The Tokenisation of Assets and Potential Implications for Financial Markets

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Foreword

Distributed ledger technologies (DLTs) are poised to become a transformative feature of financial markets, both in financial products and in the underlying market infrastructure itself.

The tokenisation of assets, involving the digital representation of real assets on distributed ledgers or the issuance of traditional asset classes in tokenised form, is a core part of this technology's revolutionary potential. Though the technology and practice of tokenisation are nascent, its theoretical benefits include: efficiency gains driven by automation and disintermediation; transparency; improved liquidity potential and tradability of assets with near-absent liquidity; and faster and potentially more efficient clearing and settlement. It suggests a reconsideration of core financial market activities, from trading, pricing and liquidity of securities, to processes such as clearing and settlement, and activities such as repo and securities lending.

This report analyses the impact that wide-spread adoption of tokenisation could have, discusses emerging opportunities and risks of the application of DLTs for financial markets and their participants, illustrated with case studies in OECD and non-OECD economies. It investigates the role of trusted third-party authorities in decentralised networks as guarantors of the connection between the on- and off-chain worlds, and explores the need for a tokenised form of central bank currency or stablecoin for the payment leg of security settlements on DLT-based trading venues.

Policy makers have a role in ensuring that tokenised markets are consistent with regulatory aims of promoting financial stability, protecting financial consumers, and ensuring market integrity. For some jurisdictions with a technology-neutral approach to regulation, existing regulation may need to apply to new actors and new products, and new requirements may need to be designed to address emerging risks stemming from the novel nature of some of the business models and processes involved in tokenisation.

Potential gaps in existing regulatory frameworks need to be identified and addressed, and regulatory and legal ambiguity around asset tokenisation addressed, as a stepping stone to the safe development and use of tokenisation by market participants. Cross-border transactions of tokenised assets require international cooperation to limit regulatory arbitrage and to foster the safe development of tokenised markets – a goal the OECD will continue to pursue through its financial policy communities, and its wider work supporting an international policy environment to provide good governance for decentralised technologies and their markets.

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This report contributes to the work of the OECD Blockchain Policy Centre which provides a global reference point for helping policy makers to address the challenges raised by blockchain and DLT and to seize the opportunities it offers for achieving policy objectives. For more information, visit www.oecd.org/daf/blockchain. It also contributes to the OECD Going Digital project which provides policy makers with tools to help economies and societies prosper in an increasingly digital and data-driven world. For more information, visit www.oecd.org/going-digital.

Table of contents

Figures

Boxes

Executive Summary

Distributed ledger technologies (DLTs), such as the blockchain, have the potential to transform financial markets. From their most visible application in equity issuance and capital raising for small companies through Initial Coin Offerings (ICOs), to post-trade processes, clearing and settlement of securities, the technology has the potential to challenge the current construct of financial markets, affecting infrastructure and participants alike.

Tokenisation of assets involves the digital representation of real (physical) assets on distributed ledgers, or the issuance of traditional asset classes in tokenised form. The application of DLTs and smart contracts in asset tokenisation has the potential to deliver a number of benefits, including efficiency gains driven by automation and disintermediation; transparency; improved liquidity potential and tradability of assets with near-absent liquidity by adding liquidity to currently illiquid assets; faster and potentially more efficient clearing and settlement. It allows for fractional ownership of assets which, in turn, could lower barriers to investment and promote more inclusive access by retail investors to previously unaffordable or insufficiently divisive asset classes, allowing global pools of capital to reach parts of the financial markets previously reserved to large investors. The flow of private financing from capital owners to SMEs could be eased and facilitated, enhancing access to financing for SMEs.

The large-scale adoption of asset tokenisation would face a number of technology-related challenges (scalability; settlement finality; interoperability; network stability; cyber-risks); governance risks related to AML/CFT; digital identity issues; and data protection and privacy issues; as well as raising questions about the legal status of smart contracts.

A potential proliferation of tokenisation in the financial markets and the associated disintermediation could affect trading by disrupting the market-making model, which could in turn affect volatility and liquidity of related markets, especially in times of stress.

A potential take-off in tokenisation could also affect *repo* activity for the funding of positions, as well as securities lending activities used as part of trading strategies, allowing for direct and faster unwinding of collateral, easier mobilisation of collateral across security pools, more efficient use of balance sheet and lower capital intensity.

When it comes to liquidity, tokenisation could be a double-edged sword with positive effect on near-illiquid assets (e.g. participation in the capital of private SMEs) but potential risks of bifurcation of liquidity between on-chain and off-chain markets for the same asset, potentially drying up liquidity in the off-chain markets and giving rise to risks of arbitrage.

In terms of pricing of the assets, tokenisation could enhance transparency regarding transactional data and information around the issuer and the asset characteristics, and has the potential to reduce information asymmetries and improve the price discovery mechanism. At the same time, trading of tokenised assets risks could become fragmented if the asset trades on non-interoperable networks and exchanges on- and off-the chain.

The use of DLT could expedite and condense trade *clearing and settlement* to nearly real-time, reducing counterparty risks and freeing up collateral, potentially producing capital efficiencies for participants in the trade. The post-trade multi-step process could be simplified and the back-office administrative burden lowered significantly. Experimental application of DLTs on clearing and settlement has, however, produced mixed results and hurdles in the development of the technology will need to be overcome for the application to arrive at the stage where it can provide better performance than systems currently in use.

A tokenised form of central bank currency or stablecoins could possibly be necessary for the *payment leg* of security settlement on DLT-based trading venues. This raises the question of whether and how NCBs would facilitate the tokenisation of central bank money for use in tokenised markets, or whether such function would instead be performed by stablecoins (or central bank digital currencies, if these become available).

Tokenisation of physical assets may ultimately depend on the existence of a trusted and credible central authority (such as a *custodian*) who will guarantee the connection of the off-chain world with the blockchain (e.g. existence and custody of unique assets backing the tokens).

Tokenisation of assets will require a solid *business rationale* for the use of DLTs and such practice can be justified by increased realised efficiencies; increases in safety and trust; reduction in complexity and disintermediation; or by the absence of existing trading infrastructure for the asset. Wider adoption of tokenisation could be envisaged in markets with limited liquidity and multiple layers of disintermediation (e.g. private placements of non-listed SME securities). Conversely, the adoption of tokenisation in equity markets of developed economies, which enjoy high levels of trust and are supported by fast, safe and efficient processes may not be sufficient to justify the transition to DLT-based systems as there are very little net incremental efficiency gains achievable, as compared to the cost of upgrading the infrastructure and systems of all market participants.

Tokenised markets should comply with *regulatory requirements* that promote financial stability, financial consumer protection, and market integrity while promoting competition. Tokenisation can be seen as merely replacing one digital technology (electronic book-entries in securities registries of central securities depositories) with another (cryptography-enabled dematerialised securities based on DLT-enabled networks), therefore raising no issues in jurisdictions with a technology-neutral approach to regulation.

It can, however, sometimes be difficult to know with certainty whether tokenisation falls within the regulatory perimeter or is fully captured by the perimeter, especially given the novel nature of some new business models and processes involved. Potential gaps in the regulatory treatment of tokenisation may give rise to regulatory arbitrage opportunities. Existing regulation may need to apply to new actors (e.g. trusted third party guaranteeing the accuracy of information at the onboarding of the asset on-chain and safeguarding the asset) and/or new requirements may be needed to be added (e.g. covering the interoperability between DLTs or the interaction or gateways linking the on-chain and off-chain environments). New risks that may arise from the application of DLT technologies (e.g. associated operational risks; digital identity) will also need to be appropriately supervised.

At the same time, the regulatory perimeter of tokenised assets that do fall within the existing regulatory regime may not be fully and correctly understood by market participants. Regulatory or legal ambiguity around asset tokenisation can create uncertainties and risks for participants in tokenisation markets and undermine the smooth functioning of such marketplaces, with potential indirect impact on the conventional, off-chain markets. Greater clarity around the regulatory/supervisory frameworks applied to tokenised assets and markets will be a stepping stone to their safe development and use by market participants. Cross-border transactions of tokenised assets require international cooperation to limit regulatory arbitrage and for the smooth operation of tokenised markets.

Wider use of tokenised securities raises potential financial consumer and investor protection and market conduct issues, the handling of which will be essential to safeguard investors' interests and ensure a fair

and orderly market for tokenised assets. Recourse and redress in case of damage due to a technical issue, theft or non-existent real asset backing the tokenisation is only one example of such investor risk involved. Market integrity issues can arise stemming from the immaturity of the market, the potential lack of monitoring and controlling mechanisms, combined with a lack of information around tokenisation. Financial education efforts would be indispensable for the protection of investors in tokenised markets, especially given the potential for increased participation of retail investors in such markets.

1. Introduction

The emergence of blockchain and other distributed ledger technologies (DLTs)[1] and their use in financial markets can facilitate the exchange of value without the need for a trusted central authority or intermediary (e.g. government, bank) and allow for efficiency gains driven by such dis-intermediation (OECD, 2019).

Issuance of crypto-tokens[2] has been the most hyped application of DLTs, with most of the debate both for industry and regulators/policy makers focused around tokens issued in initial coin offerings (ICOs) for financing purposes. The exuberance around ICOs slowly unwound in 2018, driven by increased regulatory scrutiny and a crash in token valuations, leading to a downward trend in ICO issuance levels.

The use of DLT-based tokens in financial markets has nevertheless kept growing, and asset tokenisation has become one of the most prominent use-cases of DLTs in financial markets. Such assets include securities (e.g. stocks and bonds), but also commodities (e.g. gold) and other non-financial assets (e.g. real estate).[3]

The tokenisation of assets involves the creation of digital tokens representing real assets issued on the blockchain. The potential of asset tokenisation is theoretically unlimited, as any real asset can allegedly be "put on the blockchain". In 2019, Pacific International Lines and IBM ran a successful pilot for the tracking of a 28-ton shipment of mandarin oranges on the IBM Blockchain Platform (IBM, 2019). Tokenising real assets involves much more than simply tracking data on DLTs, and undertaking a transaction on DLTs could actually have real world legal effects, such as the transfer of ownership of a shipment. Asset tokenisation has potential cross-cutting implications for financial market practices and participants, market infrastructure and regulators across a large range of financial instruments and asset classes.

Given the above, a discussion on the potential implications of asset tokenisation for (parts of) the financial markets is warranted. Increased use of asset tokenisation could have widespread potential benefits in terms of cost and speed efficiencies, increased transparency, liquidity and more inclusive participation of retail investors in assets of constraint access to them in traditional forms. Although the use of tokenisation is currently limited, its potential is significant. Careful consideration of the possible impact on financial markets of a proliferation in the use of asset tokenisation will allow policy makers to anticipate potential perils linked to the wider use of such mechanisms.

This report provides a high-level overview of asset tokenisation; touches upon its main benefits; examines challenges to its wider adoption; discusses its potential disruptive effect on trading, liquidity, pricing, clearing and settlement; and analyses the increased importance of custodianship in a tokenised environment. The report concludes by discussing some of the high level policy implications of asset tokenisation in the financial markets.

The report does not discuss tokenisation of central bank digital currencies or other forms of 'stablecoins', given their implications for central banks and monetary policy.

2. What is tokenisation of assets and why is it important? Definitions and benefits

Given the absence of a common classification framework for crypto-assets, the market is defining tokenisation in a number of different, sometimes conflicting, ways. Tokenised assets are often confused for native digital assets such as the bitcoin or central bank digital currencies, while issuance of tokenised securities is identified by some as the next generation of ICOs.

2.1. Defining tokenised assets

2.1.1. Tokenisation of real assets that exist off-the-chain

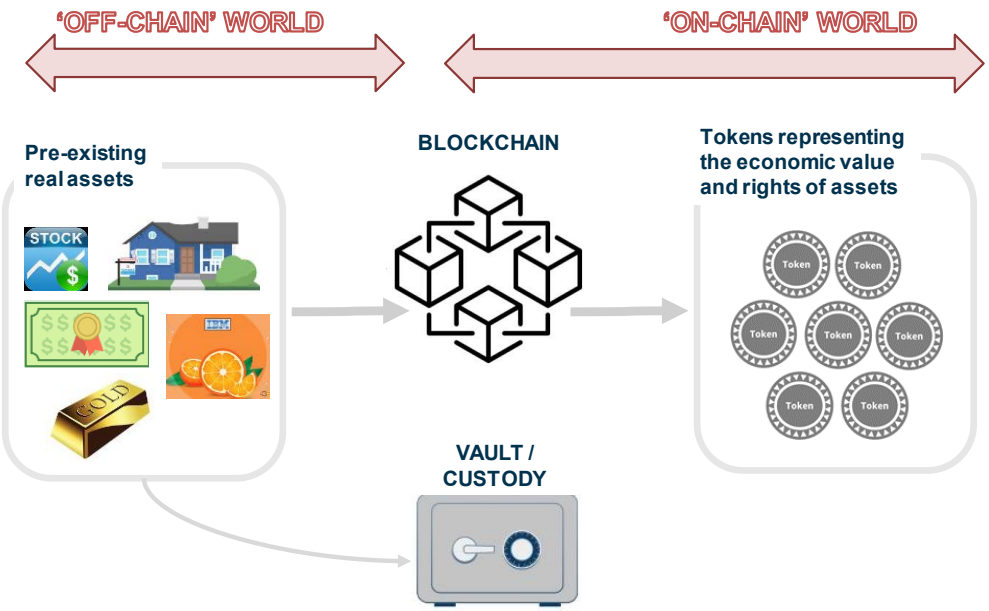
Tokenisation is the process of digitally representing an existing real asset on a distributed ledger (Hileman and Rauchs, 2017). The Financial Stability Board defines tokenisation as the representation of traditional assets – e.g. financial instruments, a basket of collateral or real assets – on DLT (FSB, 2019). Asset tokenisation involves the representation of pre-existing real assets on the ledger by linking or embedding by convention the economic value and rights derived from these assets into digital tokens created on the blockchain.

Tokens issued in asset tokenisation exist on the chain and carry the rights of the assets they represent, acting as store of value. The real assets on the back of which the tokens are issued continue to exist in the "off-chain" world and, in the case of physical real assets, those would typically need to be placed in custody to ensure that the tokens are constantly backed by these assets. This points to an increasingly important role of custodianship of assets in tokenisation transactions (see Section 3.5).

Communication between the "off-chain" (traditional financial market infrastructures) and "on-chain" environments will be crucial for assets that continue to exist off the chain.

In theory, any asset can be tokenised and rights to such asset be represented on a distributed ledger. Issuance of tokens backed by fiat currencies, which is one form of "stable coins", has rapidly increased with many new stablecoins being issued and with a market capitalisation that is growing. Real assets that are being tested in pilots or at concept stage involve real estate assets (see Annex); commodities such as gold (e.g. https://ekon.gold/), or art. Intangible assets, such as intellectual property, could also be tokenised, creating new innovative digital assets and markets.

Figure 2.1. Tokenisation of real assets that exist off-the-chain

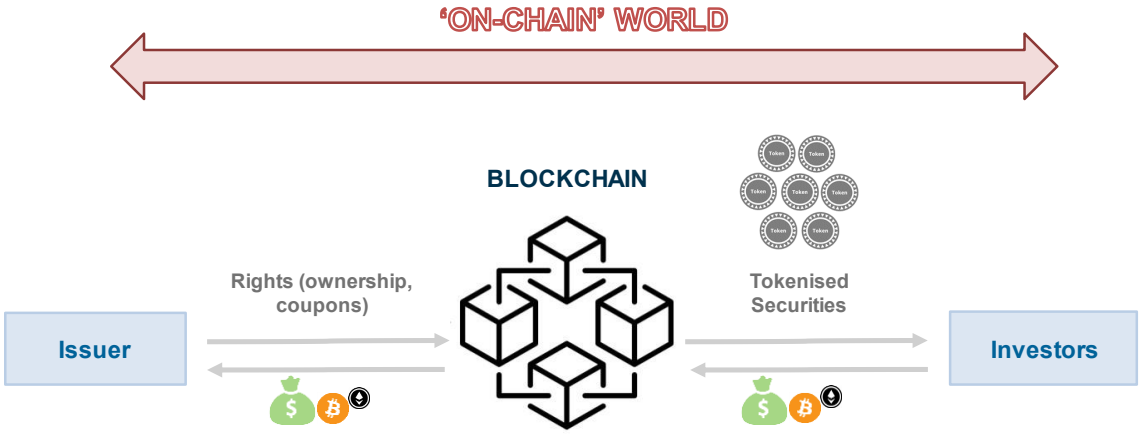


2.1.2. Tokenisation of assets native to the blockchain

Important distinctions need to be made between tokenised assets that exist off-the-chain and tokens that are "native" to the blockchain. "Native" tokens are built directly on-chain and live exclusively on the distributed ledger. The Bitcoin and other cryptocurrencies and payment tokens are examples of "native" tokens. "Native" tokens derive their value in and of themselves and are defined by their existence on the blockchain.

Tokens issued in initial coin offerings (ICOs) are another example of "native" tokens. ICOs consist of the creation of digital tokens by start-up companies and their distribution to investors in exchange for funds for the purposes of fundraising (OECD, 2019). Tokens issued in ICOs are generated within the blockchain and are not backed by an off-chain security or other asset. This has important implications for market structure and governance, given that tokens issued in ICOs are independent of the conventional, off-chain part of the market.

