financial markets	56%
Investments	29%
Insurance	69%

Note: Based on expert estimates and author calculations

We next add together the percentage market growth resulting from cost reduction (Table 2) and the addition of new customers (financial inclusion) (Table 1) to obtain the cumulative market growth due to BDLT implementation (Table 3).

Table 3. Cumulative market growth due to BDLT implementation

Segment of European finsector	Cumulative market growth by segment
Payments	55%
Retail banking	34%
Corporate banking	50%
Financial markets	61%
Investments	39%
Insurance	79%

Note: Based on expert estimates and author calculations

The rate of market penetration of BDLT technologies in the financial sector – proxied by market share where BDLT is implemented – is hypothesized to roughly follow an S-curve, a widespread finding in the literature of technology diffusion (Rogers, 1983). Our surveyed experts have already estimated approximately the time of BDLT implementation in each segment of European financial market. It is important to highlight here that the experts provided estimates under the understanding that the diffusion of technology in a market depends not only on cost reduction and new customer groups but on all seven effects mentioned earlier (p.1-2). Aggregate estimates of technology implementation (diffusion) are presented in Table 4. The year of x% diffusion is determined as the year when the market share of BDLT-based products and services reaches x% of the market.

Table 4. BDLT diffusion period

Segment of European finsector	Year of 10% BDLT penetration	Year of 50% BDLT penetration
Payments	2021	2030

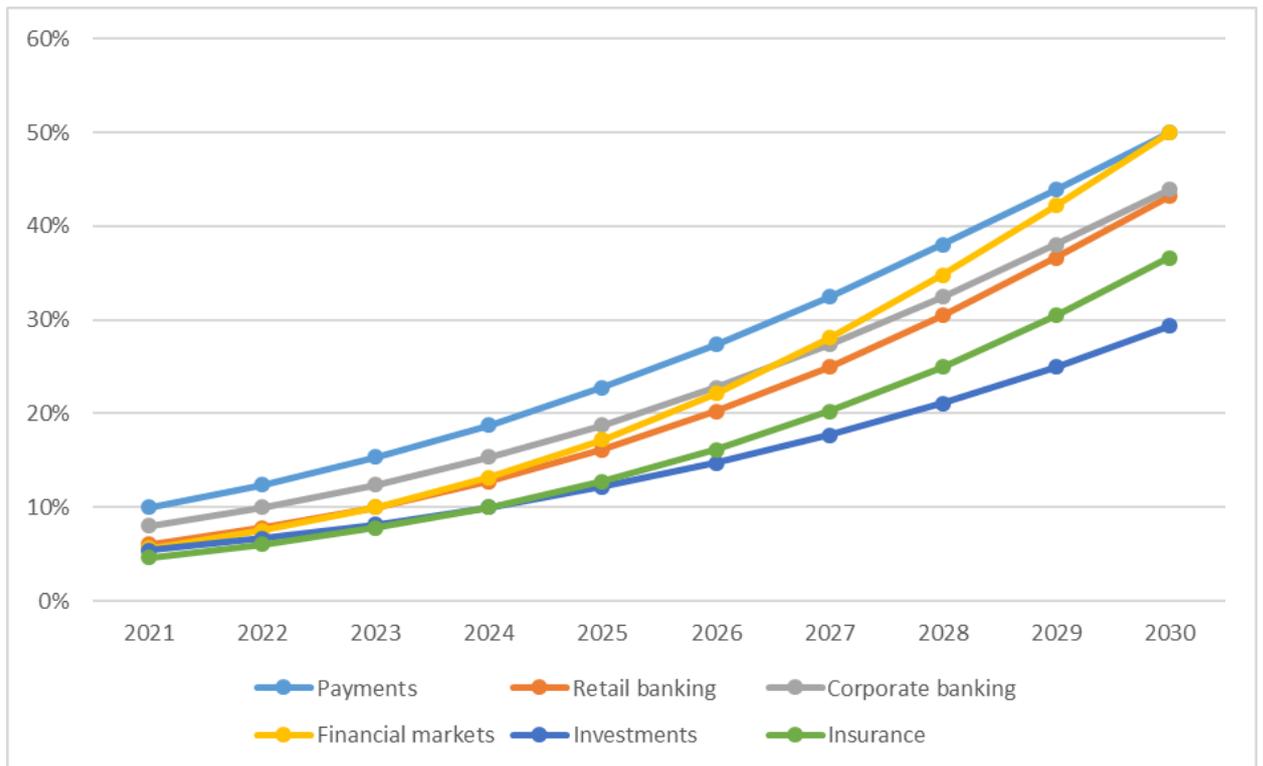
Retail banking	2023	2031
Corporate banking	2022	2031
Financial markets	2023	2030
Investments	2024	2034
Insurance	2024	2032

We apply the S-curve formula for the i -th segment:

$$f_i(t) = \frac{1}{1 + e^{a_i(t-T_i)}}$$

where $f_i(t)$ represents the BDLT products and services penetration at time t , a_i is the adoption rate and T_i is the time of 50% BDLT penetration. Table 4 shows the estimated T_i for i -th segment and determines the penetration rate $f_i(t)$ during the period 2021 to 2034. This is the period from the year the first market segment may reach 10% penetration rate to the year the last segment reaches 50% penetration rate. Figure 4 graphs the alleged evolution of BDLT penetration of the different financial market segments during 2021-2030.

Figure 4. BDLT penetration rates for financial sector segments 2021-2030



Note: Based on surveyed experts estimates

Applying the values for cumulative market growth due to BDLT adoption $gBDLT_i$ from Table 4, we estimate the growth of total market for the i -th segment for each year during 2019-2030.

$$growth_i(2019) = f_i(2019) \times gBDLT_i$$

$$growth_i(t) = (f_i(t) - f_i(t - 1)) \times gBDLT_i, t = 2020, \dots, 2030$$

The growth of each market segment is determined by the growth in the part of the market where BDLT was implemented (BDLT market penetration). We estimate the compound annual growth rates (CAGR) by averaging the growth for each market segment during the time period 2019-2030 (Table 5).

Table 5. Total finsector market segment growth due to BDLT penetration

Segment of European finsector	CAGR due to BDLT adoption 2019-2030	Cumulative market growth due to BDLT adoption 2019-2030
Payments	2.32%	32.1%
Retail banking	1.44%	18.8%
Corporate banking	1.86%	25.0%
Financial markets	2.57%	36.1%
Investments	0.99%	12.6%
Insurance	2.43%	33.8%

Note: Based on authors' calculations

All the values in Table 5 are provided in constant prices and reflect only growth due to BDLT penetration (all other factors are assumed constant). For simplicity, the deflators (related to BDLT implementation) correspond to the cost reduction estimates for each segment.

5.3 Assessment of BDLT-driven shifts in financial development

Growth rates of financial sector segments allow to estimate the changes in parameters of the European financial system development. The literature identifies the following four key parameters of financial development:

- Electronic payments penetration (Value of electronic payments to GDP)
- Financial depth (Liquid liabilities to GDP or M3/GDP)
- Financial leverage (Gross claims on the private sector to GDP)
- Market turnover (which equals the total value of shares traded divided by market capitalization)

In order to estimate changes in parameters of financial development we use BDLT enabled compound annual growth rates for financial sector segments. Bank of International Settlements (BIS) data are used to estimate shares of each segment in European Union (EU) financial sector. Several assumptions were used to arrive to those estimates:

Assumption 1. To estimate changes in electronic payments penetration we use BDLT-enabled growth of the Payments market segment.

Assumption 2. To estimate changes in financial depth we use the value-weighted (weights reflecting the share of each market segment in European financial sector) sum of BDLT-enabled growth rates of the Retail Banking, the Corporate Banking, and the Investments market segments. The Investments segment growth rate is added to account for assets of mutual funds which are included in M3.

Assumption 3. Changes in gross claims on the private sector to GDP or financial leverage are estimated through the value-weighted sum of BDLT-enabled growth rates of Retail Banking, Corporate Banking,

and the Insurance segments. The Insurance segment is included because its growth might stimulate corporate and retail lending.

Assumption 4. Market turnover growth is estimated using BDLT-enabled growth of financial markets.

Table 6 summarizes the estimated effects of BDLT adoption on parameters of the European financial system development.

Table 6. BDLT-enabled growth rates of EU financial system development parameters

Parameter of EU financial system development	CAGR 2019-2030
Electronic payments penetration	2.32%
Financial depth	1.17%
Financial leverage	1.76%
Market turnover	1.05%

Note: Based on author calculations

5.4 Impact of BDLT implementation on GDP growth

Using estimates in the relevant literature, it is possible to assess the effects of changes in parameters of financial development on the EU GDP. Moody's (2016) estimate of the elasticity of GDP w.r.t. electronic payments penetration is 0.18. According to King and Levine (1993) a 1 percent change in financial depth and leverage may increase GDP growth rate by 2.4 and 2.2 percent respectively (regression coefficients). Levine and Zervos (1998) estimated that a 1 percent change in market turnover may change GDP growth by 2.7 percent. Average annual GDP growth rates are obtained by aggregation of inputs from changes in corresponding parameters of financial development during the time period 2019-2030 (Table 7).

