Tokenization of Financial Assets

FINAL REPORT

The Board of the
International Organization of Securities Commissions

FR/17/25 November 2025

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1. Executive Summary

This Report reflects the observations from a monitoring exercise conducted by IOSCO through its Fintech Task Force (**FTF**), which had set up a Financial Asset Tokenization Working Group (**TWG**)[1] to conduct research and gather information on the current state of development and adoption of tokenization and distributed ledger technology (**DLT**) in capital markets products and services.

The main purpose of the TWG is to develop a shared understanding among IOSCO members on the adoption and current use-cases of asset tokenization in capital markets, and how regulators have prepared and responded to these developments. This Report identifies some potential implications from tokenization activities on market integrity and investor protection.

In recent years, the financial sector has been experimenting with the use of DLT for the delivery of financial services. Proponents suggest that in seeking to achieve features such as fractionalization, programmability, composability, and atomicity, tokenization might create efficiencies in the financial system, help expand availability of financial products and services, and reduce market frictions. However, the adoption of different technologies and arrangements in financial services may present novel risks or amplify existing risks which need to be understood and appropriately addressed by regulators to safeguard investors' interests. This Report provides some perspectives based on the analysis of existing examples of tokenization arrangements and notes that IOSCO's principles and guidance may be applicable to tokenization arrangements, given their technology-neutral approach.

In developing this Report, the FTF gathered evidence through literature review, regulatory surveys, and stakeholder outreach. The FTF observed that there are varying degrees of commercial adoption of tokenization arrangements, depending on the objectives, associated benefits, and challenges of their specific applications.

The FTF found that, while the evolution of lifecycle activities from tokenization appears to be quite incipient and incremental, there is evidence of growing commercial interest, though the projected growth trajectory is uncertain and uneven across asset classes, with some examples of fixed income products and money market funds taking the lead in commercial adoption. The tokenization ecosystem is still nascent, with a lack of cross-blockchain interoperability and credible settlement assets limiting the scalability of

[1] The TWG is led by staff from the Monetary Authority of Singapore (MAS) with members from the Australian Securities and Investments Commission (ASIC); Brazil's Comissão de Valores Mobiliários (CVM); Germany's Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin); Securities and Exchange Board of India (SEBI); the Central Bank of Ireland (CBI); Italy's Commissione Nazionale per le Società e la Borsa (CONSOB); the Securities Commission Malaysia (SCM); Mauritius' Financial Services Commission (FSC); Morocco's Autorité Marocaine du Marché des Capitaux (AMMC); Québec's Autorité des Marchés Financiers (QAMF); Spain's Comisión Nacional del Mercado de Valores (CNMV); the United Kingdom's Financial Conduct Authority (FCA); and the United States Securities and Exchange Commission (SEC).

tokenization arrangements in the financial sector.

The impact of tokenization on lifecycle activities varies by implementation model and the degree of integration with DLT. Based on this:

(a) While creation and issuance processes of digital tokens to represent financial assets have evolved, the impact of tokenization on distribution and secondary trading activities for these tokens has been more limited and largely continues to rely on conventional financial infrastructure and intermediaries, due to accessibility and liquidity concerns regarding DLT platforms.

(b) In clearing and settlement activities, the FTF found that DLT-based settlement infrastructure enables faster settlement times, but when given a choice, it appears that market participants continue to favor the use of traditional settlement infrastructure. This is possibly due to a variety of factors, such as the lack of familiarity with the use of DLT-based infrastructure, vulnerabilities that may stem from its digital nature (operational or cyber) or the operation of network effects present in traditional infrastructure.

(c) In asset servicing activities, the FTF observed implementation of digital custody and improvement in collateral mobility (e.g., intraday repo transactions).

Tokenization can have wider implications for the operating environment in which these assets and related services are employed by changing the technologies and infrastructure used for the creation of financial assets. Risks do not manifest in a uniform manner across tokenized arrangements. Rather, such risks are highly specific to the use-case and will depend upon factors such as the choice of the DLT network architecture being used and the tokenization structure adopted for the financial asset.

The analysis shows that the majority of risks arising from the current commercial application of tokenization fall into existing risk taxonomies. Market participants are not unfamiliar with managing such risk types. However, the manifestation of vulnerabilities and risks that are unique to the technology itself may require the introduction of new or additional controls to manage them. Such risks and controls have been acknowledged by issuers and operators in their publications such as public prospectus documents.

Examples include:

(a) Risks relating to the representation of financial assets in the form of tokens. There are currently well-established legal frameworks and structures for the treatment of financial assets created in paper certificate or book-entry form. It can be unclear whether the existing legal treatment for financial assets equally applies to those that are created or represented in the form of tokens, and the activities conducted on those tokens through the blockchain.

For non-native tokens, the range of structuring options for token creation can lead to investor uncertainty about the rights to and ownership of the underlying assets. Thus, despite owning the digital token, investors may not understand the legal aspects of ownership rights and their rights to transfer tokenized financial assets.

(b) Risks relating to the use of DLT-based infrastructure in hosting tokenized financial assets. These assets face operational vulnerabilities and risks unique to this infrastructure, including cyber-attacks on blockchain nodes, congestion in transaction processing, data leakage, market fragmentation, smart contract bugs, and loss of private keys.

As tokenization scales up, regulators should also be cognizant of possible changes in market activities and market structure. The hosting of assets and investments on common DLT networks will also inevitably increase dependencies and interconnectedness among market participants and stakeholders, leading to amplification of the risks currently faced in the conventional markets. Tokenization could also suffer from potential spill-over effects from increased inter-linkages with the crypto asset markets. The analysis reveals early signs of such inter-linkages, such as the increasing use of some tokenized money market funds as "stablecoin"[2] reserve assets or as collateral for crypto-related transactions.

Regulatory considerations

To address the risks arising from tokenization and to provide regulatory clarity, IOSCO members have adopted a range of regulatory responses, including application of existing regulatory frameworks, issuance of specific guidance to clarify the applicability of existing regulatory frameworks, sandbox regimes, and regulatory amendments.

In developing their regulatory responses to asset tokenization in the securities markets, IOSCO members may consider the applicability of IOSCO's standards, which are technology-neutral, principles-based and outcomes-focused, taking into consideration their legal framework and domestic contexts. These include the Objectives and Principles of Securities Regulation,[3] the Recommendations for Crypto and Digital Asset Markets,[4] and the Recommendations for Decentralized Finance.[5]

[2] There is no universally agreed definition of stablecoin. The term stablecoin does not denote a distinct legal or regulatory classification. Importantly, the use of the term "stablecoin" in this report is not intended to affirm or imply that its value is necessarily stable. Rather, the term is used here because it is commonly employed by market participants and authorities.

[3] Available at: https://www.iosco.org/library/pubdocs/pdf/ioscopd561.pdf.

[4] Available at: https://www.iosco.org/library/pubdocs/pdf/IOSCOPD747.pdf.

[5] Available at: https://www.iosco.org/library/pubdocs/pdf/ioscopd754.pdf.

2. Introduction

A. Background

In recent years, the financial sector has been experimenting with the use of DLT for the delivery of financial services. One prominent application of DLT is the tokenization of certain financial assets in the capital markets. Tokenization generally refers to the creation, issuance, or representation of assets on a digital token ledger or a programmable platform.[6]

Broadly, tokenization experiments and commercial use-cases (collectively "**tokenization arrangements**") typically seek to achieve one or more of the following features: [7]

(a) **Fractionalization**, which refers to the division of assets into smaller shares that makes them potentially more accessible to investors.[8]

(b) **Programmability**, which refers to the storage of code-based instructions that will execute automatically in response to predetermined triggering conditions, data or logic.[9]

(c) **Composability**, which refers to the combination and re-use of programmed instructions in new ways, for the creation of new products and transactions.[10]

(d) **Atomicity**, which refers to the execution of multiple steps in a single inseparable transaction.[11]

Proponents suggest that in seeking to achieve these features, tokenization might create

[6] *E.g.,* "the process of generating and recording a digital representation of traditional assets on a programmable platform", Bank for International Settlements (**BIS**) (2024), "Tokenisation in the context of money and other assets: concepts and implications for central banks", available at https://www.bis.org/cpmi/publ/d225.htm ("**CPMI Tokenization Report**"); "the issuance or representation of assets in the form of digital tokens using technologies such as distributed ledgers", Financial Stability Board (**FSB**) (2024), "The Financial Stability Implications of Tokenisation", available at https://www.fsb.org/2024/10/the-financial-stability-implications-of-tokenisation/ ("**FSB Report**"); "the creation of assets or representations of assets on a digital token ledger", International Monetary Fund (**IMF**) (2025), "Tokenization and Financial Market Inefficiencies", available at https://www.imf.org/en/Publications/fintech-notes/Issues/2025/01/29/Tokenization-and-Financial-Market-Inefficiencies-561256 ("**IMF 2025 Report**").

[7] While tokenization is one potential means to achieve these features, it is not the only means to do so. For example, it is often noted that fractionalization can already be achieved through traditional finance, such as securitization or certain types of financial intermediation. FSB Report, *supra* n.6 at 5; IMF 2025 Report, *supra* n.6 at 17.

[8] FSB Report, *supra* n.6 at 5; IMF 2025 Report, *supra* n.6 at 17.

[9] CPMI Tokenization Report, *supra* n.6 at 8; FSB Report, *supra* n.6 at 7; IMF 2025 Report, *supra* n.6 at 4.

[10] CPMI Tokenization Report, *supra* n.6 at 9; FSB Report, *supra* n.6 at 7; IMF 2025 Report, *supra* n.6 at 4.

[11] IMF 2025 Report, *supra* n.6 at 4.

efficiencies in the financial system, support the expansion in availability of financial products and services, and reduce market friction.[12] At the same time, realizing these benefits could entail costs and trade-offs; for example, atomic settlement cycles may reduce settlement risk but also require pre-positioning of settlement assets.[13]

The use of a new technological medium to deliver financial services — as proposed in tokenization arrangements with the use of DLT — should not in itself materially affect the applicability of existing regulatory principles and frameworks.[14] Such arrangements may give rise to the same types of risks that exist in traditional finance. However, some risks, such as technology and cyber risks and other operational risks, might be amplified or materialize in a different manner that are unique to the DLT technology used, with this being dependent on the maturity of the network structure and the structure of tokenization arrangements.[15] For example, operational transfer and final settlement might not coincide in some tokenization arrangements, resulting in settlement risk; the automation of transaction execution might trigger highly correlated movement of funds, creating correlated liquidity risks; the ability for investors to self-custodise their own tokens, instead of going through a custodian, could introduce unique custody risk; and the combination of automated processes across different applications might mean that multiple processes are simultaneously prone to operational disruptions.[16]

At present, the tokenization ecosystem is still nascent and remains a small part of the financial sector, with challenges for interoperability between blockchains resulting in liquidity fragmentation of tokenized products. This is further complicated by a lack of credible settlement assets which are needed to mitigate the counterparty risks involved in DLT transactions. The costs of implementing tokenization arrangements – in the form of system transition costs and potential operational risks – also reduce business incentives to adopt tokenization.[17]

B. Purpose

Recognizing the potential for growth in tokenization and its implications on investor protection and market integrity, the FTF established TWG as a dedicated working group in 2024 to develop a shared

[12] FSB Report, *supra* n.6 at 10; IMF 2025 Report, *supra* n.6 at 9.