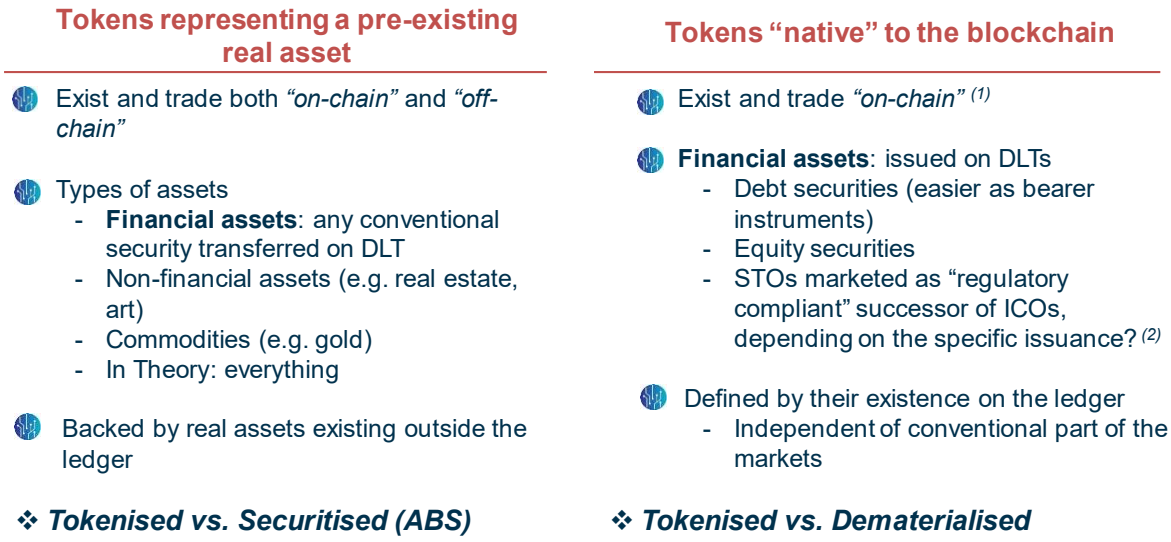
Figure 2.2. **Tokenisation of assets "native" to the blockchain**



Examples of tokenisation of assets native to the blockchain include tokenisation of the equity of a non-listed company, where the free float of the company is digitally represented by tokens and placed to investors on the blockchain. Such a transaction would constitute the equivalent of a digitalised on-chain private placement of securities. A similar structure would apply to private debt placements.

Investment funds and alternatives such as private equity and venture capital funds, as well as real estate investment vehicles, are also thought to be suitable for tokenisation given the near-total absence of liquidity of participation in such funds/vehicles.

Figure 2.3. The two types of asset tokenisation



Notes: (1) Tokens native to the blockchain can also trade between and among customers of platforms within the platforms' omnibus account. (2) STOs are marketed as more "regulatory compliant" forms of token issuances, however, such determination will only depend on the specific issuance on a case-by-case basis.

To illustrate the difference between tokenisation of dematerialised (book entry) real world assets which also exists in the real world against those 'native' to the blockchain, one can think of the consequences of a potential failure of the underlying blockchain technology. If a Blockchain were to face operational failure for whatever reason, shareholders whose shares exist off the chain and which were "recorded" on the Blockchain would remain shareholders post-failure, as opposed to native token-holders, where there is no real world connection at all.

2.2. Tokenising financing assets: equity and debt

When it comes to financial assets, tokenisation of securities (equity and/or debt) is seen by the market as the sector with the most imminent potential for growth. This is mainly driven by the recent hype around tokens issued in, mostly unregulated, ICOs and the currently trending 'Security Token Offerings' or STOs, which has been marketed as a more "regulatory-compliant" successor of ICOs aiming to raise capital, as well as 'Security Tokens' representing existing securities in secondary DLT markets. Both the above designations are self-defined by market participants and the designation of an issuance as regulatory compliant will only depend on the particular issuance on a case-by-case basis.

STOs are securities offerings consisting of the issuance of DLT-based tokens that aim to comply with the securities regulatory framework at the jurisdiction of issuance and at the jurisdictions where the offering is

marketed to investors. Regulations applying to the offering and throughout the security lifecycle are digitally represented on the blockchain through programmable enforcement of ownership and trading restrictions, for instance ('programmable securities'). STOs are self-defined as there is no formally agreed classification for such token offerings. Security Tokens, also self-defined, are tokenised versions of securities that are already issued by conventional methods (existing share certificates) which aim to bring these assets onto the secondary on-chain market in digital form. Whether the issuance will be regulatory compliant does not depend on the designation/use of a particular 'label' but will be determined on a case-by-case basis.

The electronification of financial markets and the use of automation for the issuance and trading of financial instruments is not new; securities have existed in electronic-only format for a long time in what is described as "dematerialised" form. Tokenised securities could be seen as a form of cryptography-enabled dematerialised securities that are based and recorded on a decentralised ledgers powered by DLTs, instead of electronic book-entries in securities registries of central securities depositories. The decentralisation of tokenised securities, coupled with the ability to automatically transact and settle without trusted intermediaries, may be where most of the disruptive potential of tokenisation lies. Tokenised securities eliminate the need for the use of intermediaries or proxies in the distribution of dividends or votes, giving investors full control of the equity they own.

Box 2.1. Industry initiatives for standardisation of token protocols: ERC1400, CMTA

In the early days of tokenisation, each token created was supported by a new, unique smart contract on the Ethereum blockchain. Lack of consistency in the engineering of the smart contracts used in each bespoke token ecosystem increase friction with stakeholders like custodians or exchanges who had to perform a technical due diligence.

To that end, an industry-led initiative has been promoting the development of a standardised framework for the tokenisation of securities, which resulted in the ERC1400 standard. The standard is programmed to automatically enforce specific conditions that relate to legal and regulatory requirements applicable to securities in different jurisdictions and allows for automated compliance of the tokenised asset with pre-defined requirements built in the code.

Indicatively, identification of investors and whitelisting is automatic and investors are able to invest only if they fulfil certain suitability criteria in line with the ones set by the regulator, depending on the jurisdiction. Securities asset servicing and corporate actions such as dividend distribution or lock-up periods are programmed in the standard and apply automatically without any further intervention. Importantly, the use of standardisation reduces the burden of technical due diligence for all stakeholders participating in the same ecosystem (potentially including regulatory authorities).

While the ERC1400 is not the only standard available for asset tokenisation, the direction of the industry towards the standardisation of smart contracts and protocols is expected to assist the proliferation of asset tokenisation as a practice.

The Swiss Capital Markets and Technology Association is planning the issuance of its own standard security token, implementing the minimum requirements under Swiss law and matching the legal tokenisation blueprint it issued in 2018 (CMTA, 2018).

Source: *Polymath network, Security Token Roundtable https://thesecuritytokenstandard.org/.*

As mentioned above (Section 2.1), and depending on the jurisdiction, tokenised securities can be either directly issued on the blockchain or issued as conventional securities that are tokenised at a second stage. Direct issuance on DLTs is more straightforward for bonds, given that these are 'bearer' assets on which no ownership information is recorded and whose possession accords ownership, but this will ultimately depend on the jurisdiction. Direct issuance of equities, as registered securities, is more cumbersome; the majority of current applications of equity tokenisation involve the digital representation of the rights to a share. Changes in corporate legislation would be required for equity tokens issued on DLTs to be recognised as such and not as the digital representation of share certificates.[4] The State of Delaware in the United States has updated its General Corporation Law to allow any company to issue equity in the form of a token and for tokenised stock or share to be legally admissible as evidence of ownership (Delaware State Senate, 2017).

Examples of tokenised securities issued directly on the blockchain include the Ethereum-denominated bond that Nivaura issued, cleared, settled and registered on a public blockchain infrastructure using the UK FCA regulatory sandbox (Allen & Overy, 2017) or the issuance, admission and trading of tokenised equity by 20/30 on the London Stock Exchange's Turquoise platform (see Annex). Examples of traditional securities issued on conventional platforms and transferred on the blockchain to be tokenised include the Schuldschein bond that Daimler issued in conventional form and with the use of blockchain technology in parallel (Daimler, 2017) and the tokenisation of Mt Pelerin's shares in Switzerland, in compliance with the Swiss regulatory framework (see Annex). Importantly, the Mt Pelerin's shares never existed in certificated form: these were issued in book entry form and then recorded and linked to tokens.

2.2.1. Parallels of tokenisation to asset-backed securitisation

An easy way to understand tokenisation of assets that exist in the off-chain world is to use the parallel of a DLT-based asset-backed securitisation. In the same way that securitisation as a structured finance technique pools assets together and sells securities carrying claims on the rights (cash flows) backed by the pool of assets, tokenisation of a real estate portfolio pools together real estate assets and represents the rights attached to such portfolio through tokens.[5] As tokens are in most cases digital representation of securities, tokenisation could be considered as a proxy for asset-backed securitisation on the blockchain.

Through both processes, illiquid financial assets are converted into liquid marketable securities, funded by and tradable in the capital markets. Some of the main differences lie in the structuring, as bundling is not necessarily the norm in tokenisation; the resulting securities being ring-fenced by originators in securitisation, which is not the case in tokenisation; and the fact that in securitisation there can be credit enhancement while in tokenisation the security's/token's credit quality can never be higher than that of the underlying asset. Setting up a structured product is expensive, and these investments are typically buy-and-hold investments with high minimum tickets for investors. In contrast, the possibility of fractionalisation allows for small minimum investments, while the application of DLTs facilitates trading in secondary markets.

Whether the arrangements between token holders and issuers are enforceable in a court of law will depend on the legal and regulatory framework applicable to the tokenisation transaction (especially in the absence of full documentation accompanying the structure).

Based on the above parallel, lessons learned in securitisation markets should be considered in tokenisation markets. These pertain to transparency of collateral; legal clarity of tokenholder claims on income streams produced by the assets; investor protection issues; duties of asset pool managers; incentives produced by originate-to-distribute business models; as well as the risks specific to the offering of such products to individual investors.

2.3. Benefits of tokenisation

The application of DLTs in asset tokenisation may deliver *efficiency gains* through the transfer of value without the need for trusted centralised intermediaries and/or through the efficient automation of processes, resulting in faster, potentially cheaper and frictionless transactions driven by disintermediation and automation. The use of smart contracts may reduce the cost of issuing and administering securities, further reducing the cost of transactions, increasing speed of execution and streamlining transactions. Smart contracts may facilitate corporate actions (e.g. coupon or dividend payments, voting), escrow arrangements (e.g. release of funds) and collateral management (e.g. exchange of ownership interest). Custody chains typically involved in traditional securities holdings may be shortened and their transparency increased, avoiding potential liquidity problems for market participants in case of operational issues or financial distress of sub-custodians (FSB, 2019).

Automation introduced in the issuance, distribution, management of securities but also around securities servicing and corporate actions may reduce costs throughout the securities transaction lifetime, benefiting issuers and investors alike. The distributed nature of the network with no single 'point of failure', the immutability of the ledger and the application of cryptography may add to the resilience and safety of the infrastructure. This of course depends on the applicable consensus mechanism and the governance model of each DLT which may give rise to other vulnerabilities (e.g. risks of forks).

In addition to the efficiency gains driven by its disintermediation potential, asset tokenisation may bring benefits of increased *transparency* regarding transactional data and information around the issuer and the asset characteristics, through enhanced information recording and sharing.[6] The financial markets may benefit from the data integrity, immutability and security (no single point of failure, subject to consensus and governance vulnerabilities) as well as automatic auditability that are inherent to many blockchain-based systems. In addition, DLT-based security registries may provide increased transparency and a clear record of beneficial ownership with certainty at any point in time. The role of registars/transfer agents may thus be rendered redundant and corporate/shareholder registries replaced by the decentralised ledger itself.

Increased transparency may also be achieved in terms of regulatory compliance and interactions with regulators: as programmed regulatory restrictions are automatically enforced, the regulator may be automatically notified through smart contracts when restrictions are modified or turned-off. Regulators may also have quasi-real-time information about specific on-chain events of interest to them.

It should be highlighted, however, that the quality of the data that is inputted into the blockchain is critical for the robustness of information recording and sharing. DLTs do not resolve the 'garbage in, garbage out' conundrum and poor quality of data inputs (e.g. malicious or erroneous 'oracles' feeding external data into the network) will result in a transparent, immutable, time-stamped repository of unsound or flawed outputs. In a tokenised world, it could be argued that there will be a need for regulated entities attesting to the accuracy of data before these are inputted onto the blockchain.

Tokenisation of assets could allow for *direct access* of investors in primary and secondary markets. ICOs were a prime example of tokens issued directly to investors on platforms/issuing venues facilitated by technology companies and without any middleman function in the traditional sense (OECD, 2019). Secondary trading, however, continues to occur mostly at centralised exchanges, and pure decentralised exchanges are yet to dominate tokenised trading (see Box 3.2).

The benefits from the wider use of assets tokenisation may be enjoyed by investors who would have the possibility to hold *fractional ownership* of assets (or interest in funds). Tokenisation of assets may allow for the slicing up of assets, dividing ownership into smaller claims than typically observed in stocks and bonds, in a way similar to structured products and securitisation. Investors, particularly retail, may therefore gain access to asset classes and risks that may have been otherwise beyond their capacity (e.g. participation in private equity funds) and participate in capital markets with lower minimum tickets or portfolio sizes.[7]

Investors would thus potentially be able to better design or diversify their investment portfolio in certain asset classes with larger ticket sizes in their conventional form (e.g. real estate, gain exposure to a specific neighbourhood or diversify holdings internationally) or with new digital assets (e.g. intellectual property).

Fractional ownership may allow for more *inclusive access* of small and retail investors to somehow restricted asset classes, while enabling global pools of capital to reach parts of the financial markets previously reserved to large investors. Private placements of equity or debt of small and medium-sized companies (SMEs) are examples of security transactions that are traditionally restricted to large institutional investors and funds.

Increase in the participation of retail investors in previously restricted asset classes in a tokenised world would not mean that participation of retail investors in high-risk products should be completely unrestricted. Limitations to their participation and relevant thresholds to protect their interests can apply, as with the example of accreditation of investors under Regulation D in the United States or through the application of suitability requirements. Compliance of tokenised assets with the relevant (pre-existing) applicable regulatory framework will allow for such safeguards to be in place, therefore clarity around the applicable regulatory framework is of paramount importance for the issuers and participants in tokenised markets.

In addition to enhancing inclusiveness in markets that were previously restricted to larger or institutional investors, a potential proliferation of tokenisation of such securities may *enhance access to finance for SMEs* by potentially allowing any type of investor, including retail ones, to indirectly or directly fund SME projects. The flow of private financing from capital owners to small corporates could be facilitated, allowing for a more efficient allocation of capital within the economy and increasing inclusiveness not just for the investor side but also for seekers of capital unable to access capital markets otherwise.

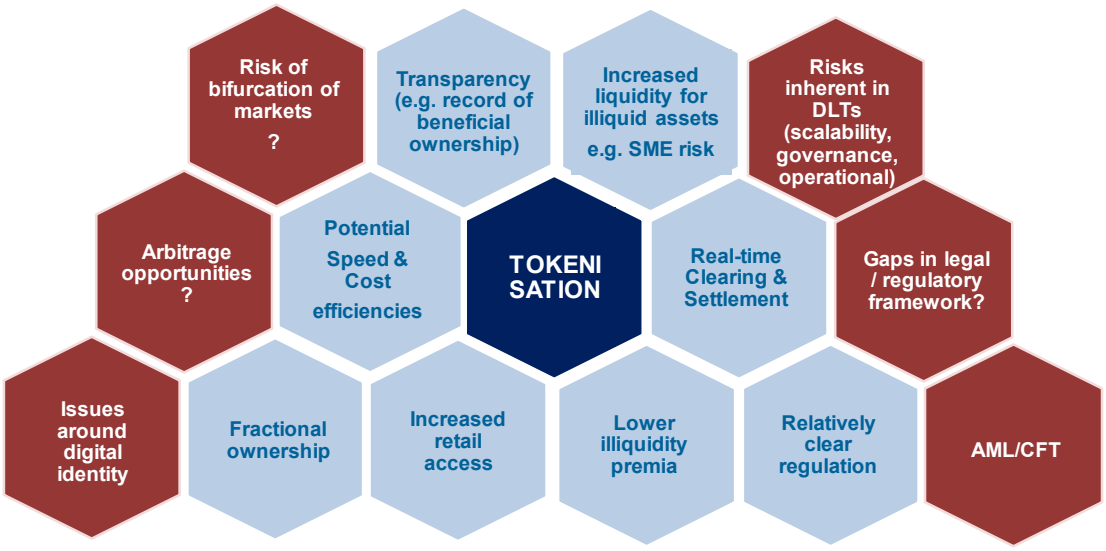
The financing of SMEs and the real economy could potentially be facilitated not just through direct smaller-size investment and holding of fractional ownership in assets previously illiquid or completely unavailable to part of the investor base, but also through the *tokenisation of funds*. Investors may further diversify their risks by allocating capital in asset classes that traditionally lack liquidity (e.g. private equity and venture capital), indirect promoting the use of such flows of capital from institutional investors to SMEs and start-ups, and enabling global pools of capital to finance their needs.

Importantly, a large part of the market argues that tokenisation of securities may benefit from a relatively clear regulatory and supervisory framework when compared to other crypto-assets, allowing for better regulatory compliance by its users. Although tokenisation has not benefited from regulatory arbitrage in the same way that the ICO market did over the past two years, the extent to which current regulation is sufficiently covering any and all aspects of tokenisation processes and practices is still debated. Potential for regulatory arbitrage may still be present in asset tokenisation markets, and possible gaps in regulation may still need to be examined.