Table 7. Effect of BDLT-enabled growth rates of EU financial system development parameters on GDP

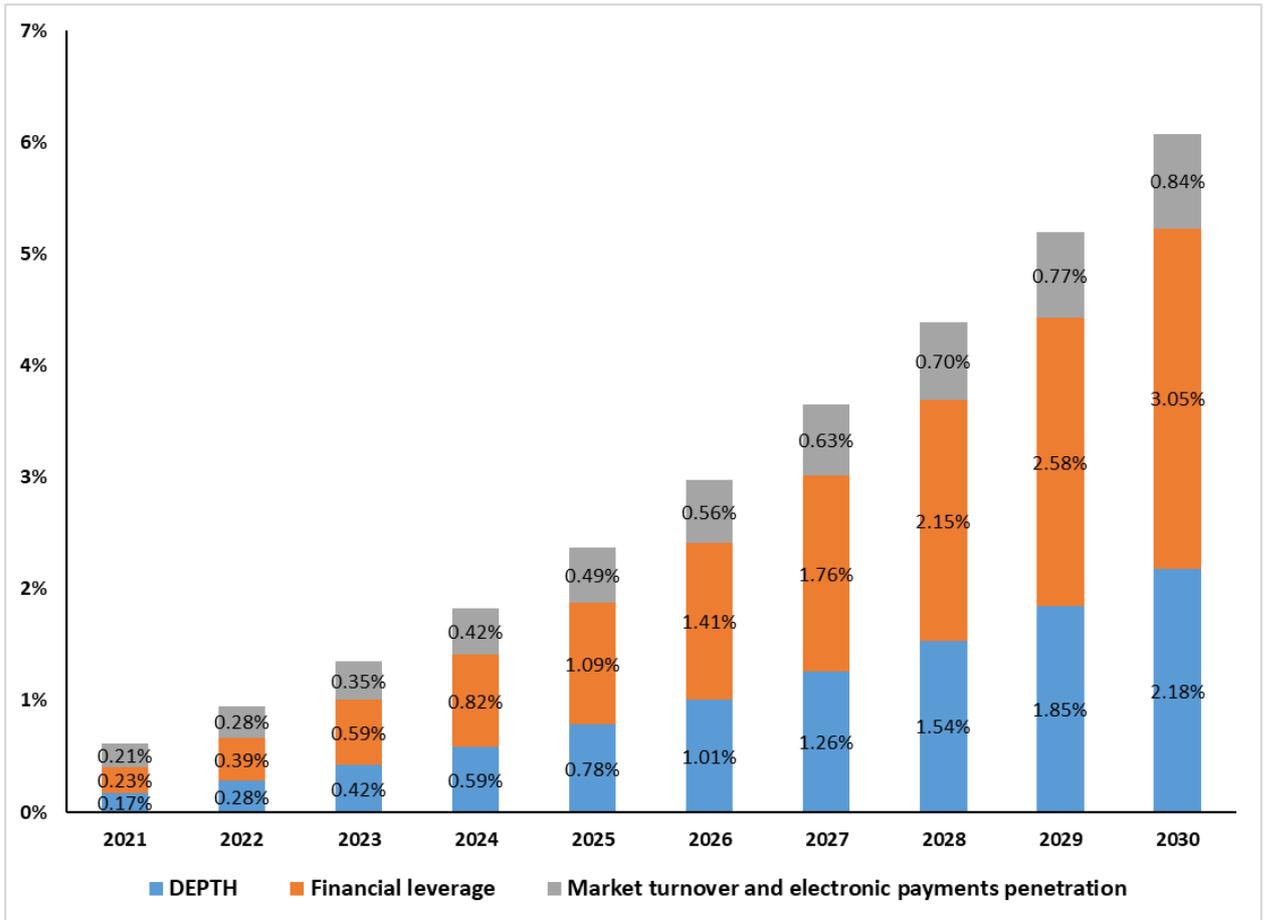
Parameters of EU financial system development	Average annual EU GDP growth due to BDLT adoption (2019-2030)
Electronic payments penetration	0.04%
Financial depth	0.18%
Financial leverage	0.25%
Market turnover	0.03%
TOTAL	0.51%

Note: Based on author calculations

As follows from Table 7 the main impact of BDLT implementation on GDP is provided through the growth of financial depth and leverage parameters. The estimated BDLT-enabled cumulative growth of European Union GDP from 2019 to 2030 will be 6.3% (estimated as cumulative GDP growth from 2019 to 2030, Fig. 3). This growth will be due to increase in financial depth and leverage by 15% and 23% respectively⁵⁹ due to BDLT implementation (estimated as cumulative 2019 to 2030 growth from Table 6). Annual EU GDP growth rate will increase each year following higher penetration of BDLT.

⁵⁹ In this research we do not consider strong relationship between parameters of financial system development. More sophisticated model should be developed to assess the interactions between parameters.

Figure 5. Components of cumulative BDLT enabled GDP growth 2021-2030



5.5. Key risks

The quantitative analysis in the previous sections allows to estimate the effects of BDLT implementation in a perfect scenario of high adoption rates for every market segment of the financial sector and significant cost reductions. In reality, however, the adoption rate depends on possible risks and barriers that arise in the course of BDLT implementation. For example, according to World Bank data the financial leverage has increased by almost 70 percent during the past decade. Further significant increase in financial leverage may cause financial instability problems even for western and northern European countries where leverage is relatively high. Such a risk may invite additional regulatory restrictions on BDLT based services.

Similarly, it is not clear if implementation of BDLT in financial markets has advantages compared to centralized exchanges for financial instruments. As indicated in a recent study on BDLT applied to securities markets (ESMA, 2017) BDLT implementation may face substantial risks (including operational risks, interoperability and scalability issues) that will undermine the positive effects and may substantially decrease the adoption rate of BDLT. Such risks may cause delays and even failure of BDLT implementation in various segments of the European financial market.

We have identified the following ten (10) risks for BDLT implementation on the basis of our literature review and expert interviews:

- scalability issues (including slow speed of transactions)
- cyber threats
- decentralization issues (choice between completely decentralized network, partially decentralized as in permissioned DLT, or centralized network)
- awareness/information asymmetries

- cultural resistance to change
- high cost of implementation
- high energy and environmental costs
- regulation and legal risks
- financial risks
- network interoperability, people risk and other operational risks

The first three risks are very interrelated. More decentralized ledgers have better resistance to cyber threats but have major scalability problems as opposed to more centralized networks. Scalability solutions (as in Lightning DLT) may increase cyber threats vulnerability. Interactions between risks was omitted at this stage of the analysis for simplicity.

Our interviewed experts provided estimates for each risk listed above ranging from 0 (no risk) to 4 (very high risk). The aggregate survey results of BDLT implementation risks are presented in Table 8 (maximum value for 10 risks for each segment is 40).

Table 8. Aggregated BDLT implementation risks for finsector’s segments

Segment of European finsector	Aggregated BDLT risks
Payments	25.3
Retail banking	23.4
Corporate banking	15.9
Financial markets	20.8
Investments	19.4
Insurance	20.4

Note: Based on expert estimates

The highest aggregated risks were obtained for the Payments segment due to major scalability as well as the demand for capital intense solutions and regulatory constraints. The least vulnerable to operational risks was the Corporate Banking segment where BDLT solutions could be mostly based on private networks.

One can also look at the aggregated risks and their overall importance for the financial sector as a whole. The highest value was reported for regulation and legal risk whose impact on BDLT implementation for each market segment was estimated by most of experts as very high (4). Relatively high value was assigned to “high cost of implementation” and “network interoperability, people risk and other operational risks”.

5.6 Differences of BDLT effects and risks across European countries

The effects and risks may vary across different countries. The effects of BDLT implementation may differ significantly between Western and Northern Europe and Eastern Europe. The level of financial leverage in Eastern Europe is significantly lower while the banking system is much more vulnerable. For instance, in Romania the ratio of private bank credit to GDP is 52.7 percent, one among the lowest as reported by the IMF (2018). The Romanian stock market has a market capitalization of just 20 percent of GDP. Insurance density and insurance penetration are the lowest in Europe. Romania has weak and small financial sector which is very vulnerable to financial crises due to a large proportion of public debt in bank assets and high share of nonperforming loans for SMEs. Financial inclusion is still one of the key issues in that country.

That is why BDLT implementation may have much larger effect for the Romanian financial system and for the country's GDP. For example, currently SMEs have very limited access to financing. Banks prefer to invest in public debt than provide resources to the economy. With BDLT implementation the interest rates may decrease which would allow directing more resources to risky assets including loans to SMEs. BDTL-based platforms may simplify access to financial services for unbanked population in rural areas. The effect of the law introducing zero fee accounts for poor unbanked population (higher fees for others) may be further supplemented by low-cost BDLT-enabled solutions; BDLT-based investment platforms will create additional instruments to attract households to financial markets. Assuming that BDLT will enable financial inclusion for wide groups of population and SMEs in Romania the markets for corporate and retail banking will increase along with the investments segment. Adding to investments, corporate and retail banking markets 30%, 10% and 30% respectively due to BDLT enabled new customer groups will result in 8.0% increase in Romanian GDP by 2030 (repeating the analysis of Sections 1-3 above) compared to 6.2% BDLT enabled increase in European GDP.

The financial sectors of other Eastern European countries are still much weaker than those of their Western and Northern European counterparts. For instance, World Bank data indicate that in Hungary private credit by deposit money banks to GDP was 34 percent in 2016 (decreasing during last several years) compared to 75 percent in Germany and 170 percent in Denmark. Hence, BDLT effects can be much more significant in Eastern Europe. Moreover, as mentioned earlier the effect of further growth of financial depth may be negative for GDP of high-income countries with developed financial system. That is why BDLT implementation risks if not carefully addressed by regulators and authorities may pose a threat to stability of financial systems.

Underdeveloped financial infrastructure in some Eastern European countries may provide opportunities for BDLT implementation. New BDLT-based solutions can be relatively easier to implement compared to very well established infrastructure in the leading European countries where changes of infrastructure may be more expensive to implement and also pose a potential threat to financial stability.

Finally, in some countries unbanked population may adopt BDLT financial technologies (especially related to remittance) faster compared to conservative and aging populations in other countries which may increase the risk of cultural resistance to change thus slowing down the implementation of BDLT.

