Distributed ledger technology for securities clearing and settlement: benefits, risks, and regulatory implications.

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Abstract

This article outlines the benefits and risks of the distributed ledger technology (DLT) for the clearing and settlement phase of the trade life cycle and describes its potential role for central counterparties and central securities depositories. Although the industry is attempting to solve the technological and operational issues that DLT systems still face, such as the harmonization of technical standards, outstanding legal risks are such that the financial industry is asking for regulatory guidance and intervention. This article wants to contribute to the debate whether to regulate DLT by first presenting potential regulatory barriers that may have to be removed for this technology to be fully adopted and then identifying areas requiring an update of the legal framework in order to address certain prudential and conduct risks that this technology could introduce.

Keywords: Distributed ledger technology, blockchain, clearing, settlement, and financial regulation.

JEL: E44, G15, G18, G21, K22

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Introduction

Distributed ledger technology (DLT), of which the blockchain technology[1] is the best known example, has attracted significant interest from the financial industry. DLT gained notoriety by being used for the trading of cryptocurrencies, such as Bitcoins, which are issued and validated by the system users rather than by a central authority. Since the deployment of virtual currencies, the financial industry has been investigating whether this technology can be applied to securities markets in order to create a more efficient market, compared to the usage of ledgers based on classical double-entry bookkeeping.

According to Goldman Sachs (2016), DLT could reduce transaction costs of insurance underwritings by $2-4 billion in the USA alone and the costs related to securities clearing and settlement would decrease by $11-12 billion. An analysis of Banco Santander, Oliver Wyman, and Anthemis Group (2015) suggests that DLT could reduce banks' infrastructure costs attributable to cross-border payments and trading of securities by $15-$20 billion. The World Economic Forum (2015) even estimates that by 2027, up to 10% of the value of the global GDP will be stored on blockchains.

Although financial institutions have yet to demonstrate that DLT is a viable and sustainable solution to cover the complete securities trade life cycle, they developed several proofs of concept in particular niches of the trading and post-trading ecosystem. A non-exhaustive list of examples: the Australian Stock Exchange cooperated with Digital Assets to use DLT for the clearing and settlement of equity transactions (McDowell 2017); Nasdaq and SEB constructed a mutual fund trading platform based on the blockchain technology (Parsons 2017); The French

[1] The terms 'blockchain and 'distributed ledger' are often used interchangeably by business practitioners. Blockchain technology can be described as the process of adding blocks of cryptographically signed data yielding immutable records, while distributed legers are databases where several users collaborate to reach a consensus on the correct state of the data. Not all distributed ledgers use blocks, while most blockchains use a consensus mechanism (see Euroclear and Oliver Wyman 2016).

CSD 'ID2S' will apply the blockchain technology to issue French commercial paper as of 2019; the Canadian Securities Exchange developed a DLT securities clearing and settlement platform to allow companies to issue equity and fixed income securities via security token offerings (McDowell 2018).

The large number of proofs of concept illustrates the broadly accepted view of the financial industry that this technology could yield a large number of benefits (see infra)[2]. Yet, there is widespread belief in the industry that the operationalization of DLT is going to be a gradual step-by-step evolution rather than a big bang revolution. According to the German Banking Industry Committee (2016), DLT and legacy systems are likely to exist in parallel for the next 20 to 30 years, with a gradual adaptation of the technology. DLT is still suffering from various internal and external barriers, such as the complexity of a transition from legacy systems to DLT-based systems, negative public perception issues linked to cryptocurrencies, inertia in the mainstream adoption of the technology, and unclear government regulation (Swan, 2015; Mainelli and Milne 2016; Goldman Sachs 2016). The latter will be the main focus of this article.

Regulatory developments

Over the last few years, the financial industry has advocated more regulatory guidance (e.g. ECSDA 2017), and/or an update of the legal framework, for providers or users of DLT (e.g. Goldman Sachs 2016; German Banking Industry Committee 2016; Polish Bank Association 2016; Caceis 2016). According to the German Banking Industry Committee (2016), DLT systems work in a fundamentally different way compared to legacy systems and thus a different regulatory approach is needed. Existing regulations reflect a conceptualization of what financial markets currently look like, and at the time the requirements were drafted, legislators could not

[2] As there is not a single harmonized solution in place and there are currently a variety of different DLT systems being explored, all the arguments included in this article might not necessarily be generalizable to every developed DLT system.

have foreseen that DLT could become important for financial markets. This view has been confirmed in 2017 by the Bank for International Settlements (BIS), stating that new legal and liability frameworks are needed to make sure that the legal underpinnings of DLT arrangements are sound, that their governance is robust, and that appropriate data controls are in place.

Several regulatory initiatives have been launched to examine the potential influence of DLT on the (post-) trade ecosystem and to assess the need for new financial regulations or a modification of existing ones. For instance, the European Central Bank's Target2-Securities (T2S) Harmonization Steering Group decided in August 2016 to create a task force on DLT to assess the impact of this technology on post-trading and European financial market integration. Shortly after the launch of T2S, in February 2017, the BIS published an analytical framework, with key questions for the industry on the use of DLT in payments, clearing, and settlement. The document intends to facilitate central banks and markets authorities to detect the opportunities and risks of DLT arrangements in their conceptual, experimental or implementation phase. Yet, the BIS framework does not include principles that the industry should adhere to.

At the same time, the European Securities Markets Authority (ESMA) published a report outlining its views on DLT when applied to financial markets. The report discusses the potential risks and benefits of DLT under several scenarios and reflects on the potential interaction with existing EU rules. ESMA's position is that regulatory action would be premature at present, because the technology is still evolving and the number of practical applications is limited. Yet, ESMA acknowledges that certain concepts or principles, such as the legal certainty attached to DLT records and settlement finality (see infra), may require more clarification.

In April 2017, the European Central Bank confirmed that it considered the blockchain technology as not mature enough for an inclusion in the Eurosystem's financial market infrastructure but that it would closely follow its evolution. Together with the Bank of Japan, the ECB has already developed several DLT prototypes for the exchange of securities against cash.

In July 2017, the European Commission launched a European expertise hub on blockchain technology. This expertise hub started a study to examine the feasibility of a EU blockchain infrastructure and will also reflect on the conditions needed to achieve an open, trustworthy, transparent, and EU law-compliant data and transactional environment (European Commission 2017). The European Commission's Joint Research Center, together with the Directorate-General for Internal Market, industry, entrepreneurship, and SMEs, also launched the #Blockchain4EU project to develop industrial use cases for blockchain and DLT.

In July 2018, the Financial Stability Board developed a framework and identified metrics to monitor financial stability implication of crypto assets (FSB 2018), while the securities and markets stakeholder group provided in October 2018 an advice to ESMA on initial coin offerings and crypto assets where the key request is for ESMA to provide level 3 guidelines or to aim at supervisory convergence on whether crypto assets can be considered as transferable securities under MiFID II. Hence, European legislators are examining whether virtual securities can legally be considered as securities.

On a national level, the UK's Financial Conduct Authority (FCA), launched a discussion paper on DLT in April 2017 stating that it will maintain a technology-neutral approach to regulation. The FCA considers its rules flexible enough to accommodate the use of DLT by regulated firms and has thus not yet proposed any changes (FCA 2017). Similar to the regulators from Singapore and Australia, the FCA did launch a regulatory sandbox, which allows firms to test in a monitored environment innovative products, services, and business models. This sandbox allows the FCA to closely monitor DLT-related market developments in order to be prepared to review its rules if specific developments would require so.