Nevertheless, such ‘programmable’ securities are thought to potentially offer new possibilities of *automated compliance* with regulatory requirements. For example, in jurisdictions applying a limit to the number of investors allowed to participate in an offering, such limit may be programmed and built into the smart contract used for the distribution of tokenised securities, blocking any further investors from participating once the regulatory threshold applying has been reached.

Asset tokenisation and the trading of tokens representing assets in secondary markets may *increase or create the potential for liquidity* for those assets, provided there is sufficient volume of trading (or a market-making function). This could be particularly important for assets with near-absent liquidity, such as some SME securities or Private Equity/Venture Capital (PE/VC) investment funds. At the same time, trading in secondary markets of tokenised assets that continue to be traded off-chain, risks creating a bifurcation of markets with negative consequences to liquidity conditions at conventional exchanges (see Section 3.2).

Figure 2.4. Benefits and risks of asset tokenisation



According to some, tokenised securities may benefit from lower "illiquidity premia[8]" which will allows investors to capture greater value from the underlying asset (Deloitte, 2018). As investors expect higher yields from typically illiquid assets these carry an illiquidity premium over and above the fair value of the asset, to reflect the higher risk of holding assets that cannot be easily sold over a longer period of time or in market downturns. Tokenised assets may carry *lower illiquidity premia* allowing for the asset to trade closer to its fair value. This, however, may be a difficult proposition to test as liquidity/illiquidity premia are difficult to isolate, quantify and dissociate from systemic or market risk. According to some market participants, the benefit described above may be greater for the most illiquid asset classes (e.g. privately held SME equity, real estate, etc.), given that these carry the highest illiquidity premia.

A potential indirect benefit of asset tokenisation to market participants is related to potentially *faster clearing and settlement* driven by the near-immediate transfer of ownership on the blockchain and the continuous reconciliation of the ledger that is updated with every transaction. Increased efficiencies in clearing and settlement processes may perhaps be the biggest breakthrough of asset tokenisation with wider disruptive implications for financial markets (see Section 3.4) and may result in reduced counterparty and operational risks (FSB, 2019) in permissioned blockchains. Uncertainty around settlement finality in public permissionless blockchains eliminates such potential benefit. At the same time, the ability to conduct 'atomic swaps', i.e. the wallet-to-wallet exchange of two digital assets simultaneously in a single operation[9] across different blockchains without going through any centralised intermediary (e.g. exchange) significantly may reduce, if not eliminate, counterparty risk, however, these types of transactions are not widespread as the underlying technology is still quite nascent.[10]

Issuing and transacting in a tokenised world is argued by the industry to be promoting the creation of *new products and asset classes*. This is not necessarily accurate, as it is rather the form and not the substance of the asset classes that changes through tokenisation. Nevertheless, a tokenised environment may indeed create new and different incentives to participants, stemming from the nature of the underlying distributed ledger technology. For example, the more applications/use-cases are built on top of the base protocol layer of a tokenisation platform, the more network effects can be realised and the more value can be derived from participation in the platform. Distribution of incentives is also different in a tokenised marketplace, with the different participants absorbing higher or lower rents from security transactions, when compared to traditional 'off-chain' markets.

Box 2.2. Energy consumption and validation mechanisms

The choice of validation mechanism or consensus process will determine the amount of energy consumed for each transaction that gets validated in a blockchain network and/or the cost thereof.

Energy intensive 'proof-of-work' consensus mechanisms, such as the ones applicable to the Bitcoin blockchain, require miners to solve complex mathematical puzzles to validate a new transaction, adding a block to the chain and permanently and irreversibly recording a new transaction. The proof-of-work validation mechanism is slow and highly energy-intensive given that the machines performing the 'work' are consume huge amounts of computing power for mining and render this consensus process unsustainable. According to one estimate, bitcoin transactions may consume as much electricity as Denmark by 2020.

Blockchain applications are increasingly shifting to 'proof-of-stake' mechanisms. These are energy efficient alternative validation mechanisms for the verification of transactions/blocks without the need for expensive computations. Miners are replaced by validators and the choice of the validator in such mechanisms is based on the holding of a stake (tokens) in the network.

Proof-of-stake mechanisms are also considered to be safer, as validators lock up their stake and put their capital at risk, given that they are slightly compensated for every validated transaction but harshly penalised for manipulation or attempted attack to the network. While in proof-of-work security comes from burning energy, in proof-of-stake security comes from putting up economic value at loss.

It should be noted, however, that neither proof-of-stake nor proof-of work models are immune to manipulation though a "51% attack". In the case of proof of stake models, an entity or a coalition of entities holding more than 50% of outstanding tokens can validate any transactions they wish, regardless of rules, including, in theory, double spends and misappropriation.

Source: *Vitalik Buterin, A proof-of-stake design philosophy.*

2.4. Challenges to a wider adoption of asset tokenisation

The adoption of asset tokenisation at a large scale would face a number of challenges related to the underlying technology itself. Scalability is still a technological challenge of DLT-enabled networks and is relevant to asset tokenisation given the significant throughput that would be required for the scale of global financial markets. Settlement finality, i.e. final and irrevocable settlement of payment instructions with deterministic finality, may still be a hurdle for some blockchains. Interoperability between different networks needs to be secured for connectivity between markets to be allowed. Other operational risks include network stability, exposure to cyber-risk, risk of hacking and 51% attacks, but also business risks related to the migration to a DLT-enabled environment.

Governance issues, particularly relevant to fully decentralised ledgers, relate to the difficulty in identifying a sole owner or node accountable for the full network. The absence of a single accountable point is a problem that also arises when regulating DLT networks, or when responsibility for a failure in the network needs to be assigned. Network participants can perform '51% attacks' if the majority of the network decides to make changes that are not in line with the initial plan or can 'fork' if they disagree with the original protocol and decide to deviate and develop a separate network by adjusting the basic code (for permissionless DLTs).

Rapid advances in the field of digital technology raise forward-looking questions regarding technological robustness of market infrastructures based on DLT in the face of quantum threats to symmetrical cryptography[11] and even more so to asymmetrical[12] cryptography. The latter is, for example, useful for signing transactions on public blockchains. Further research is required on asymmetric postquantum cryptography for its safe use in tokenised markets.

A potentially unclear regulatory and legal status for certain tokenised assets is a risk to market participants, and can be addressed by clarity and interpretation of existing law and regulation by financial regulatory and supervisory authorities (see Box 2.3 and Section 4).

The legal status of smart contracts still remains to be defined, as these are still not considered to be legal contracts in most jurisdictions (see Box 2.3). Until it is clarified whether contract law applies to smart contracts, enforceability and financial protection issues will persist. The auditability of the code of such smart contracts will require additional resources from market participants who will wish to confirm the basis on which such smart contracts are executed.

Box 2.3. Enforceability of smart contracts and legal status of cryptoassets under private law: the example of the UK Jurisdiction Taskforce

Perceived uncertainty around the legal status of cryptoassets and the enforceability of smart contracts under private law may inhibit the wider of use and trading of such assets as investors are not confident that their legal rights are appropriately protected. In particular, there is perceived uncertainty around whether cryptoassets qualify as property under private law, and whether smart contracts written in code give rise to binding legal obligations.

These questions are critical because if cryptoassets are not recognised as property under private law, they cannot be owned. Similarly, if a smart contract does not give rise to binding legal obligations, the rights of transacting parties cannot be enforceable in the event of a technology glitch.

Similar uncertainty exists as to whether DLT records of cryptoassets are capable of amounting to a ‘register’ for the purposes of evidencing, consulting and transferring title to certain types of securities under private law.

The UK Jurisdiction Taskforce (the “UKJT”) of the LawTech Delivery Panel brings together the Judiciary, the Law Commission of England and Wales and technology and legal professionals, with the Financial Conduct Authority acting as a technical advisor. In May 2019, the UKJT launched a public consultation to identify and analyse key legal questions that need to be answered in order to provide a dependable foundation for the mainstream utilisation of cryptoassets and smart legal contracts in England and Wales.

The objective of the Taskforce is to issue a legal statement on the status of cryptoassets and smart contracts under English private law, expected in H2 2019.

Source: *Source:* UKJT (2019).

Questions arise also around data protection and privacy but also around storage of data and regulation applicable to the usage, sharing and storage of data. This is particularly pertinent in jurisdictions with data privacy regimes such as GDPR in Europe, requiring watertight consent management processes in place, effective data rights management systems to be in place, which can be somehow addressed in permissioned blockchains. Data Erasure clauses, however, provide clients with the ‘right to be forgotten’, which is the total antithesis of the immutability of the blockchain and will be harder to address for

information that is written on the chain.[13] Nevertheless, it has been proven that privacy of transactions can be achieved in tokenised environments, where only relevant parties have visibility to transaction details (e.g. Monetary Authority of Singapore Project Ubin, Phase 2; EY's zero-knowledge proof (ZKP) private transaction protocol of Project Nightfall (EY, 2019).

Wider issues around identity and the management of digital identity at scale will also need to be addressed. Currently, there are no clear mechanisms in place to prevent, for example, 'wash trading' and other market manipulation techniques. Without a unified approach to digital identity, participants can artificially affect the price of a digital asset through such techniques. As trading expands from within an exchange to across exchanges and across jurisdictions, that risk is expected to drastically increase. Such risks can be addressed by using strong AML/KYC checks and the use of regulatory-compliant platforms.

Risks related to AML/CFT are prominent in DLT-based systems and are particularly high in tokenised markets that are based on public permissionless networks, especially when the protocol allows for anonymity of users. In 2019, the Financial Action Task Force has issued important guidance on obligations of virtual asset activities and service providers (see Box 2.4) (FATF, 2019).

As private incentives established through the securities lifecycle are expected to be shifted around, fade or disappear in a tokenised environment, market participants do not equally share the motivation to transition to a blockchain-enabled market. For tokenised assets to achieve enough depth to be traded solely on-chain, the tokenisation of the asset must be advantageous to the issuer in terms of cost and potential benefits, and, importantly, investors also need to trust the tokenised market. To that end, public investment in financial education would be necessary if tokenised markets were to reach retail investors.

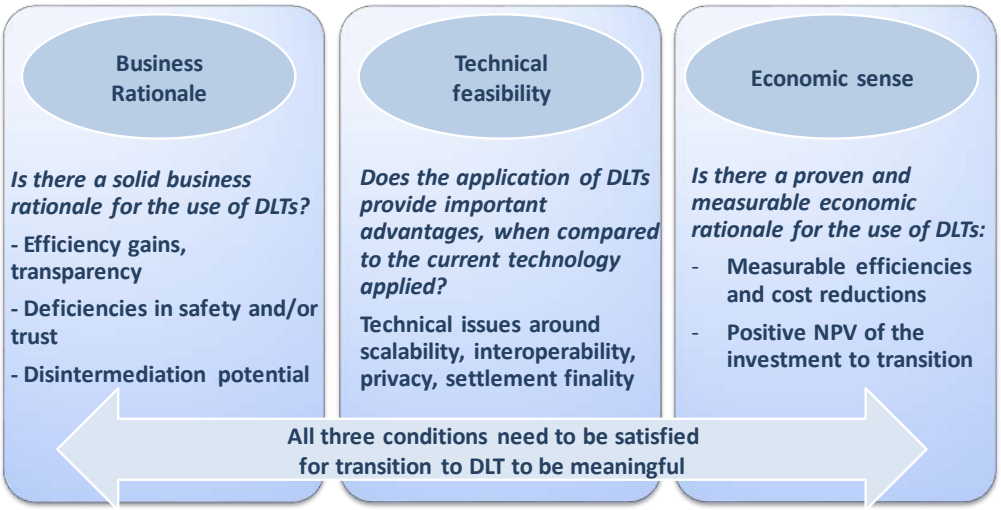
Moving from legacy infrastructure to DLT-based networks requires significant investment from market participants, and can only be expected to materialise once efficiency gains are proven and measurable for each asset type of security and for each process of the securities lifecycle. Vested interests of certain market participants may still instigate barriers to the adoption of DLT-enabled tokenised markets.

The willingness and ability of the industry to agree on coordinated efforts to develop global or interoperable infrastructure solutions is not guaranteed. According to some, clear-cut incentives to transition to a blockchain-enabled financial market infrastructure would be required for the entire system to transition to an on-chain environment. Standardisation in the protocols and coordination between market participants would also enable the quicker adoption of DLT-based technologies and a broader and faster transit to such networks.

Risk of unrealistic expectations built by some industry participants may incentivise them to transition to DLT-based solutions without a proven rationale for such transition. The application of DLT-enabled use cases in the financial markets and beyond is meaningful only where there is

i) *a solid business rationale* for the application of DLTs (e.g. does the use of DLT solve a real business problem? Are there deficiencies in trust or safety, is there sufficient room for disintermediation, are there measurable efficiency gains to be reaped? How does the DLT-based use case compare to the conventional one?);
ii) *a technical feasibility assessment* proving that the application of DLTs provides significant advantages when compared to the currently applying technology, and also that major technical challenges are overcome; and
iii) *an economic rationale* for the transition to DLTs, i.e. proven and measurable economic justification for the application of DLTs (e.g. measurable efficiencies and cost reductions and how these compare to the investment required for the transition to an on-chain environment).

Figure 2.5. Conditions for a meaningful application of DLTs in financial markets



Box 2.4. Financial Action Task Force (FATF): latest standards relating to virtual assets

On 21 June 2019, the Financial Action Task Force (FATF) adopted and issued an Interpretive Note to Recommendation 15 on New Technologies (INR. 15) that further clarifies the FATF's previous amendments to the international standards relating to virtual assets and describes how countries and obliged entities must comply with the relevant FATF Recommendations to prevent the misuse of virtual assets for money laundering and terrorist financing and the financing of proliferation.

Previously, in October 2018, the FATF updated its Standards to clarify their application to virtual assets and virtual asset service providers by amending Recommendation 15 and adding two new definitions to the FATF Glossary. INR. 15 establishes binding measures relevant for both countries and virtual asset service providers (as well as other obliged entities that engage in or provide virtual asset products and services) in order to establish a more level playing field across the virtual asset ecosystem.

The obligations require countries to assess and mitigate their risks associated with virtual asset activities and service providers; license or register service providers and subject them to supervision or monitoring by competent national authorities (notably, countries will not be permitted to rely on a self-regulatory body for supervision or monitoring) and implement sanctions and other enforcement measures when service providers fail to comply with their AML/CFT obligations; and underscore the importance of international cooperation. Some countries may decide to prohibit virtual asset activities based on their own assessment of the risks and regulatory context, or to support other policy goals.

Further, INR. 15 requires countries to ensure that service providers also assess and mitigate their money laundering and terrorist financing risks and implement the full range of AML/CFT preventive measures under the FATF Recommendations, including customer due diligence, record-keeping, suspicious transaction reporting, and screening all transactions for compliance with targeted financial sanctions, among other measures, just like other entities subject to AML/CFT regulation. This includes coordination with relevant authorities to ensure the compatibility of AML/CFT requirements with Data Protection and Privacy rules and similar provisions.

The FATF has also published updated Guidance for a Risk-Based Approach to Virtual Assets and Virtual Asset Service Providers, which builds upon the FATF's 2015 guidance paper, to further assist countries and providers of virtual asset products and services in understanding and complying with their AML/CFT obligations.

Source: FATF, 2019.

3. How can asset tokenisation disrupt the financial markets

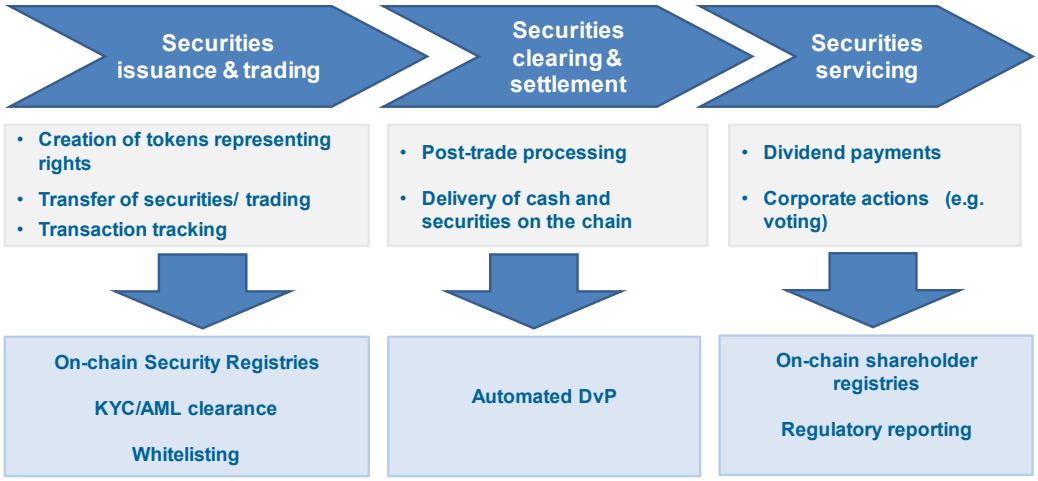
A potential future proliferation in the use of asset tokenisation in financial markets can have implications on liquidity, but it can also affect trading, asset pricing, clearing and settlement of securities, and even monetary policy transmission.

When looking at the potential disruptions in the markets from such a phenomenon, a differentiation needs to be made between the following two structures in the securities context:

i) tokenisation of securities that also exist off-the-chain, e.g. securities traded off-chain, with some part or the entirety of securities being tokenised and transferred on-chain; and

ii) issuance of securities in tokenised form directly on-chain and native to the blockchain, i.e. without issuing securities in the "conventional" form.[14] [15]

Figure 3.1. Areas in securities markets with DLT use-cases and potential



3.1. Trading implications

DLTs enable transactions where trust is distributed between the nodes participating in the network, with no central trusted authority or middleman needed to validate a relationship between two transacting parties. Investors can act as the broker-dealers for themselves, and transactions are validated and confirmed by the participants of the decentralised network in exchange for some transaction fee. As such, the market-making model is expected to be disrupted by an increased use of tokenisation, with implications for the structure, and possibly for the smooth functioning, of the markets.