7. BDLT Deployment in practice: Case Study Analysis

6.1 Approach

While the previous section projects quantified BDLT impacts, the very BDLT deployment process relied on a qualitative approach. The review was meant to capture the obstacles to BDLT deployment and qualify the effects of BDLT deployment to the financial sector. The following steps were followed:

1. Desk Research. A screening of potential cases was performed based on a desk research mixing both documentary and web sources. A series of possible cases were identified from various sources including Crunchbase, Medium, and other sources showcasing recent investments in BDLT companies or visible applications.

2. Appraisal and selection. Two tools were used to assess the relevance of each case: expert feedbacks as well as direct contacts with entrepreneurs. The conclusion of that effort was that a limited number of applications currently live were driven by European players. The selection was driven by the availability of cases and their fit with the following 5 priority criteria:

1. **Technology.** The application should be based on Blockchain or Distributed Ledger Technology;
2. **Sector.** The application should be implemented in the financial sector;
3. **Company structure.** Only companies structured around an established team were considered for assessment. This criterion was deliberately chosen to favour companies with internal capacity and a minimum level of maturity;
4. **Application Maturity.** The application should be either live (deployed to the market) or in the process of going live (deploying to the market/entering the market);
5. **EU anchorage.** The company driving the application should be headquartered in Europe;

As a result, 3 Live applications and 2 applications being deployed at the very moment of the research effort were identified. These are the following:

- 1) **Komgo** is a BDLT-based platform to digitize finance along the commodity trade value chain. The lead success is the digitization of letters of credit – shrinking the process from days to minutes while ensuring a secured transaction.
- 2) **SatoshiPay** provides micro-payment solutions (in cents or fraction of cents) to access digital content. Tens of thousands of transactions are currently being performed on this middleware with a growing user base.
- 3) **SettleMint** offers a middleware and a range of complementary services allowing for the full digitization and tokenization of activities in areas such as financial and supply chains. Besides being used by one of the world's largest retailer, it has also been used to digitize Islamic Development Bank subsidies, leading to an estimated \$150 million impact.
- 4) **SmartValor** went live at the very moment of the study. It provides a token (including securities) exchange allowing for alternative investment. The exchange has created strong traction right passed commercialization, deploying a high level of transactions.
- 5) **Centrifuge** also went live at the time of the study and proposes a decentralized Operating System dedicated to the digitization of the financial supply chain. It raised funds through several rounds and is considered a leading player in its segment

3. Desk Research. An extensive desk research was conducted which followed a documentary review grid. The grid guided the collection of relevant quantitative and qualitative information useful to prepare the case writing but also the semi-structured interviews to be held with key decision-makers (C-level) in each of the targeted companies.

4. Semi-structured interviews. A total of 10 semi-structured interviews were implemented. These interviews were framed by interview guidelines. Each interview touched upon the following topics:

1. Company trajectory, success factors and current state of play
2. Solution(s): key features, underlying rationale (challenges, targets, unique selling proposition, etc.)
3. Effects and impacts at company level but also broader (sector/societal spill-over)
4. Key trends and way forward
5. Critical Factors including drivers and opportunities as well as policy improvement tracks

5. Reporting. Final reporting was conducted by the lead researchers and a review by team members was performed to control the quality of the case. The cases were then submitted to companies for amendment and validation.

The following section presents each case study in a sequential way, starting from the 3 live applications and concluding on the 2 deploying ones.

6.2 Live BDLT Applications

Case 1-Live Application: KOMGO (Trade Finance & Commodities)



1. Pain points and challenges addressed

Commodity trade finance is subject to high financial compliance constraints which apply to the supply chain in its entirety. It encompasses regulatory constraints that vary from a country to another.

Commodity trade involves a high number of financial intermediaries to secure financial flows underlying the trading of various commodities. The trading chain of commodities is known to be paper based, each document attached to a financial transaction being linked to high security requirements. Various documents fall under that scope, including bills of lading, certificates of origin, certificates of quantity and quality, certificates of insurance, as well as letters of credit. Such paper-based *modus operandi* implies “long wait time for payments, increased insurance costs, increased opportunities for frauds (...) it can take up to 90-120 days to prepare for trading” (Consensus, 2019). Time lags associated to regular shipping procedures (including KYC) are thus a heavy burden affecting its performance while solutions are needed to streamline processes and access liquidity.

At the core of the trading chain are Letters of Credit (LC). LCs consist in the commitment of a financial intermediary to pay a third party in the possible event of default from its client. It thus ensures an organisation that if its trading partner is not able to pay, the financial institution will proceed with the transfer. The process involves an assessment of the creditworthiness of the trading partner as well as the financial intermediaries linked to both parties (the importer's bank will issue the LC to the Exporter's bank). The issuance of credit instrument (LC or SBLC) generally implies an important workload of back and forth and paperwork spreads over multiple stakeholders (applicant, issuing bank, advising bank, recipient) through multiple reviews and checks to ensure coherence of transactions along the value chain. In that context, more than 95% of the data generated and exchanged along the process would be of no added value. This information is currently siloed in the information system of each organization. Komgo allows it to be shared on a trusted ledger to accelerate processes and avoid mistakes and double typing.

2. Solution and underlying drivers

Company trajectory. Komgo aims to “*catalyse the world's commodity trade market*” (Komgo, 2019 – see also <https://komgo.io/>). It consists in an eponym blockchain-based network for data storage, exchange/transactions and efficient messaging along the chain of commodity trade finance. The project started in September 2016 as a mutual initiative of ING, Société Générale and Mercuria called Easy Trading connect.. It led to the on-boarding of large lead-users and the operational launch of two key pilots in the areas of crude oil and soybeans transactions.

The initiative started in Geneva which is a major commodity hub.

Following several proofs-of-concepts the main companies involved decided to reach out to the industry to launch a dedicated venture to move to production stage. Komgo SA was registered in August 2018 with 15 shareholders all active in the supply chain (ABN AMRO, ING, Natixis, BNP Paribas, Koch, Rabobank, Citi Bank, MacQuarie, Shell, SGS, Mercuria, Crédit Agricole, Gunvor, MUFG and Société Générale). Komgo went live in December 2018 with a first transaction of North Sea crude oil being financed on the platform.

Application. Komgo emerged as a way to streamline current financing mechanisms. It acts as both a network and an online platform for decentralised commodity trade finance. From a technical view it can be considered as a permissioned, seamless DLT-based network solution to support the transactions along the supply chain. In practice, it provides a peer-to-peer exchange of documents and evidence necessary to financial transactions and KYC due diligence in the commodities market. Thanks to secured data and immutable information embedded in the chain, no coherence checks and controls are needed anymore at every step. Komgo offers blockchain-based assets such as on-chain timestamped and immutable data, leading to a secure and automated LC process. Simplification and automation are key features of Komgo. It is now building upon the potential of smart contracts to associate auto-match functions to the traded LCs (Global Wass, 2019a).

Komgo currently focuses on the digitization of LC/SBLC issuance, access to liquidity via discounting and KYC. Each member of the network receives a “*Kapsule*”, which covers several components (database, identity, authentication module, and the Komgo app) and all users to allow for interactions in a digital environment. komgo is a decentralized ‘conduit’ and the data are not stored by komgo. Cryptographic methods are used to secure the evidence needed for the

digital validation of the process, using among other features smart contracts to propagate status to the members of the smart contract.

The overall platform has successfully passed penetration testing undertaken with Thales and Consensys (Komgo, 2019).

3. *Effects and impacts*

Deployment. In 2018 Komgo entered into a collaboration with Consensys to develop the full architecture of the platform which has been developed on Quorum. 5 scrum teams have been set up in AGILE mode.

The infrastructural basis was consolidated by the end of 2018 (going live on 21/12/2018 with its first transaction the next day), and the KYC solution entered production in March 2019. Shareholders were the primary users of the platform which is now growing and on-boarding new users with no shareholding position in the platform. New products are on their way such as invoice discounting, LC confirmation, certification etc.

Komgo connected to another Ethereum-based platform dedicated to post-trade processing, Vakt which handles the full process of physical energy transactions. Both Komgo and Vakt involve similar stakeholders, in the case of Vakt, BP, Equinor, Shell, Gunvor Mercuria, BFOET⁶⁰, Koch Supply & Trading, ABN Amro, ING and Société Générale. The interoperability between both networks was enabled by the use of a common technology to allow Vakt users to use the financing solutions available in Komgo (Wass, 2019).