Certain regulators, like the Australian Securities and Investment Commission (ASIC) and the Financial Services and Markets Authority (FSMA) of Belgium via its FinTech Portal, preferred to launch innovation hubs. These hubs allow to have discussions with the industry and provide support and guidance to (regulated and unregulated) firms navigating the regulatory framework.

It is clear from these initiatives that regulators are monitoring the rapid development of DLT to identify any need for regulatory action. Nevertheless, reflections on the usage of DLT for securities transactions are still in their infancy – currently at the level of whether virtual securities should legally be considered as securities – and there are currently very few federal US or EU regulations applicable to the institutions providing or using this technology.[3] The large majority of legislators are of the opinion that it is too early to draft hard law because it could be an impediment to innovation and because it is still insufficiently clear whether any specific DLT solution will be widely adopted in the securities markets.

Significance of the article

Although the current academic literature on virtual currencies, blockchains, and DLT has increased substantially over the last few years, there are only a handful of published articles on the specific impact of this technology for securities markets. They mainly focus on the technical underpinnings of the technology, its applications, and/or (dis)advantages (see e.g. Caytas 2016;

[3] For virtual currencies, regulators, such as the New York State Department of Financial Services, have issued regulations defining and regulating virtual currency business activity. For securities transactions, France is the only country to date in Europe with legislation in place allowing the use of blockchains. Yet, the law is applicable only to unlisted securities, including fund units, unlisted shares and bonds, and negotiable debt securities.

Pinna and Ruttenberg 2016; Mainelli and Milne 2016; Micheler and Von der Heyde 2016; Klimos 2018). Scholars have not yet devoted much attention to the regulatory aspects, and literature on regulatory implications of DLT applied to clearing and settlement is rare[4].

This article first describes the current custody and post-trading landscape without the usage of DLT and compares it to a possible DLT post-trade system. It pinpoints the benefits and risks that this technology might bring when applied to the clearing and settlement phase of the trade life cycle. In addition, it discusses the future role for central counterparties and central securities depositories. The article then presents potential regulatory barriers to a full adoption of DLT, and identifies areas requiring an update of the legal framework. Although legislators might think that it is premature to regulate providers and/or users of this technology, a reflection on this matter is worthwhile. When this technology fully materializes, it will introduce risks that could have to be addressed by legal action. A timely reflection on these risks and requirements may speed up the regulatory process when it is due.

This article often refers to Anglo-Saxon legislation but is more targeted at the European landscape. The main reason is that the USA has only a handful of central counterparties and a single central securities depository, while the European market is fragmented and diverse. Yet, numerous insights and conclusions can be generalized to non-EU settings, given that European regulations applicable to market infrastructures are based on international guidelines, such as the CPMI-IOSCO Principles for Financial Market Infrastructures. This topic is also important to non-European countries, given that non-European investors - especially credit institutions

[4] This article focuses on the post-trading landscape (i.e. clearing and settlement), given that the financial industry recognizes the role that this technology might have on these activities. Also, it is not sufficiently clear whether DLT would have a large impact on the trading of securities. According to some industry participants, such as Goldman Sachs (2016) and Euroclear and Oliver Wyman (2017), trading venues or other trading facilities are likely to be less affected as participants of these infrastructures still need to find counterparties, which is not going to change when using DLT.

located in the USA - are often participants of European central securities depositories or clearing members of central counterparties.

Clearing and settlement without DLT

Before this article discusses the potential impact of DLT on the custody holding chain and trading life cycle, it first explains how these currently work without DLT[5].

The custody holding chain explained

Figure 1 shows the custody holding chain and shows eight examples of different relationships between end investors, funds, and participants of a CSD.[6]

Example 1 of this figure displays a direct holding system[7]. Examples 2, 3, 4, and 5 then illustrate indirect holding systems, whereby the clients of an issuer CSD are not always local participants, like domestic credit institutions or investments firms, but can also be global custodians, investor CSDs, or depository banks. As documented by Priem (2018a), investors have no direct relationship with the CSD in these indirect holding systems: they have established relationships with the clients of the CSD that provide safekeeping and

[5] The holding chain and trading life cycle, thereby focusing on the securities leg of the transaction rather than the cash leg, are explained in a simplified manner merely to pinpoint the benefits and risks that DLT could introduce. For a detailed explanation on the functioning of trading venues, CCPs, and CSDs, see e.g. Loader (2013), Priem (2018a), and Priem (2018b). The graph displayed in this paper is a simplified representation as in reality, the trading flow can be different based on whether e.g. a) the trade takes place over-the-counter or on an exchange, b) the members of the CCP are also CSD participants or not, c) the CSD settles in commercial or in central bank money, e) the trade is a cross-border transaction where the participants have accounts in distinct CSDs, and f) the client of the CSD is a global custodian acting as an account provider for the indirect client of the CSD or not.

[6] CSDs offer services for securities to be accurately issued and settled, being a) the exploitation of securities settlement systems, b) the initial book entry registration of securities on securities accounts, and c) the provision and maintenance of securities accounts at top tier level.

[7] Direct holding systems are currently applied in certain Scandinavian domestic markets, and entails a system where each ultimate investor has a securities account at the CSD.

administrative services related to the holding and transfer of financial instruments on behalf of their customers.

Examples 5 to 8 display CSD links, where one CSD – the investor CSD – becomes the client in the securities settlement system of another CSD, which can be another investor CSD or the issuer CSD. In Europe, with one local CSD per country, CSD links are used by market actors active in different Member States. Without such CSD links, they would have to become a participant of every domestic CSD, which would be costly.

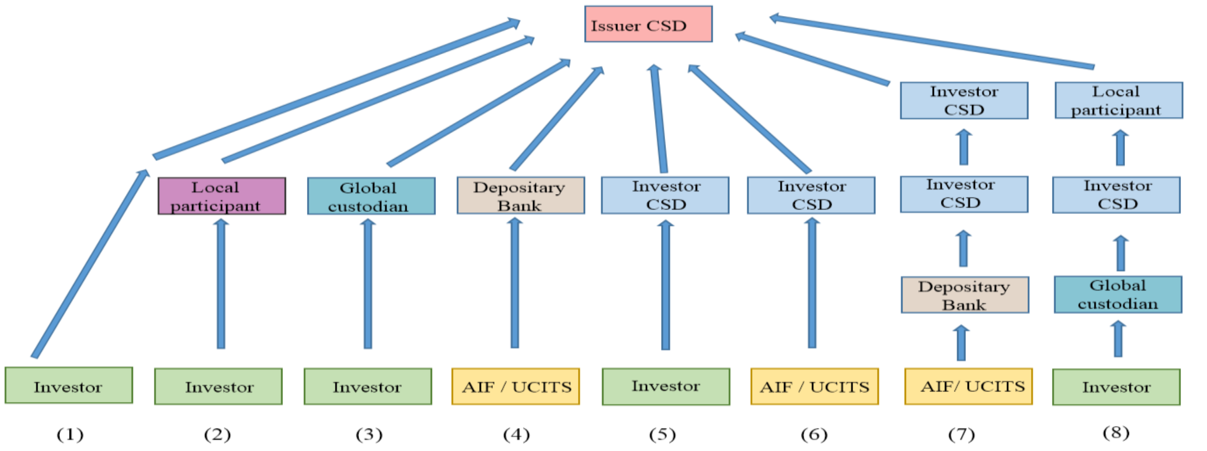

Fig. 1. The holding chain: eight examples of different relationships between end investors or funds, participants (i.e. local participants, global custodians, depository banks, and investor CSDs), and issuer CSDs. Source: Priem (2018a)

The trade life cycle

When securities are transferred from one investor to another, the trade life cycle kicks in. Figure 2 is a simplified representation of the security leg of the trade life cycle. Trading, clearing, and settlement currently take place in multiple sequential steps.