3.1.1. Disintermediation and disruption of the market-making function

Market-makers provide two-way pricing to investors who want to buy or sell a security. The role of market-makers is more prominent in markets with a smaller investor base and a need for liquidity provision, particularly in times of market stress, when market-makers take the other side of the trading order in the absence of balance between supply and demand. In theory, the matching between buyers and sellers in a decentralised market for tokenised securities is automatic and no dealer intermediation is required. At least in the securities context, the efficiency gains of tokenisation are linked to the disintermediation of the broker (or other middleman, such as depositories and/or clearing houses, for instance).

In practice, however, operators of asset tokenisation offer market-making services to clients even in blockchain-based markets.[16] This does not necessarily mean that dealer intermediation cannot be replaced by the technology underlying the distributed ledger, but rather that DLT-based tokenisation networks currently in operation may not have sufficiently liquidity; or that the provider of the platform may have economic incentives that encourage the preservation of the broker model in a tokenised environment. According to some securities industry participants, brokers are still useful in decentralised environments for the execution of large-sized orders. This points to the critical question of how much decentralisation is desirable and whether the right incentives are in place for a fully decentralised tokenisation market to emerge.

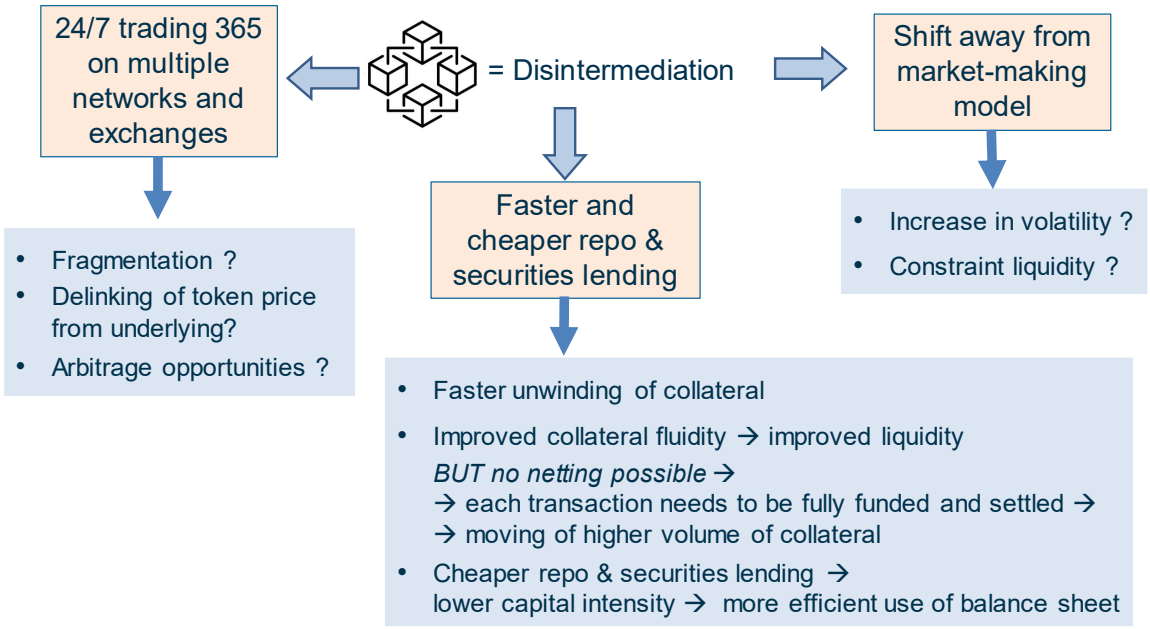
The way that efficiency gains will be distributed across network participants will depend on the level of decentralisation (fully decentralised networks or centralised exchanges); type of DLT (permissioned/permissionless); the validating mechanisms and verification process applicable to the confirmation of transactions; whether mining is required or not; or the use of smart contracts. In practice, part of the efficiency gains will naturally be captured by the developers of the protocol and the providers of the infrastructure for the distributed network which effectively acts as the issuance and/or trading platform for the tokenised asset. Indeed, the vast majority of the secondary trading of tokens today happens in centralised crypto-trading platforms[17].

A shift away from a market-making model could have an impact on the smooth functioning of some markets and the redistribution of risks across them. The resilience of the markets could be affected by potential systemic effects of sell-offs that may occur in the absence of market-makers warehousing traded assets on their balance sheets and acting as “shock-absorbers”. In times of stress, intermediaries sitting in the middle of transactions take “the other side of the deal”, and may mitigate extreme volatility that may result as a result of investor herding behaviour likely to occur when investors are moving to the same direction. At the same time, dealer intermediation is not guaranteed at all times, and market-makers are thought to pull back from stressed markets, even if they provide liquidity under normal circumstances, so as to cover themselves from losses when market valuations change (Adrian et al., 2013). In the case of tokenised assets, a total absence of an intermediary capable and willing to warehouse tokens and provide liquidity when markets go down could have knock-on effects on the liquidity of the market. Such effect would be exacerbated for native tokens trading solely on the blockchain, and may be somehow mitigated for tokenised assets for which an off-chain market will also exist in parallel, with conventional market participants.

Whether a complete disintermediation of tokenised asset trading is desirable is open to debate. Market-makers provide liquidity and allow for a smooth trading flow, as buyers and sellers do not need to post matching orders simultaneously. Without any market-making activity to smooth out rapid swings in supply and demand, the overall volatility of the market may increase.

A complete disintermediation could therefore have an effect on the markets, particularly in times of stress and extreme volatility. Timely liquidation of large holdings in a tight timeframe may become challenging, particularly in less liquid securities (fixed income as opposed to equities). At the same time, if broker-dealers are present in blockchain-based markets of tokenised assets, the efficiency gains of decentralised DLT systems may not necessarily be fully realised.

Figure 3.2. Potential implications of tokenisation for trading and pricing



3.1.2. Disruption of repo activity

A potential take-off in asset tokenisation activity could also have an impact on the repo activity for the funding of positions, as well as on securities lending activities used as part of trading strategies. The shift of the above activities on-the-chain has the potential for faster and less costly securities lending, as fewer steps are involved in the process and transfer/unwinding of collateral is direct and instantaneous. This would potentially mean that the overnight repo market becomes an almost 'instantaneous' market.

What is more, the wider market could benefit from improved liquidity levels as collateral would be freed up and mobilised across securities pools sitting in different accounts across the globe and participating in the same network.[18] When assets and transactions of such assets are recorded on a distributed ledger, everyone has the knowledge of where the assets sits at a specific point in time, therefore collateral can be traced and moved through different pockets in the system in a seamless way.

The flipside of the above improved levels of liquidity in collateral is that no netting would longer be possible, and each transaction would probably need to be fully funded and settled. This would result in the moving of higher volume of collateral in gross terms instead of mobilising only the net collateral post netting.

The efficiency gains will be mostly enjoyed by intermediaries performing these specific activities, who would benefit from more efficient use of their balance sheet and lower capital intensity associated with such activities by reducing the capital tied up for such operations. This may partly explain that pilot projects run by banking and technology consortia for on-chain collateral management are being implemented on *permissioned* blockchains managed by these market players.[19]

Box 3.1. Permissioned vs. Permissionless distributed ledgers for asset tokenisation

The impact of tokenisation in financial markets will depend to a large extent on the type of distributed ledger used and on the rights and incentives provided to participants by the network.

In permissioned distributed ledgers, only authorised participants are allowed to join the network and a central authority grants participants access, rights to read, write or validate transactions. For example, only a limited number of approved network participants can validate transactions and propose updates to the ledger. Permissioned DLTs allow for easier AML/KYC checks and implementation of privacy requirements as well as a higher security for the network given the control over access and transaction validation, although these come at the cost of potentially lower resilience given the dependence on a central authority. Consensus depends on appointed validators participating in the network and tasked with verifying transactions executed in the network.

In permissionless ledgers, on the other hand, anyone can join the network and participate in validation of transactions (e.g. Bitcoin blockchain). Permissionless networks provide for far greater decentralisation and complete disintermediation and therefore allow for the full materialisation of efficiency gains and automation promised by DLTs. Such networks offer greater resilience given the larger number of nodes in the network and the absence of a single point of failure. Native cryptocurrencies issued in permissionless ledgers allow for the alignment of incentives in such networks.

At this stage of development of the tokenisation market, permissioned ledgers are the dominant architecture for issuing and trading platforms and networks. As such, some of the main functions of securities transactions is expected to remain centralised and controlled by the central authorities of the network, perhaps represented by established intermediaries in conventional securities markets. Permissioned networks allow for greater privacy, too, by controlling access to and updating of data to permissioned only nodes.

The deployment of tokenisation in permissionless ledgers would allow for the full realisation of the efficiencies offered by the use of DLTs, however, represents higher risks for the markets and their participants. From a regulatory perspective, it is difficult to regulate a fully decentralised system without a ‘single point’ of contact where regulation would apply. Compliance with legal and regulatory requirements such as AML/CFT controls is more challenging in fully decentralised networks, while additional complexities arise in terms of governance; cross-border application of regulation; and respective financial consumer protection considerations.

3.2. Liquidity implications

In a scenario of proliferation of asset tokenisation, the number and diversity of assets that would trade in public markets and gain liquidity could increase, given that in theory, any asset can be tokenised. DLT infrastructure providers already allow for the white-labelled tokenisation of different types of tangible and intangible assets using the same infrastructure and protocols (see for example https://polymath.network/ or https://tokeny.com/).

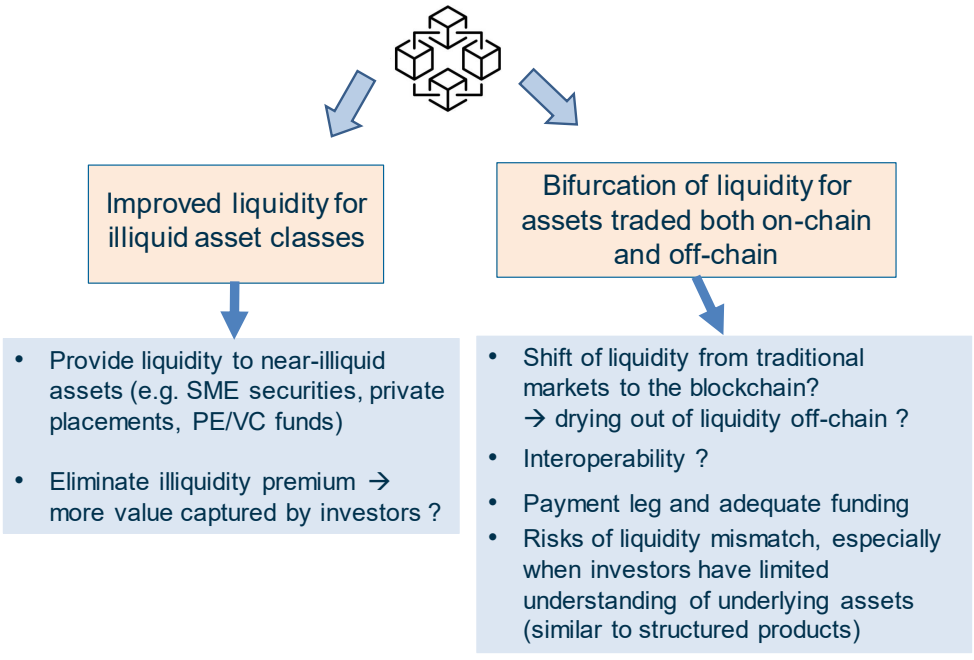
3.2.1. Benefits for liquidity and conditions for securing sufficient market depth

Asset tokenisation can be a double-edged sword with both positive and negative implications on liquidity. On the one hand, tokenising illiquid assets, such as small and medium-sized enterprise (SME) securities or Private Equity/Venture Capital (PE/VC) funds, can provide ample liquidity to near-illiquid asset classes. Similarly, tokenisation of assets with limited liquidity, such as private placements of non-listed securities; participation in the capital of private limited liability companies; and small-sized bonds also holds a promise for improved liquidity in these asset classes. Some industry participants estimate that tokenisation could possibly *"unlock trillions of euros currently in illiquid assets, vastly increasing the volumes of trade"* (Deloitte, 2019).

Secondary market trading for such assets, once tokenised, is vital for liquidity while it also assists in price discovery and promotes further capital formation. The potential indirect benefit of improved liquidity in asset classes as the ones mentioned above could be increased flow of funds into investment essential for the financing of SMEs and the real economy.[20]

It should be noted, however, that sufficient demand-side interest for regular trading would be required for any of the corresponding tokenised markets to gain sufficient depth that will allow the abovementioned benefits to materialise. This, in turn, necessitates that the efficiency gains of a potential move towards a tokenised form of the market are sufficiently large to make such transition meaningful in terms of economics of the transaction. It also requires blockchain-based marketplaces that are interoperable, or decentralised networks with sufficient number of active nodes. Market readiness is also a key condition for the smooth operation of any tokenised ecosystem, which, in turn, may require a shift in mindset of market participants who may be reluctant to participate in blockchain-based systems and the existence of technical and operational know-how by existing market infrastructure operators.

Figure 3.3. Potential implications of tokenisation for liquidity



Efficiency gains to be reaped are more important in those markets where the complexity of the process is high, there are multiple levels of intermediation, speed is low and costs are high, or in markets with a deficiency of trust. As such, a wider adoption of asset tokenisation at a large scale could be more easily envisaged for private placements of non-listed securities, small-sized bond issuance or private equity/venture capital funds.

Conversely, public equity markets in developed economies benefit from highly automated and efficient processes where the potential for efficiency gains through the use of DLTs is very limited. Importantly, such markets enjoy high levels of *trust* by their participants. The net incremental efficiency gains achievable through a possible transition to a tokenised form of the market could therefore be more limited.[21]

3.2.2. Bifurcation of liquidity between on-chain and off-chain markets for the same asset

On the other hand, tokenising part of the free float of securities that continue to also trade off-the-chain may result in a shift of liquidity from conventional markets on to the blockchain, drying up liquidity in the off-chain markets. The above scenario is not a risk when tokenised securities (and assets in general) are issued directly on the blockchain and do not have an underlying asset in the real world.

Parallel trading of tokenised assets both on-chain and in conventional markets risks creating a bifurcation of markets for the same asset with negative consequences on liquidity conditions and potential heightened risk of arbitrage. A take off in the use of tokenised assets and their subsequent trading on-chain risks stripping the conventional market of valuable liquidity with potential costly implications for market participants and the smooth operation of the markets.

The level of interoperability and communication between on-chain and off-chain markets for tokenised assets could define the magnitude of such impact on liquidity. A potential bifurcation between the on-chain and off-chain markets for tokenised assets would, to a large extent, depend on the level of interconnectedness of traditional marketplaces for an asset with the blockchain-based decentralised ones for the tokenised representation of such asset. Risks of arbitrage will also occur naturally on exclusively on-chain markets, with non-interoperable DLT networks and exchanges giving rise to such risk of arbitrage.

Some argue, however, that tokenisation could actually reduce the issue of asymmetric information across different markets, as tokens have the capacity to incorporate information on all on-chain transactions, making the price of the asset more representative and reducing bifurcation problems existing today in assets traded on different markets. In addition, initial price differentials between on-chain and off-chain markets might reflect differences in information and liquidity of trading venues, and potential arbitrage could drive off-chain prices towards on-chain prices (presuming these are more representative).

A second, separate consideration around liquidity in DLT-based markets is related to the payment leg of transactions for on-chain markets that operate in parallel with off-chain ones. In tokenised markets which operate alongside conventional payment infrastructure facilities, participants may need to decide on the allocation of liquidity to each of the two systems. Liquidity management may become more challenging for participants, and there is a risk that one of the two facilities ends up inadequately funded (MAS and Deloitte, 2017). At the same time, greater transparency obtained in DLT-enabled transactions may offer advantages for liquidity management, allowing participants to substitute and optimise pledged collateral with greater efficiency (MAS and Deloitte, 2017).

In addition, tokenisation could create risks where there is a liquidity mismatch between the token and the underlying asset, or where investors have limited understanding of products packaged into a token (FSB, 2019). This is not dissimilar to risks arising in structured products.

Box 3.2. Centralised vs. Decentralised Exchanges/Trading Platforms and Initial Exchange Offerings (IEOs)

Most crypto-asset exchanges/trading platforms operating to date are centralised exchanges/trading platforms , where a central operator controls most of the processes (order matching, clearing, settlement, custody) in a similar fashion that conventional exchanges function. Compliance with regulation, as well as on-boarding, KYC and AML/CFT checks are facilitated by the existence of a central point of responsibility who can be held accountable for the platform's operation. Examples of centralised trading platforms currently operating include Coinbase, Binance, Kraken, etc. Although none of these platforms holds a broker-dealer license, many of these are trying to secure broker-dealer licenses as they engage in activities akin to those of broker-dealers (e.g. on-boarding of investors for secondary trading). The requirement to register as a broker-dealer or exchange depends on whether the platform engages in activities involving tokenised assets that are securities.