Effects. In its first life stage Komgo mobilised 10 early adopter institutions for 15 nodes successfully deployed and maintained in User Acceptance Testing (UAT). The first effects were demonstrated by the two pilots carried out by the founding partners:

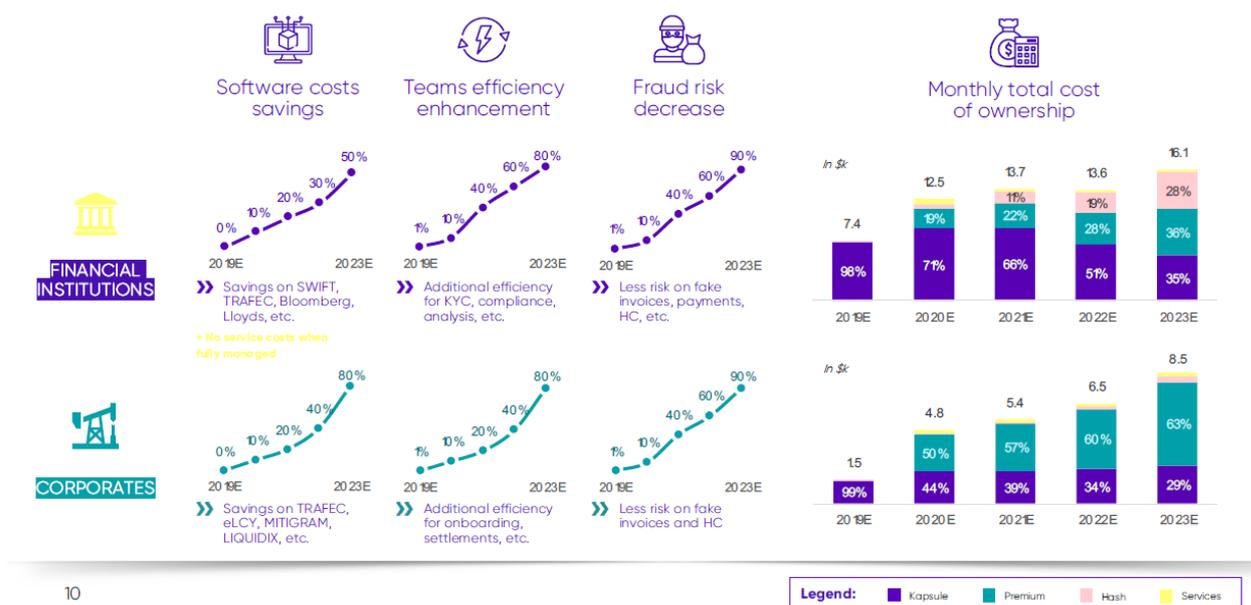
- Crude oil (2017): issuance of digital Letter of credit between Mercuria and ChemChina in a parallel mode run “*significant savings*” (AGEFI Commodities, 2019);
- Soybeans (2018): the follow-up pilot was carried out by ING, Société Générale, Louis Dreyfus Company and ABN Amro. Partners put transactions of 60.000 tonnes of soybeans between the US and China on chain, a process usually taking 20 to 25 days was reduced to 5 days (AGEFI Commodities, 2019), in that very case leading to a completed process 7 days earlier than the paper-based one (Wass, 2019).

As of today, North Sea crude oil flows can be secured on Komgo by an LC in a just a few clicks instead of several hours.

The future effects claimed by Komgo are summarised in Figure 6 below (Komgo, 2019):

⁶⁰ Brent, Forties, Oseberg, Ekofisk and Troll

Figure 6: Komgo effects – a Summary



Source: Komgo, 2019

It was highlighted that “Independent trading companies involved in the pilots estimate that blockchain could soon decrease operational costs by up to 30%” (AGEFI Commodities, 2019). Benefits were estimated along the full chain to 30-40% in cashflow gains, with an expected cost reduction of 20-50% and possibly more at industry level (Consensus, 2019). Through the interoperability with Vakt, Komgo estimates that full commodity trade processes across platforms reached a pace 100 times faster with decreased human error and fraud risks.

The success of Komgo also opens new business perspectives: for example, questioned by Global Trade Review (2019), Citi global head of commodity trade finance Kris van Broekhoven explained that “it is entirely possible that the efficiencies brought by komgo will allow us to do business that we are not seeking to do today”⁶¹.

The priority is now for Komgo to scale up its user base with low-cost access. The company is in the process of raising funds between now and end of 2019. It also continues the integration process with key financial players (between 3 and 7 in 2019).

4. Critical factors

Technological development has proven to be a driver for the company more than a challenge. Adoption on the other hand is the key of Komgo success. Scale is in that respect a critical driver Komgo now addresses to achieve a wider impact on the commodities sector (a critical mass of platform users is needed to achieve its full potential). In doing so the company has faced and still faces regulatory challenges:

- Regulation impacts Komgo clients both from a time (delays) and budgetary (costs) perspective. The distributed and encrypted technology in which Komgo is anchored is

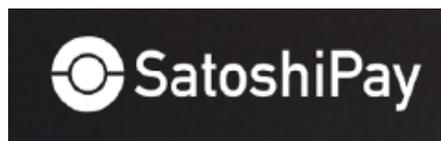
⁶¹ Source: <https://www.gtreview.com/news/fintech/komgo-blockchain-platform-for-commodity-trade-finance-goes-live/>, consulted on 09/01/2019

seen as a new way to alleviate risks of fraud, which should lead to lighter and more efficient processes .

- The validity and portability of e-documents has been a clear challenge for the company. While some regulators show willingness to move faster on these two topics, the lack of common framework is perceived by the company as a hampering factor to its further deployment, creating inefficiencies. The reduction of regulatory capital asked from banks due to the reduced risks should in that respect be a driver to regulatory change – on top of a possible reduction in administrative burden.

Another critical challenge relates to the culture of larger organisations. Their capacity to work with smaller companies and fintech start-ups is perceived as a challenge that requires a cultural change. This also translates into practices: Baptiste Audren (Head of Products and Business Development, Komgo) for instance reported in Global Trade Review that “*One of the challenges is that people still want to modify and add clauses. So the mindset has to change and it will take a bit of time for people to realise that there is a standard format*” (Wass, 2019a).

Case 2-*Live* Application: SatoshiPay (Payment)



1. Pain points and challenges addressed

Due to too high transactional fees, usual payment systems do not allow for cross-border micropayments. Micropayments refer to small instantaneous ad-hoc payments (less than 1 Euro)⁶². A fundamental reason behind this state of play is the intermediation of the transnational payment value chain which implies that a transfer will involve an “*anchor*” (financial intermediary in the receiving country) to ensure that the pay-out is made. Such process is anchored in usual KYC burdens that translate into costs and time lags for a transfer to be completed. It is estimated that the user cost for each transfer is often between 10 to 20 cents fixed charge per transaction to which 1% to 3% of the transaction value should be added (Radia, 2018).

Micropayments are relevant to multiple markets where a global pay-out standard is needed and/or where micro-sums should be paid for in an easy fashion. Among the markets under the scope is the one of digital content publishers. Content publishers and advertisers are increasingly under the pressure of losing revenue due to the growing weight of ad-blocking software as well as adverse effects from paywalls (Radia, 2018). Micropayments come as a way to tackle the missed opportunity of monetizing day-to-day digital content. Such scope encompasses written, digital, game, or any other type of digitized content. The same range of challenges can thus apply

⁶² See also <https://www.forbes.com/sites/forbesdallascouncil/2019/04/25/are-micropayments-the-future-of-online-transactions/#7d82df767202>

to a broader set of economic segments across sectors, such as service sector segments where digital freelance workers perform their activity across borders.

2. *Solution and underlying drivers*

Company trajectory. In the context of SatoshiPay, micropayments are currently used to access digital content (or fraction thereof) or services. The company is thus currently active in the publishing market. Founded in 2014, SatoshiPay was first incorporated (and is still located) in Berlin and in the same year incorporated in the UK. It built upon acceleration and fundraising to develop its technology and services around its Stellar-based platform (while it initially used the bitcoin blockchain network⁶³). It currently employs 19 “tech” profiles including PhDs. By late 2018 the company had signed up 3.000 publishers of limited size. It competes with organisations such as Piano and Paypal but also Blendle and Brave.

SatoshiPay targets publishers but also entities willing to build micropayment services upon a Stellar infrastructure. Its mid-term to long-term vision is to become a middleware between the distributed ledger (the chain) and applications willing to use it for (for payments but also all sorts of instant payments). It comes as an alternative to traditional payment solutions and new entrants in the BDLT-enabled payment solutions. In 2017 the company decided to enter in a collaboration with the French TEMPO to develop in the direction of on-chain fiat exchange (EURO-pegged Token – EURT) to improve its current fiat pay-out and keep avoiding fluctuations in cryptocurrency values⁶⁴.

Application. As a product, SatoshiPay is an online cloud-based platform for micropayments through which users can be charged micro-amounts to access digital content and/or services. The process is login-free and builds upon the use of a Wallet while the company does not retain any fund or personal data. It relies on Stellar which can handle more than 1.000 transactions per second⁶⁵ and uses “Lumens” at its core token. SatoshiPay is not subject to e-Money licence requirements. Users buy an initial credit with which is embedded in their day-to-day web activities. Recipients of payment pay a 10% transaction fee regardless of its amount, and no effect passed onto the users (Radia, 2018). Figure 7 below illustrates the way SatoshiPay functions from both a user and web viewpoint:

⁶³ Which is associated to pace and cost issues; and leading to a recent proof-of-concept (POC) with IOTA which does not charge transaction fees.

⁶⁴ See <https://medium.com/@SatoshiPay/satoshipay-launches-stellar-integration-and-six-new-partnerships-1ce6c74059b6>

⁶⁵ With an average Stellar transaction fee of 0.000002 Euros when applied to the SatoshiPay average rate, in line with the calculations presented on <https://www.stellar.org/developers/guides/concepts/fees.html>

Figure 7: Illustration of SatoshiPay in practice



Source: SatoshiPay⁶⁶

From a technical standpoint SatoshiPay addresses the challenge of accelerating the link between digital KYC and the pay-out side of a service or content access. The solution can be seen as a private distributed machine-to-machine payment system (Consilium, 2017). It is a middleware upon which various services and applications can be built. Users can feed in their wallet with any payment method, and an automated process allows for transfer to the publishers’ wallet and immediate content access. Incentive mechanisms can be embedded into the system, allowing for rewards or other forms of incentive to users. It is accessible through any type of hardware (smart phone, computer, etc.). The use of a distributed ledger infrastructure allows for transactions that are fast (3 to 5-second settlement), secured and low-cost (lower variable with no fixed fee) compared to regular payments.