[13] IMF 2025 Report, *supra* n.6 at 11. *See also* CPMI Tokenization Report, *supra* n.6 at 13, on the investment trade-offs of tokenization.

[14] Organisation for Economic Co-operation and Development (**OECD**) (2021), "Regulatory Approaches to the Tokenization of Assets", available at https://www.oecd.org/en/publications/regulatory-approaches-to-the-tokenisation-of-assets_aea35466-en.html ("**IMF 2021 Report**"), at 12.

[15] CPMI Tokenization Report, *supra* n.6 at 17; FSB Report, *supra* n.6 at 14.

[16] CPMI Tokenization Report, *supra* n.6 at 18-19.

[17] FSB Report, *supra* n.6 at 12; OECD (2025), "Tokenization of assets and distributed ledger technologies in financial markets: Potential impediments to market development and policy implications" ("**OECD 2025 Report**"), available at https://www.oecd.org/en/publications/tokenisation-of-assets-and-distributed-ledger-technologies-in-financial-markets_40e7f217-en.html, at 10-16.

understanding among IOSCO members on the adoption and current use-cases of asset tokenization in the securities markets.

Given the evolving nature of tokenization, IOSCO considered it prudent to monitor developments in this space to better understand the costs, benefits, and risks to the market. This Report sets out the findings of the FTF TWG's monitoring work.

C. Methodology

To inform this Report, the FTF gathered evidence through literature review, regulatory surveys, and stakeholder outreach, as summarized below.

(a) **Survey of FTF members:** A survey of FTF members was conducted in 2024 to understand the current regulatory approach and expectations of members with respect to tokenization.

(b) **Engagements with Affiliate Members Consultative Committee (AMCC) [18] members:** The AMCC conducted roundtables connected with IOSCO's work on tokenization in Toronto (2024) and Qatar (2025) to obtain its members' views on the costs, benefits, and risks of tokenization.

(c) **IOSCO's industry stakeholder engagement:** The FTF hosted roundtables in Singapore, Tokyo, and Zurich. Attendees represented different roles within the tokenization ecosystem, including Fintech and technology firms as well as academics who had conducted policy research and analysis on tokenization. During each roundtable, participants shared experiences and insights relating to existing tokenization arrangements and the extent to which the projected benefits might have materialized in certain tokenization arrangements.

(d) **Literature review:** The FTF reviewed papers written by international organizations, standard-setting bodies, academics, industry associations, market participants, and other stakeholders on tokenization. This information may help IOSCO members understand the issues, risks, and challenges of tokenization. In addition, the FTF analyzed existing examples of tokenization arrangements in the market.

The Appendix includes a list of working definitions for common terminology used when describing tokenization, to minimize confusion from the fact that some definitions focus on the underlying technology, while others consider the features of tokenization, the types of assets tokenized, and the linkages, if any, between reference assets and digital tokens.[19] However, the definitions are not intended to be comprehensive or exhaustive. Given the present state of tokenization, it is challenging to definitively settle on a singular, universally accepted definition. For the purpose of this Report, it is

[18] The AMCC comprises 74 IOSCO affiliate members. The members represent securities and derivatives markets and other market infrastructures, self-regulatory organizations, investor protection funds and compensation funds, as well as other bodies with interest in securities regulation. There are currently 35 jurisdictions represented in the AMCC, which also includes 14 regional or international associations.

[19] FSB Report, *supra* n.6.

more important to understand the key concepts rather than a set of strictly defined terms.

D. Structure of the Report

Chapter 3 of the Report sets out the level of adoption and commercial interest in tokenization across asset classes, as well as the impact on the life cycle activities for money market funds and fixed income instruments (viz. issuance and distribution, secondary trading, post-trade services (i.e., clearing and settlement), and asset servicing (i.e., custody and collateral management).

Chapter 4 of the Report sets out the issues that can arise from tokenization arrangements and their potential risk implications to market integrity and investor protection, including areas such as recording of ownership, settlement finality, and interoperability across blockchains.

Chapter 5 of the Report summarizes the steps that authorities have taken to manage the risks and regulatory concerns arising from tokenization, including application of existing regulatory frameworks, and issuance of specific guidance to clarify the applicability of existing regulatory frameworks, sandbox regimes, and regulatory amendments.

Chapter 6 of the Report concludes by noting considerations in addressing the issues, risks, and challenges identified in the Report.

3. Adoption of Tokenization in the Capital Markets

This Chapter provides an overview of the state of development and adoption of asset tokenization in the capital markets. It describes the lifecycle activities undertaken across tokenized fixed income products and money market funds (**MMFs**), including a closer look at the impact of tokenization through some existing examples in the market.

While implementation models for tokenization across different firms may vary, the depth and scale of adoption and use-cases remain somewhat limited. In most of the examples analyzed, the change in processes has been more of an evolution than a revolution, given the need to integrate with existing market infrastructure and systems for a seamless process. Nonetheless, tokenization has introduced certain incremental changes to the lifecycle processes and new players or roles to support the ecosystem.

A. Motivations for Tokenization Adoption

Proponents claim that asset tokenization has the potential to address various market inefficiencies present in the lifecycle of financial assets. [20] Market inefficiencies include frictions such as information asymmetries, search problems, transaction costs, and counterparty risks.

A recent report on tokenization and financial market inefficiencies published by the International Monetary Fund ("**IMF Fintech Note**") [21] explains both the positive and negative potential effects of tokenization on financial markets.

For example, shared and programmable ledgers have the potential to reduce market frictions and costs in asset issuance, trading, servicing, and redemption, because a separate record of asset owners may not be needed when every asset is linked to the owner's ledger record. Therefore, the services of a registrar may not be strictly required, at least from a purely technological perspective. [22] Other benefits could include a reduction in certain forms of counterparty risk through atomic settlement, faster distribution of dividends and interest payments and reduced search frictions. While these could have potential cost savings and lessen the need for certain intermediaries, such benefits

[20] IMF 2025 Report, *supra* n.3.

[21] *Ibid.*

[22] From a technological perspective, the services of a registrar are strictly speaking not required because of the inherent nature of the distributed ledger. However, from an implementation and regulatory perspective, a registrar (in the form of a transfer agent) may continue to persist as a feature, and local regulatory requirements may nonetheless require a registrar in the lifecycle of a product.

have yet to be observed widely in the marketplace.

However, shareability and programmability features may facilitate wider and faster spread of shocks across the markets and thereby increase the cost of operational risk events.[23] Increased inter-connectedness may magnify the externalities of market participants on each other.[24]

The core features and value propositions associated with tokenization have also been recently discussed in a report published by the World Economic Forum in May 2025 (the "**WEF Report**").[25]

B. Overview of the Level of Adoption and Commercial Interest in Asset Tokenization

B.1. Overview

Information on the level of adoption and commercial interest in this section was gathered from the IOSCO FTF survey, industry discussions and roundtables, and was substantiated with relevant data published by international bodies.

FTF Survey

The FTF survey responses showed the level of *interest* observed in respondents' jurisdictions for tokenization of capital market products to be split almost equally.[26] However, as to the actual level of *adoption* of tokenization,[27] as reflected in commercialized use-cases, a majority of respondents (91%) indicated nil or very limited tokenization use-cases.

Most jurisdictions have noted a greater proportion of market participants conducting experimentation (57%) than actual use-cases (43%), which covered tokenization of at least one capital market product.

Literature Review

Some reports suggest that commercial interest in financial asset tokenization is growing. For example, a recent survey of over 300 institutional investors, jointly undertaken by EY Parthenon and Coinbase in January

[23] IMF 2025 Report, *supra* n.6, Chapter 4.

[24] An example of a negative externality is the socialization of losses for certain intermediaries, particularly those that are systemically important. An intermediary that has implicit or explicit guarantees of a government bailout can have incentives for excessive risk-taking because it internalizes the full upside of risk (that is, higher profits) but not the full downside, some of which is borne by the public safety net.

[25] World Economic Forum (**WEF**) (May 2025), "Asset Tokenization in Financial Markets: The Next Generation of Value Exchange" ("**WEF Report**"), available at: https://reports.weforum.org/docs/WEF_Asset_Tokenization_in_Financial_Markets_2025.pdf.

[26] In the survey, "interest" refers to market participants' sentiments expressing interest in tokenization of capital market products and their implementation of experiments in such tokenization.

[27] In the survey, "adoption" refers to market participants' tokenization of capital market products and the offering of such tokenized products on a commercial scale.

2025,[28] highlighted that among those who are interested in tokenized assets, 11% are already invested and another 61% expect to invest by 2026.

The apparent interest has also been tempered with skepticism. For instance, some have argued for a thoughtful and balanced analysis of costs and benefits of tokenization, which comes with its own trade-offs.[29] Some market participants have reservations about the actual value propositions of tokenization. When asked why they do not use DLT today in a survey of 26 asset managers conducted by Calastone, 55% of respondents highlighted deployment costs, 19% highlighted a lack of feature benefits, and 10% pointed to a deficit of internal expertise.[30]

Consequently, it has been acknowledged by international bodies, such as the OECD, that the vast majority of tokenized transactions have been part of experimental or pilot programs.[31] This is consistent with the FTF survey responses highlighted earlier. The OECD also noted that the environment is fragmented into pockets of liquid tokenized asset platforms, and live projects have rarely reached a meaningful size.

However, interest in unlocking the potential benefits of the technology with asset tokenization continues to scale up, particularly for certain products[32] and activities. Some of these product types and services are elaborated below.[33]

B.2. Fixed Income Products

There is evidence of steady year-on-year growth in cumulative issuances and amounts issued for tokenized bonds. This issuance has

[28] Coinbase and EY-Parthenon, "2025 Institutional Investor Digital Assets Survey", available at: https://coinbase.bynder.com/m/8362167ae26ecf/original/EY-CB-Institutional-Investor-Survey.pdf. The survey was conducted by Coinbase in collaboration with EY-Parthenon, targeting 352 institutional investors (decision-makers such as COOs, CEOs, Heads of Transformation) with influence over allocation decisions. The survey took place from January 13–24, 2025, and prioritized firms with over $1 billion in assets under management (AUM). The respondent base was primarily from the US (62%) and Europe (28%), with some representation from APAC, Latin America, and Africa.

[29] For example, see "Demystifying Tokenization: Embracing the Future", available at: https://www.world-exchanges.org/our-work/articles/demystifying-tokenization-embracing-future. Therein, the World Federation of Exchanges highlighted among other things that instantaneous settlement is not that simple. The attraction of being able to trade without necessarily having to have all the funds available up front seems to remain strong, even if experimentation with immediate settlement continues. Where settlement is not instantaneous, the cost of having to post margin is generally quite low, with the collateral being returned once the trade is complete.

[30] Calastone, "White paper: Decoding the Economics of Tokenization: Transforming Cost Dynamics in Asset Management", available at: https://www.calastone.com/insights/white-paper-decoding-the-economics-of-tokenization-transforming-cost-dynamics-in-asset-management/#_ftn2.

[31] OECD 2025 Report, *supra* n.17.