Conversely, in theory, decentralised exchanges/trading platforms have no central operator or point of contact/control/liability for the platform. Order matching, clearing and settlement and filing all happen in a complete decentralised fashion between nodes and through the use of smart contracts. There is no central management of orders, no custody or escrow and each nodes holds the funds until the trade. The absence of single point that can be held responsible for the operation of the exchange/trading platform makes regulatory compliance and the enforcement of regulation difficult in decentralised exchanges/trading platforms. In practice, however, most so-called decentralised exchanges/trading platforms are operated by a central actor that sets up the interface of the platform and the order book, etc (e.g. Raiden, Herdius).

Centralised exchanges/trading platforms facilitate exchanges between fiat and crypto-assets, while decentralised exchanges/trading platforms work mostly within crypto. Both centralised and decentralised exchanges/trading platforms face issues with security (showcased by large hacking attacks and loss of funds already occurred in a number of cases). Decentralised exchanges/trading platforms currently in operation do not have enough participation to support transactions and face liquidity constraints.

Initial Exchange Offering (IEOs) started to be offered by exchanges/trading platforms as another type of Initial Coin Offerings (ICOs) which combined issuing and listing of tokens in one step. The exchange/trading platform acts as the issuer on behalf of the company and as a direct seller of the project's tokens on the exchange, and participants can purchase the tokens directly from the exchange. Although issuing through IEOs allows the tapping of an existing user base of the exchange and a natural listing, such issuances can give rise to important conflicts of interest. Importantly, it raises questions on whether exchanges that offer IEOs should be licensed broker/dealers. It should also be noted that trading platforms facilitating IEOs may also be liable for the unregistered offering of securities, as it would likely participate in the offering as an underwriter or in some other function.

3.3. Pricing implications

Trading in a tokenised environment would benefit from enhanced transparency provided in DLT-based networks.[22] An important benefit of improved transparency is a reduction in information asymmetries, and this, in turn, has the potential to improve the price discovery mechanism, providing investors with incentives

to increase their participation and bring additional liquidity in the market, also improving competition conditions in the market.[23]

It should be noted, however, that the increased transparency level inherent to trading on the blockchain may not appeal to participants of markets where anonymity and obscurity is of value. For example, fragmented large purchases or sales from market participants, such as large institutional investors, who may not wish to impact the markets with a large block trade order will not be possible in a DLT-based network.

The fundamental argument for the application of DLTs in financial markets is linked to cost and operational efficiencies delivered by the technology and by disintermediation. Cost efficiencies can reduce trading costs for investors participating in tokenised markets, provided that savings garnered are passed on to investors. This could, in turn, promote market participation and boost trading volume in tokenised markets with wider benefits for public markets.

The connection between on-chain and off-chain markets for tokenised assets can have additional implications for the pricing of instruments. Trading of tokenised assets in a decentralised world occurs 24/7 on multiple networks and exchanges. In the absence of connections between the on-chain and off-chain interfaces, trading of tokenised assets risks becoming fragmented. Such fragmentation will, in turn, almost certainly give rise to arbitrage opportunities across universes. Conversely, a potential interoperability between markets could allow for some sort of "dual-listing" of assets on- and off- the chain, similar to companies listing conventional securities on more than one exchanges simultaneously.

Arbitrage can potentially occur even in native tokenised assets, when these are traded in different exchanges with limited or no connectivity. This may lead to inconsistencies in the way assets are marked-to-market and valued if there are discrepancies in the pricing at the different platforms, while at the same time creating exchange arbitrage opportunities.

In addition to arbitrage opportunities mentioned above, fragmentation of the markets on which the token trades may result in the delinking of the token's price from the price of the underlying asset in conventional markets. This could happen as a result of a fragmentation of the trading venues in which the token trades, or of the investor types participating in the respective markets. In a scenario where tokenisation is prevalent, even if such price dissociations occur for brief periods, they could conceivably have an impact on market stability in some markets.

The potential proliferation of the issuance and use of tokenised assets could also have indirect implications on the way market participants collect and interpret market data such as price, volume, volatility. The way analysts create indicators that can be used to predict the direction of the markets and of instruments on a more general basis would consequently be affected. In such a scenario, the price of a tokenised security may become the leading price indicator for the underlying market, in the same way that some derivatives are used as leading price indicators for the asset on which the derivatives are based. For example, in some markets, futures or credit default swaps (CDS) are much more actively traded than the underlying asset, and although this can be helpful as price reference for the underlying instrument, it can also pose risks: where CDS are more actively traded than the underlying asset, the CDS prices are used as signals of early concerns for the underlying and which are then passed on to the underlying asset, affecting its price. That said, tokenised assets are fully backed by the underlying asset, which is itself collateral to the token issued, instead of just a reference asset as would be the case for a CSD.

The question of interoperability is not limited to the connection between the on-chain and off-chain world or between different blockchains; an additional level of integration would be required in relation to the links between legacy infrastructure of financial market participants and blockchain-based infrastructure. Market participants would need to build DLT-based systems as the utility on which tokenisation of assets can occur.[24] Given the complexity of internal and external networks of legacy financial market infrastructure and the multitude of actors, processes and interests involved even for a simple trade, such integration and

interoperability may prove a challenge with possible repercussions on the smooth functioning of parts of the markets.

According to standard corporate finance theory, the fundamental valuation and pricing of the asset should be independent of the form of the asset or the medium through which it is being transferred. It could however be argued that the different risks that the tokenised form of the asset will hold as compared to the conventional form of the asset may lead to a delinking of the price of the on-chain asset from the off-chain one.

3.4. Implications for post-trade services: impact on clearing and settlement

In some traditional financial markets, central clearing houses act as central counterparties (CCPs) to both sides of a trade, ensuring that the trade is matched and is executed even in case of default of one of the parties, thereby reducing counterparty risk. Clearing houses confirm trade data and use central securities depositories (CSD) to record transactions. Custodians holding investor assets work with CSD to ensure the safe delivery/transfer of assets and funds to each of the respective transacting parties and handle the settlement of transactions.

Part of the inefficiencies in post-trade processes derives from the need of both sides of the trade to maintain records of the information around the transaction and the resulting counterparty risks, and the cost of reconciling each party's data with the data of the counterparty at each step of the contract execution (Swift Institute, 2015). The use of the blockchain in post-trade allows for the maintenance of a single, shared, immutable ledger of transaction information that is updated at each step of the process and can be instantly accessed by all involved parties.

DLT-enabled systems and the use of smart contracts for clearing and settlement of tokenised assets have the ability to verify ownership, confirm trade matching and record transactions in an automated, immutable, transparent and near-immediate way. The distributed ledger can act as a decentralised registry of data on transactions, and a counterparty to all transacting parties.

Blockchain technology can also enhance efficiency in the settlement process, reducing complexity and shortening the settlement cycle to near real-time (T+0) compared to T+3 or T+2 settlement periods currently applying.[25][26] The use of DLTs could reduce back-office costs and data discrepancies, facilitating the faster reconciliation of data (BIS, 2017). Enhanced efficiency could also be driven by the fact that legal and beneficial ownership in DLT-based clearing and settlement systems is not be split between investors and nominees. In a typical case of a traditional security settlement, the investor will be recorded as beneficial owner, while the nominees/brokers will be listed as the legal owner in the ownership records of the CSD (Allen & Overy, 2018). The use of DLTs for clearing and settlement reduces the number of intermediaries involved and streamlines the process of paying or delivering securities to the ultimate beneficial owners.[27]

If tokenisation of assets were to take off, a potential disruption in the market structure could involve the replacement of CSDs by the distributed ledger as a decentralised version of such depositories. Similarly, central clearing houses could, in theory, ultimately be made redundant by the use of the blockchain platform itself as the clearing entity, acting as the common counterparty for the completion of trades. Trades will effectively be settled through the validation of transactions by participants of the network.

A shorter settlement cycle could enhance investor protection by reducing counterparty and principal risks. In addition to lower exposure to counterparty risks, investors benefit from a release of capital otherwise held in the form of risk-based margin requirements for central clearing purposes. Such collateral margin requirements could, in theory, be completely eradicated[28], reducing asset encumbrance for assets pledged, indirectly affecting financial market liquidity. Liquidity would also be directly improved by the faster settlement cycle through the reduced delays in change of ownership of assets.

Both the technical feasibility and the operational savings and costs efficiencies derived from disintermediation in post-trade remain to be fully assessed and quantified through real-life applications. Impediments to the full realisation of the theoretical potential cost efficiencies of DLT-based clearing and settlement may include, for instance, the fact that the application of DLTs in post-trade processes may not be full and comprehensive throughout the process: aspects of the post-trade clearing and settlement may still require back-office reconciliation. In case that other activities that affect securities positions and the payment or delivery of securities or payment, such as securities lending or derivatives, are not based on the same technology, the full scale of efficiencies cannot be realised.

Proof-of-concept projects and experimental application of DLTs on clearing and settlement have produced mixed results when it comes to the delivery of efficiency gains. For example, the joint Bundesbank/Deutsche Börse blockchain project for securities settlement, proved fundamentally suited to high-volume use, but did not perform better than clearing and settlement systems currently in use: settlement sometimes took longer and generated relatively high computational costs (Weidmann, 2019). Important hurdles in the development of the technology need to be overcome for the application to arrive at the stage where it can provide better performance than systems currently in use.

It should be noted, however, that conventional clearing provides anonymity that is valuable to trading parties and which will have to be secured also by near real-time settlement on the blockchain.

3.5. The possible need for a central authority in a decentralised, tokenised world: the relevance of custodianship

This section of the report assumes, for purposes of discussion, that the blockchain, in the particular regulatory context and configuration in which it sits, requires a trusted third party. This will ultimately depend to a large extent on the applicable regulatory environment.

Despite its potential for disintermediation at many levels, tokenisation of assets will ultimately depend on the existence of a trusted and credible central authority that will guarantee the backing of tokens issued by the real assets, as well as hold such assets in custody. This could imply a potential central role for a third party trusted authority, such as custodians[29], who may be called to act as the trusted party that will guarantee the connection of the off-chain world to the distributed ledger environment.

When distributed ledgers interact with the real world, a trusted third party is generally required to make that connection (Hileman and Rauchs, 2017). Data around the characteristics and the ownership of the asset to be tokenised need to be verified by a trusted authority that will confirm the accuracy of the information around the asset's characteristics (including around ownership) before it is placed on the blockchain.

Such trusted authority will also need to ensure that the digital representation of the asset on the ledger is unique and that the same asset is not being represented by multiple tokens in multiple platforms.

The role of such trusted authority is not limited to onboarding and transitioning from the off-chain to the on-chain world, but importantly, involves the safeguarding or the asset. Adequate safekeeping of assets backing tokens at all times will need to be ensured, similar to conventional custodianship.

Given the above, a potential shift in power dynamics may be observed in a tokenised world where clearinghouses and central security depositories are eliminated, while custodians gain a key role in the structure of tokenised markets as the centralised trusted authority ensuring the smooth connection of the on-chain platform to the off-ledger environment. The role and responsibilities of custodians would perhaps be redefined to include responsibility for guaranteeing the backing of tokens by the unique real asset in addition to safeguarding such assets.

For example, a 'bad-actor' custodian could sell the real assets while letting the tokens trade on-chain, leaving it without backing; or could lend the paper shares backing a tokenised security, thus doubling the market supply and making personal profit. Appropriate regulation and supervision of blockchain-related custodians will safeguard against such risks of misconduct.[30]

Of course, the role of a central authority could include ensuring the transition of the asset from the off-chain world on to the blockchain and ensuring the accuracy of the information around the asset to be tokenised. This role is not necessarily to be assumed by custodians; other stakeholders could emerge for that function.

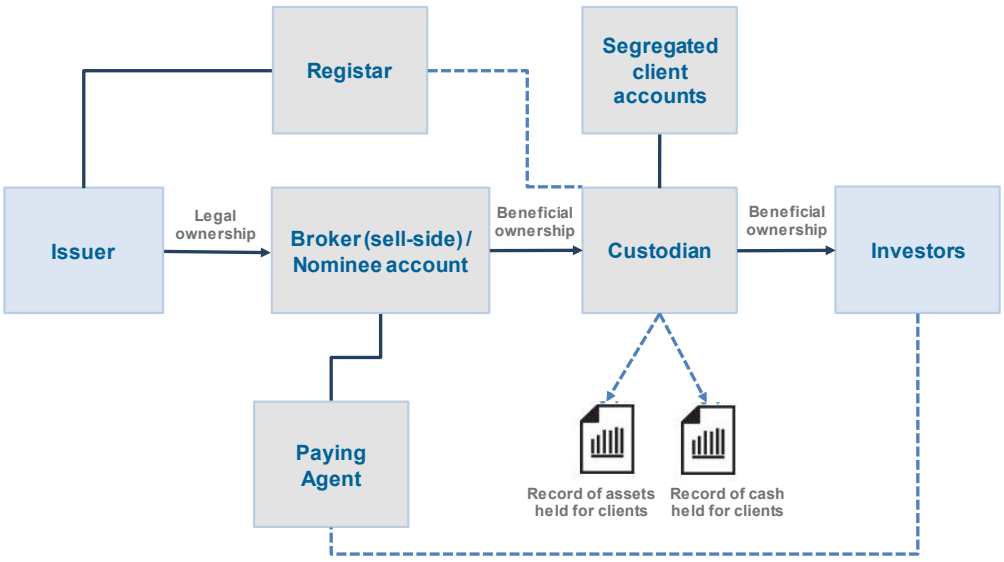
It remains to be seen to what extent this change in roles will induce a fundamental change in the distribution of incentives within participants, or whether participants' roles and corresponding rents will be transferred to other parts of the trade process. How this will develop at market level will depend to a large extent on the actors who will opt to undertake such functions in the marketplace. For example, 'custodial' wallet operators aim at being more than technology providers for wallets and participate actively in the execution of a transactions by providing custodian services in addition to the provision of software/hardware associated to the wallet.[31]

The above considerations would not apply to tokenised assets directly issued on the blockchain, for which ownership is directly linked to the holding of the corresponding private key (bearer assets, such as bonds). For such issuances, custodians could safeguard private participants' keys and ensure consistency between keys and assets held by these addresses.[32]

3.5.1. The possible need for central parties in decentralised markets for tokenised assets

The possible need for a trusted central authority in tokenised securities platforms showcases that the application of DLTs in financial markets does not completely eliminate the need for central third parties and that a complete decentralisation is not a realistic or desirable prospect for tokenised securities marketplaces.

Figure 3.4. Simplified scheme of securities issuance



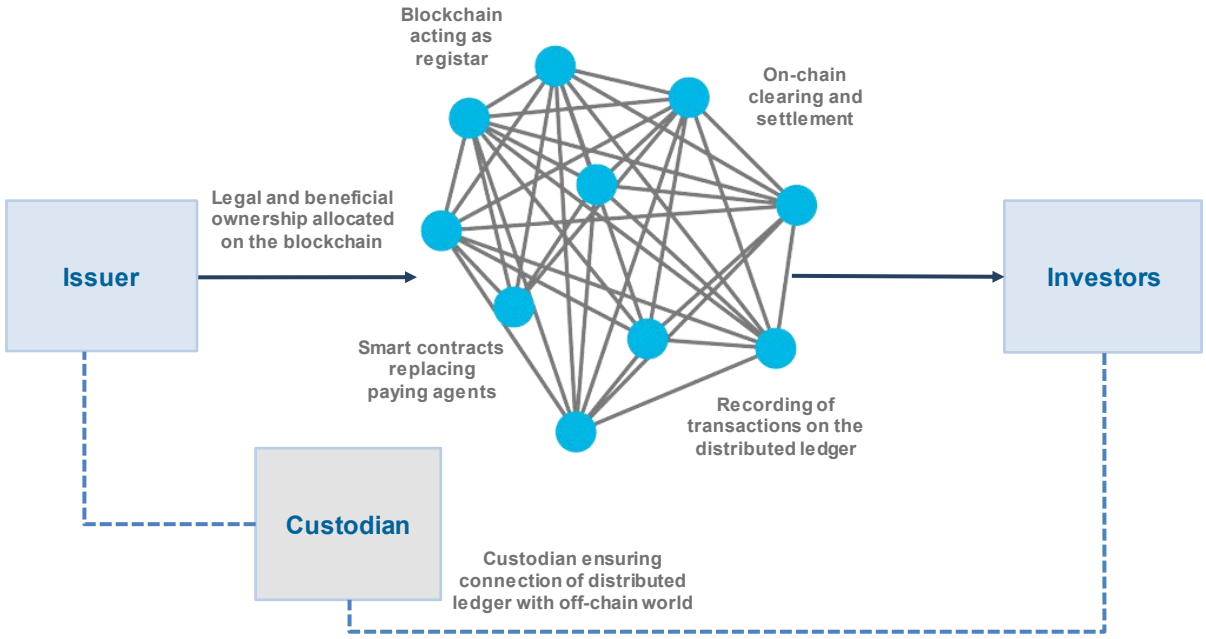
Source: OECD, adapted from Cohen, 2019.

The functions performed by intermediaries in securities market could be categorised in three general groups of activities: (i) confirmation of the existence of the asset and its characteristics, of transacting party identities and of legal and regulatory requirements that they need to comply with; (ii) recording data around transactions, reconciling data and preserving records for all transactions; and (iii) safeguarding transactions (e.g. to avoid 'double-spending') and assets (Swift, 2016).

DLTs are by design capable of replacing the functions related to data recording, reconciliation and record keeping. They can also, to a certain extent, allow for confirmation of transacting parties and compliance with regulation (see Box 2.1 on ERC1400 standard). Double spending is also addressed by the underlying technology and the application of verification mechanisms that prevent such flaws. Safeguarding of assets remains a function that needs to be performed by intermediaries, as is dispute resolution and enforcement of investor rights.