3. *Effects and impacts*

Deployment. In 2018, Radia reported that the user base of SatoshiPay was comprising “c.135,000 SatoshiPay wallets, and around 23,000 transactions have been processed to date. Today, about 200 publishers generate 10 or more transactions per month, equating to a run rate of c.2,000 transactions per month from the active base.”. The company started to generate “real” revenue and launched its first large-scale micropayment service to further grow beyond its current turnover. Business material shows both conservative and optimistic revenue projections applied to client target groups, illustrating the multiplication of potential revenues using SatoshiPay. Hundreds of transactions can be handled every second and the Stellar Foundation distributed free Lumens as an incentive to adoption.

Effects. Since its deal with City A.M., SatoshiPay announced in 2019 a partnership with the German corporate Axel Springer, considered the largest European digital publisher with more than €3.5 Billion in turnover in 2017 of which 60% would be linked to digital media activities⁶⁷. It also unlocked a partnership with The Register. SatoshiPay has welcome new investors in its capital: the latest valuation of the company positioned it at a £15.000.000,00 grade boosted by

⁶⁶ See <https://satoshipay.io/>

⁶⁷ Source: <https://www.coindesk.com/satoshipay-integrates-blockchain-payments-for-major-european-publisher/>; SatoshiPay had prior relation with the group through Axel Springer Plug and Play (accelerator that hosted but also acquired minority shares in SatoshiPay)

profits and a recent fundraising round of 2 million Euros)⁶⁸, bringing Aeternity Ventures⁶⁹ and thus strengthening its smart contract capabilities⁷⁰. The future of SatoshiPay will be oriented toward an increase of B2B2C business and a sustained long-term vision of its B2B activities.

The very existence of SatoshiPay allows for new pricing strategies and a reduction of “frictions in online content monetisation” (Coinsilium, 2017). This comes with a raise of the Internet of Things (IoT) market expected to reach \$171B in 2019 and \$241B in 2022 for Europe only (Kalal, 2019). Radia (2018) highlighted that SatoshiPay’s “addressable markets (...) are multi-billion-dollar markets and growing at double-digit CAGRs”. The company now observes raising trends in stablecoins and security tokens which are expected to strongly impact the future of the European economy. Other impacts can be listed such as environmental ones – due to the low level of CO2 emissions associated to the Stellar model. It is also observed at SatoshiPay that the use of Blockchain and DLTs in particular are of particular relevance on countries with no well-anchored financial infrastructure and where impacts can consequently be “huge”⁷¹.

“BDLT enables the integration of the global financial payment system, especially in underbanked areas”

—
Dr. Aaron Lindner, Chief Growth Officer, SatoshiPay

4. Critical factors

The company relies on its critical asset which is high-level human capital and a strong technological capacity. The user base is the key priority of the company which faced several challenges along its deployment effort:

- Financial regulation (in particular in France and Germany according to SatoshiPay) created hurdles that affected the speed of deployment. Legal stands to ensure compliance were deemed difficult. Regulatory compliance was therefore seen as the Number 1 obstacle to the deployment of SatoshiPay. It remains so with respect to the stablecoin uptake by the company. At this stage SatoshiPay uses coupons to ensure that the tokens do not belong to users but to the company itself, while its ambition is to reach a point where users own and control the coins – but such approach would require an estimated 2-year compliance effort and would entail variations in terms of coupon validity.
- The confusion between cryptocurrency and blockchain or distributed ledger technologies has been a key issue for the company. Investment patterns are said to be very much aligned with the volatility of bitcoin and other cryptocurrencies despite fundamentally different uses and markets. The same applies to many perceptions, highlighting the existence of a clear information asymmetry.

⁶⁸ Source: <https://www.directorstalkinterviews.com/qa-with-blue-star-capital-plc-satoshipay-lonblu/412769116>

⁶⁹ See <https://www.cryptomak.co.uk/aeternity-teams-up-with-satoshipay-for-faster-transactions/>

⁷⁰ See <https://www.chipin.com/aeternity-and-satoshipay-start-working-together/>

⁷¹ Source: interview with SatoshiPay, 24/05/2019

- The role of large lead users has been key for both public and private blockchain in creating traction. Although it is not seen as an obstacle it can be considered a challenge for the company which aims for a critical mass of transactions to reach its potential.
- From a technological point of view scalability has emerged as an issue that led to a shift from bitcoin blockchain to Stellar and its Lumens. Still it is anticipated that scale can always become an issue again as it links to the volume of transactions and protocols at stake (which can be altered or modified).

Case 3-Live Application: SettleMint (Investment and Supply Chain)



1. Pain points and challenges addressed

Organisations have long been striving for irrefutable and incorruptible results as well as diminished costs. Digitisation has been a key trend in all sectors of the economy where a shift from paper-based notary processes to more optimal modes has been actively sought. From that angle the key driver for financial players has been efficiency⁷².

Two main pain points were in that respect addressed by SettleMint:

- 1) The sub-optimisation of non-digitised processes: the absence of instant processing is seen as a weakness of the financial system.
- 2) The costly intermediation of financial organisations. A classical share acquisition process for instance can involve 13 intermediaries.

The potential of BDLT in that respect appeared to be hampered by its lack of accessibility. This was very much linked to its newness and information asymmetries around it. That situation constituted the ground for SettleMint's vision.

2. Solution and underlying drivers

Company trajectory. SettleMint was co-founded by an ex-innovation manager from a large European bank with a strong track record on the capital market and an ex-CTO of a digital transformation company. BDLT fell under their radar in 2014. After running together an online brokerage platform for the bank as well as its first equity crowdfunding platform, internal challenges led the managers to set up the company in Leuven (Belgium).

This initiative was driven by the ambition to make BDLT accessible, a belief that has driven the company development ever since its creation in 2016: the goal of the company was at that time (2016) to create a toolkit that could accelerate BDLT development, testing and deployment from

⁷² Source: SettleMint interview, 09/05/2019

months to days, accelerating BDLT deployment by 2 years. End of 2016, the company started raising funds for its development.

SettleMint currently employs 20 people and stabilised in the course of 2019. The company allowed for 30 applications to be built upon its technology with 6 of them going in full production. With its growth the decision was taken to open offices in Dubai (2018), Riyadh (2019) and Singapore⁷³. It also developed partnerships with NTT Data, CTC Global Singapore and Simac⁷⁴.

SettleMint's current key targets are financial intermediaries from capital markets as well as the insurance sector. Its mission is oriented toward building BDLT capacity in client organisations. It delivers functionalities that democratise the use of BDLT and builds the skills and competences of developers and managers across its client base.

Application. The key product of SettleMint is Mint⁷⁵, a middleware upon which an API is built to allow for the easy and rapid development of BDLT applications. This product is in layman terms a toolkit to build blockchain-based apps.

The API integrates BDLT functionalities from 9 to 10 different technologies and looks into new ones such as Corda, IBM Fabric, etc. It is therefore chain-agnostic and uses a modular approach but often links to private formats due to corporate consumer preferences. One of the key features remains the use of smart contract functionalities made available to API users.

The fundamental aim of the product is to anchor digitisation in organisations. In that sense, the change process management embedded in the servicing of SettleMint plays a crucial role in ensuring that digitisation does not take place in a superficial fashion but is fully embedded in the client's practice and corresponding cultural anchor.

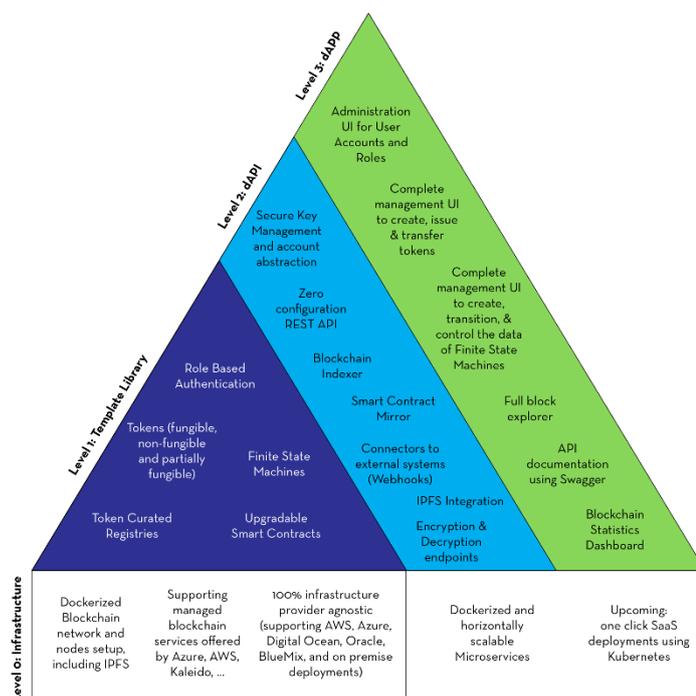
Mint can be technically summarised as the combination of three layers as illustrated below (see Figure 8):

⁷³ See <https://updates.settlemint.io/settlemint-awarded-proof-of-concept-for-blockchain-in-securities-services-5a5bb75f1912>

⁷⁴ See <https://settlemint.com/for-partners>

⁷⁵ See <https://settlemint.com/>

Figure 8: the 3-layer structure of Mint



Source: SettleMint⁷⁶

Mint is the core product of SettleMint but not the only one as the company sells solution in SAAS such as Mint for Supply Chain and Document Tracking, Mint for Asset Tokenization,⁷⁷ CertiMint⁷⁸, as well as a licensing options for more complex cases. Each is presented as a sub-component of the Mint product.

The company also targets specific sectors through Mint for Energy and Mint for Democracy⁷⁹. The goal being to empower its clients, SettleMint only provides “seed” support (for instance, a lead on the first case, less prominence in the development of the second, and a full independence left to the client in its app development from the 3rd case onward).