[32] Apart from fixed income and MMFs, the issuance of alternative assets such as private equity, commodities and real estate has also seen some impact from tokenization. For the purposes of this note however, the focus is on fixed income products and MMFs. See section 3.1 of the WEF Report, *supra* n.25, for more information.

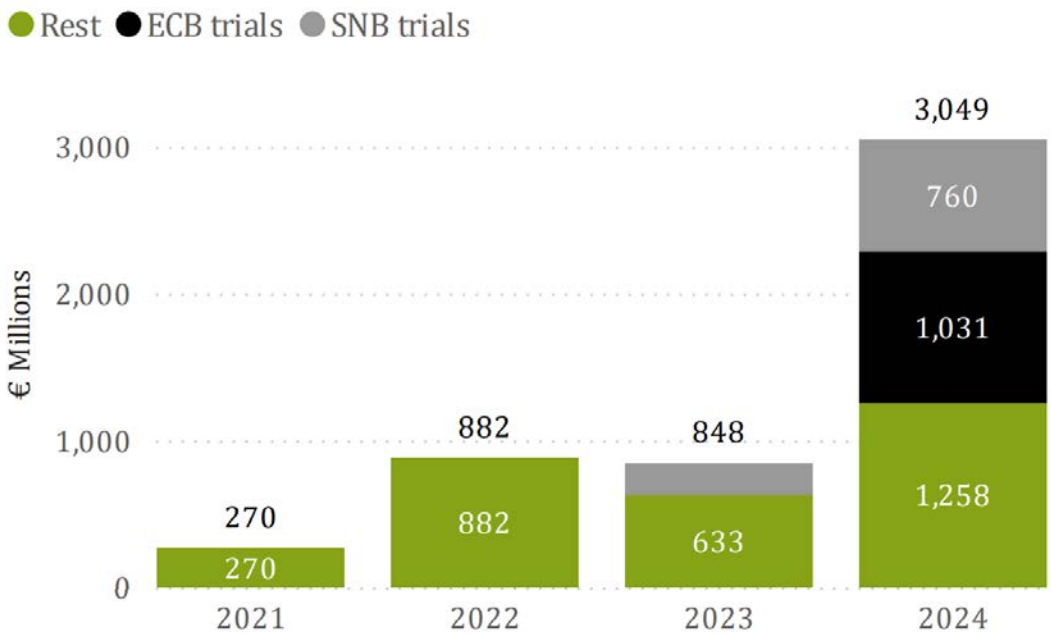
[33] For a discussion of traits or features that make an asset class more ready or suitable for tokenization, refer to WEF Report, *supra* n.25, Figure 6.

been particularly active in the commercial, sovereign, supranational and agency sectors.[34] Yet, the notional value of $10 billion worth of tokenized bonds issued in the last decade remains relatively small compared to the $140 trillion outstanding amount globally.[35] Some market participants believe that there could be further growth in this market – 65% of the respondents of a 2024 survey conducted by the Official Monetary and Financial Institutions Forum opined that bonds are the asset class most likely to be tokenized.[36]

Examples of tokenized fixed income products include UBS AG's CHF375 million bond issued on SIX Digital Exchange in 2022, the Asian Infrastructure Investment Bank's $500 million bond (of which $200 million was raised via a tap issuance in October 2024) issued on Euroclear's Digital Securities Issuance in 2024, digital bonds issued by the City of Lugano, and the World Bank, as well as other corporations, government-related entities, and international organizations.

Chart 1: Issuance of Tokenized Fixed Income Instruments

Amount of tokenized fixed income instruments issued (by type of trial)

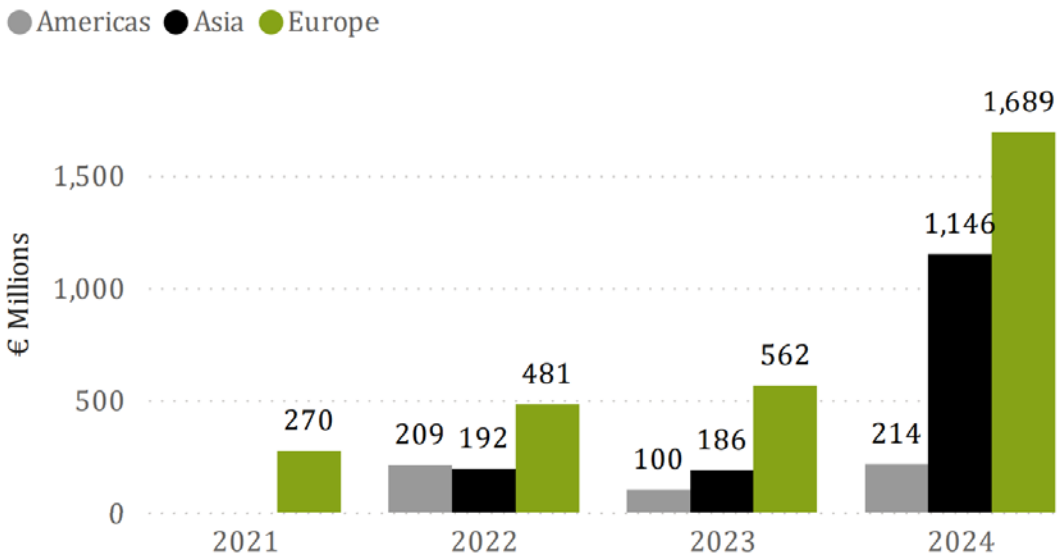


[34] WEF Report, *supra* n.25, citing Aldasoro, I., Cornelli, G. Frost, J., Koo Wilkens, P., & Shreeti, V. (2025), "Tokenization of government bonds, mimeo", and Association for Financial Markets in Europe. (2024), "Use of DLT and tokenization in financial markets".

[35] McKinsey, 20 June 2024, "From ripples to waves: The transformational power of tokenizing assets" ("**McKinsey**"), available at: https://www.mckinsey.com/industries/financial-services/our-insights/from-ripples-to-waves-the-transformational-power-of-tokenizing-assets.

[36] OMFIF Digital Monetary Institute, "Digital Assets 2024 Report", available at: https://pdf.omfif.org/digital-assets-report-2024.

Amount of tokenized fixed income instruments issued (by geography of issuer)



Source: AFME's DLT-Based Capital Market Report 2024

B.3. Repos and Collateral Markets

Repos and collateral have also been identified as potential use-cases in tokenization, and experimentation with DLT-enabled repos is growing across global capital markets. The WEF Report estimates that the global collateral market is worth more than $25 trillion.[37] The global repo market is also very large, with an estimated size of more than $15 trillion in outstanding value and a daily turnover of around $3–4 trillion.[38] According to the same report, programmable ledger-powered collateral management could unlock more than $100 billion annually in capital that might be redeployed for higher efficiency.[39]

Key providers of tokenization solutions for repos and collateral management include Kinexys by J.P. Morgan and Broadridge's Distributed Ledger Repo offering. Kinexys by J.P. Morgan has processed over $2 trillion in tokenized transactions since launch, with daily volumes exceeding $3 billion. According to

[37] WEF Report, *supra* n.25, section 3.3 citing Securities Finance Times "Collateral supply, demand and mobility", available at https://www.securitiesfinancetimes.com/specialistfeatures/specialistfeature.php?specialist_id=802.

[38] WEF Report, *supra* n.25, section 3.3 citing International Capital Market Association, "How big is the repo market?", available at https://www.icmagroup.org/market-practice-and-regulatory-policy/repo-and-collateral-markets/icma-ercc-publications/frequently-asked-questions-on-repo/4-how-big-is-the-repo-market/.

[39] WEF Report, *supra* n.25, section 3.3 citing GFMA (2023), "Impact of distributed ledger technology in global capital markets" ("**GFMA Report**"), available at https://www.gfma.org/wp-content/uploads/2023/05/impact-of-dlt-on-global-capital-markets-full-report.pdf.

Broadridge data, it processes $2 trillion in transaction value monthly,[40] and the LDR Intraday Repo solution delivers a 50-60% average reduction in transaction costs and improved liquidity management.[41]

B.4. Money Market Funds

MMFs are mutual funds that invest in short-term, high-quality money market instruments. Each investor in an MMF is considered a shareholder/unit holder of the investment pool.

In the last two years, tokenized MMFs have attracted billions in assets under management. Issuers of such MMFs include established incumbents, such as BlackRock and Franklin Templeton, as well as fintech start-ups, such as Spiko and Ondo Finance.

Apart from exploring the potential and actual efficiencies of tokenization for such issuances, it is noted that a few tokenized MMFs are now being used as "stablecoin" reserve assets or collateral for crypto transactions.[42] Tokenized MMFs are also used interchangeably with "stablecoins" – tokenized MMFs are used for treasury management and collateral, and "stablecoins" are being used for liquidity and payment – with firms such as Circle seeking to serve both use cases.

B.5. Equities

Relative to other asset classes, the tokenization of equity (stocks) remains quite limited. According to the WEF Report, the market capitalization of tokenized public stocks was estimated at nearly $16 million by March 2025. In contrast, the global public equity market was valued at nearly $115 trillion in 2023.[43] The relatively limited market for tokenized stocks can be attributed to the fact that current public equities markets – especially in advanced economies – are already highly efficient, benefiting from decades of technology modernization and proven intermediary chains.[44]

That said, the market has recently seen the offering of certain tokens with labels and/or descriptions suggesting that the tokens represent ownership in stocks of certain private companies (e.g., "stock tokens").[45] There is no clear consensus on what "stock tokens" mean. However, examples of such so-called "stock tokens" in the market may merely represent a promise by the issuer to provide token holders with monetary gains associated with fluctuations in prices or valuations of these companies, without necessarily providing token holders with any shareholder rights. Product disclosures of such tokens may not always be clear in informing token holders of the rights represented by such tokens,

[40] https://www.broadridge.com/capability/middle-and-back-office-solutions/post-trade-processing/distributed-ledger-repo-solutions.

[41] WEF Report, *supra* n.25, Case Study 6.

[42] See further details in Chapter 3, subsection F2 below.

[43] WEF Report, *supra* n.25, citing Blockworks Research. (2025, March 24).

[44] WEF Report, *supra* n.25, section 3.2; GFMA Report, section 2.1.2.

[45] https://www.bloomberg.com/news/articles/2025-07-12/robinhood-s-private-stock-tokens-lure-investors-draw-scrutiny.

which can pose significant investor protection risks as discussed further in Chapter 4.

As mentioned earlier and also in Chapter 6, the use of a new technological medium (i.e., DLT) to deliver financial services should not in itself materially affect the applicability of existing regulatory principles and frameworks. Consistent with the principle of "same activity, same risk, same regulatory outcomes", the applicability of regulatory frameworks would depend on the economic substance of the token and its substitutability vis-à-vis conventional financial instruments.

C. Lifecycle Activities Across Bonds and Money Market Funds

Publicly available reports and data show that fixed income products and funds are taking the lead in terms of the size and number of tokenized issuances in the market.[46]

This section examines the role of tokenization in the lifecycle activities of both bonds and MMFs. While there is necessarily some degree of difference between the lifecycle activities of bonds and MMFs, they generally fall within the following broad stages discussed below: issuance and distribution; trading and post-trade; and asset servicing (i.e. custody and collateral management).