Another related question that may require a degree of centralisation is around responsibility for loss or theft of assets that sit on the network, either through a technical failure of the network or due to malicious activity by third parties.

Figure 3.5. Simplified scheme of corresponding tokenised security issuance



Notes: The above structure assumes that the technology allows the investor to retain beneficial ownership for tokens that are held by a custodian. In terms of technology, this would translate in a separate wallet address for the exercising of voting or other rights than the wallet address that holds the assets in custody. Such technology is in the early stages of its development.

3.6. A case for tokenised central bank currency or stablecoins in tokenised securities

For settlement to be achieved at near real-time and for delivery to be certain in securities transactions (Delivery versus Payment or DvP), the securities transacted and the corresponding payments need to switch ownership simultaneously. For the payment to be exchanged without the lengthy processing times or costly fees involving intermediaries off-the-chain, a tokenised form of currency on the blockchain would need to be available and used in such operations, for the payment leg of the transaction.[33]

As the tokenised securities are on the blockchain, the existence of a tokenised form of currency allows for certainty around delivery and near real-time settlement to become a viable and feasible proposition. In the absence of Central Bank tokenised cash outside the context of sandboxes of proof-of-concept projects, platforms offering tokenisation services use *stablecoins*[34] for the payment leg of security settlement in DLT networks. Stablecoins are also used by such platforms for the payment leg when it comes to securities asset servicing and corporate actions throughout the lifecycle of the security (e.g. dividend payments). The question is therefore raised around whether and how NCBs would be willing to facilitate the tokenisation of central bank money for use in tokenised markets, or whether such function will be instead performed by stablecoins (or central bank digital currencies, if these become available).

Project Ubin in Singapore is an example of the use of tokenised currency for DvP in securities settlement. A group of banks, supported by the Monetary Authority of Singapore (MAS), have deployed a payment system prototype using DLT in which bank users can exchange currency on the blockchain, placing a tokenised form of the Singapore Dollar (SGD) on a DLT (MAS and Deloitte, 2017). The resulting digital representation of the SGD or 'SGD-on-ledger' is a specific limited-use coupon issued on a one-to-one basis in exchange for money, with the only purpose of serving in the settlement of interbank debts and with no value outside of this purpose. Each token represents a binding claim on central bank's currency and is fully backed by an equivalent amount of SGDs held in custody, while ledger holdings do not receive interest (unlike money in bank accounts).

Project Ubin was inspired by the model of another project for interbank payments developed by the Bank of Canada, Project Jasper. The third phase of Project Jasper demonstrated that a DLT-based system can functionally address the steps required to execute an irrevocable settlement of equities against central bank cash (Bank of Canada, 2018). This included the successful implementation of a DvP settlement flow of cash and equities between counterparties on a shared ledger.

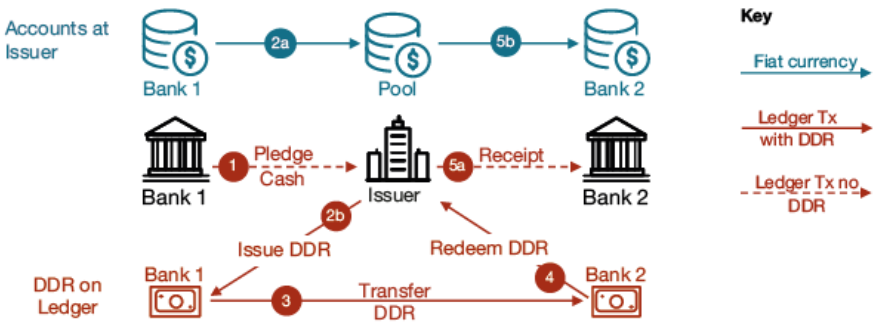
In the context of this project, both cash and equity were tokenised according to a digital depository receipt (DDR) model, and the ensuing tokens represented secure digital claims for the underlying asset on deposit at the token issuer. The cash tokens represented a claim for issued by the Bank of Canada on Canadian dollar deposits held in accounts at the bank, while the equity tokens represented a claim issued by CDS for the underlying equity held at CDS.

In the example of the Jasper proof-of-concept, participants need to be members of the Payment Canada Large Value Transfer System (LVTS) in order to tokenise cash, and members of the Canadian Depository for Securities (CDS) to be able to tokenise equity. Members of the LVTS can obtain cash tokens from the Bank of Canada by pledging cash from their existing account at the Bank, in exchange for a cash token for the given amount. Bank of Canada transfers the same amount from the requestor's account to a pool account. Cash tokens can be redeemed at the Bank of Canada in exchange for the underlying cash in the member's account, transferred from the pool account. Similarly, CDS members can obtain equity tokens from CDS by pledging the given equity in their CDS account and redeeming these tokens at CDS in exchange for receiving the underlying equity in their account. This approach ensures that the amount of cash and equity on-chain equals, and is backed by, the same amount in the corresponding pool at all times (see Figure 3.4).

Project Jasper demonstrated that the tokenisation of both cash and equities on a shared ledger resulted in better asset interactions during DvP settlement relative to the siloed CDS and LVTS systems. In addition, immediate finality of settlement resulted in the ability to instantly reuse cash and equity tokens, which in theory supports liquidity efficiency, in that the system only requires the minimum amount of liquidity necessary to settle each net position with true finality (Bank of Canada, 2018).

Similar projects testing the feasibility and benefits of DLT application in securities settlement have taken place in other jurisdictions, too, such as the European Central Bank (ECB) and Bank of Japan (BOJ) joint research project STELLA (ECB and BoJ, 2018) which showcased experimental results and conceptual analysis of DvP success across single ledger and cross-ledger situations.

Figure 3.6. Tokenisation of cash and equity at the Bank of Canada Jasper III



Source: Bank of Canada (2018).

Commercial applications of DLTs in clearing and settlement are also undertaken by securities exchanges around the world. The Australian Securities Exchange (ASX) proposed an implementation roadmap to replace the CHESS settlement system with a DLT-based clearing system planned to go live by 2021 (ASX, 2017). This move will enable efficient trade settlement and reconciliation, while driving down operational costs.

Private consortia of banks are looking into alternative solutions in order to facilitate the cash side of a transaction settlement, by establishing permissioned networks with their own 'utility' settlement coin. An example of such initiative is the UBS-led settlement project involving 14 banks aiming to build the "utility settlement coin" (USC) (UBS, 2016), while the JPMorgan Coin has a similar purpose despite different mechanics in its design.

4. High level policy considerations

4.1. Conditions under which tokenisation of assets is meaningful

Tokenisation of assets could improve liquidity and tradability, as it may benefit from efficiency gains. Tokenisation could lower barriers to investment by enabling access to previously illiquid, unaffordable or insufficiently divisive assets. It may ease and simplify the flow of capital to smart-ups and SMEs through the issuance of debt and equity in private companies where no trading infrastructure exists, and has the potential to potentially indirectly enhance SME financing through the tokenisation of institutional SME funding (PE/VC funds).

As with all DLT-based applications, asset tokenisation would require a solid business rationale for the use of decentralisation and the blockchain. In other words, the use of DLTs in the financial markets needs to be justified by efficiencies and related cost reductions; increases in safety, resilience and trust; reduction in complexity and disintermediation; or by the absence of existing trading infrastructure for the asset. Tokenisation of assets could therefore be more meaningful in those markets where there are efficiency gains to be reaped in terms of costs, speed, complexity of processes and intermediation; or in markets with a deficiency of trust.

Wider adoption of asset tokenisation at a large scale might therefore be more easily envisaged in markets with limited liquidity and multiple layers of intermediation, such as private placement of non-listed securities/participation in private limited liability companies, small-sized issuance of bonds or the tokenisation of private equity/venture capital funds. The efficiency gains to be realised by the adoption of asset tokenisation for public equities in developed economies requires a weighing of the cost and ease advantages against the fact that such markets enjoy high levels of trust by their participants and are supported by fast, safe and efficient processes with small net incremental efficiency gains achievable through such transition. At the same time, the increased tech sophistication of such venues may facilitate or even accelerate the adoption of tokenisation.

At the same time, it could be argued that some of the potential benefits of asset tokenisation could only be achieved if the network reaches sufficient scale. Sufficient scale would help to ensure the full realisation of benefits such as increased liquidity. This could mean that under such a scenario, asset tokenisation would end up being more of a complement, rather than a replacement, of current conventional markets for the same assets, at least at the initial stage of development of that market, for certain processes or parts of the security lifecycle. This would still allow market participants to test the capabilities of DLTs and enjoy some of its benefits.

The adoption of asset tokenisation at a large scale would face a number of challenges related to the underlying technology itself. Widespread adoption of DLTs requires the resolution of technical challenges around scalability, given the significant throughput that would be required for global financial markets, settlement finality, interoperability between platforms, appropriate levels of privacy, and buffers against cyber-risk and hacking. The legal status of smart contracts still remains to be defined, and until it is clarified whether contract law applies to smart contracts, enforceability and financial protection issues will persist.

As private incentives established through the securities lifecycle are expected to be shifted around, fade or disappear in a tokenised environment, market participants do not equally share the motivation to transition to a blockchain-enabled market. The willingness and ability of the industry to agree on coordinated efforts to develop global or interoperable infrastructure solutions is not guaranteed. Most importantly, moving from legacy infrastructure to DLT-based networks requires significant investment from market participants, and will only be expected to materialise once efficiency gains are proven and measurable for each asset type and part of the securities lifecycle.

A potential transition of financial markets and products to a tokenised environment enabled by DLTs is not expected to happen in the near-term even by the most prominent advocates of the blockchain technology. The shift to DLT-based markets could more easily be envisaged to be deployed in a gradual manner, prioritising those processes that have the most potential for efficiency gains first. Tokenised markets may flourish as a complement to current conventional markets, for certain processes along the security lifecycle, such as post-trade.

According to some market participants, tokenisation has the potential to provide a more efficient and less costly way to issue and administer securities particularly for niche small markets, such as SME or start-up equity and debt funding[35], thus potentially allowing smaller companies access to capital market financing (Reuters, 2019). Enhanced transparency and availability of data could alleviate part of the information issue observed in SME markets, while disintermediation and automation could reduce costs and increase the efficiency of issuing, trading and administrating SME securities, which usually involve multiple layers of intermediation and relatively high complexity (e.g. documentation). The potential for increased liquidity is crucial for SME markets which traditionally face lower liquidity than markets for larger corporates. However, market views differ over the potential of tokenisation to serve niche markets; it is argued by some market participants that large players active in mature markets are more technology-ready and have the know-how and capacity required to invest in the adoption of tokenisation practices faster than small niche markets for SMEs.

Interoperability between blockchains but also between the on-chain and the off-chain worlds is of paramount importance for the successful development of asset tokenisation.

Ultimately, legacy and DLT-enabled systems could end up converging into a hybrid version of interfaces with conventional infrastructure elements combined with automation and DLT-based applications in areas such as clearing and settlement, where efficiency gains are high enough to justify the (gradual) transition to a decentralised infrastructure.

Standardisation in the protocols and coordination between market participants would also enable the quicker adoption of DLT-based technologies and a broader and faster transition to such networks. Policy makers can facilitate such coordination in areas where the application of DLTs has proven to be meaningful and beneficial to financial markets and their participants.

4.2. Implications of tokenisation for financial markets

The implications of a potential expansion in the use of tokenised assets are widespread and would affect financial markets in a number of ways mentioned in this note.

A potential proliferation of tokenisation in the financial markets would have implications and potential disruptive effect on processes and participants alike. Efficiency gains in tokenisation stem to a large extent from its potential for disintermediation. Such disintermediation could affect trading by disrupting the market-making model, which could in turn affect volatility and liquidity of related markets, especially in times of stress.

A potential take-off in tokenisation activity would also affect repo activity for the funding of positions, as well as on securities lending activities used as part of trading strategies. The shift of the above activities 'on-chain' would allow for direct and faster unwinding of collateral, easier mobilisation of collateral across security pools, more efficient use of balance sheet and lower capital intensity associated with such activities.

When it comes to liquidity, tokenisation can be a double-edged sword with positive effect on near-illiquid assets (e.g. participation in the capital of private SMEs) but potential risks of bifurcation of liquidity between on-chain and off-chain markets for the same asset. The latter may result from a shift in liquidity from conventional markets on to the blockchain, drying up liquidity in the off-chain markets and giving rise to risks of arbitrage.

In terms of pricing of the assets, tokenisation enhances transparency and has therefore the potential to reduce information asymmetries and improve the price discovery mechanism. At the same time, trading of tokenised assets risks becoming fragmented if the asset trades on non-interoperable networks and exchanges on- and off-the chain.

The use of DLT can expedite and condense trade clearing and settlement to nearly real-time, reducing counterparty risks and freeing up collateral, producing capital efficiencies for participants in the trade. The post-trade multi-step process is simplified and the back-office administrative burden is lowered significantly. Experimental application of DLTs on clearing and settlement has, however, produced mixed results and hurdles in the development of the technology will need to be overcome for the application to arrive at the stage where it can provide better performance than systems currently in use.

Importantly, a tokenised form of currency or stablecoins may be required for the payment leg of security settlement on DLT networks. A potential proliferation of tokenised markets raises the question of whether and how NCBs would be willing to facilitate the tokenisation of central bank money for use in tokenised markets, or whether such function will be instead performed by stablecoins.

Tokenisation will ultimately depend on the existence of a trusted and credible central authority that will guarantee the connection of the off-chain world with the blockchain (e.g. existence and custody of unique assets backing the tokens issued).

4.3. Considerations for policy makers

Tokenised markets should comply with regulatory requirements that promote financial consumer and investor protection, market integrity and competition and seek to guard against build-up of systemic risks. Tokenised assets can be seen as cryptography-enabled dematerialised securities based on a DLT-enabled networks, instead of electronic book-entries in securities registries of central securities depositories, therefore merely replacing one digital technology with another, therefore raising no issues in jurisdictions with a technology neutral approach to regulation. Nevertheless, it can sometimes be difficult to know with certainty whether tokenisation falls within the regulatory perimeter or is fully captured by the perimeter, especially given the novel nature of some new business models and processes involved in tokenised markets. Potential gaps in the regulatory treatment of tokenisation may give rise to regulatory arbitrage opportunities, similar to the ones witnessed in the ICO market. This is less of an issue in jurisdictions where a technologically neutral approach applies to financial regulation.

To date, it is not completely clear whether tokenised assets, tokenisation processes, the markets in which they trade and the processes involved are fully compliant with the existing regulatory and supervisory framework covering the corresponding asset markets, particularly for assets native to the blockchain.[36] Given the inherent global nature of decentralised networks enabled by DLTs, such gaps would need to be examined both at national and cross-jurisdictional basis. In addition, the absence of a central point of

accountability due to the decentralised nature of the network may be an impediment to the implementation of regulatory action when such mechanisms are used.

At the same time, tokenised assets that fall within the legal and regulatory perimeters of existing frameworks (policy frameworks and regulatory regimes) may not be fully and correctly understood by market participants. Regulatory or legal ambiguity around asset tokenisation can create uncertainties and risks for participants in tokenisation markets and undermine the smooth functioning of such marketplaces, with potential indirect impact on the conventional, off-chain markets (traditional assets and FMIs) for such assets.[37] Legal and regulatory ambiguity is also slowing down the adoption rate of such technologies as participants are uncertain of the conditions under which they can participate in such markets and/or engage investors.

Greater clarity around the regulatory and supervisory frameworks applied to tokenised assets and markets will be a stepping stone to their safe development and use. Existing regulation may need to apply to new actors (e.g. trusted third party guaranteeing the accuracy of information at the onboarding of the asset on-chain and safeguarding the asset) and/or new requirements may be needed to be added (e.g. covering the interoperability between DLTs or the interaction or gateways linking the on-chain and off-chain environments). New risks that may arise for the application of DLT technologies (e.g. associated operational risks, risks related to digital identities) will also need to be appropriately supervised.

At the national level, different institutions regulating and supervising virtual assets should aim for a coordinated approach covering all different facets of such activity (e.g. payments, investments, taxes, accounting, AML/CFT compliance, law enforcement and crime prevention).

Cross-border transactions of tokenised assets require international cooperation to limit regulatory arbitrage and for the smooth operation of tokenised markets. International coordination is warranted when it comes to a more harmonised legal treatment of tokenised assets so as to avoid regulatory arbitrage. An appropriate balance needs to be struck between managing emerging risks and allowing space for innovation to flourish. The potential development of standards or principles that would apply to DLT-enabled networks operating in the financial markets (and beyond) could facilitate coordination at global level and promote a level playing field for participants performing the same activity.

Wider use of tokenised securities raises potential financial consumer protection and market conduct issues, the handling of which will be essential to safeguard investors' interests and ensure a fair and orderly market for tokenised assets. Recourse and redress in case of damage due to a technical issue, theft or non-existent real asset backing the tokenisation is only one example of such investor risk involved.[38] Market integrity issues can arise stemming from the immaturity of the market, the potential lack of monitoring and controlling mechanisms, combined with a lack of information around tokenisation. Risks to market integrity can damage market confidence and raise the possibility of consumer and investor loss.

Financial education efforts would be indispensable for the protection of investors in tokenised markets, especially given the potential for increased participation of retail investors in such markets. Tokenised markets will require appropriate understanding of technological aspects, over and above standard financial knowledge, for the informed participation of investors in such markets. Indicatively, tokenised assets are typically secured by the investor’s private key; loss of the private key results in loss of the entire investment[39]. The assessment of the suitability of tokenised assets for each individual consumer and/or investor is another example of a consideration in such markets, taking into account the individual needs, circumstances and/or risk tolerance levels of each participant in tokenised markets.