In the trade execution phase, a buy side and a sell side client/investor, acting through their respective brokers, seek to buy and sell financial instruments to each other on a trading venue[8], which serves as a meeting point for all buyers and sellers.

[8] E.g. a regulated exchange, a multilateral trading facility (MTF) or an organized trading facility (OTF).

When the trade is executed and the clearing phase starts, the sell instruction and buy instruction are forwarded to the central counterparty (CCP). A novation takes place, whereby the CCP acts as a buyer to the seller and a seller to the buyer. The clearing members, being the direct clients of the CCP acting on behalf of the buy side and sell side clients, post collateral to the CCP to mitigate the latter's credit and counterparty risk. They will need to post (or collect) collateral in function of the financial instruments' value changes until the instruments finally mature.

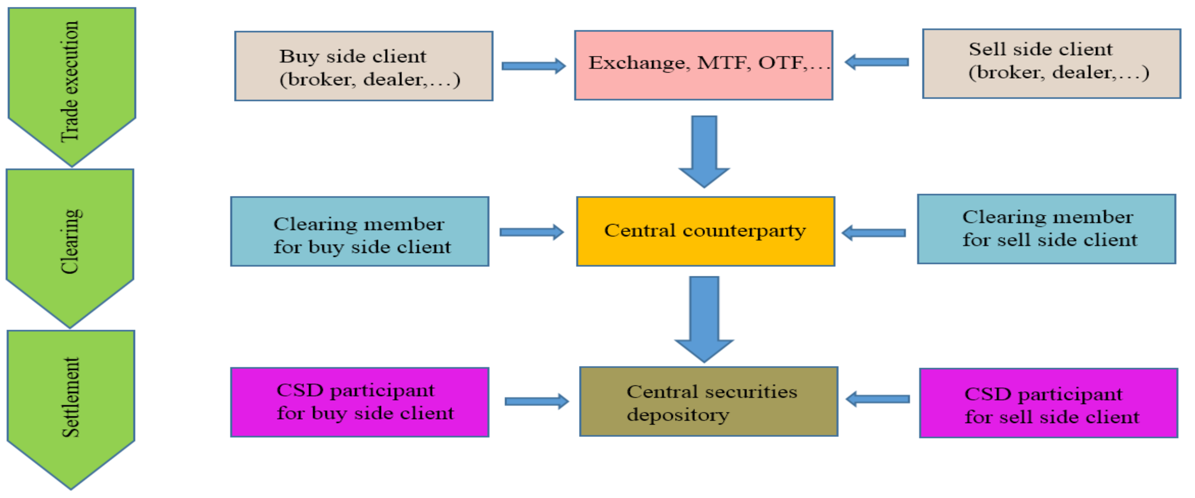

Fig. 2. A simplified representation of the security leg of the trade life cycle.

After the novation, the CCP will forward the settlement instruction to the CSD, most often two business days after trade day. The CSD will operate the securities settlement system by crediting and debiting the securities accounts of its participants, acting on behalf of the buy side and sell side clients, respectively. In case of net settlement[9], these instructions were first netted by the CCP in order to lower the outstanding positions of its clearing members, thereby reducing their liquidity requirements.

[9] Netting is the process where the obligations between participants are offset against each other, thereby reducing the number and value of payments or deliveries that are needed to settle the set of transactions that the participants have with each other. Deferred net settlement is a settlement mechanism which settles on a net basis at the end of a predefined settlement cycle. A real-time gross settlement system, by contrast, is a settlement mechanism where settlement occurs in real time and individually on a transaction-by-transaction basis for the full value.

The large majority of European CSDs nowadays outsource their settlement service to the Target2-Securities (T2S) platform operated by the Eurosystem. This pan-European platform was launched in 2008 and became operational in 2015. Its main objective is to achieve an integrated and harmonized securities settlement infrastructure via a centralization of the settlement in Europe. This integrated model, where CSDs are interconnected through a single platform, intends to enable cross-border real-time settlement inside Europe. The CSDs connected to T2S still have their own accounts. The balances reflected in their ledgers are automatically updated and realigned. The final ledger remains legally within the remit of each CSD's regulatory and legal framework (Pinna and Ruttenberg 2016).

As illustrated by the two figures above, the current financial industry structure is dominated by centralizing institutions. The trade life cycle and custody chains can be long, with numerous intermediaries having their own proprietary databases with overlapping information on transactions[10], leading to a lot of duplication. Participants in the post-trade value chain often need to manually update their digital records to reconcile them with any change that occurred in the records of counterparties at a different level in the holding chain, leading to a considerable operational risk (Pinna and Ruttenberg 2016; Goldman Sachs 2016).

Clearing and settlement with DLT

As stated above, financial institutions have yet to demonstrate that DLT is a viable and sustainable solution to cover the complete securities trade life cycle. It is thus still unclear which DLT system in terms of operational functionality would best suit for the clearing and settlement of securities. Nevertheless, this section outlines a potential DLT system, in order to pinpoint the

[10] E.g. volume, value, identifiers of the counterparties, timestamp, etc.

risks and benefits of this technology[11]. This (fictitious) example is based on Euroclear and Slaughter and May (2016), Pinna and Ruttenberg (2016), and Finra (2017). It is only one potential example of what a DLT system could look like.

Figure 3 represents this DLT system, in which clients would trade securities with one another. As the system is decentralized, all clients would have a copy of the ledger recording the securities[12], the ownership details, and the entire transaction history of each security (Swan 2015). When two clients enter into a trade, they would first sign the transaction by applying their private keys to unlock the securities and then transfer the ownership to each other via their public keys[13]. The signed transaction would be broadcasted to the entire system in order to be validated. The validation process would then be executed by other clients, comparable to what 'miners' do in a Bitcoin system.

More specifically on the validation process, which is a necessary step before the ledger can be updated, a consensus-based verification process would be used, meaning that a consensus has to be reached between several participants of the system on the validity of the underlying database.

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[11] A discussion of the specificities of the technology itself or a detailed overview of the technical details of DLT is out of scope of this article and is already elaborated in great detail in e.g. Pinna and Ruttenberg (2016) and Euroclear and Slaughter and May (2016).

[12] The digital assets may be created on the network itself or may be digital representations on the network of the physical assets (Finra 2017). Digital assets that are originated on the ledger are called 'native assets' or 'native tokens', while assets that are represented electronically on the ledger are referred to as 'non-native assets' or 'non-native tokens' (BIS 2017). The whole process of issuance of securities and the concept of tokenization is out of scope of this article.