Proponents have observed that tokenized fixed income products could mitigate certain challenges that bonds face over the course of their lifecycle. These challenges that could inhibit capital market efficiency include siloed data structures, large numbers of agents, fragmented workflows and entrenched manual processes which lengthen settlement periods.[47]

Further, proponents have also suggested that tokenized MMFs may bring about faster settlement, instantaneous transfer, access to new distribution channels and the potential to be used more efficiently in the collateral management space. Though traditional fund structures have enjoyed widespread adoption, they may face cost inefficiencies, limited transparency, and uneven degrees of accessibility to end investors.

Accordingly, within each lifecycle stage discussed below, the focus is on two main aspects: (i) how tokenization may change the lifecycle process and/or roles of market participants therein; and (ii) to what extent existing examples in the market align with the potential changes.

D. Issuance and Distribution

How Tokenization May Change the Lifecycle Process and Market Roles

The issuance and distribution of securities traditionally involve three main steps: origination, structuring, and distribution. The process can involve some inefficiencies, including high costs, lengthy timelines, and operational

[46] GFMA Report, *supra* n.39, section 3.1.

[47] See generally, JP Morgan and BCG, "The Future of Distributed Ledger Technology in Capital Markets", Exhibit 3.

risks.[48] For example, the origination of new securities can be slowed by extended settlement periods. Structuring requires the preparation and reconciliation of numerous documents across organizations, which may create delays. Distribution relies on transaction managers to generate primary market liquidity through various means, but workflows can remain fragmented across asset classes.

For funds, the lifecycle essentially mirrors that of securities, beginning with fund design and setup, which includes regulatory compliance and legal approvals, followed by the distribution phase, where investors can subscribe or redeem units. Issues may arise from setup, the complex web of intermediaries, increasing demand for faster service, limited accessibility due to high minimum investments, and potential inaccuracies in information transmission.[49]

The impact of tokenization on issuance and distribution varies depending on the implementation model and the degree of integration with DLT. Three models are commonly discussed for fixed income products: [50]

(a) "Books and records" model: [51] This approach is relatively limited, supporting only pre-issuance workflows and serving primarily as an introduction to DLT for institutions and regulators.

(b) "Digital twin" model: Such tokens often referred to as digital representations of financial asset(s) that were originally issued off-chain. This model has been explored or adopted to bring off-chain assets on-chain to enhance certain activities pertaining to the asset such as collateral mobilization and post-trade efficiency, with primary issuance remaining largely unchanged.

(c) "Digital native" model: These tokens are seen as digital representations of financial assets issued directly on-chain. It aims to unlock the full spectrum of benefits that DLT and tokenization offered, such as reduced issuance costs and the creation of new security types.

For funds, tokenization can similarly occur at different levels: [52]

(a) Tokenization of the fund: Also referred to as last mile tokenization, while the fund units/shares are represented by tokens, the underlying assets of the funds are managed traditionally. Only at the point of investor subscription or redemption are tokens issued or burned to represent ownership. The official register (of unitholders) can either be fully on-chain (token holders) or a hybrid of on-chain/off-chain registers.

(b) Tokenization of underlying assets: In this model, the underlying assets themselves

[48] See generally, GFMA Report, *supra* n.39, section 2.1.1.

[49] Guardian Funds Framework, sections 4.2 – 4.3.

[50] Guardian Fixed Income Framework, section 4.1.1.

[51] This refers to the arrangement where DLT is used only for documents and administration associated with issuance and distribution.

[52] Guardian Funds Framework, section 3.4.

are also tokenized, with the motivation to enable more efficient trading, registry, and settlement, and simplify regulatory requirements by reducing layers of cost and intermediation.

(c) Tokenization of value flows: In this model, the entitlements to value flows are also tokenized, with the motivation to allow for the creation of financial products derived from underlying flow commitments, supporting a unified, self-executing model across assets.

Proponents suggest there are several anticipated effects and benefits from tokenization in this context.[53] Particularly where routine or repeated issuances are concerned, DLT-based issuance could be lower-cost and/or faster than traditional alternatives. Second, fractionalization could broaden access to traditionally illiquid assets by lowering minimum investment sizes, helping to improve liquidity and diversify risk. Third, improved transparency and efficiency could result from DLT's single, immutable record accessible to all parties, reducing reconciliation needs, trade errors, and information discrepancies. This could free up resources for more value-added activities and potentially reduce portfolio cash drag for investors. Fourth, greater product innovation, as tokenization supports the creation of bespoke instruments, automated income flows, streamlined asset servicing, and improved ESG tracking.

In terms of roles and responsibilities, for fixed income issuances, existing activities performed by market participants to originate, structure, and distribute securities will likely persist. Nonetheless, if tokenization results in streamlined processes, there could be a shortening of iteration and response times to market conditions.[54] For MMFs, tokenization could likewise reduce the time and complexity of activities in the fund lifecycle, as well as reducing the involvement of intermediaries often required in conventional transaction processes. While this could provide investors with greater flexibility, transparency, and efficiency, it also comes with attendant risks as discussed in Chapter 4.[55]

Although empirical data is still emerging, the available data suggests that the potential benefits of tokenization are not merely theoretical. For instance, Leung et al. (2023) found that tokenized bonds had underwriting fees 0.22% lower, yield spreads 0.78% lower, and bid-ask spreads 0.035% lower than comparable conventional bonds.[56] As acknowledged in the IMF Fintech Note, these reductions are economically significant, representing 25.8% of average underwriting fees, 23.9% of average yield spreads, and 5.3% of the average bid-ask spread, respectively. A report published by J.P. Morgan and Apollo (under the auspices of Project Guardian), suggested that portfolio

[53] GFMA Report, *supra* n.39, section 2.1.1.2; Guardian Funds Framework, section 3.4.2.

[54] Guardian Fixed Income Framework, section 4.1.1.

[55] Guardian Funds Framework, section 3.4.

[56] Hong Kong Monetary Authority (**HKMA**), "Research Memorandum 04/2023 on An Assessment On The Benefits Of Bond Tokenization" ("**HKMA Research Memorandum**"), available at: https://www.hkma.gov.hk/media/eng/publication-and-research/research/research-memorandums/2023/RM04-2023.pdf.

managers can be fully invested more consistently due to the programmability of DLT, which allows for automated portfolio deployment of cash. This means that managers' portfolios would experience less cash drag.[57] Assuming the average manager holds ~3% cash and a balanced portfolio could generate ~8% over cash in the long-term, the net result for a client is a ~24bps reduction in costs.[58]

Observations from the Analysis

IOSCO observed that tokenization could offer efficiency gains for fixed income products. However, the process and roles of participants are largely unchanged in fixed income issuance and distribution.

This is illustrated by the UBS digital bond issued on SIX Digital Exchange in 2022. As explained in Boxed Example 1 below, the main parties and workflows remain the same for digital bonds issuance.

While some empirical research suggests a reduction in underwriting fees and costs of investments, some examples do not tend to clearly or conclusively show if these and other aforementioned benefits have been achieved as issuers do not tend to publicly disclose actual quantifiable efficiency gains, if any.

Boxed Example 1 – UBS Bond on SDX

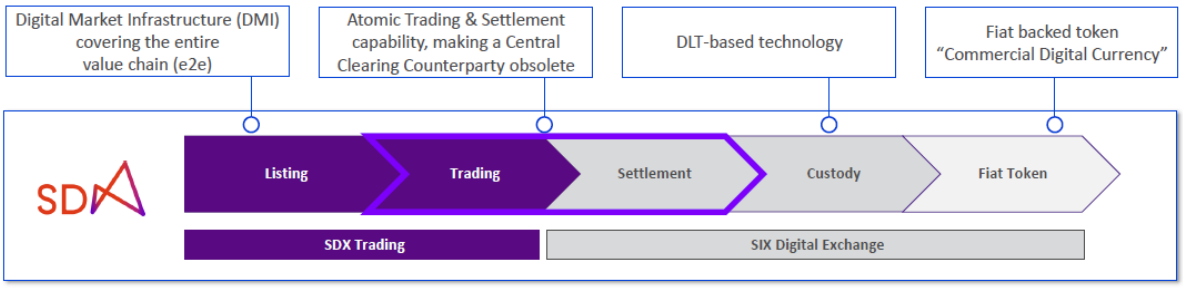
The UBS digital bond is a senior unsecured digital bond (ISIN: CH1228837865) issued by UBS AG, London Branch on SIX Digital Exchange ("**SDX**"). It is a native token that is directly created on SDX's DLT network. The UBS bond has the same instrument structure, legal status and rating as a conventional UBS bond. The token representing the digital bonds is dual listed on both SDX Trading AG ("**SDX Exchange**") and SIX Swiss Exchange, allowing for trading at both venues. However, from 1 June 2025, digital bonds issued on SDX solely trade on SIX Swiss Exchange, leveraging the live operational link between SIX SIS and SDX (explained below).

SDX is the digital market infrastructure covering the entire value chain for tokenized products, as seen in the flow diagram below.[59] SDX is part of the exchange services division of SIX group and operates alongside the traditional SIX Swiss Exchange. There is an operational link to SIX SIS (traditional CSD) that allows for SDX digital bonds to be held and settled at SIX SIS, thereby allowing for interoperability between conventional and tokenized infrastructure.

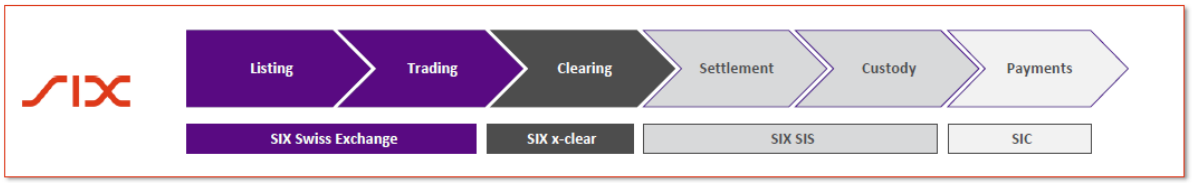
[57] J.P. Morgan. (2023), "Portfolio management powered by tokenization. Kinexys by J.P. Morgan", p 16, available at: https://www.jpmorgan.com/kinexys/documents/portfolio-management-powered-by-tokenization.pdf.

[58] *Ibid*.

[59] Available at: https://www.six-group.com/dam/images/events/2023/sibos-2023/20230317-sdx-digital-securities-brochure.pdf.



SIX Swiss Exchange, on the other hand, is the conventional market infrastructure that also covers the entire securities value chain, as seen below.