1. Effects and impacts

Deployment. SettleMint has been active across various sectors. It built for instance a case on a tokenised system of incentives to future energy purchases with Elia. Elia was the first to develop a financial mechanism (coupon/voucher) using SettleMint API. The company also contributed unlocking the potential of Proximus (Belgian telecom group) data monetisation with their corporate clients, an opportunity currently estimated at around \$85.000.000,00. Less relevant to

⁷⁶ Source: <https://settlemint.com/for-developers>, consulted on 03/08/2019

⁷⁷ Mint for Supply Chain and Document Tracking and Mint for Tokenization respectively allow for secured asset tracking and tokenisation.

⁷⁸ CertiMint offers a seal-based certification feature for BDLT applications connected to the Mint platform. See also <https://settlemint.com/solutions/certimint>

⁷⁹ See <https://settlemint.com/solutions/mint-for-energy> and <https://settlemint.com/solutions/mint-for-governance>

the core focus of the study but relevant to the structural impact of the technology, SettleMint supported the transparency control Indonesian elections in collaboration with Democracy Anchored, tokenising 25 million votes through nodes which were polling stations put on chain⁸⁰.

Given the scope of the present study the two most relevant cases remain Carrefour Belgium (supply chain, currently running live) and in particular the one of the Islamic Development Bank. The latter consisted in creating a sharia compliant subsidy distribution system for its 57 member countries (totalling 1.7 billion people). The diversity of instruments ranging from food stamps to cash made the distribution and controlling process difficult if not impossible. Using Mint and more specifically its Mint for Tokenization component, the Bank created a Social Cryptocurrency that led to savings estimated to nearly \$150.000.000,00 in addition to other forms of impact. This experience of subsidy tokenisation⁸¹ led SettleMint to a more recent business case on behalf of the Standard Chartered Bank Singapore⁸² to tokenise different types of securities.

Following Regional Government support from the Flemish VLAIO⁸³ agency, SettleMint was recently awarded a grant of €1.807.750,00 from the European Union⁸⁴ and is now expanding. It focuses on deploying the ease of use and pace of its product in connection with new market places to valorise its SAAS model.

Effects. SettleMint claims that “*Using Mint, implementation time and cost are typically reduced by 80%*”⁸⁵. Time-to-market has emerged as a key part of the company unique selling proposition, as commercialisation is ensured at a fraction of time and of the cost for Mint users. Examples shared with the authors show a full technical integration of features within hours.

“While internet brought ‘voice over IP’, the real revolution introduced by BDLT is enabling ‘trust over IP’”

—
Matthew Van Niekerk, CEO and Co-Founder, SettleMint

The payback period for the company is in consequence short (from 3 to 11 months) and positive impacts over clients are usually observed within a year. Among the benefits specific to the capital

⁸⁰ See <https://settlemint.com/settlemint/2019/05/22/how-blockchain-can-be-valuable-for-democracies-but-not-by-replacing-paper-voting/>

⁸¹ See also <https://settlemint.com/project/2017/10/15/settlemint-to-create-sharia-compliant-financial-products-for-the-isdb-member-countries/>

⁸² See <https://updates.settlemint.io/settlemint-awarded-proof-of-concept-for-blockchain-in-securities-services-5a5bb75f1912>

⁸³ See <https://datanews.knack.be/ict/nieuws/settlemint-haalt-1-5-miljoen-binnen-bij-vlaio/article-news-1466075.html> <https://settlemint.com/settlemint/2019/05/15/settlemint-awarded-1-591-million-r-d-grant-from-vlaio/>

⁸⁴ Horizon 2020 SME Instrument Phase 2 which is currently being merged into the European Innovation Council (see <https://settlemint.com/settlemint/2019/03/26/settlemint-awarded-1-8-million-from-horizon-2020-instrument-grant/> and <https://ec.europa.eu/research/eic/index.cfm>)

⁸⁵ Source: <https://settlemint.com/settlemint/2019/03/26/settlemint-awarded-1-8-million-from-horizon-2020-instrument-grant/>, consulted on 03/08/2019

markets are the efficiencies created from removing intermediaries and back-office needs. For some asset classes it comes down to impacts over the reserve ratios associated to financial products: as the technology offers a trusted environment for block transactions, risks of non-delivery are marginalised.

As a result, the company generated turnover right from the first year and tripled its outcome on the second year. It doubled it again in 2019.

1. Critical factors

Besides cryptocurrency and the successful launch of initiatives such as ICOs and STOs the financial sector remains seen as a late runner in BDLT (compared to various adoptions in supply chain for instance – including agri-food traceability). The financial sector remains its slower adopter, with a major share of the applications showcased that remain at a POC (proof of concept) stage without entering production or running live. The key driver at the source of efforts in the direction of further blockchain deployment remain automation and efficiency gains. This echoes the experience of a key decision-maker in the company who was confronted to a previous employer (bank) that did not follow through with internal BDLT R&D requests.

In addition to this challenge is the one of information asymmetries. The general knowledge of BDLT and its potential but also limitations remains limited. Technology is thus not seen as challenging as some other business-specific aspects. The information challenge makes the communication with new clients more difficult.

Funding and financing also proved to be a challenge for the company which had to seek public funding to support the fulfilment of its vision and the acceleration of its journey.

Another aspect is the one of interoperability across platforms and systems which might hamper the development of the sector.

Regulation is also a key factor. Although no specifics were pointed by the company, the need for an increased openness to technology companies in the financial sector was stressed, referring to the issue of confidence in incumbents.

6.3 Deploying BDLT to the Financial Sector

Case 4- Deployment of Smart Valor (CH) – Market Deployment July 2019



1. Pain points and challenges addressed

The investment process is usually hampered by heavy book-keeping requirements and regulatory compliance. In the capital market a lot of hurdles face companies opening their shares, such as the difficulty to access credit from financial institutions. Intermediation in that respect adds layers of and time and costs⁸⁶, involving intermediaries such as banks (incl. custodian banks), central registries, clearing and settlement houses, the exchange and the companies at stake. Intermediaries charge fees and imply execution delays due to settlement procedures.

Tokenising securities such as equity would allow for more flexible fund raising and a possible increase in liquidity. It would open the possibility of lowering these costs and instant settlement. The process of tokenising equity consists in associating shares to a virtual token. The shares thus come in the form of tokens that can be broken down into several parts if needed. It would also make investments more liquid with the possibility of fractional ownership. The crypto-asset market cap does not even compare to the real assets market which is hundreds to thousands of times larger depending on the market (listed equity, commodities, real estate or derivatives). Putting securities on chain could therefore have important impacts over the financial sector.

The use of tokens would also enable current financial investors not able or struggling to access <\$5.000.000,00 issuers across borders. The possibility for strengthened analytical capabilities together with the global infrastructural dimension of tokenising securities and the onboarding pace thus open an opportunity for the financial intermediaries themselves.

Despite of its potential and while security tokens were subject to a great deal of attention in 2019, no compliant global exchange existed for initial listing and secondary trading of security tokens.

2. Solution and underlying drivers

Company trajectory. Founded by Olga Feldmeier in 2017, Smart Valor deployed in July 2019 to address this challenge and propose a single trading venue for offerors to list their security tokens and purchasers to pursue them legally. Its priority niche is the one of progressive and affluent investors with \$500.000,00 to \$5.000.000,00 net liquid assets.

Smart Valor is headquartered in the Zug “*crypto-valley*”⁸⁷ in Switzerland where it is hosted by the Thomson Reuters incubator. It has offices in Vaduz, Munich, Hong Kong and Seoul. It built

⁸⁶ See also <https://blogs.worldbank.org/allaboutfinance/benchmarking-costs-financial-intermediation-around-world>

⁸⁷ See <https://www.businessinsider.com/what-its-like-in-zug-switzerlands-crypto-valley-2018-6?r=US&IR=T>

a compliant exchange in 12 months and aims to roll-out from payment and utility tokens to security tokens: it first received the financial intermediary license in Switzerland, and set its crypto-fiat exchange in Liechtenstein in 2018; and in 2019 obtained the Swiss FinTech license before unlocking an e-money license and the Multilateral Trading Facility (stock exchange license) status in Liechtenstein.

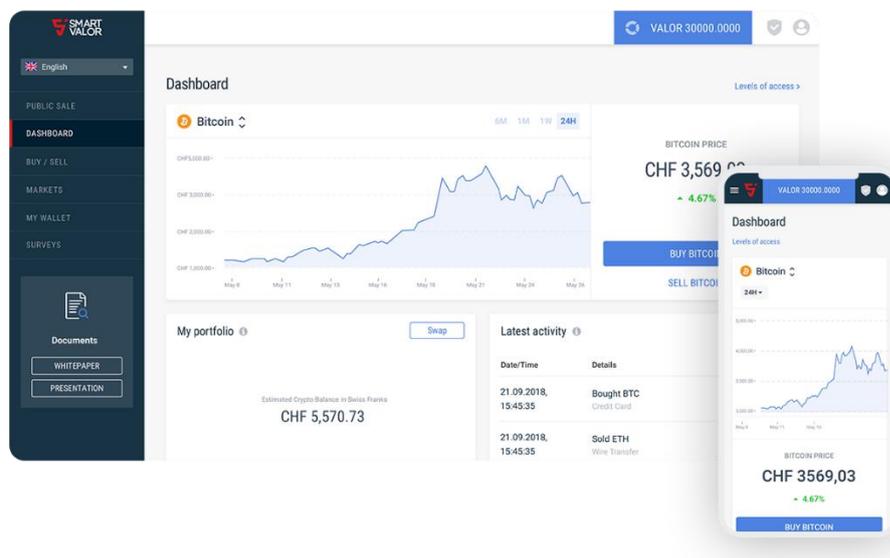
It currently employs 35 tech (cryptography, software...) and financial (banking, regulation...) professionals. Following its main expansion across Europe, its main ambition is to implement its roll-out to 10 key countries. The company also organises the CRYPTO SUMMIT in Switzerland (of which the third edition was the largest BDLT conference in the country).