Annex A. Case studies: Practical examples of tokenisation transactions

Technical feasibility of asset tokenisation is being tested in major jurisdictions around the world, in safe environments (regulatory sandboxes, FinTech Hubs of central banks and other regulatory/supervisory institutions). These tests allow participants to interact with the regulator and understand the requirements that would apply to each particular use case, test the operational feasibility and readiness of their product and onboard additional participants to their projects.

Innovative companies participating in sandboxes set up by regulatory authorities can establish their innovative business in the market with greater regulatory clarity throughout the cycle of the firm (FCA, 2019a). This allows companies to test the viability of their business model while it is being designed; better understand and appropriately interpret the regulatory requirements for authorisation and operation; and prepare for supervision and reporting throughout their operation.

The interaction of regulators with innovative firms allows the regulator to advance their understanding of the application of new technologies in the financial markets and expedite regulatory guidance around such applications. When it comes to DLTs, the UK Financial Conduct Authority notes that many of the informal steers that the Advice Unit issued to sandbox companies have ultimately converted into General Guidance by the FCA (FCA, 2019a).

This section provides an overview of major equity, debt and real estate tokenisation transactions that have been practically implemented in the context of sandboxes or FinTech hubs of institutions, and raises some preliminary thoughts on issues faced by relevant regulators and participating companies in each of these cases.

Tokenisation in the debt markets

Tokenising bonds: the case of the Nivaura ETH-denominated bond

FinTech company Nivaura was the first company to execute a tokenised security issuance in the UK FCA Sandbox. Nivaura issued an Ethereum-denominated bond that was issued, cleared, settled and registered on a public blockchain infrastructure using the UK FCA regulatory sandbox (Allen & Overy, 2018).

The project involved the issuance of two bonds: the Control Bond, which provided a model for the tokenisation of fiat money, and the Experimental Bond, which represented the first ever cryptocurrency bond fully settled on an open public blockchain using smart contracts (Cohen et al., 2018). The control bond was a GBP-denominated bond, structured as a conventional privately placed registered Eurobond cleared through the traditional clearing systems. The experimental bond was an ETH-denominated bond, fully registered, cleared and settled on an open, public blockchain. Nivaura acted as the custodian, enabling compliant on-boarding and offering digital custody services.

At the first stage of the project, the firm mirrored the normal issuance process for a short-term debt instrument using DLT, potentially streamlining the traditional approach, for example by removing the need for registrars and nominees. The transfer of the securities from the issuer to the investors was recorded

on the blockchain which acted as the register, allowing legal and beneficial title to be united with the actual end investors (Cohen et al. 2018). As a result of the increased transparency and visibility it can offer, it was proven that DLT has the potential to support effective reconciliation and auditing. These systems could enhance transparency, accuracy and clarity in relation to the ownership of assets.

The second stage of the project demonstrated that it is possible to issue and pay for a legally enforceable financial instrument exclusively on a public blockchain without using any of the conventional financial market infrastructure. Importantly, the blockchain constituted an independent third party, which fulfilled the requirement for third party reconciliation of the registrar (the blockchain was in fact the registrar). Nivaura, the FinTech firm facilitating the issuance, did not have direct control over the allocation of assets and money held on that register (Cohen et al. 2018).

The issuance of the Experimental Bond demonstrated that automating the end-to-end securities issuance lifecycle process, along with the option of tokenisation, has the potential to significantly reduce cost and shorten time to market. Legal fees and complexity are reduced, as the structure is leaner and the documentation simpler. The registrar was dispensed with, the payments were made on a peer-to-peer basis with smart contracts used to automate the delivery of the bonds and the payment of interest and principal. There was no need to have a paying agent in the ETH-denominated bond, and less need for a long chain of custody for the investor (Cohen et al. 2018).

Given the above, the tokenisation of bonds allows corporate issuers to execute more efficiently, by simplifying the structure, reducing the number of parties involved, simplifying the quantity of documentation required, automating many of the processes, saving on complexity, time and cost. Importantly, such structures open up this form of capital-raising to a wider range of SMEs.

The limitations that were demonstrated through these issuances pertained to scalability; the ease by which irreversible and highly detrimental vulnerabilities can be introduced into smart contracts; performance limitations; and privacy considerations. Compliance concerns stemming from such structures stem from pseudonimity allowed by such platforms (Cohen et al. 2018).

Following the example of Nivaura, a range of incumbent organisations have explored similar tokenisation propositions, alongside other new entrants testing tokenised security issuances in the UK FCA Sandbox (FCA, 2019a). Tokenisation of bond instruments is perceived as more straightforward given that bonds are bearer instruments and can be representable in token form.

As with all FCA Sandbox projects, the Nivaura issuance was fully compliant with regulatory requirements. The ETH-denominated bond benefited from a fully automated process of establishing a bond instrument on a platform. Such automation also included the legal documentation, the specific terms of which were agreed on the platform and provided also in pdf format to participants. Interested investors were pre-authorised after going through AML/CFT clearance, and although the tokens were visible to all network participants, only pre-authorised participants could acquire them. Nivaura acted as the custodian of the network holding the private keys of investors, which enable initiation of every transaction.

The World Bank's global blockchain bond

In 2018, the World Bank launched bond-i, a new blockchain-operated debt instrument, and the first legally binding bond to be created, allocated, transferred and managed through its life cycle using DLTs.

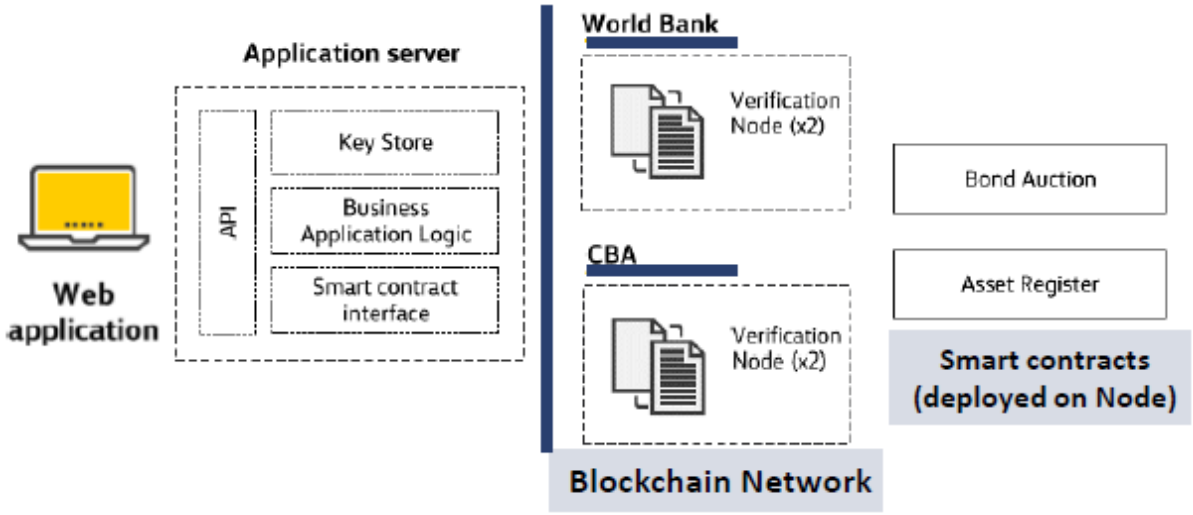
The 2-year bond raised A$110million, and the World Bank mandated the Commonwealth Bank of Australia (CBA) as arranger for the bond. The CBA Blockchain Centre of Excellence developed and built the bond-i blockchain platform, housed in the Syndey Innovation Lab (World Bank, 2018).

The bond-i platform runs on a private, permissioned blockchain, where only the World Bank and the CBA are authorised to access and validate transactions. The register is based on the blockchain ledger and is

held by CBA in Sydney. Settlement was managed by CBA as issuing, paying and calculation agent. The cash settlement was performed off-chain (World Bank Treasury, 2019).

Investors wishing to participate had to get pre-authorisation in advance. They then used their authentication key to enter bids onto a platform through the web interface. The World Bank observed the book-building real-time, pricing was finalised, following which investors saw their bids and allocation in real time (only their own bids and allocations). The platform provider had real-time access to all bids and allocations. Cash settlement, performed off-the-chain, lead to a transfer of the legal title in the registry of the registar (CBA). Smart contracts allowed for the automation of payments (e.g. coupons) based on pre-defined rules (World Bank Treasury, 2018).

Figure A A.1. The World Bank bond-i process



Source: World Bank Treasury, 2018.

The main benefits observed in this issuance related to automation and streamlining of processes, efficiency in terms of information on the blockchain which eliminated the need for reconciliation, transparency through increased real-time information for investors and issuers, as well as automated reporting and an immutable append-only platform that gives a single, common source of truth (World Bank Treasury, 2018).

Box A A.1. Standardisation of derivative transactions: International Swaps and Derivatives Association (ISDA) paving the way

DLTs and smart contracts have the potential to radically improve the efficiency of the derivatives market by automating the performance of certain events and obligations. In recent years, the focus of the International Swaps and Derivatives Association (ISDA) has been on developing common legal, process and data standards upon which these new technologies could be developed and implemented; as well as on considering the implications of increased automation from a technological, legal and operational perspective.

In developing this framework, the ISDA Common Domain Model (ISDA CDM™) was developed to ensure that a shared, standardised representation of events and actions that occur through the derivatives lifecycle is applied across the industry. The application of smart

contracts to ISDA documentation could allow for the creation of 'smart derivatives contracts', where the occurrence of certain events or the performance of certain obligations are capable of being automated.

ISDA's standardised documentation framework could provide a solid foundation for the development of smart derivatives contracts. However, increased standardisation and digitisation of legal documentation is necessary to facilitate more accurate capture and analysis of legal agreement data and to better align business implementations with underlying contractual terms. ISDA is therefore developing a legal agreement taxonomy and clause library to introduce greater standardisation by creating common, outcome-focused definitions and standard wording for commonly negotiated terms. ISDA Create, an online negotiation tool for ISDA documentation, will also allow for the creation of legal agreement data models and will promote increased digitisation of legal documentation.

Increased standardisation and digitisation of legal documentation can create the foundation for supporting faster development of technology solutions, enabling interoperability between systems and services and promoting transparency and alignment between regulators and market participants. The development and implementation of new technology in the derivatives markets, however, gives rise to potential areas of legal and regulatory uncertainty which are highlighted in ISDA's whitepapers and legal guidelines for smart derivatives contracts.

Source: ISDA (2019a), ISDA (2019b), Clack and McGonagle (2019).

Tokenising covered bonds: the case of Société Générale

Société Générale issued of a EUR100m covered bond (obligation de financement de l'habitat or OFH) as a security token, directly registered on the Ethereum blockchain (Société Générale, 2019). The ensuing tokens were rated Aaa/AAA by Moody's and Fitch and have been fully subscribed by Société Générale.

The purpose of the transaction was to prove that blockchain is a trustable, legal and compliant solution for securities issuance. The transaction proposes a new standard for issuance and secondary bond trading, reducing costs and the number of intermediaries through a more efficient process. The benefits realised include product scalability, reduced time to market, computer code automation structuring, thus better transparency, faster transferability and settlement.

In the case of the Société Générale covered bond, the cash is settled against the token as it would have been done with a regular security. The token that was issued contains the full legal rights attached to the bond; this point was cleared by Société Générale's legal advisor in coordination with the French regulator. The smart contract's code had been audited by both internal and external auditors.

The custody of the covered bond is based on a 'self-custody' solution, which means that no central securities depository (CSD) is needed. Thus, the 'custodian' task is to keep the blockchain access keys safe and to provide a strong transaction signing governance. Furthermore, the blockholder's position can be read at all times through Société Générale's issuance platform or directly on the blockchain in case of failure.

The added value for issuers stems from the transparency on investors and on the secondary market, as well from the high product optionality through the use of smart contracts. The added value for investors lies primarily in better price discovery on OTC markets as well as faster transactions.

Box A A.2 The French regulatory framework for Blockchain technology

France is one of the first jurisdictions to consider a regulatory framework for blockchain applications in the financial sector. Regulatory action around the blockchain materialised in the 2016 monetary and financial code of law; the 2017 Blockchain Executive order; and the establishment of an innovative framework for token offerings via the PACTE Action Plan for Business Growth and Transformation bill (published on 24 May 2019).

This legislation aims at offering to blockchain stakeholders a comprehensive legal structure (not a sandbox) with the aim of providing answers to the full range of questions facing all stakeholders in this emerging ecosystem, whether of a regulatory, fiscal or accounting nature.

The 2017 Executive Order allowed the use of blockchain, and recognised its value on an equal footing with standard book-entry across a wide range of financial instruments, such as fund units and unlisted shares and bonds, potentially covering assets worth as much as €2,000bn in France alone.

The PACTE Act has set out an optional framework for tokens that cannot be assimilated to financial instruments, both on the primary market of initial coin offerings (ICOs), as well as on the secondary market, spanning custody, fiat-crypto and crypto-crypto exchange.

French tax legislation was also modernised to take on board the challenges raised by digital assets. The 2019 budget act provided important clarifications for individuals who invest on an occasional basis. Trading of digital assets does not lead to taxation per se: these transactions are deemed to be neutral as long as the digital assets involved are not converted into legal tender currency, or used to acquire goods or services (principle of crypto-crypto neutrality). In the event of conversion or use, capital gains are taxed at a rate of 30% i.e. 12.8% in income tax and 17.2% in social levies.

Lastly, France is one of the first countries worldwide to provide an accounting framework for token issuers when they are not treated as financial instruments.

Tokenisation in the equity markets:

Private companies issuing shares at the Nasdaq Linq

In 2015, Nasdaq launched Linq, a DLT-based platform for the issuance and trading of private company shares (Nasdaq, 2015). Private companies used the Nasdaq Linq blockchain to digitally represent their share ownership through DLTs, complete and record private securities transactions on the blockchain.

In the first transaction, Nasdaq enabled the issuer to digitally represent a record of ownership using Linq, while significantly reducing settlement time and eliminating the need for paper stock certificates. In addition to its equity management function, Nasdaq Linq also provides issuers and investors an ability to complete and execute subscription documents online.

The tracking of ownership and trading and of the subsequent transfer of shares of private companies requires multiple manual and costly steps and exposes private issuers to errors. The Nasdaq Linq use case provides private company issuers with real-time transparency into the records or trading activity of shares and shareholders of record, drastically reducing manual ownership transfer and the related costs.

Issuance of native tokenised securities solely on-chain

In 2016, Overstock.com Inc., a publicly listed company on Nasdaq issued a new class of public securities directly on the blockchain and which exist solely on the chain, and using a transfer agent. Blockchain Voting Series A Preferred Shares were fully compliant with regulatory requirements, raised total gross proceeds of approximately USD10.9m. The shares offered same day settlement (Overstock, 2016).

Tokenisation of equities at the London Stock Exchange: the 20|30 Group equity issuance

London Stock Exchange tested the issuance, admission, and foundations for trading of equities, with 20|30 becoming the first UK company to successfully complete the tokenisation and issuance of their equity as part of the UK Financial Conduct Authority's (FCA) Sandbox 4 (20|30 Group, 2019).

Contrary to the issuance of tokenised bonds, which can be representable in token form as bearer instruments, tokenisation of equity is less straightforward as equity regal and regulatory requirements and company law apply to the shares issued and tokens can only represent the rights to a share and not be the share itself.

The issuance tested the ability for equity to be tokenised and then issued to investors, using a mechanism that provided legal certainty to investors, so that investors benefitted from holding intrinsic shareholder rights.

In the tested structures, shares are issued and held by a trust, and the legal ownership of shares issued remains with the trust. Tokens issued represent rights to the shares, i.e. beneficial ownership of these shares. While direct tokenisation where shares are issued directly as tokens may be possible, it is still at development stage and requires an amendment to various UK law to achieve the same level of legal certainty and ownership.

The tested structure was the first primary distribution and settlement in the United Kingdom of digital representations of Equity Tokens on a blockchain, which included both the primary issuance of Equity Tokens, and settlement of those Tokens in a blockchain environment

Earlier on, and as part of FCA's first sandbox, another firm used DLT to enable UK private limited companies to digitally represent and manage their shares and corporate governance processes. This showed the potential for DLT to improve the efficiency of operations and result in significant savings on legal costs that would otherwise be incurred by these companies.

Tokenisation of existing shareholding by Mt Pelerin

Mt Pelerin Group SA ("Mt Pelerin") was the first company that tokenised all its shareholding in compliance with the Swiss regulatory framework, tokenising all of its issued shares (issued as uncertificated securities) on the blockchain in the form of Ethereum tokens (ERC20 compatible) (https://www.mtpelerin.com/shareholders).

Mt Pelerin tokenised its shares by applying the CMTA tokenisation blueprint (CMTA, 2018), with certain adaptations from the published blueprint documentation to Mt Pelerin's specific transaction. Initially, all of the shares in Mt Pelerin, issued as uncertificated securities (i.e. book-entry securities), were tokenised and recorded in the name of the original shareholder of Mt Pelerin in the form of "MPS tokens" on the Ethereum blockchain, out of which up to 5% of the equity were offered for sale to the public, by way of a public offering of equity securities in Switzerland and on a private placement basis in selected foreign jurisdictions, in compliance with local selling restrictions. Purchasers were required to undergo full AML/KYC identification and were individually registered in the shareholder's register of Mt Pelerin as shareholders upon completion of the sale. Indeed, despite the tokenisation of the shares, Mt Pelerin is required to

maintain a private shareholders' register, which is not replaced by the blockchain, even though the tokenisation allows to simplify and digitalise many of the corporate processes, from the registration of share transfers and shareholder identification, to certain corporate actions.