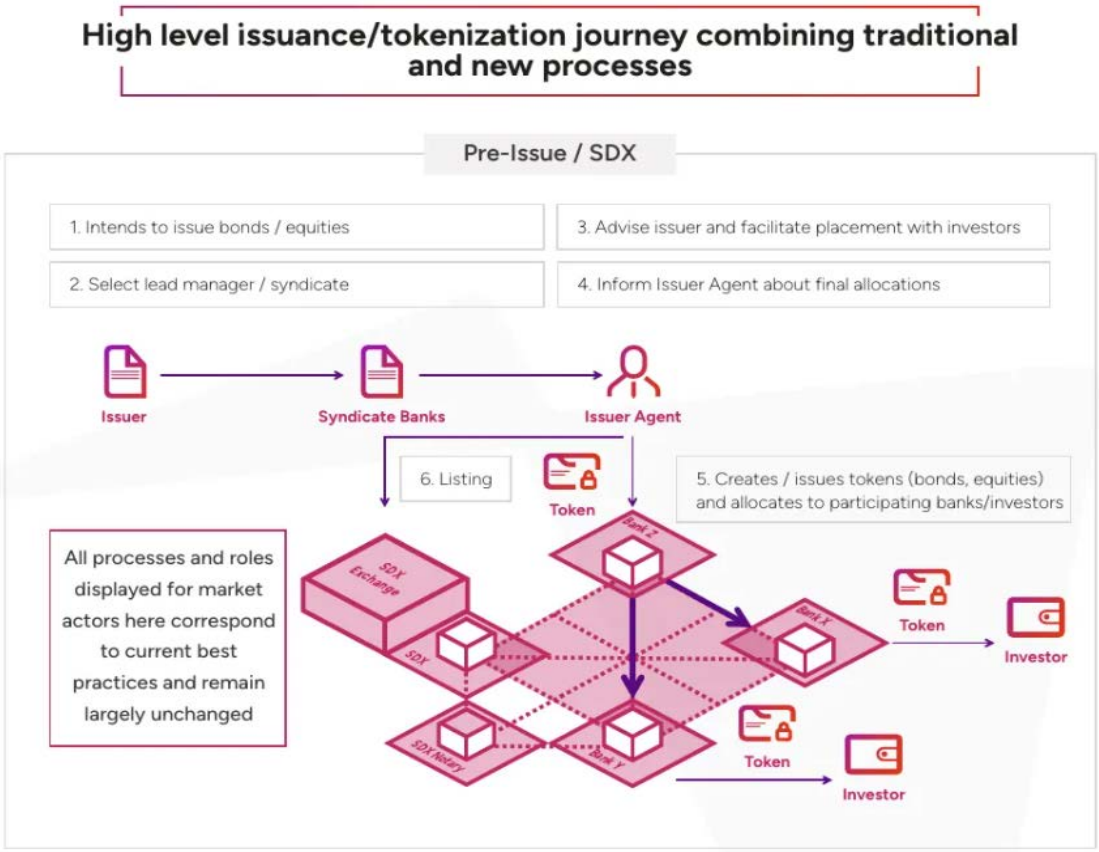
The key features of the bond are summarized in the table below.[60] As explained below, the legal status of the debt securities is unchanged. Tokenization is not a change of form of the debt securities, but the format in which those tokenized intermediated securities are held and cleared.

Issuer	UBS AG, London Branch
Expected Issue Rating	Aa3 / A+ / AA- (Moody's / S&P / Fitch)
Status	Senior unsecured
Currency	CHF
Maturity	3 years
Coupon	2.33% p.a, fixed for life
Use of Proceeds	The net proceeds will be used by UBS AG for general corporate purposes of its group
Assurances	Pari passu clause, events of default clause
Issuer Calls	Tax Event
Form	Uncertificated securities (einfache Wertrechte) in accordance with article 973c of the Swiss Code of Obligations. Intermediated securities by entry into the main register on SDX distributed ledger
Main Register	SDX
Denominations	CHF 50,000
Governing Law	Swiss law, place of jurisdiction Zurich
Documentation	Standalone prospectus, closely aligned to UBS AG EMTN
Selling Restrictions	United States and U.S. Persons, European Economic Area, United Kingdom, Australia, Austria, Ireland, Japan, Singapore, HK, PRC, Belgium, Spain, France, Italy
Listing	SDX Trading and SIX Swiss Exchange
Settlement and clearing	SDX CSD and SIX SIS (via operational link)

Key digital bond features

[60] Available at: https://www.ubs.com/global/en/investor-relations/investors/bondholder-information/digital-bonds/digital-bonds-content.onlycontent.html.

The issuance process of the UBS bond on SDX is outlined in the diagram below.



(a) As noted in the diagram, the processes and roles for market participants in the issuance remain largely unchanged from conventional infrastructure. The issuer (in this case, UBS AG, London Branch) appoints an agent to facilitate its issuance ("**issuer agent**") on the SDX platform on its behalf. This process of appointing an issuer agent takes place for traditional SIX Swiss Exchange issuances as well. The issuer agent must be a member of SIX Digital Exchange AG (**SDX CSD**).[61]

(b) The issuer agent is responsible for creating digital bonds and initiating the issuance process on the SDX platform. This involves setting up the digital bond on the SDX portal and ensuring that all necessary details and documentation are in place.

(c) On the day of issuance, the issuer agent on SDX's DLT network issues tokens representing the digital bonds and allocates/distributes them to participating SDX CSD member banks who hold these tokens on custody on behalf of the end investors.

From the legal perspective, the tokenization of bonds happens via the creation of uncertificated securities becoming intermediated securities by entry into the main registry on

[61] https://www.sdx.com/securities-services/.

SDX's distributed ledger. This is no different from other traditional UBS bonds being registered with a traditional CSD such as SIX SIS, except that the main register is a DLT network instead of a centralized electronic system. This type of conventional security is converted into a digital token in the securities accounts that the SDX participants store on their node at SDX. The token represents the intermediated security and is deposited in the member bank's nodes on the SDX network. Therefore, there is no difference between a digital and a traditional bond, and the legal status is unchanged.

There is no clearing process for trades matched on SDX Exchange, as all trades are settled atomically (T+0). This means that investors' accounts will have to be fully funded at the point of order placement, and "delivery-versus-payment" ("**DvP**") settlement takes place immediately on SDX's DLT network once a trade is matched via an exchange of the tokenized UBS bond and a tokenized settlement asset.

In terms of the settlement asset, SDX members can choose between tokenized CHF ("tCHF") issued by SDX or production wCBDC.

- tCHF: Members of SDX CSD will have to maintain a CHF account with SIX Interbank Clearing AG, where at the member's request, SDX CSD will mint CHF tokens for the member on SDX's DLT network and deduct the corresponding amount from the member's SIX Interbank Clearing AG account. The CHF tokens reflect 1 to 1 CHF reserves held by SDX in its SIC (central bank settlement account) and are the main settlement asset used for DvP when SDX was initially launched.

- wCBDC: More recently, as part of the Helvetia Pilot, the SNB is providing wCBDC on SDX, enabling financial institutions to settle transactions involving digital (token-based) assets directly on the SDX CSD with wCBDC. The Pilot, running until at least June 2026, may be extended based on future assessments. Therefore, wCBDC can also be used for settlement on SDX. The wCBDC is considered as a risk-free settlement asset unlike tCHF, and members of SDX should be automatically eligible for settlement using wCBDC.

With respect to tokenized MMFs, the examples show that tokenization is being applied at the fund level only (as opposed to other parts of the transaction value chain), with shares issued on blockchains as part of the ownership record. This approach combines blockchain and traditional recordkeeping (resorting to a hybrid of on-chain/off-chain registers), with the aim of delivering operational efficiencies. Where offered to retail, there is potential for increased flexibility due to the possibilities for 24/7 trading[62] and fractional ownership. The question as to which share record is the official legal source as regards to ownership is explained in the respective Boxed Examples below.

[62] Provided that the product is available for trading, which depends on the product structure and applicable law.

In this regard, in the very common case of hybrid solutions based on both on-chain and off-chain ledgers, it is essential to understand which of the two ledgers (or what combination of those ledgers) is the official legal record of ownership and, therefore, should be taken as a reference in the event of discrepancies. If the official legal record of ownership is exclusively the off-chain register, this may impede the single immutable features offered by using DLT, and issuers will need to operate concurrently with traditional centralized data storage systems.

Boxed Example 2 – Franklin OnChain U.S. Government Money Fund

The Franklin Onchain U.S. Government Money Fund (the "**Fund**") is a Delaware company that is a registered investment company under the Investment Company Act of 1940 ("**1940 Act**"). The offer and sale of its shares is also registered under the Securities Act of 1933.

The Fund is a government money market fund and, as such, invests in very liquid assets, primarily in U.S. Government securities, particularly U.S. Treasuries, and seeks to maintain a stable net asset value. The Fund's shares are issued in tokenized form on blockchains, such that the record of ownership of shares is maintained in part on blockchains.

The Fund's shares are issued directly on a blockchain. The BENJI token (representing the shares in the fund) is now issued on eight blockchains, including Stellar.

The current recordkeeping system combines features of the blockchain and a traditional book-entry record, such that the blockchain functions as an integral part of the primary record. The internal off-chain book-entry system records private shareholder information (e.g., name, DOB, or SSN), and the blockchain records transactional and other non-private shareholder information—purchases, redemptions, dividend rates, dividend distributions, net asset value, trade dates, and transaction memo information—as well as the complete transactional and operational history of the Fund. Thus, an on-chain transfer involving whitelisted wallets has immediate effect (i.e., it does not need to be reconciled to an off-chain record for a transfer of ownership to be effectuated).

The Fund has essentially created a permissioned system for the issuance and transfer of its securities on top of public, permissionless blockchains. However, the transfer agent retains full control and administrative rights with regard to the DLT-integrated recordkeeping system for the securities that are issued, which are effectuated through the use of certain blockchain-based technologies, including smart contracts. Thus, the transfer agent has unilateral control over all transactions involving the securities and can, for example, take corrective measures where erroneous or impermissible transactions have occurred or where the private key associated with an investor's wallet has been lost or stolen. Given its registered status, the Fund's shares are fully accessible to retail investors.

Analysis of existing examples noted potential fragmentation of entities involved in the core phases of tokenization, such as the issuer, asset manager, provider of the tokenization platform and wallet management solution. This fragmentation risks compromising one of the main potential benefits of using DLT, namely disintermediation that was purported to be able to reduce the number of subjects involved in the overall value chain of the securities markets.

E. Trading and Post-Trade

E.1. Secondary Trading

How Tokenization May Change the Lifecycle Process and Market Roles

Secondary trading in fixed income markets is already highly efficient across many centralized execution venues, so tokenization is not expected to immediately disrupt existing market structures or trading workflows.[63] As observed in some examples, DLT-based securities may continue to be traded on centralized execution venues,[64] with settlement subsequently occurring on distributed ledgers.

Nonetheless, there may be some adaptations. For instance, empirical studies support the view that tokenization can improve liquidity for bonds. As mentioned above, research indicates that tokenized bonds exhibit bid-ask spreads that are 5.3% lower than those of conventional bonds.[65] This improvement doubles to 10.8% when tokenized bonds are accessible to retail investors. These liquidity gains are derived from tokenized bonds settling faster, trading without intermediaries and fractionalizing into smaller amounts that lower the barrier to entry. However, it has also been noted that native securities have thus far exhibited low levels of secondary market liquidity.[66] This is largely because industry experimentation has focused on core DLT infrastructure, primary market issuance, settlement processes, and repo transactions, rather than active secondary trading. The resulting lack of liquidity disincentivizes investors from holding native securities for active trading.