[13] Asymmetric key cryptography, where a public and a private key are used, is often applied in the case of cryptocurrencies. The receiver (e.g. beneficiary) can send his public key (representing the 'address' where the digital asset is located on the network) to the sender, where the sender encrypts the message with the receiver's public key. Then, the message is sent and the receiver opens it through his private key (i.e. the code that gives the holder access to the assets when it matches with the corresponding public key). Both private and public keys are mathematically linked, often based on elliptical curve cryptography (see Bheemaiah 2017) meaning that the private key can decrypt the information that is encrypted only with the corresponding public key, and vice versa. The private key is known only to the beneficiary. If the beneficiary loses the key, it also loses the right to dispose of the assets, so it is important for this party to properly protect its private keys.

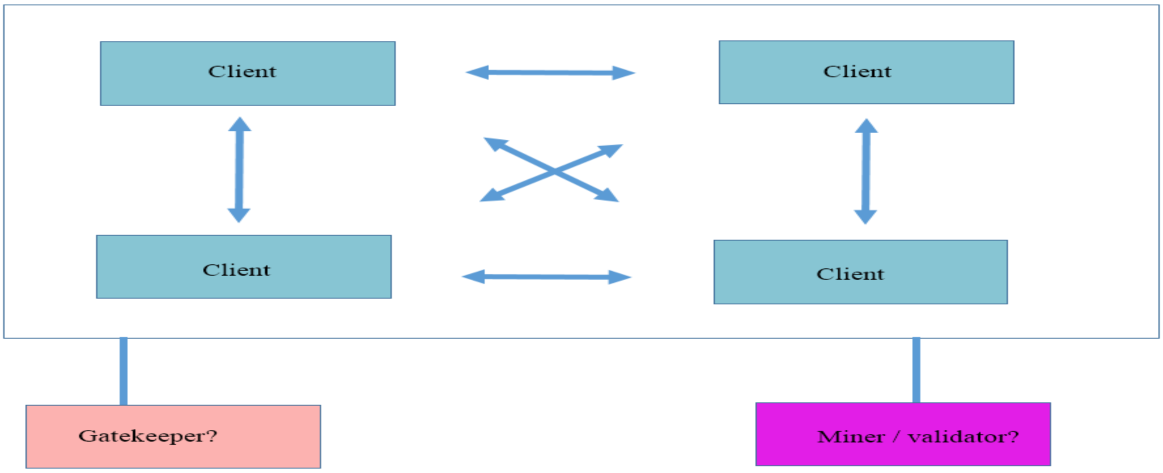

Fig. 3. A DLT system in which participants trade securities with one another.

One of the key goals of this validation process would be to ensure that the seller is the rightful owner of the securities being sold, based on the transaction history recorded on the DLT system.

Several consensus techniques exist[14]. One possibility could be that the originator of the transaction first needs to provide the hash value[15] of the latest version of the ledger and validators would then check whether the correct hash function was provided (Pinna and Ruttenberg 2016). If this is the case, the new transaction would also be cryptographically hashed and permanently recorded. It would thus be impossible to add wrong transactions to the ledger

[14] There are multiple alternative consensus mechanisms, such as proof-of-stake algorithms where the creator of the next block is chosen via various combinations of random selection and wealth (i.e. the stake) and proof-of-work mechanisms where the validators have to computationally solve intensive puzzles (Swan 2015, Finra 2017).

[15] Hashing is running a computer algorithm over a content file generating a compressed string of alphanumeric characters (i.e. the hash function). These cannot be back-computed into its original content. Every digitalized financial instrument, represented by records, could be transformed into a hash string as a unique and private identifier, meaning that the hash function itself depends on the transaction data, the identities of the counterparties, and the result of previous transactions (Goldman Sachs 2016). It is not possible to infer the values of the data from its hash, while it is easy to compute the hash from the given data values. Every time that a validator wants to check that the records are still the same and no modification has been done, the same hash algorithm is run and the hash signature should be the same as before. The hash string can also be used as text in blockchain transactions, thereby proving that e.g. the actual assets exist. This way of working can be considered as a secure timestamping function of when a specific attestation has been executed (Swan 2015). A new version of the distributed ledger would also include the hash of the previous version, which allows a validation of the new version of the ledger by checking whether the fixed-length output corresponds to the hash included in the updated version (BIS 2017). Each block will thus contain a hash function reflecting the contents of the previous block, which itself will include a hash function referring to a block even more adjacent to the initial block.

without the consent of the relevant parties involved in the process (Goldman Sachs 2016). A cyber-attack of a DLT system would be very hard, as the attacker would have to attack the majority of the validators in order to be successful (Klimos 2017). This step also implies that the ledger would be constantly growing because new transactions would be added after each validation.

In case transactions are added in 'blocks' to the ledger, the term 'blockchain' is used rather than DLT. These blocks are chained to each other via a time stamp. Because of the chaining and the use of hash functions, a malicious client or hacker wanting to change a transaction would need to change not only the transaction and its time details, but also every other transaction in the previous blocks, making a blockchain immutable (Bheemaiah 2017; Euroclear, Oliver Wyman 2016). After the validation, all participants of the DLT system would get an updated copy of the ledger, often via automatic synchronization.

This potential way of working indicates that the settlement of a transaction could be contemporaneous with the validation process whereby the new asset ownership would be reflected in the system. Because there are fewer intermediaries involved, a lot of currently repetitive business processes could be eliminated. The trade life cycle could be simplified, leading to reduced settlement times and no more costs due to the manual reconciliation of potentially conflicting trade data stored in various duplicated ledgers (Bheemaiah 2017; ESMA 2017b; Euroclear, Slaughter and May 2016) [16].

Unpermissioned DLT systems, such as those used for cryptocurrencies, are DLT systems that are accessible to anyone who wishes to join the system. In such a system, the validation

[16] Although proponents of the DLT technology are of the opinion that it should be possible to move from T+2 to T+0, it is not entirely clear whether market participants actually favor instantaneous settlement, since the ability to net transactions would disappear. Netting has advantages in terms of liquidity requirements compared to real-time settlement because, without netting, participants need to have all the required funds immediately available in order to be able to fulfill their payment in real time (Finra 2017; Caytas 2017).

mechanism would play a key role because not every participant would necessary be a trusted party. Examples of stringent validation mechanisms could be the activation of numerous participants as validators or a more stringent validation algorithm. As a consequence, those DLT systems would be slower (see Caytas 2017). In the case of Bitcoins, for instance, validators often have to solve trillions of mathematical puzzles in order to calculate a hash value (Euroclear, Slaughter and May 2016; Goldman Sachs 2016), which limits the maximum numbers of transactions that can be simultaneously treated to 7. A comparison with e.g. the VISA credit card payment system, that can accommodate peak volumes of 10,000 transactions per second, shows how ineffective unpermissioned systems would be in case large volumes need to be cleared and settled (Swan 2015; Bheemaiah 2017).

Permissioned systems, where only authorized parties are allowed are generally considered as more suitable for securities markets because of the participants being considered as more trustworthy requiring a less stringent validation process (see e.g. ESMA 2017b; Mainelli and Milne 2016). Furthermore, the risk of money laundering or other illicit activities would be lower when only reliable system participants can use the system. Also, the need to copy all data to the internal ledgers of the participants would be lower when participants are considered as more trustworthy because they fulfill certain pre-defined access criteria.