The MPS tokens are freely transferable, but in order for a new acquirer to exercise any of a shareholder's social (e.g., voting) or financial (e.g., dividends) rights attaching to the Mt Pelerin shares, the acquirer must apply to the issuer for registration on the shareholders' register, which includes a full AML/KYC identification process in accordance with applicable corporate documentation of Mt Pelerin.

On the technology side, the Mt Pelerin tokenised shares are more that ERC-20 tokens and are in particular enhanced by the implementation of the BRIDGE protocol features. BRIDGE is an open source technology developed by Mt Pelerin to provide a standardised framework for financial tokenisation. Designed in Switzerland according to the CMTA standards, it works as a layer on top of any Ethereum-compatible blockchain network and deals with the issuance and application of compliance over the entire lifecycle of tokens, in particular tokenised equity securities. In essence, the BRIDGE protocol allows the issuer to create rules that are attached to one or several tokens and define how those may be transferred. The application of these rules is monitored and enforced by a rules engine, which operates on multiple dimensions (tokens, persons, time). With this framework, issuers can define legally robust frameworks of operations for their tokens' primary and secondary markets, and are able to implement and adapts compliance requirements in an evolving legal and regulatory landscape, including selling and transfer restrictions based on AML/KYC and sanctions controls, blocking periods, MiFID II, etc. With its features, BRIDGE is an advanced tool for issuers to replicate on chain the regulation of virtually any jurisdiction, and guarantee the enforcement of a consolidated compliance in the issuance and trading of tokenised securities.

Mt Pelerin is working towards creating a bank built on a new kind of core banking system leveraging smart contracts and tokenisation to represent assets digitally, and already offers tokenisation, AML/KYC and other technology and compliance services to third parties today.

Box A A.3. The Capital Markets and Technology Association (CMTA) Blueprint for the tokenisation of shares of Swiss corporations

In 2018, the Capital Markets and Technology Association (CMTA) in Switzerland issued a blueprint for the tokenisation of shares of Swiss corporations using DLTs.

The blueprint provides detailed guidance on the process through which equity securities of Swiss corporations could be tokenised, i.e. incorporated into digital tokens recorded on a blockchain (CMTA, 2018).

In the context of this blueprint, the shares are to be represented by the tokens. The tokenisation process described in the CMTA blueprint involves shares that have already been issued pursuant to Swiss corporate law in uncertificated form (i.e. book-entry securities) which are in a sense ‘wrapped’ into digital tokens, so that the tokens and the underlying shares are tied to each other in a manner that prevents the shares from being transferred without the corresponding tokens and vice-versa.

Source: CMTA, 2018.

Trading platforms for tokenised assets

The Swiss SIX and its SDX platform for digital assets

Switzerland's stock exchange, owned and managed by SIX, is building a fully integrated trading, settlement and custody infrastructure for digital assets, SDX. Such infrastructure will provide a safe environment for issuing and trading digital assets and enable the tokenisation of existing securities and non-bankable assets to 'make previously untradeable assets tradeable' (SIX, 2019). The first services are expected to be rolled out in mid-2019. The platform will start trading tokenised equity, starting with stocks and then exploring other tradeable instruments which are not yet existing in the market today, such as funds, structured products and tokenised versions of more 'esoteric' physical assets such as fine art. Assets currently traded on other markets can be tokenised and made available for trading on the SDX platform.

The platform is expected to promote the development of new products, including safer ICOs/STOs that will meet specific standards set by the regulator. SIX is also expecting to act as a bridge between existing and new financial market infrastructure. SDX will support atomic settlement and will therefore eliminate the need for collateral management and clearing. SDX will gradually offer all standard elements of asset servicing, including asset life cycle management, corporate actions, tax and reporting services. SDZ will also ensure uninterrupted access and secure storage of assets on its platform and therefore under its custody.

SIX will be fully regulated as an operator of FMI by the Swiss Authorities, FINMA and the Swiss National Bank, and intends that the planned digital asset ecosystem of SDX will comply with the same standard of oversight and regulation. Under the Swiss Financial Market Act (FMIA), different FMI categories exist. It is likely that SDX will have to comply with regulation applying to CSDs and Exchanges. This remains to be determined by the Swiss Financial Market Supervisory Authority (FINMA).

Importantly, the technical collapse of trading and post-trading is currently prohibited under the currently existing Swiss regulatory framework. A legal project is currently in consultation to allow for a new category that will be better suited to DLT-based business models.

According to the platform, the key efficiency gains that are expected to be delivered through the project consist of:

Long-term cost-savings by reducing collateral requirements and associated costs;

- Reduced operational costs thanks to significantly simplified asset servicing;
- Reduced data costs through shared single source of information to draw reports, storage and evidence;
- Fees per transaction which are likely to decrease on the new platform.
- Other expected benefits related to security offerings on SDX include:
- The creation, listing and trading of new products on a regulated marketplace in a very short period of time;
- The update of ownership in the warehouse synchronously with the exchange of any goods and money (the trade handshake is also finality of the movement);
- Seamless event management by incorporating goods ownership with lifecycle management.
- At this stage, no conclusions can be made as to whether the new DLT-based model will be more efficient when compared to conventional issuances.

Box A A.4. The BIS innovation hub centre in Switzerland

In October 2019, the Swiss National Bank (SNB) and the Bank for International Settlements (BIS) signed an operational agreement on the BIS innovation hub centre in Switzerland.

The Swiss Centre will initially conduct research on two projects. The first of these will examine the integration of digital central bank money into a distributed ledger technology infrastructure. This new form of digital central bank money would be aimed at facilitating the settlement of tokenised assets between financial institutions. The project will be carried out as part of a collaboration between the SNB and the SIX Group in the form of a proof of concept.

The second project will address the rise in requirements placed on central banks to be able to effectively track and monitor fast-paced electronic markets. These requirements arise in particular from the greater automation and fragmentation of the financial markets, but also from the increased use of new technologies.

Source: BIS and SNB (2019).

Warsaw Stock Exchange

The Warsaw Stock Exchange, as part of its Private Market initiative, is working on building a market for participations in limited liability companies using tokenisation, targeting start-up companies and SMEs. Launch expected in 2020.

Box A A.5. New framework for Simple Joint-Stock Companies in Poland

In 2019, the Polish parliament passed a law amending the Commercial Companies Code and certain other acts, the provisions of which introduce a new type of company to the Polish legal system: the Simple Joint-Stock Company (Prosta Spolka Akcyjna or PSA). The entry into force of these regulations is still pending, and no companies of this form have been formed yet.

The PSA is a new form of a company allowing for an easier incorporation of small companies, including start-ups. Some of the specific regulations regarding this form of company aim to make it especially suitable for start-ups in the IT area.

The adopted provisions create a simplified procedure for the dematerialisation of PSA shares and their records in the electronic shareholder register and enable the extensive use of electronic communication in decision-making processes, including company registration using an automated form. The law provides that the records may be kept in a distributed and decentralised database, under the condition that the security of the data contained therein is ensured. This enables the use of DLTs as one of the ways to record shared ownership for this specific form of company.

In Poland, there is currently no specific regulatory regime for tokenised assets, but if an asset meets the definition of a security or financial instrument, it is subject to the Act on trading in financial instruments (which implements MIFID II/MIFIR), regardless of the technical form of the technology used to record the asset. Nevertheless, according to Polish authorities, it can be challenging to assess in each specific case whether a particular form of tokenisation falls within the existing regulatory framework.

Source: Ministry of Finance of Poland, National Bank of Poland.

Tokenising real estate: Russia, the United States and France

In Russia, amendments to the Civil Code of the Russian Federation, adopted in 2019, provide that rights and obligations can be represented in a digital form. Following this amendment, the transfer of digital rights from one person to another would be deemed sufficient and recognisable by the law. However, special legislation will need to be enacted to identify what kind of rights can be digitalised, and this is still pending.

The example of Russia is interesting when it comes to real estate tokenisation, as it underlines potential requirements linked to the asset type and which require off-the-chain processes to take place. In particular, tokenisation of ownership of real estate in the Russian Federation requires the state registration of such right (according to Article 42 of the Federal Law on State Registration of Real Estate). So each transaction in the tokenised space will need to be also registered in the public registry, off-the-chain (Ermokhin and Levashenko, 2019).

In the United States, Propellr and Fluidity launched the tokenisation of a USD30m Manhattan property in October 2018 (Forbes, 2018).

The AnnA real estate tokenisation by Equisafe investment platform in France

In France, the first tokenisation of real estate took place in June 2019, with the tokenisation of AnnA Villa luxury property located in Boulogne-Billancourt by a consortium of 17 partners, facilitated by Equisafe investment platform and powered by Ethereum (Equisafe, 2019). This transaction constituted the first sale of a building through blockchain technology in Europe.

The AnnA property first followed a classic sale process with a notarial deed validating the value of the building and marking its transfer to a simplified joint stock company (SAPEB AnnA). Equisafe, an investment platform operating via blockchain technology, then registered this company as an issuer in its system, before dividing it into a hundred digitised shares/ tokens, which were then transferred via the blockchain to the promoter (SAPEB Immobilier, assisted by developer Valorcim). The real estate developer could therefore exercising his ownership rights over an entire building via the blockchain.

Tokens issued complied with the requirements applying to financial securities as per Article L.211-1, II of the French Monetary and Financial Code. The tokens were divisible and a 10,000 factor of divisibility was applied, resulting in investment with a minimum ticket entry of EUR 6.5. A one-year vesting period applied to initial tokenholders.

The ownership rights of the company owning the building was thus fully coded on the blockchain. Each token issued on the back of this transaction contained the conditions of purchase, sale and exchange of securities, as well as the rights to which it gives access, such as dividends and voting rights.

All documents traditionally exchanged on the sale chain of a real estate property transaction were recorded and encrypted on the blockchain (notarial deed, certificate of ownership, identification data of buyers and sellers). Registration of the title deeds on a blockchain register, in which the information is certified by notaries, digitised, unfalsifiable and permanently accessible, can allow for a faster exchange and tracking of information from the creation of the asset to its sale.

In addition to benefits related to transparency and information sharing, the expected benefits of the transaction include faster and more efficient transaction structure, greater liquidity, financial inclusion and the democratisation of an investment allowed by proposing an accessible minimum investment amount.

Equisafe plans to expand to other types of tokenised assets, such as property rights and investment funds. Investors will need to go through KYC checks and a risk profile assessment so that they can be matched to suitable investments.

Other: Securities lending

In March 2018, Credit Suisse Group AG and ING Groep NV completed a EUR25m securities lending transaction using blockchain-based software (Reuters, 2018).

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Notes

[1] DLTs and the blockchain are terms used interchangeably in this paper.

[2] Crypto-tokens, digital assets, DLT-based tokens and digital tokens used interchangeably in this paper. The Financial Stability Board defines digital tokens as any digital representation of an interest, which may be of value, a right to receive a benefit or perform specified functions or may not have a specified purpose or use.

[3] Crypto-assets backed by other crypto also fall under this definition. Technically, collateralised stablecoins of fiat and commodities would also fall under this definition. Uncollateralised algo-driven coins would not fall under this definition as there is no asset backing the issuance of the coin. These types of assets are outside the scope of this paper, which focuses on tokenised securities and does not cover tokenisation used solely for payment purposes.

[4] This is, to a large extent, linked to the recognition of the blockchain as a valid representation of ownership of the asset (instead of a proxy). The digital ledger would need to be recognised as evidence of ownership for equities to be able to be issued natively on DLTs and recognised as such.

[5] In contrast to securitisation, tokenisation may or may not involve tranching.

[6] Increased transparency may not be desirable by large institutional investors and for the execution of block trades (see Section 3.3 on pricing implications).

[7] The sale of risky assets to retail investors should, in all cases, be accompanied by consumer protection safeguards adapted to tokenised assets.

[8] Liquidity and illiquidity premium used interchangeably to describe the compensation investors seek for the risk of loss relative to an investment's fair value if an investment needs to be converted to cash quickly.

[9] Technically two transactions which are linked (two bilateral transfers on different chains which are confirmed by both sides within a certain time period, using hash technology).

[10] It should be noted that atomic swaps can only happen when both assets are locked-on in the position of the buy and sell-side prior to the execution of the trade. It should also be noted that the reduction of counterparty risk does not necessarily translate into total reduction in transaction risk, as new risks emerge with the application of DLTs (e.g. operational, security/hacking and cyber risks).

[11] Threat of Grover's quantum algorithm (Silverman, 2015).

[12] Threat from Shor's algorithm (Silverman, 2015).

[13] A practical solution to privacy issues involves the use of a combination of on-chain/off-chain mechanisms augmented by zero-knowledge proofs. For example, a third party identity provider or claim 'attester' can provide binary yes/no responses to the ledger without disclosing the detailed information.

[14] The second structure may or may not be considered as tokenisation, given the absence of a real-word asset to back the token issued directly on the blockchain. However, in the absence of a common classification, we have included both structures under the tokenisation umbrella for the purposes of this note. Further clarification as to the classification of such structures will be required in the future.

[15] It should be noted that, *from a purely legal perspective*, tokens representing securities have a "real world" part to them, as there is always a claim/debt relationship between the issuer and holder of the security, which corresponds to a related contractual and legal framework.

[16] See for example https://www.circle.com/en-gb/trade.

[17] Centralised crypto-asset trading platforms such as Coinbase, Poloniex, etc.

[18] Same blockchain or interoperable blockchains.

[19] For example, in March 2018, Credit Suisse Group AG and ING Groep NV completed a EUR25m securities lending transaction using blockchain-based software (https://www.reuters.com/article/us-blockchain-securities/banks-complete-25-million-euros-securities-transaction-on-blockchain-platform-idUSKCN1GD4D1).

[20] Tokenisation of SME debt or equity will not necessarily overcome issues related to asymmetric information and difficulty in assessing credit risk related to small companies. Fundamental impediments to the assessment of creditworthiness of SMEs will persist in tokenised markets, although enhanced transparency and availability of data could alleviate part of the information issue, while disintermediation and automation could reduce costs and increase the efficiency of issuing and administrating SME securities involving multiple layers of intermediation and a relatively high administrative burden/complexity (e.g. documentation) (see Section 4.1).

[21] Such benefits would consist of enhanced transparency and reduced counterparty risk, for instance.

[22] It is unclear whether this is currently achieved, as most trading at the moment happens in off-chain trading at trading platforms.

[23] It should be noted that a unified approach to identity is a prerequisite for improved transparency to lead have an impact on pricing. Otherwise, there is a risk that a high bid-ask may come from the same investor/organisation in an attempt to inflate the price of the asset. Such unified identity is not necessarily granted in ledgers pseudonymous at the protocol layer, which can allow users to hold one or more addresses that are not linked to their real-world identity.

[24] Similar to the World Wide Web serving as the platform for utilities such as the email. It should be noted that it took almost 30 years from inception of the World Wide Web to the email.

[25] To note that faster or even near real-time settlement can be achieved without the use of DLTs, provided that securities and cash are held in the position of the counterparts prior to the execution of the trade.

[26] The reduction in settlement periods has an indirect effect on banks and other intermediaries who use the assets during the T+2 for securities lending and other investment activities.

[27] Intermediaries are expected by some market participants to reposition along the value chain (for example, traditional clearinghouses could leverage their expertise and offer custodianship services).

[28] This would not be the case for derivative instruments, where collateral can sometimes be held for the life of the derivative contract, and not just during its execution.

[29] The term 'custodian' is used to describe the activity, the function could be undertaken by broker/dealers, notaries or other participants who take up this role in a DLT network and who would need to comply with rules and regulations applicable to the activity of safeguarding of assets.

[30] In case of native tokens such risk is eliminated as there is no backing to the token (no separation between the asset and the token).

[31] Examples of custodial wallet providers include BitGo, PrimeTrust, Kingdom Trust, OnChain Custodian, etc. Examples of simple wallet providers include Trezor, Metamask, etc. Note that for small amounts of retail investments, investors may choose to self-custody their tokens (for native tokens).

[32] Custodian Wallet providers currently in operation are different to the above notion of custodians as they provide some level of control over the asset, with the ability to sign; execute; and transfer assets, as well as sign transactions. However, they do not have full control to initiate a transaction on behalf of a client without their instruction as they do not hold the private key to enable the release of the transaction.

[33] Other crypto, such as the bitcoin, could also be used for the payment leg, however, the volatility of such assets is so high that it renders their use in such processes impractical or even speculative.

[34] Tokens backed by fiat currencies. The use of other crypto-currencies would be cumbersome given their significant price volatility.

[35] Examples include private placements of non-listed securities; participation in the capital of private limited liability companies; and small-sized SME bonds.

[36] For tokenised assets which are issued on the back of pre-existing regulated assets, the representation of the existing asset on the blockchain should not change its regulatory status. Even in these cases, the use of DLTs may affect the way in which regulation applies to the asset, the processes or the market.

[37] To some extent, the absence of common definitions or harmonised terminology of the different categories of digital assets further inhibits the assessment of whether such assets fall within the boundaries of the regulatory perimeter for each activity.

[38] Protocols developed by the industry try to address the issue of lack of recourse and redress mechanisms: for example, a pre-defined 'approved authority' can be allowed to move tokens from one wallet to another without having the private key of either wallet. Such mechanisms could resolve issues that arise in case of death of a tokenholder or loss of private key.

[39] Unless the key is held by a specialised custodian, or unless the protocol used addresses this concern. For example, under the ERC1400 protocol, an investor can directly contact the issuer of the security, provide their identity and have the asset transferred back to their wallet using a 'forced transfer mechanism'.

www.oecd.org/finance/