For funds, the development of secondary markets could offer several potential advantages. By enabling the creation of secondary pools of liquidity and facilitating collateralization, secondary markets for fund tokens could improve price transparency and reduce information asymmetry, provided that timely, high-quality disclosures are made.[67] This is especially relevant for private asset investments, where transparency and liquidity have traditionally been limited. Key potential improvements include:[68]

63 Guardian Fixed Income Framework, section 4.2.1.

64 Centralized execution venues may also not be able to benefit from DLT if they are required to operate centralized execution protocols under their existing regulatory permissions.

65 HKMA Research Memorandum, *supra* n.56.

66 GFMA Report, *supra* n.39, section 2.1.2.

67 Guardian Funds Framework, section 4.4.

68 *Ibid*.

(a) Increased liquidity: For fund tokens, secondary markets provide investors with the ability to sell their fund tokens at any time, particularly beneficial during periods of market volatility or when investors need to rebalance their portfolios.

(b) Price discovery: Trading fund tokens on a secondary market can reduce information asymmetry between buyers and sellers, as all transactions are transparently and immutably recorded on the ledger, leading to more efficient price discovery.

(c) Broader investor access: Secondary markets can attract a wider range of investors — including retail investors, family offices, and institutions—that may not have traditionally participated in such assets.

(d) Fractional ownership: Tokenization allows for the buying and selling of smaller portions of assets, making high-value investments more accessible to a broader audience.

(e) Market intelligence: By monitoring secondary market activity, fund managers can gain valuable insights into investor sentiment and asset valuations.

Two categories of execution venues may emerge for secondary trading. The first is the traditional execution venue, which transacts at the ISIN (International Securities Identification Number) level. Such venues may incorporate tokenized products with targeted modifications to accommodate the unique features of such instruments. The second category consists of execution venues designed specifically for DLT-based products, which transact at a token identifier level. These platforms are built to support DLT-enabled features such as programmability, atomic settlement, and fractionalization.

Observations from the Analysis

Trading of tokenized bonds may take place through traditional or DLT-based infra-structure which co-exist in the current ecosystem. For example, a core feature of the UBS digital bonds issued on SIX Digital Exchange is that the bonds are dual listed on both traditional and digital exchanges (viz. SIX Swiss Exchange and SIX Digital Exchange respectively), allowing for trading at both venues, as explained in Boxed Example 1.

There is some evidence that tokenized MMFs offer advantages in broadening investor access and fractional ownership, but many of the promised benefits — particularly around secondary market liquidity — are not clearly evidenced in the use-cases yet.

For example, in the case of BUIDL, it seems broadly that a substantial part of the order / trading flows from existing conventional infrastructure remains (see Boxed Example 3 below). Security holders of BUIDL must register through the transfer agent's website (viz. Securitize, LLC) to become whitelisted by the transfer agent prior to being able to register for securities. When a BUIDL token transfer is executed on a blockchain (e.g., Ethereum or Solana), the transfer is recorded in that ledger once the block is confirmed and finalized. This record is then updated in an off-DLT relational database system that is operated under the sole discretion of the fund's transfer agent whose system of record serves as legal record of ownership. Once whitelisted, security holders may engage in transactions with other whitelisted entities, provided that they continue to meet the minimum ownership threshold. Any on-chain transaction involving whitelisted entities does

not have legal effect unless and until the transfer agent reconciled the on-chain record with the off-chain record.

Boxed Example 3 – BlackRock USD Institutional Digital Liquidity Fund

BlackRock USD Institutional Digital Liquidity Fund Ltd. (the "**Fund**" or "**Issuer**") is a limited company incorporated under the laws of the British Virgin Islands, (**BVI**), operating as a professional fund as defined under section 55 of the BVI's Securities and Investment Business Act, 2010 (**SIBA**). The Fund's investment manager is Blackrock Financial Management Inc., a Delaware corporation registered as an Investment Adviser with the SEC pursuant to the US Investment Advisers Act of 1940.

The Fund is not subject to public reporting obligations under SIBA and qualifies for an exception to registration as a US investment company under section 3(c)(7) of the US Investment Company Act of 1940. Under such an exception, each of the Fund's investors must be an "accredited investor" and either a "qualified purchaser" or a "knowledgeable employee," in each case as defined under applicable U.S. federal securities law or a non-US person (as defined in Regulation S under the U.S. Securities Act of 1933) that is outside of the United States at the time it acquires the Fund's shares (together, the "**eligible investors**").

The Fund has essentially created a permissioned system within public, permissionless blockchains for the following activities: issuance, recording ownership, custody of tokens in client wallets, secondary market trading between whitelisted qualified investors, dividend payment, and initiation of the redemption process.

To invest in shares of the Fund, an eligible investor must register through the Fund's transfer agent's website. To streamline purchases and redemptions, a third party provides a facility to certain investors that enables investors to use stablecoins such as USDC to subscribe to shares of the Fund.[69] Further, investors may be able to exchange BUIDL tokens for USDC in near-instant on-chain transactions with other Fund investors, as opposed to redeeming with the Fund and waiting for off-chain settlement in fiat currency.

When a token transfer is executed on a blockchain, the transfer is recorded in that on-chain ledger once the block is confirmed and finalized. This record is then reconciled with an off-

[69] Securitize, "Securitize Integrates with Zero Hash to enable purchase of BlackRock's Tokenized BUIDL Fund via USDC Conversion", at https://securitize.io/learn/press/securitize-integrates-with-zero-hash-enables-purchase-of-buidl-fund-via-USDC-conversion.

chain database that is operated under the sole discretion of the transfer agent. It is this off-chain system that serves as legal record of ownership.[70]

In addition to fulfilling eligible investor requirements, all prospective security holders must be whitelisted by the transfer agent prior to being able to register for securities. Subscriptions must be notified to the transfer agent for transactions to be recorded on the transfer agent's books and records and be recognized as having officially taken place.

Once whitelisted, security holders may be able to engage in transactions with other whitelisted qualified investors.

E.2. Clearing and Settlement

How Tokenization May Change the Lifecycle Process and Market Roles

Traditional clearing and settlement processes for both bonds and MMFs involve multiple intermediaries including clearing agents, brokers and central clearing houses, to manage counterparty risks and ensure a smooth settlement process. However, this can also result in operational frictions such as additional back-office costs, settlement lags, and suboptimal capital usage, particularly in time-sensitive transactions like repos and collateral transfers.

Clearing

To date, the use of DLT in the clearing and settlement workflow has mainly focused on DLT-based settlement, and atomic settlement in particular. With atomic settlement, clearing and settlement activities are synchronized into a unified workflow (see below for more details on DLT-based settlement), which could eliminate the need for certain clearing activities (e.g. trade confirmation, margining).

However, atomic settlement may not be appropriate or desirable for all asset classes, transaction types and use-cases, as it also presents risks and costs (see discussion on atomic settlement below). Therefore, where clearing activities of tokenized financial assets are still needed and hosted on DLT-based infrastructure, this could facilitate the automation of existing clearing functions and processes.[71] For example:

(a) In relation to post-trade processing, the use of DLT could enable relevant participants to use a single source of data, reducing the need for sequential processing (e.g. affirmation, confirmation, match messages) and reconciliation between legacy systems.

(b) Another area in the clearing chain where the use of DLT could enhance existing processes is in risk management. In margining, with real-time information on positions available in a DLT-based system, this could facilitate more frequent and

[70] GFMA, "Deep Dives – Impact of DLT in Capital Markets" ("**GFMA Deep Dive**"), p. 54, at https://www.gfma.org/wp-content/uploads/2025/08/3.-deep-dives-impact-of-dlt-in-cap-mkts-final.pdf.

[71] GFMA Report, *supra* n.39, p.86, 87, 89.

precise margin calculations, facilitating more efficient margin management. Furthermore, the reduction in the time gap between margin calls and posting of margins through the use of DLT (see below for more details on DLT-based settlement) could help to reduce risk exposure to the clearing house. In default management, this could facilitate a swifter updating of positions of defaulting and non-defaulting members as positions are liquidated.[72]

However, these purported improvements to clearing remain largely theoretical at the moment, as the hosting of clearing activities on DLT-based infrastructure has not seen commercial adoption in this nascent stage of the market, and with the use of DLT focused on settlement instead.

Settlement

The hosting of settlement activities on DLT-based infrastructure presents opportunities to facilitate greater accessibility and programmability of settlement processes.

In relation to accessibility, DLT allows for a shared, synchronized ledger (accessible to all participants) to record transactions as well as for financial assets and settlement instruments to reside on the same ledger, which conceptually eliminates the need for participants to maintain and reconcile separate ledgers.

In relation to programmability, DLT supports the programming and automation of multiple legs of transactions based on pre-defined rules/conditions.

Possible benefits to DLT-based settlement arising from these attributes include reduced time and failure rates for settlement.[73] The technology allows for options such as atomic settlement—where both sides of a transaction occur at the same time—or locking tokenized securities on the ledger until all settlement conditions are met. These features could reduce the rate of failed trades, shorten settlement delays, and minimize the risks that typically arise during legacy settlement periods. As a result, traders benefit from improved outcomes and potentially lower operational risks and costs.

In the same vein, atomic or near-instantaneous settlement enabled through tokenization could also reduce counterparty risk and operational expenses. This means that unsettled positions could be largely eliminated, which streamlines back-office processes and decreases exposure to market and credit risks.

The availability of faster settlement options through DLT could enhance capital allocation and efficiency.[74] Shortened settlement cycles reduce the duration for which collateral is locked, allowing for more effective liquidity management. This is discussed further in the sub-section on collateral management.

[72] Fernando Cerezetti, Max Chan, and Rafael Plata. (2023), "Decentralized Clearing? An Assessment of the impact of DLTs on CCPs – EACH Forum Paper", p 12, available at: https://eachccp.eu/wp-content/uploads/2023/03/Decentralized-Clearing-An-Assessment-of-the-impact-of-DLTs-on-CCPs-February-2023.pdf.

[73] GFMA Report, *supra* n.39, section 2.1.2.2.

[74] IMF 2025 Report, *supra* n.6, p 11.

Nevertheless, it is important to note that implementing DLT-based settlement is not without risks or challenges. There are also risks relating to pre-funding of cash in some cases. The promise of shorter or real-time settlement may require a combination of quicker deployment of funds, real-time valuation, and instantaneous execution of orders. The associated risks relating to pre-funding of cash and pre-positioning of assets are addressed in greater detail in Chapter 4.

DLT-based settlement workflows can be implemented to varying degrees based on the nature of the assets being settled, to mitigate some of these frictions. Three main models can be summarized as follows: [75]

(a) Books and records: At the baseline level, DLT can be used primarily for recordkeeping where DLT acts as a database facilitating updates between participants, but settlement execution and finality remain with the CSD and must be reconciled on existing systems. In this model, no DLT-based products are issued, and no DLT-based payment instruments are used.

(b) Partial DLT integration: Hybrid settlement using traditional and digital assets. DLT-based financial assets would settle on a distributed ledger, but payment would be coordinated through existing payment systems (e.g., FedWire) or in commercial bank model (prevalent among international central securities depositories, such as ClearStream). This is one model which commercial issuances currently utilize.

(c) DLT-native settlement: End-to-end DLT processing without traditional intermediaries, using programmable tokenized instruments. Here, the financial assets and settlement instruments would either settle on the same distributed ledger or settle on one distributed ledger, with payment coordinated through interoperability with a separate distributed ledger. This model would facilitate tokenized settlement instruments such as commercial bank money (including deposits), and DLT-based payment instruments issued by a central bank (e.g., a CBDC).