Application. Smart Valor consists in a security token exchange for alternative investment. Smart Valor securitises and distributes digital assets such as company shares, venture capital funds, real estate development projects, etc. and offers an exchange, a protocol and a vault. It uses consortium and public blockchain for its marketplace.

The exchange is compliant with Swiss and Liechtenstein regulations. Investors are on-boarded according to Swiss KYC and AML regulation and security, utility or payment tokens are written over smart contracts audited by Smart Valor before primary or secondary listing on the exchange. Investors use their wallets and receive advice for optimal timing and exposure to digital assets. Smart Valor also buys and sells large amounts of cryptocurrencies and advises STOs.

Figure 9 illustrates the application in use:

Figure 9: Smart Valor seen by its users



Source: Smart Valor⁸⁸

Besides the decentralised record structure and instant settlement, Smart Valor offers programmable securities based on smart contract functionalities (allowing for pre-programmed/conditional payment structures and execution). It also allows for cryptocurrency trading as well as vetted utility tokens. Issuers access liquidity and benefit from frictionless

⁸⁸ See <https://smartvalor.com/en/valor-platform>

onboarding and accreditation from investors globally. Investors can invest, sell, buy or auction security tokens with the possibility with no need of further security (custody by Smart Valor).

3. *Deployment*

Smart Valor triggered a lot of traction in the media with numerous media and business references. It ranked among Forbes' top-10 most exciting tech European SMEs for 2018, a Bobsguide.com's "The eight blockchain companies to watch out for in 2018", and received various awards. It issued the first CHF-backed stable coin and recently partnered with SpaceFund for the tokenisation of the CV fund for space technologies and its distribution beyond US borders.

The full version of the exchange went live in July 2019 and is now taking off: Summer deployment of Smart Valor was successful with 10.000 registrations from more than 140 countries. Transactions are taking place and they grow together with the number of returning customers. Reaching scale is thus the next horizon for Smart Valor.

Its recent deployment (going live online with the crypto-to-crypto part before scaling up to crypto-to-fiat) was followed by a new round of achievement with new users to top up its basis of 3.000 users. Smart Valor received additional backing from Venture Incubator and other international investors such as Tally Capital who recently contributed CHF3.200.000,00⁸⁹. It is estimated to work at an annual \$3.000.000,00 turnover⁹⁰.

4. *Critical factors*

The onboarding process with association of currency accounts of financial intermediaries and appropriate due diligence steps were successfully completed. Adjustments had to be made in the tokenisation approach to better comply with dividend expectations as set by the companies. The company organised its fund raising and was in that respect listed in token exchanges such as in Kore, with 2 (equity backed) ICO rounds announced for 2020.

The role of regulation was however critical to Smart Valor deployment along its deployment path and was felt as the major hurdle. This links to the decentralisation of data, while regulation was built around a centralised system where clearance was organised in organisations separate from the core financial entities.

A crypto- exchange requires three types of licences encompassing exchange, custody, as well as clearing and settlement. Three companies should be created to cover the all three ranges of activities, while in countries such as Liechtenstein and Switzerland there is a possibility to apply for a single license.

However, despite its location in two of the most BDLT-friendly regulatory environments (Switzerland and Liechtenstein), compliance costs were a key entry barrier to Smart Valor and have been tremendous for the start-up. The company does not have hundreds of human resources like other financial intermediaries. They related to legal and auditing costs ranging from the licensing procedure to the very AML compliance of Smart Valor. A same exchange was set up with two different venues and licencing proved time-consuming and resource intensive.

⁸⁹ Source: Smart Valor, 2019

⁹⁰ Source: <https://www.crunchbase.com/organization/smart-valor>

Besides the regulatory challenge, the volatility of investment patterns linked to the hype and crypto-currency variations shows a great deal of sensitivity of the financial BDLT area to the cryptocurrency world. While the first investment round was fast and straight-forward, bringing more strength did not help with the struggle of the company to go for the next round. The major confusion with Bitcoin prices proved to be a hampering factor in that respect. This trend was even felt in the submission of job applicants – which followed bitcoin value curves.

This information asymmetry also concerns new entrants such as financial stakeholders who step out of their comfort zone. Partner search in the new space of financial BDLT and tokenised securities proved to be more challenging, with the necessity to open classical financial intermediaries to the possibility of opening a bank account on the basis of such business model, etc.

“Regulation is important, right regulation is even more important: regulators’ duty is to look into the technology to make sure we can draw the economic and social benefits from BDLT”

—
Ivan Anastassov, Head of Investor Relation, Smart Valor

Case 5- Deployment of Smart Valor (CH) – Market Deployment July 2019



1. Pain points and challenges addressed

Current book-keeping practices (including ordering, invoicing, etc.) find their roots in the medieval age. Recent digitisation trends aimed at limiting paper-based financial interactions led to efficiency gains and faster processes. Still, the annual Visa study found that “*at any given time, approximately USD 20 Trillion of payments owed are locked up due to lengthy and often unfair payment terms*” (Centrifuge, 2019).

The administrative supply chain processes thus still take time and impose burdens over stakeholders⁹¹. Company accounting systems are usually working in silos, each company working with its own tools or using solutions that do not always fit the ones used by other entities in their supply chain, network etc.

⁹¹ See <https://medium.com/centrifuge/https-medium-com-centrifuge-how-to-design-a-token-for-a-functioning-economy-a3e3aec932c0>

Part of the solution lies in non-fungible tokens (NFT) which are tokens that remain immutable⁹². They are associated to real assets which cannot be transformed and as such remain unique, such as contractual documents, invoices, etc.

2. *Solution and underlying drivers*

Company trajectory. Centrifuge was created in 2017 by serial ICT entrepreneurs⁹³ and is meant to improve “*access to affordable financing and liquidity*” (Centrifuge, 2019). It made its protocol paper public and has an open approach to BDLT⁹⁴. The latest version of the Centrifuge White Paper indicates the release strategy underlying the corporate approach which is not meant to control the network but to fully decentralise it in view to become one of its key service providers:

“While the initial development is supported by Centrifuge, the company, the network is not governed, deployed, or operated by this company. The network and Centrifuge OS at large are designed and released to be a decentralized platform from day one. The duty of Centrifuge, the company, is to build a reference implementation of Centrifuge OS components, support the initial launch, and assist OS users with their onboarding”. (Centrifuge, 2019)

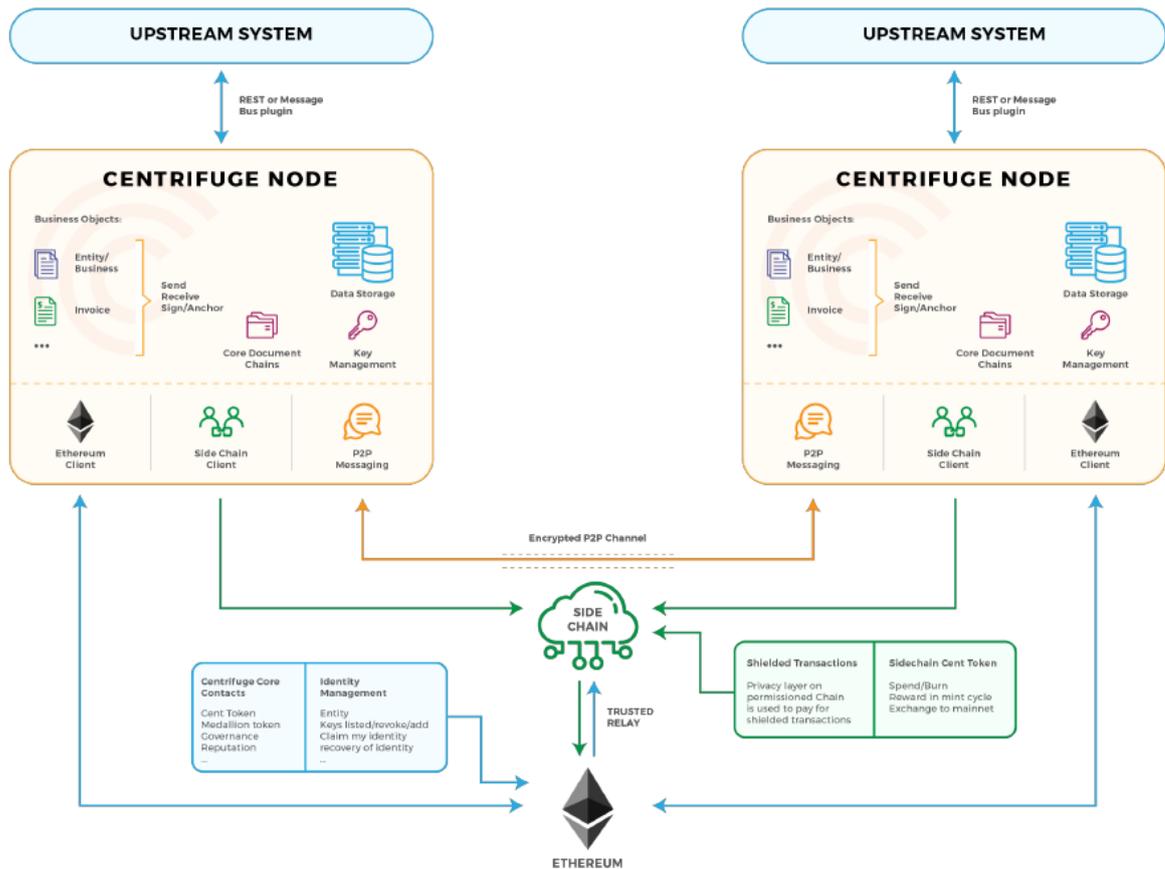
Application. Centrifuge is a decentralised Operating System (OS) for the financial supply chain. It covers both protocol and network layers and aims to support the creation of applications, providing the infrastructure for exchanging financial documents used along the supply chain to support payments, orders, etc. Figure 10 illustrates the core functioning of Centrifuge:

⁹² See <https://medium.com/centrifuge/introducing-business-nfts-financial-business-documents-as-tokens-on-decentralized-networks-ec4b773f7ec5>

⁹³ Who previously built “*Taulia, which transacts with over 1.5 million suppliers from 164 countries and has provided over \$100 billion of liquidity and early payments to SMBs. To fund that endeavour, over 8 years they raised \$150 million from top tier VCs*” (source: <https://www.mosaicventures.com/mosaicblog/2018/3/5/why-we-invested-in-centrifuge-and-a-short-love-letter-to-crypto-in-berlin->)

⁹⁴ See <https://medium.com/centrifuge/the-centrifuge-protocol-the-inner-workings-4fcbc9f7aa2f>

Figure 10: Centrifuge OS Components



Source: Centrifuge, 2019

Centrifuge is based on a public blockchain (Ethereum⁹⁵) for the notarization of official documents transformed into non-fungible tokens. It aims to cover the full purchase-to-pay and order-to-cash process cycles as well as their respective administrative underpinnings.