However, a permissioned system requires one (or more) institutions acting as a gatekeepers and screening potential participants before the latter can access the DLT system. These gatekeepers would grant access only to participants meeting the access criteria, which would be included in a rulebook (ESMA 2017b). The presence of a gatekeeper implies that in a permissioned DLT system, a central institution cannot be completely ruled out. Such a system is thus in sharp contrast with the initially developed open Bitcoin system, where there are no access restrictions and no central institution acting as a gatekeeper (Yermack 2017).

Apart from data on transactions, distributed ledgers could also contain computer code, so-called 'smart contracts'. These contracts self-execute and automatically process a transaction on the ledger when pre-defined conditions are met (see e.g. Bheemaiah 2017). They are decentralized: they are not be held by a single centralized server but are be distributed amongst the system participants (Swan 2015). In the case of securities markets, these smart contracts could be used to automate certain non-elective corporate actions (Euroclear, Slaughter and May 2016)[17]. They could also allow an automatic execution and payment of certain derivatives as soon as certain criteria would be met (e.g. the stock price being below or above a certain threshold) (Euroclear and Oliver Wyman 2016).

A smart contract has the same features as a traditional contract. It is an agreement between two or more parties to do or not do something, in exchange for something else. The difference is that a smart contract is defined by code, which executes under precisely predefined conditions without any human discretion (Swan 2015; Bheemaiah 2017). As these contracts will execute automatically, they are considered to be 'self-enforcing' (ISDA and Linklaters 2017). They might even be executed based on information they receive from outside the DLT system. So-called 'oracles' might be deployed, which are computer servers that are programmed to scour data (news) feeds in order to validate whether user-provided expressions are true. These oracles will only act as programmed, avoiding the risk of collusion with a counterparty, as there is no human arbitrator (see also Brito et al. 2014).

[17] Even without the usage of smart contracts, the processing of corporate actions would be simplified in a DLT system compared to the current multi-tier holding systems where investors and intermediaries only have access to the accounts held by the intermediary closest to them in the holding chain. The issuer CSD often does not have a view on who the actual security holders are because the multiplicity of intermediaries involved in the transaction process limits the traceability of securities holdings and makes it difficult to link a security to their end beneficiaries (Euroclear, Slaughter and May 2016).

The future role for CCPs and CSDs

As far as CCPs and CSDs are concerned, it is currently less clear what the role for these infrastructures would be when DLT is applied to the clearing and settlement phase of the trade life cycle.

Some financial institutions, like Société Générale (2017), expect that CSDs may no longer be required, as the issuer of the securities and the investors buying them can directly trade with each other via updates of the shared ledger. The DLT technology could also reduce counterparty risk[18]. Indeed, the almost instantaneous settlement would reduce the time that each party is exposed to counterparty default risk. Counterparties would moreover have pre-trade transparency that counterparties on each other, given that the content of the ledger would be copied in their own internal systems. Several market players therefore expect that CCPs in their traditional role might not be needed anymore (Euroclear, Oliver Wyman 2016; ESMA 2017b).

According to ESMA (2017a), a distinction has to be made between spot transactions and transactions with a maturity, like derivative transactions. For spot transactions having a single clearing and settlement instruction extinguishing the obligations of each party, DLT could reduce the role of the CCP and the CSD. For derivative transactions with a maturity, however, the outstanding rights or obligations remain throughout the entire life of the contract and the need to mitigate counterparty risk subsists until the contract's maturity. For these contracts, DLT is unlikely to fully eliminate counterparty risk. Clearing could thus still be useful to hedge risk until securities and/or cash are finally and irrevocably exchanged (Pinna and Ruttenberg 2016).

Because of their changing role, Euroclear, Slaughter and May (2016) and ESMA (2017b) expect that CCPs and CSDs will start offering new services, such as the coordination of the

[18] Counterparty risk can be considered as a pre-settlement risk and is here defined as the risk that one counterparty of the trade does not deliver the security or cash as per the agreement. The longer the time between trading and settlement, the higher the likelihood that counterparty risk materializes.

evolution of the permissioned DLT protocol (e.g. modifying or updating source codes), the management and safekeeping of private keys in order to ensure network security, and the management of the introduction or cancellation of tokens on the ledger. In addition, they could take up the role of gatekeeper or validator. Nevertheless, because these services are no core clearing or settlement functions and thus fall outside existing legislation applicable to these services, other type of financial institutions could also start offering them. If this would indeed be the case, CCPs and CSDs would not remain as important as they are today. According to Pinna and Ruttenberg (2016), CSDs are, however, more suitable to act as validators compared to other market participants. Traders, for instance, would face competition issues when validating the transactions of their peers. A non-market participant institution, like a CCP or a CSD, would face fewer conflicts of interests.

Challenges and risks related to DLT systems

As documented above, DLT systems could have numerous benefits when applied to clearing and settlement, such as reduced settlement times, less counterparty risk, lower settlement fees, simplified operational processes because of fewer intermediaries, and a higher level of transparency. Yet, this technology still faces challenges.

First, in order to increase transparency and trust in the DLT system, all information on the transactions in the ledgers is typically observed by all system participants and duplicated into their own ledgers. When applied to financial markets, this transparency might cause privacy or competition issues, and thus breach applicable laws, such as the General Data Protection Regulation (GDPR)[19]. All participants would be aware of all the existing transactions and their

[19] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC.

details, such as the quantity of the assets bought together with their value (ESMA 2017a; Goldman Sachs 2016). Certain solutions, such as advanced obfuscation and encryption techniques[20], are currently being examined to enhance participants' privacy together with the use of economic avatars based on tokenized identity (Bheemaiah 2017)[21].

Second, as market participants are currently developing their own niche DLT systems, there is a risk that there will be incompatibility issues between the different developed systems, leading to fragmentation (see e.g. Goldman Sachs 2016). One of the goals of DLT is to reduce the number of layers within the custody chain. When each 'layer' starts using its own proprietary DLT system, the opposite would be realized, leading to more operational risks (Pinna and Ruttenberg 2016). The lack of standardization could lead to a situation where manual post-trading validation processes are still necessary or become even more important, thereby blocking disintermediation (Klimos 2018).

Nevertheless, several market-driven initiatives are currently fostering common DLT protocols and standards. Examples are the HyperLedger Linux Foundation[22], the R3

[20] These techniques enable participants – or a central authority depending on whether the system is permissioned or not – to validate the transactions by performing the mathematical computations without having a view on the exact inputs and outputs of the computations. An example is homomorphic encryption, where e.g. asset quantities for a transaction may be hidden to all participants except for the sender and recipient of those transactions, while all participants are still able to verify the validity of the transaction. Another example is the Quorum Platform developed by JP Morgan, where transactions are fully replicated across all nodes but the database is split into a private database and a public database. All the participants concur on the public database but their private databases differ. Furthermore, the industry is currently experimenting with 'mixers', which allow users to pool a set of transactions in unpredictable combinations, thereby making the tracking of identities more difficult (see Böhme et al. 2015).

[21] Avatars are pseudonymous identities that are linked to the original identity in a separate database where only a trusted gatekeeper has access to. The gatekeeper can assign certain rights to the avatars in order to allow them to perform certain tasks, such as buying and selling securities, without the need for them to reveal their identity to their counterparties.