In terms of the roles of market participants, the following changes could occur: [76]

(a) Central counterparties (CCPs): In the long term, CCP processes like netting could be encoded in smart contracts, thereby altering the operational role of a CCP. In DLT-based markets for specific asset classes and transaction types, CCPs could fulfil standard setting and governance functions. Participants could develop distributed financial market infrastructure, where CCP responsibilities (e.g. for managing default funds and setting margin requirements) are shared among market participants via predefined smart contracts or encoded in market-wide infrastructure.

(b) Central securities depositories (CSDs): In the DLT-based ecosystem, a key open question is around where settlement finality and beneficial ownership will be recorded. If settlement finality is recorded using DLT, CSDs could evolve to be a

[75] GFMA Report, *supra* n.39, section 2.1.3.2.

[76] GFMA Report, *supra* n.39, section 2.1.3.2.

governor of DLT-based settlement systems. However, in most models, they may remain a central actor in DLT-based settlement.

(c) Custodians: Custodians could gain operational efficiencies in asset classes and transactions moving to DLT-based settlement. Smart contracts can automate the generation, notification, and validation of settlement instructions, streamlining straight-through-processing. Custodians will likely continue handling cash settlement through traditional systems to manage the payment leg. However, if tokenized assets and DLT-based payment settle on the same ledger, custodians may shift to managing conversions between cash and DLT-based payment instruments, provided legal certainty around finality is ensured.

Accordingly, it has been observed that DLT-based clearing and settlement is expected to function as an additional, complementary channel alongside existing infrastructure.[77] In this regard, it has been suggested that repos and OTC derivatives, where collateral payments play a key role, may present the most significant opportunity for DLT-based settlement,[78] such as addressing challenges in common processes, including posting collateral for repo transactions[79]

Observations from the Analysis

Tokenized bonds provide evidence of atomic trading/settlement capability, and the synchronization of clearing and settlement. For example, with the UBS bond offered on SDX Exchange, all trades are settled atomically (T+0), and the clearing process is no longer necessary. As explained in Boxed Example 1, members of SDX CSD can choose between tokenized CHF ("tCHF") issued by SDX or production wCBDC for a settlement asset. In addition, SDX also provides an option for transactions to be settled through SIX SIS, where the process follows that of a traditional non-tokenized product and takes place on a T+2 timeline.

In light of the options for settlement available, it bears noting that the selection of a particular option might be premised on the preference to harness the benefits of DLT-based settlement infrastructure as described above, or to continue placing reliance on traditional infrastructure due to a variety of factors such as greater familiarity in processes or the operation of network effects, amongst other things.

The analysis of Spiko EU T-Bills Money Market Fund illustrates some of the issues relating to DLT-based tokenized MMF settlement assets. The official share register is maintained on distributed ledgers. The blockchain transaction which updates the distributed ledger is the legal record of ownership, which is valid except in cases of fraud. Subscribers can request subscriptions and redemptions in both fiat currency and stablecoins. Please refer to Boxed Example 4 below for more details.

[77] GFMA Report, *supra* n.39, section 2.1.3.2.

[78] *Ibid*.

[79] See Boxed Example 6.

Boxed Example 4 – Spiko EU T-Bills Money Market Fund

The Spiko EU T-Bills Money Market Fund (the **"Fund"**) is a sub-fund that sits below the Spiko SICAV umbrella fund, which is incorporated in France. The Fund is managed by Twenty First Capital SAS (the **"Fund Manager"** or **"Twenty First Capital"**), a portfolio management company authorized by the AMF. The Fund Manager is responsible for the management of the unitholder register and has a technical assistance service-level agreement with Spiko Finance SAS (**"Spiko Finance"**) for this purpose (which does not constitute a delegation of liability management). The Fund's shares are distributed by the Fund Manager and Spiko Finance SAS, which is a registered financial investment advisor and appointed by the Fund Manager as a distributor of the Fund.

The Fund is a euro-denominated money market fund. The objective of the Fund is to offer investors capital preservation and consistent performance matching or exceeding the capitalized €STR (Euro Short Term Rate) at the conclusion of the recommended minimum investment period of one day, after deducting all fees billed to the Fund.

The official share register is maintained on distributed ledgers. The ownership of the Fund's shares is recorded on the Ethereum blockchain and other Ethereum-compatible blockchains, to which the Fund Manager has access via the tokenization platform provided by Spiko Finance.

The transfer of ownership (or the exact moment of the creation or destruction of the securities) is recorded as soon as the transaction is included in a block that is validly added to the blockchain (and, thus, there has been a change in the holding address).

Under French law, the blockchain register is only valid as proof of ownership if there is no fraudulent activity. If the blockchain or the investors' access to their accounts were compromised, the Fund Manager could request through the tokenization platform a correct version of the register to be restored, by burning compromised tokens (or even the whole issuance if needed) and then re-creating and allocating new tokens to the correct addresses.

F. Asset Servicing[80]

F.1. Custody[81]

How Tokenization May Change the Lifecycle Process and Market Roles

Broadly, custody can be understood as consisting of two core types of activities. First is record-keeping, which entails maintaining records of positions and transactions by conducting post-trade reconciliation among custodian, asset manager, sub-custodian, and CSD ledgers. Second is account management, which entails safekeeping of clients' assets and monies in accounts segregated from the custodian's own assets and liabilities.[82] For the purposes of this Report, the focus is on the custody of the digital tokens, not the underlying assets.

The impact of DLT on custody depends on whether financial institutions opt for a books and records only approach or a fully digital custody approach.[83] Under the books and records only model, assets and cash will remain within traditional market infrastructure, with DLT serving as a reference tool for record-keeping. Under the fully digital custody model, safeguarding involves both digital twins and digital native tokenized assets in addition to the current account-based custody model.

Proponents suggest that digital books and records could be deployed to potentially help make record-keeping more efficient.[84] DLT used across the custody chain could simplify post-trade reconciliations that currently occur between participants, which proponents suggest could lead to greater operational efficiency through less manual intervention, enhanced data transparency, and auditability. However, DLT may introduce new reconciliations with existing databases as the records become a sub-ledger native to a financial institution's general ledger reporting.

Digital custody can be multi-layered, with digital assets stored in different ways.[85] For example, it can also be safekept in "decentralized" ways via investors' own wallets or centralized via wallet-account structures consolidated by intermediaries. Where investors do not hold keys directly, a digital asset custodian will undertake responsibilities, including holding investors' private keys, and monitoring the process to approve transactions.[86] However, beyond the safe-keeping of the private keys in the wallet, it is crucial that the custodian is able to exercise

[80] Asset servicing refers to the operational support of investment funds across its lifecycle activities including custody, valuations, accounting, compliance reporting and transaction processing like dividend or income distribution. For the purposes of this Note, the focus is on custody and collateral management.

[81] Custody is defined as the safekeeping and administration of securities and other assets on behalf of asset managers, asset owners, and trading firms.

[82] GFMA Report, *supra* n.39, section 2.1.4.1.

[83] For a discussion on tokenized fund share registers forms, see Guardian Funds Framework, section 5.1.1.

[84] Guardian Fixed Income Framework, section 4.2.

[85] Guardian Funds Framework, section 4.6.4. For an overview of different types of custodial arrangements (viz. full custody, shared custody, hosted custody and self-custody), refer to WEF Report, *supra* n.25, Table 2.

[86] Guardian Funds Framework, section 4.5.

possession and control of the digital assets if these tokens are also under custody. Accordingly, digital custody could introduce a new infrastructure for DLT-based asset safekeeping via the wallet-and-key model, relying on private keys for transaction authorization.[87] That being said, it has been observed that new infrastructure is less likely to displace the account-based custody model in the near or medium term given the prevalence of traditional assets, presence of tokenized assets that require traditional backing, and regulatory requirements for security accounts in various jurisdictions.[88]

As for changes to the role and responsibilities of CSDs or custodians, much will depend on the design and structure of the tokenized assets in question In the case of digital twins, the local custodian or participant could propose transaction and ownership changes to the distributed ledger. [89] The CSD or custodian would need to verify regularly that the record of ownership for the traditional asset exactly matches the record of ownership for the digital twin, as shown in the illustrative diagram below.[90] For these reconciliations, the traditional CSD ledger could likely remain the golden source of truth, given its legally established nature today. Accordingly, the purported benefits of tokenization in this regard may be negated to a certain extent for as long as traditional and DLT-based infrastructure continue to run in parallel. It has been observed that this will likely remain the case in the short to medium term given the nascent state of DLT compared to the entrenched traditional infrastructure.[91]

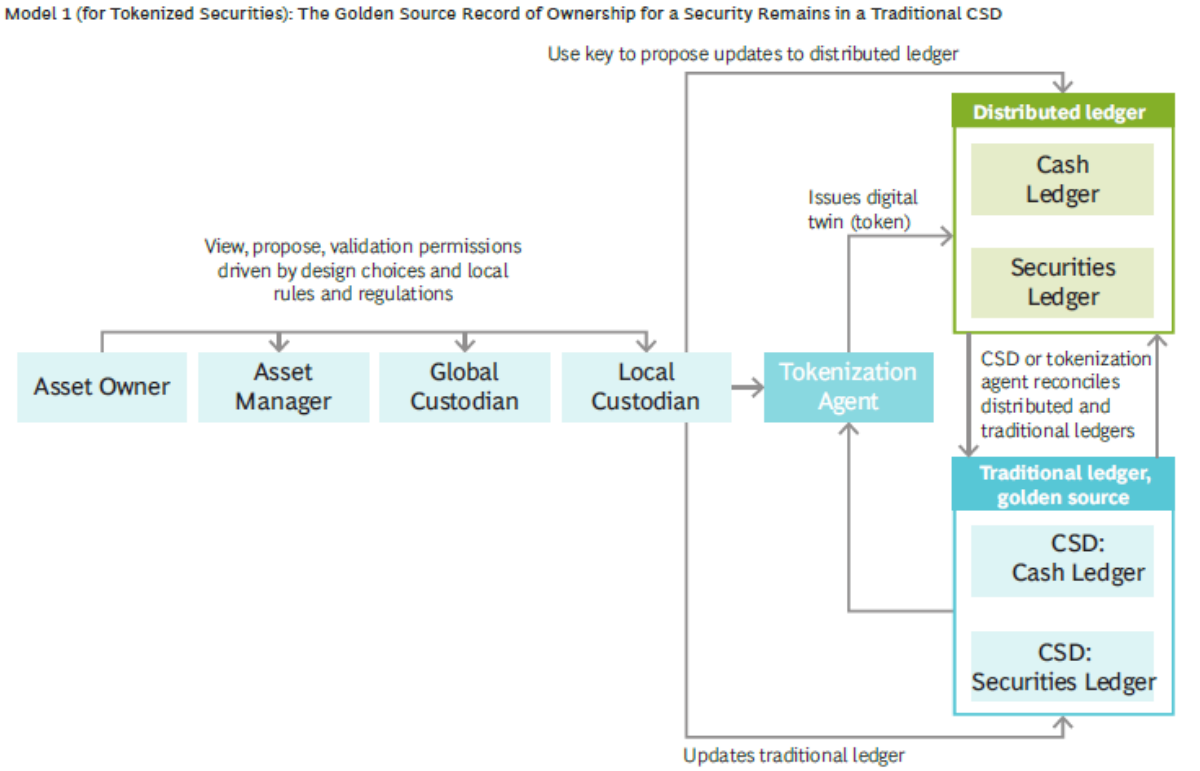
87 Guardian Fixed Income Framework, section 4.2.