The company anchored the non-fungibility of its token in a system of “single source of truth” and allows for interoperability between organisations and networks. It leaves the ownership of data to the users and offers transparent, censorship-resistant and long-term verifiability features for the documents put on chain when tokenised.

While contracts are deployed on chain, Centrifuge Nodes store all master and transactional data and exchange it only with other authorized Centrifuge Nodes in Centrifuge’s private P2P (peer-to-peer) network. Centrifuge is also creating its own blockchain, the Centrifuge Chain, which will be public and attached to Ethereum and other major public infrastructure blockchains. The Centrifuge Chain will offer scalability, far cheaper transaction fees and interoperability with other blockchains than Ethereum (Centrifuge, 2019).

3. Deployment

⁹⁵ See <https://medium.com/centrifuge/why-we-launch-the-centrifuge-crypto-network-without-a-token-for-now-90319906ae1>

The revenue generation model of the company is still developing around the possible network effects within a decentralized blockchain operated ecosystem. The long-term goal is the issuance of a Centrifuge network token, which is required to participate, collaborate and govern the Centrifuge network. Centrifuge will gain from an appreciating token price as well as from network fees. Centrifuge received a seed investment of \$3.800.000,00 in 2018⁹⁶ mainly from 2 strategic investors, and could add a convertible note \$3.700.000,00 in 2019 mainly from an additional strategic investor. Centrifuge established close collaborations with companies such as Elemica⁹⁷, a specialist of supply chain digitisation, or the financial services experts Hokodo⁹⁸ and Avvaneo⁹⁹. The partner network is expanding and new use cases are explored. Centrifuge just reported its first live transactions with partners.¹⁰⁰

4. *Critical factors*

The platform itself is constantly being tested to improve among other things its User Interface (UI) and User Experience (UX) as well as the speed of transactions. The key remains the business-oriented nature of the technological development which should address large, medium and small businesses' challenges and opportunities.

“It is quite important that closed and permissioned networks are at a decent and acceptable first step but they are not a solution for the problems we face today”

—
Maex Ament, CEO, Centrifuge

If regulation is not a challenge for the protocolling activities of the company, it could become a hurdle for some user groups subject to regulatory constraints (such as in the banking industry, insurance and so on – for instance, what are the legal implications of tokenising a mortgage? Etc.). Regulation could thus prove a hampering factor to BDLT deployment to new Centrifuge clients and new adopters.

The key challenge faced by Centrifuge is the prioritisation and locking in of key lead users to ensure corporate traction. “Multipliers” are sought (source: Centrifuge, 16/05/2019). As the company deploys a business-oriented approach (aiming to fix business challenges rather than pushing a demand-less technology), the role of business users to orient the first monetisation waves of the OS is key.

⁹⁶ See <https://www.eu-startups.com/2018/03/berlin-and-san-francisco-based-blockchain-startup-centrifuge-raises-3-8-million-to-build-the-operating-system-for-global-commerce/>

⁹⁷ See <https://medium.com/centrifuge/centrifuge-partners-with-elemica-to-enable-digital-finance-on-an-open-protocol-48203431b1a1>

⁹⁸ See <https://medium.com/centrifuge/hokodo-and-centrifuge-announce-partnership-to-build-first-decentralized-trade-insurance-e1da1dbbe92c>

⁹⁹ <https://medium.com/centrifuge/connecting-blockchain-with-financial-process-automation-155115822d2a>

¹⁰⁰ <https://medium.com/centrifuge/centrifuges-tinlake-goes-live-with-the-financing-of-more-than-usd180k-2cc6ce176a1b>

8. Concluding Remarks

BDLT deployment beyond cryptocurrency and Initial Coin Offerings is still at an early stage. This report shows that BDLT covers a disruptive but unfulfilled potential for the financial sector. It however also shows that following up on a long series of proof-of-concepts, the technology is now being deployed through multiple applications ranging from commodity trading to alternative (tokenized) investments, showing a great deal of promise.

7.1 Still at an early stage, non-crypto BDLT's are now Deploying

The early stage of BDLT deployment makes it difficult to assess real impacts. Despite the perceptions established by cryptocurrencies, the broader financial sector does not prove to be a fast adopter of BDLT. Based on expert views and insights from deployed or deploying use cases, this study estimates that BDLT will decrease the costs and increase the frequency of transactions, resulting in a cumulative market growth of all financial segments. Automation through smart contracts and disintermediation effects resulting in efficiency gains appear to drive this trend. Qualitative analyses show clear impacts in terms of revenue generation but also efficiency along the targeted value chains. The predominance of pilots links to the remaining “hype”, with variations in investment patterns that rather seem linked to the fluctuation of cryptocurrencies.

7.2 BDLT show Strong Impact Prospects for the Financial Sector and Beyond

Broader effects at the sector level are still unclear due to the early stage of deployment of the technology. Cases such as Komgo however suggest critical impacts (such as 30-40% cashflow gains along the all supply chain) that show promising upscale potential. Start-up valuations also show the increase in corporate value of BDLT players in the financial sector. Central and Eastern European countries face a window of opportunity in that context as suggested in Box 5 below.

Box 5: A Window of Opportunity for Eastern European Countries

Europe does not appear to be in a lead position in the area of BDLT for the financial sector. BDLT however constitute an opportunity for Central and Eastern European countries as per both our quantitative and qualitative analyses. Such opportunity is linked to the less strong financial structures in these countries.

In addition, new solutions enter the financial sector such as (fractional) micropayments and tokenised equity which offer an unprecedented disruption opportunity to liquify assets in the global market. Energy consumption reductions and resulting environmental gains also seem to emerge from several technological groups, although such gains are rather marginal compared to economic ones. New trends are developing which suggest that areas such as Security Token Offerings (STO), supply chain management (including in agri-food), healthcare and gaming will be among key domains for BDLT take-off.

7.3 Uptake Hampered by Critical Factors

While the drivers of BDLT deployment in the financial sector are largely linked to cost and time efficiency gains, the technology as such does not seem to be perceived as the key challenge. The usual reference to scalability is seen rather as a temporary hurdle for which multiple solutions are developed by the industry. On the other hand, interoperability is perceived to be a potential critical factor in the future as many standards are currently deploying and connections across platforms will become necessary.

Besides the obstacles and barriers identified herein, the empirical analyses explored the predominance of key barriers for market deployment. These are not exhaustive but highlight some of the current factors impacting the commercialisation of BDLT solutions in the financial sector. Regulation typically comes first to mind as illustrated in Box 6 below.

Box 6: Regulatory hurdles: a system shaped around centralisation

Multiple regulatory frameworks apply to financial BDLT applications in specific sectors, from Know Your Customer (KYC) and Customer Due Diligence (CDD) to Anti-Money Laundering (AML) and Combating the Financing of Terrorism (CFT). The function of each BDLT application will usually define whether or not the company should be considered liable (and therefore in need of regulatory compliance) or not. Countries such as Liechtenstein, Luxemburg, Malta or Switzerland are often seen as being ahead compared to others. But while the regulation itself is perceived as a barrier, the compliance process is the real hurdle for BDLT companies which are often start-ups for which handling time (delays) and costs of regulatory compliance often creates a great deal of difficulties.

Still, other obstacles arise which are less linked to operational risks, regulation or technological features but rather to information asymmetries. For instance, this report shows that different types of information asymmetries can be observed, such as the lack of clear and streamlined information with respect to BDLT on the user side (linked to the overflow of information of all kinds, making decision making of possible adopters difficult); or the confusion between BDLT and cryptocurrencies. The latter in particular is illustrated by the case studies which clearly highlight an alignment between attitudes toward BDLT applications and cryptocurrency values and their fluctuation¹⁰¹.

The culture of organisations with respect to BDLT testing and adoption also remains a challenge very much linked to the unwillingness to migrate to other formats or structures. Large corporations are however actively taking BDLT onboard (Axel Springer, Carrefour, etc.). This is a critical factor as all technological champions are putting efforts in raising their volume of lead-users to reach a critical mass that makes their revenue model sustainable and creates the necessary traction for their success.

Such challenge comes on top of other business-specific challenges which can be related to the access to resources – whether finance or talents.

¹⁰¹ The volatility of bitcoin has affected private sector perceptions of BDLT applications in a negative way, leading to an alignment of the BDLT investment climate with hype and negative downs of cryptocurrency valuations.

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