[22] The main objective of HyperLedger is to achieve cross-industry collaboration with the focus on generating improved performance of the DLT systems being developed. Among the members of the initiative are: ABN Amro, BNY Mellon, ANZ Bank, CLS Group, CME Group, DTCC, Deutsche Börse Group, JP Morgan, State Street, Swift, and Wells Fargo (HyperLedger 2018).

Consortium[23], the Post-Trade Distributed Ledger Group[24], and the CSD Working Group on DLT[25]. Incompatibility issues thus do not seem to be the stopping point for this technology.

The establishment of an agreement on standardised DLT solutions, however, is likely to take time and could thus reduce the speed at which this technology is implemented. Even more, when existing market participants are replacing their legacy systems by DLT systems, the latter will have to be interoperable with the former for a short to medium period of time (ESMA 2017a).

As illustrated in this section, the technological challenges of DLT systems, such as fragmentation and privacy issues, are currently being addressed by the industry. It is generally assumed that these risks will cause certain delays but will not be blocking. However, the legal challenges for this technology when applied to clearing and settlement could be a hurdle when not properly addressed. Because of its importance, the rest of this article is addressed to these regulatory challenges[26].

Regulatory challenges when DLT is applied to clearing and settlement

According to the German Banking Industry Committee (2016), DLT systems work in a fundamentally different way compared to legacy systems and thus a different regulatory approach is needed. In case existing clearing and settlement providers would use DLT as a mere

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[23] The R3 Consortium consists of more than 200 companies, including Barclays, BBVA, Goldman Sachs, JP Morgan, BNY Mellon, Bank of America, Commerzbank, Deutsche Bank, HSBC, and Unicredit. The Consortium has created an open-source DLT system, called Corda.

[24] The Post-Trade Distributed Ledger Group is a group of almost 40 financial institutions, including financial market infrastructures, which acts as a forum to collaborate and share best practices.

[25] The CSD Working Group on DLT is a consortium comprising of Russia's National Securities Depository, Switzerland's SIX Securities Services, the Nordic subsidiary of NASDAQ, Chile's DCV, South Africa's Strate, and Argentina's Caja de Valores. Together with Swift, this working group is considering the use of ISO 20022 standards for e-proxy voting in order to foster interoperability amongst DLT solutions and legacy systems (CSD working group on DLT 2017).

[26] This article focusses on regulations specifically targeting CCPs and CSDs. A discussion on e.g. the compliance of gatekeepers with Know-Your-Customer and Anti-Money Laundering Regulation and the compliance of system developers with property or copyright law is out of scope of this article.

technological improvement, ESMA (2017a) foresees limited regulatory challenges: the EU regulatory framework does not prescribe the type of technology that market infrastructures have to use and is thus considered as 'technology neutral'. DLT operationally replacing the current set up of market participants and market infrastructures would be a different matter. Permissioned DLT systems[27] would meet two types of legal challenges: a) existing post-trade regulations could act as a barrier to the introduction of this technology and, in case the technology does succeed in getting implemented, b) this technology might introduce prudential and conduct risks that are most likely insufficiently addressed by the existing regulations.

Barriers to entry

Although a complete list of all the potential barriers to entry due to existing regulations is out of scope of this article, this section discusses a few major ones to illustrate that existing legislation may have to be updated for this technology to be fully implemented.[28]

The EMIR regulation[29] requires standardised OTC derivative contracts to be cleared through a central counterparty. EMIR thus foresees an important role for CCPs in order to reduce counterparty credit risk, granting them a quasi-monopoly. New types of market participants, such as DLT FinTechs operating a permissioned system, may want to enter the market. If they set up a DLT system without a CCP for these type of derivatives, they would be in breach of EMIR. If CCPs would act as validators, it is still not clear whether the validation of trades would legally be considered as central clearing. In addition to this EMIR requirement, Basel III lowers

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[27] Unpermissioned DLT systems would likely not be eligible, as it would appear very difficult or even impossible to regulate all (regulated and non-regulated) participants as they would typically be institutions that are scattered over different countries and jurisdictions (Peach 2017).

[28] One of the caveats of this discussion is that it is currently not clear which scenario will unfold. Will operators of DLT systems, which are currently unregulated, start providing clearing and settlement services? Or will licensed CSDs and/or CCPs start offering DLT services?

[29] Regulation (EU) No 648/2012 of the European Parliament and of the Council of 4 July 2012 on OTC derivatives, central counterparties and trade repositories.

capital requirements for institutions that clear their OTC derivatives through a CCP. OTC derivatives trades in a DLT environment without a CCP could therefore lead to higher capital requirements for counterparties, which would make DLT systems less attractive.

Second, article 3 of the CSDR regulation[30] requires that 'any issuer established in the European Union that issues or has issued transferable securities admitted to trading or traded on trading venues, arranges for such securities to be represented in book-entry form, which should be able to take the form of immobilisation[31] or of immediate dematerialization'[32]. Where a transaction in transferable securities takes place on a trading venue, the relevant securities have to be recorded in book-entry form in a CSD on or before the intended settlement date, unless they have already been so recorded. This implies that such issuances cannot lawfully exist without an issuer CSD. A DLT system without an issuer CSD would thus not be an option from the issuers' point of view.

In particular, in order for an institution to obtain a CSD license, it must be designated by the Member State in which it is located as the operator of a securities settlement system under the Settlement Finality Directive (SFD). Based on the discretionary interpretation of the Member State and the business case at hand (assuming that the industry decided on a uniform DLT system), it is possible that not every Member State will designate this DLT system as a securities settlement system.

The SFD definition of 'system' is based on the notion 'transfer order', which in turn refers to the notion of 'account': a transfer order is 'any instruction by a participant to place at the disposal of a recipient an amount of money by means of a book entry on the accounts of a credit

[30] Regulation (EU) No 909/2014 of the European Parliament and of the Council of 23 July 2014 on improving securities settlement in the European Union and on central securities depositories and amending Directives 98/26/EC and 2014/65/EU and Regulation (EU) No 236/2012.

[31] Immobilisation means the act of concentrating the location of physical securities in a CSD in a way that enables subsequent transfers to be made by book entry.

[32] Dematerialised form means the fact that financial instruments exist only as book-entry record.

institution, a central bank or a settlement agent or any instruction which results in the assumption or discharge of a payment obligation as defined by the rules of the system, or any instruction by a participant to transfer the title to, or interest in, a security or securities by mean of a book entry on a register or otherwise'.[33]

Securities accounts as we currently know them may not exist in a DLT system. Neither SFD, EMIR, nor CSDR explicitly describe what accounts should look like and whether there is a legal difference between accounts, records and/or ledgers. Given the definition of a transfer order under the SFD and the definition of a securities account under CSDR[34], some Member States might take the view that only double-entry (or multiple-entry) book keepings could be considered as accounts and that transfer orders could only exist when legacy ledgers are maintained[35]. If so, a DLT system without double-entry accounts would not be considered as a securities settlement system. As a consequence, the operator of a DLT system would not be eligible for a CSD license and issuers using the DLT system would violate article 3 of CSDR. As this depends on the interpretation of the Member States, divergent views within Europe could arise, leading to a situation where DLT providers could act as a CSD in certain countries, and not in others. Hence, even when legislators wanted to be technology neutral, the interpretation of the law could be such that the law at hand does become a barrier. Alternatively,

[33] Directive 98/26/EC on settlement finality in payment and securities settlement systems. The Member States ultimately decide what a securities settlement system is, given that article 2 of this directive defines a system as a formal arrangement: (i) between three or more participants (being narrowly defined in the directive, without counting a possible settlement agent, a possible central counterparty, a possible clearing house or a possible indirect participant) with common rules and standardised arrangements for the execution of transfer orders between participants, (ii) governed by the law of a Member State chosen by the participants; the participants may, however, only choose the law of a Member State in which at least one of them has its head office, and (iii) designated, without prejudice to other more stringent conditions or general application laid down by national law, as a system and notified to the Commission by the Member State whose law is applicable, after that Member State is satisfied as to the adequacy of the rule of the system.

[34] CSDR defines a securities account as an account on which securities may be debited or credited.

[35] A DLT institution could also create a 'side-system' in which accounts are provided to be able to adhere to the CSD regulation but the question raises whether this is then still a 'pure' DLT system or rather a hybrid system between a DLT and a legacy system.

infrastructures might have to keep the securities on securities accounts and tokenize them into the ledger in order to fulfill the legal requirements, but this process could create additional operational risks. Both EMIR (article 39) as CSDR (article 38) require that CCPs and CSDs – and their participants throughout the clearing / holding chains – keep records and accounts that enable them, at any time and without delay, to segregate in their accounts the securities of their clients from those of any other client and, if applicable, from their own assets. As documented above, security accounts where a debit and/or credit is possible may legally speaking not exist in a DLT environment.

Finally, under the assumption that a Member State does consider a DLT system as a securities settlement system under the SFD and that the operators succeed in obtaining a CSD license, the moments of entry and of irrevocability of the transfer orders in that system will need to be defined[36] in order to be compliant with article 39 of CSDR requesting the CSD to ensure that the securities settlement system it operates defines the moments of entry and of irrevocability of transfer orders. In addition to the difficulties surrounding the notion of a transfer order in a DLT environment (see supra), fixing the point in time when the settlement can be considered as final will be very burdensome in a DLT environment as it might not be a clear moment in time (BIS 2017). Settlement finality will depend on when the consensus is reached and/or when the transaction is added to the ledger (see Böhme et al. 2015). The timing could depend on a multiplicity of factors, given that the validators first have their role to play and could thus each individually influence the total timing between validation and the update of the ledger. Hence,

[36] This in accordance with articles 3 and 5 of the SFD. More concretely, this directive protects against the implementation of normal insolvency law and more specifically the so-called zero-hour rule. That is, certain Member States have this zero-hour rule, which gives retroactive effects to the pronouncement of an insolvency. In particular, the orders that the participant introduced after zero hour of the day of pronouncement of its insolvency but before the actual pronouncement of the insolvency can be challenged by its liquidator. This would grant the liquidator the power to insist on the transfer to him of the underlying amount originally due to the institution. Settlement finality is thus the moment at which the transfer is irrevocable and unconditional and not susceptible to the insolvency of the participant unwinding the transfer.

a transaction might be added to the ledger even after bankruptcy proceedings were already commenced against one of the counterparties. Also, given that transactions written to the ledger are immutable, it will be difficult to fix the point in time that instructions can no longer be revoked and offsetting instructions would need to be used to undue erroneous transactions (Manning et al. 2016).

Legal requirements to address prudential and conducts risks that DLT could introduce

The potential regulatory barriers discussed above already show that existing legislation, such as SFD, EMIR and CSDR, were not written with DLT in mind. Legislators were not yet aware that this technology existed and could become important for financial markets. Even if potential regulatory barriers would be eliminated and DLT systems would be operationalized, additional requirements might have to be introduced to address prudential and/or conduct risks introduced by this technology. According to Zetzsche et al. (2017), DLT systems might be secure from a technological perspective, but from a legal perspective these systems might spread risks amongst participants that were formerly concentrated with a limited number of central institutions. These new types of risks need to be formally addressed. Whether these new requirements should be part of a rulebook, soft guidelines and/or hard law is a question that legislators, together with the industry, should further reflect upon.

The Bank of International Settlement (2018) shares the opinion that new requirements might have to be introduced, stressing that more work is needed to make sure that the legal underpinnings of DLT arrangements are sound, that their governance is robust, and that appropriate data controls are in place. Indeed, DLT might be more efficient and safe compared to existing legacy systems but when there are governance deficiencies, DLT systems might even turn out to be inferior (Evans 2014). For instance, given the difficulty to correct transaction errors, new enforceable procedures and governance requirements would have to be created on how to handle possible mistakes, both from a technological and governance perspective (ESMA 2017a). Useful questions to elaborate on would be a) to whom does a participant need to flag errors, b) which correcting mechanisms would apply, and c) within which timeframe would the error need to be solved.

According to Zetzsche et al. (2017), new rules that govern the interactions between participants should also be created. Examples include rules regarding potential liability issues of participants and rules requiring users to put risk and compliance management systems in place. With respect to the underlying software code, requirements and processes regarding changes in the code and regarding dispute resolution would be needed. The governance requirements could indicate rules to be followed by the parties setting up the code design, the validators, and the users of the system.

ESMA (2017a) agrees with Zetzsche et al. (2017) that participants themselves should put in place appropriate governance frameworks. An appropriate governance framework for the entire DLT system might be as important as the current governance requirements that central market infrastructures and their participants need to adhere to, as different legal entities share the responsibility for at least some processes of the trade life cycle. ESMA (2017a) also expects that in a permissioned DLT framework, authorized participants would use risk mitigation techniques, similar to those that participants of CCPs and CSDs currently have in place. These tools would need to ensure proper investor protection and avoid financial stability issues due to market contagion in case a participant defaults.

In addition, new rules could define the securities law that is applicable to the securities on the DLT system. Because securities laws are not harmonized in Europe, it will be difficult for international DLT systems, with market participants located in several jurisdictions, to identify the applicable law in case a counterparty defaults. If every participant would have to follow the law of the jurisdiction in which it is located, the DLT system would need to take into account numerous legal and regulatory regimes. European legislators have launched various initiatives to harmonize securities laws, but have not succeeded in this task. Indeed, already in 1996, the Giovannini Group, a group of experts in financial markets, was formed, in order to identify inefficiencies in the EU financial markets and to propose practical solutions to the European Commission for the creation of an integrated financial market. In 2001 and in 2003 this group identified a list of 15 barriers to an efficient EU cross-border clearing and settlement, categorized into three broad groups: a) technical requirements and market practices, b) taxation, and c) legal certainty. They also proposed actions to eliminate these barriers.

According to the Giovannini group (2003), the absence of an EU-wide framework for the legal treatment of securities is the most important legal risk in cross-border transactions. Furthermore, the group stated that conflict-of-law rules, which attempt to determine which country's substantive law applies, are not completely effective. These conflict-of-law rules are traditionally national and can thus be divergent amongst countries. European legislators have tried to overcome the *lex rei sitae* approach (i.e. the law of the jurisdiction of the issuer or the law of the jurisdiction in which the records of the issuer are held) to avoid the difficult 'look through approach' in which each level of the custody chain needs to be assessed to know the applicable law. For instance, various directives, such as the SFD, the Financial Collateral Directive[37], and the Winding-up Directive[38] follow the 'Place of the Relevant Intermediary Approach" (PRIMA), which makes the jurisdiction of the relevant securities account the key criteria to determine the securities law that is applicable. However, according to the European

37 Directive 2002/47/EC of the European Parliament and of the Council of 6 June 2002 on financial collateral arrangements.

38 Directive 2001/24/EC of the European Parliament and of the Council of 4 April 2001 on the reorganisation and winding up of credit institutions.

Commission (2010), the aforementioned directives do not specify exactly the criteria to determine where the account is exactly located or maintained, which can be problematic in the case of DLT. Indeed, not only can ledgers be stored in many different countries, securities accounts might not even exist (Böhme et al. 2015).

Alternatively, the international Hague Securities Convention (2006) requires that the law governing the account agreement should be applicable unless the account agreement expressly provides that another law is applicable to all such issuers. In 2009, the International Institute for Unification of Private Law (UNIDROIT) adopted the Geneva Securities Convention on substantive rules for intermediate securities, which complements the Den Hague Securities Convention and tackles the rights of investors towards intermediaries and the control of the integrity of the securities. Yet, European Member States were reluctant to sign the convention, most likely because it was very Anglo-Saxon based and would force European Member States to turn their civil law approach into a US inspired contractual approach of holding securities. According to the European Post trade Forum (2017), legal uncertainty as to ownership rights in book entry securities is still pertinent. Unfortunately, after almost 20 years of acknowledging that the securities laws should be harmonized, this goal has not yet been reached. This barrier would thus likely make DLT only attractive in an environment where a failure to harmonize substantive securities laws would be relevant. This could be in a situation where DLT handles a specific asset class government by a national legislation.

In the case of tokens that represent the securities, it is even less clear whether existing domestic securities laws would legally recognize these digital assets as securities. The key question is whether an entry on a DLT system, as a digital representation of real assets, is a proof of ownership of those assets. Because ownership of digital assets does not fit within most current legal frameworks, a legal gap exists that will need to be addressed by (new) laws and regulations.

More clarification is also needed on the legal status of smart contracts (Pina and Ruttenberg 2016). Only a few legislators, such as those of the state of Arizona, have enacted legislation giving legal status to smart contracts, thereby clarifying that smart contracts can be as legally effective as any other contracts. Even if computer code might be too rigid to allow all contracts to be drafted in an algorithmic way[39], regulators might start examining whether and how contract law should be modified for smart contracts to be valid and enforceable, given their automated and deterministic nature. Further reflection is needed on whether smart contracts can ultimately replace existing legal contracts in their entirety or whether they can only be used to automate the execution of the actions that are specified in legal contracts.

Conclusion

This article presents the benefits and risks of an application of the distributed ledger technology to securities markets, and especially to the clearing and settlement phase of the trade life cycle. Because there are fewer intermediaries involved in a DLT system, a lot of currently repetitive business processes could be eliminated. The entering of transaction data separately in each layer of the custody chain, thereby requiring costly reconciliation processes, would no longer be necessary. This, in turn, could lead to reduced settlement times and transaction costs. DLT could thus yield substantial economic cost saving in the financial industry because of the reduced back office costs tied to manual reconciliation of conflicting trade data.

[39] As ISDA and Linklaters (2017) explain, it is not possible to include clauses as 'in good faith' or 'commercially reasonable manner' in a smart contract. The key philosophical question is whether these clauses where discretion is possible should be eliminated via the use of smart contracts. Without them, legal uncertainty could be reduced but on the other hand, their absence reduces flexibility and discretion of one of the contracting parties, which might be useful in case of unforeseen circumstances.

On the other hand, although the industry is attempting to solve the technological and operational issues that DLT systems still face, such as the harmonization of technical standards, outstanding legal risks are such that the financial industry is asking for regulatory intervention (e.g. ECSDA 2017). Legislators and regulators are monitoring the rapid development of DLT to identify the needs for regulatory action, but their reflections are still in their infancy and the large majority of legislators are of the opinion that it is too early to draft hard law.

Yet, a reflection on this matter is worthwhile, as this technology might one day fully materialize and bring risks to financial markets that will need to be addressed by legal actions. The regulation process could move faster when these risks and the requirements to address them are already reflected upon beforehand. This article intends to contribute to the debate about regulatory developments by first presenting potential regulatory barriers that may have to be removed so that this technology could be fully adopted and then identifying areas requiring an update of the legal framework in order to address certain prudential and conduct risks that this technology might introduce.

In particular, this article documents that, because EMIR requires that all standardized OTC derivative contracts are cleared through a central counterparty, a DLT system without a CCP would not meet the EMIR requirements. Also, because double-entry accounts might legally not exist in a DLT system, it is unlikely that a DLT provider would be able to obtain a CSD license in all European Member States and thus be able to offer issuance services or adhere to the asset segregation requirements.[40] Because of the difficulties surrounding the notion of a transfer order in a DLT environment, the point in time when settlement can be considered as final will

[40] ID2S is currently the only DLT provider that has obtained a license as a CSD from the French market regulator. However, this CSD does not use tokens as securities but decided to use traditional securities accounts in order to be BMR compliant. In addition, the settlement of the securities itself is outsourced to T2S. This institution uses thus the DLT technology but mainly for the issuance of commercial paper.

also be very difficult to determine, making it difficult for these systems to comply with the settlement finality requirement of CSDR.

In case these potential regulatory barriers could be overcome and DLT systems would be operationalized, certain new legal requirements may have to be brought forward because of prudential and/or conduct risks being introduced by this technology. For instance, technological and governance requirements to correct errors of the immutable ledger may have to be required together with liability, risk, and compliance management systems of participants. It is up to the legislators, in consultation with the industry, to further discuss whether these requirements should be part of a rulebook of the DLT system, included into soft principles or rather be enforced by hard law requirements.

When dealing with the legal issues presented in this article, legislators should also take into account that when modifying existing laws or creating new ones, a level playing field should exist between all financial services providers. Legislation should also avoid a situation in which CSDs apply the distributed ledger technology and are heavily regulated for doing so, while new (FinTech) companies apply DLT for the same purposes but remain unregulated (Polish Bank Association 2016). Different actors offer the same regulated services should be subject to the same legal requirements. The various services offered by various market participants (CSDs, FinTech companies, custodians, CCPs, etc.) could be mapped and regulated accordingly.

This article focused on the post-trading landscape, given that the financial industry recognizes the role that this technology might have on these activities. It is not yet sufficiently clear whether DLT could play a meaningful role in the trading of securities. Micheler and Von der Heyde (2016), think that DLT could make it possible to merge trading, clearing, and settlement into one real-time process. Also, Bank of New York Mellon (2016) and the French Banking Federation (2016) expect that DLT could incorporate the full life-cycle of securities, thus avoiding further complication of the ecosystem by introducing an additional set of interfaces with off-ledger systems and/or assets. The distinction between trading, clearing, and settlement could thus become blurry. Further research is needed to assess the potential impact on trading venues.

Finally, regulators may want to pay attention to new operational risks that might arrive in case the trading, clearing, and settlement part of the entire value chain implement different approaches to DLT at different moments in time, thereby causing fragmentation issues. In case an important market player successfully operationalizes a DLT system for the clearing and settlement of securities, regulators should examine whether the use (or non-use) of DLT by one infrastructure is not used as a barrier to entry to another; this being at odds with the non-discriminatory access requirements included in EMIR and CSDR.

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