88 GFMA Report, *supra* n.39, section 2.1.4; Guardian Fixed Income Framework, section 4.1.2.

89 GFMA Report, *supra* n.39, section 2.1.4.2.

90 GFMA Report, *supra* n.39, Exhibit 2.1.13.

91 GFMA Report, *supra* n.39, section 2.1.4.2.

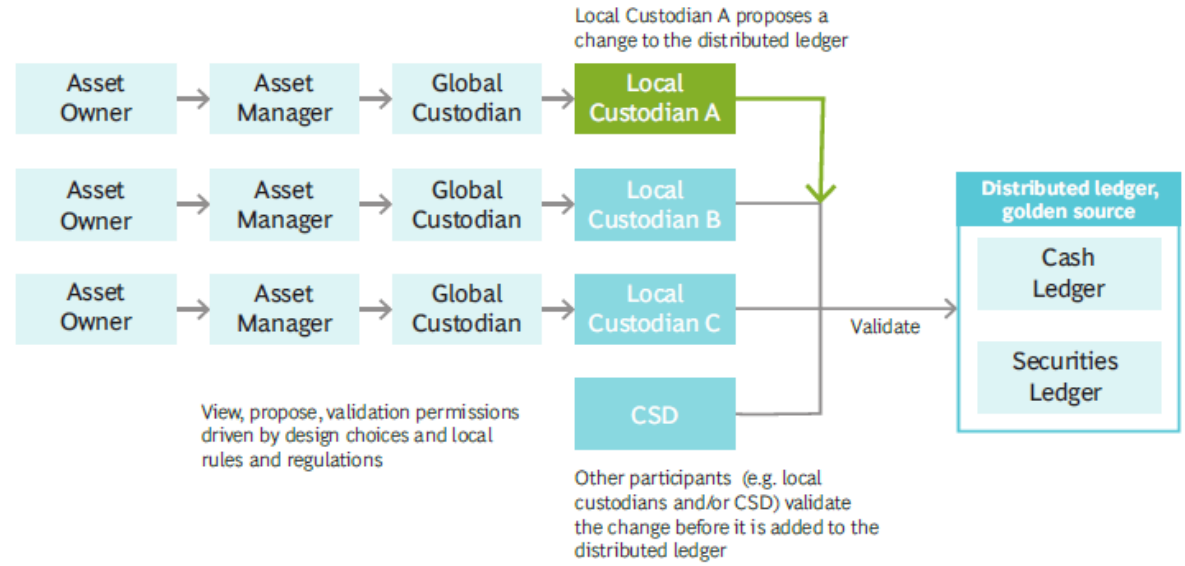


In the case of digital native assets, where ordinarily the distributed ledger becomes the only source of truth, the CSD role may shift toward governance while custodians and other intermediaries play a larger role in validating transactions on the distributed ledger.[92] Governance activities could include enforcing data standards, determining validation mechanics, and arbitrating disputes. In terms of updates to the distributed ledger, several options are possible. Custodians, brokers, or other direct DLT participants could be responsible for both proposing and validating updates to the shared ledger of ownership as seen in the illustrative diagram below.[93]

[92] Depending on the legal requirements in different jurisdictions, alternative models may also be possible where a CSD may not be required.

[93] GFMA Report, *supra* n.39, Exhibit 2.1.14.

Model 2 (for Security Tokens): The Golden Source of Ownership Exists Solely on the Distributed Ledger, Managed by CSD or Custodians, or Both



Source: BCG analysis

The evolution of custody as outlined above (whether under the digital twin or digital native model) could also have consequences for costs, though any savings could take time to materialize clearly or fully. On the one hand, simplifying reconciliations could lower the total cost to service clients.[94] On the other hand, upfront operational and capital expenditures will be necessary to build custody platforms and link legacy and DLT-based platforms for reconciliations (at least in the short/medium term).[95]

Observations from the Analysis

With respect to tokenized bonds, the analysis suggests that custody-level changes have been applied for books and records and there is evidence of digital custody using both self-custodied and third-party wallets.

In the case of the UBS bond issued on SDX, ownership records are updated via direct entries to SDX's distributed ledger, which is the main register (*Hauptregister*) and serves as the definitive record of ownership under the Swiss law. SDX CSD is regulated and responsible for supporting the issuance, settlement, custody and ownership recording of the digital bond into the main registry on its DLT network.

Likewise, in the case of bonds issued on Euroclear's Digital Securities Issuance service, Euroclear is regulated as a CSD in Belgium and responsible for recording the ownership of the tokenized bonds. Please refer to Boxed Example 5 below for more details.

94 GFMA Report, *supra* n.39, section 2.1.4.2.

95 *Ibid*.

Boxed Example 5 – Euroclear

Euroclear Bank's Digital Securities Issuance service (**D-SI**) supports the issuance, distribution, primary market settlement and redemption of digitally native notes (**DNN**) on DLT.

The D-SI is part of the Digital Financial Market Infrastructure (**D-FMI**) initiative connected to the traditional securities settlement system of Euroclear Bank for settlement of secondary market transactions conducted OTC or on trading venues, granting investors full access to trading venues and liquidity management facilities.

The D-SI service covers:

(a) the acceptance of DNNs as dematerialized securities with the automatic ISIN allocation,

(b) the issuing agent authorizing the creation of DNNs,

(c) the DVP settlement in EUR or USD. Once issued, DNNs are held directly by participants through Securities Wallets on the D-FMI component,

(d) the transfer of the securities and cash proceeds from the D-FMI component to the traditional component of Euroclear's securities settlement system to settle secondary market transactions, safeguarding the liquidity.

Under the D-SI service, the deal is priced, the new securities are distributed, and the primary market activity all settle on the same day.

Secondary market transactions are settled in the traditional securities settlement system of Euroclear. Euroclear performs core CSD services (as defined in Section A of the Annex to CSDR) in full compliance with the existing regulatory framework (including Central Securities Depositaries Regulation (CSDR) and Settlement Finality Directive (SFD)), both on D-FMI and the legacy system.

In terms of settlement finality, the European Settlement Finality Directive applies to settlements within the D-FMI as the D-FMI is part of the securities settlement system of Euroclear Bank which is recognized as a "system" under the Settlement Finality Directive. DNNs issued and settled in the D-FMI can be fully listed and traded on EU regulated markets.

With respect to tokenized MMFs, there is also evidence of implementation of digital custody whereby different custody options are offered, as mentioned in the respective Boxed Examples above.

F.2. Collateral Management and Repos

How Tokenization May Change the Lifecycle Process and Market Roles

Apart from fixed income products and MMFs, tokenization has also been applied in the domain of collateral management and repos. The WEF Report has identified collateral and repos as a key application of tokenization.[96] As noted in the same report, collateral is fundamental to managing counterparty risk and ensuring the smooth functioning of financial markets by mitigating credit risk. Ideal collateral would be free from credit and liquidity risks, maintain a stable value, and not correlate with the provider's credit risk.

The motivation for tokenization in the area of collateral management is to reduce operational burden of existing processes, for both fixed income products and MMFs. It has been noted by both the WEF and GFMA that the current workflows for collateral and repo markets face various inefficiencies.[97] Manual and fragmented workflows can rely on outdated and disconnected systems, leading to delays, errors and costs. Additionally, settlement inefficiencies may result from the many intermediaries coordinating complex transactions – rapid buy and sell orders – that have led to longer settlement cycles and liquidity constraints. Deferred settlement may cause collateral to be kept from other productive uses and create counterparty credit risk, which requires higher collateral value to mitigate. Rehypothecation and collateral reuse can also be slow and operationally complex. Delays in collateral release may further have knock-on effects for the next trade, resulting in trade failure.

DLT-based securities have been the focus for use in the intra-day repo market because of the potential speed of settlement.[98] It has also been suggested that DLT-based repos could improve the degree of visibility regulators have in relation to the sources and uses of securities in collateral agreements, thereby improving their ability to mitigate potential risks.

The commercial application of tokenization in collateral markets is also seen significantly in the use of tokenized MMFs. MMFs in tokenized format could enable collateral portability without requiring redemption for cash movement. Information such as valuation, liquidity, and credit ratings of the underlying MMF securities could also be made available to better reflect information on counterparty risk.

Observations from the Analysis

Kinexys by J.P. Morgan, the firm's blockchain business unit, has deployed tokenization in collateral management. The Kinexys Digital Assets platform is a multi-asset tokenization platform for institutional assets like MMFs, repos, and bonds. As of November 2024, the platform had processed more than $1.5 trillion in notional value since its inception in 2020 through its intraday repo and collateral

[96] WEF Report, *supra* n.25, section 3.3.

[97] WEF & Boston Consulting Group (**BCG**) (May 2021), "Digital Asset, Distributed Ledger Technology and the Future of Capital Markets"; GFMA Report, *supra* n.39, section 3.2.

[98] GFMA Report, *supra* n.39, section 3.2.1.

services.[99] It processes an average of more than $2 billion daily in transaction volume. Please refer to Boxed Example 6 below for more details.

Boxed Example 6 – Kinexys by J.P. Morgan

The Kinexys Digital Assets platform was established in 2020 and enables the tokenization of money market fund shares using block chain technology, allowing for settlement of transactions and transfers of collateral ownership without moving tokenized assets in underlying ledgers.

The Kinexys Digital Assets platform is used worldwide by asset managers, institutional investors, financial institutions and fintech companies, and enables them to efficiently pledge or transfer tokenized ownership interest in money market fund shares as collateral. The current focus is on institutional and large corporate clients, with the criteria and review processes aligned to that of the firm's traditional business.

As alluded to earlier, it appears that a small number of tokenized MMFs are also being used as collateral for crypto transactions.[100] BUIDL is an example which is being used as tokenized collateral in various financial and crypto market settings. In June 2025, it was announced that BUIDL will be accepted as collateral on leading crypto exchanges such as Crypto.com and Deribit.[101] Accordingly, institutional traders can post BUIDL tokens as margin for leveraged trades, earning yield on the underlying U.S. Treasuries while using the token as collateral. Further, Ethena Labs recently launched the USDtb Liquidity Fund, allowing investors to swap BUIDL for the USDtb stablecoin. As of June 2025, the largest holders of BUIDL tokens - USDtb ($1.3 bn); Spark ($800 mn); and Ondo ($150 mn) – were firms which used BUIDL tokens as collateral assets in their products and

[99] https://www.jpmorgan.com/insights/payments/payment-trends/introducing-kinexys.

[100] Based on publicly available information, there are news announcements which suggest that other MMFs are also being deployed for collateral, though these do not seem to have garnered the same traction or attention as BUIDL. For example, see BENJI token used as collateral for derivatives transaction: https://www.businesswire.com/news/home/20241121236302/en/Nonco-and-SwapGlobal-Complete-Industry-First-Crypto-Derivatives-Transaction-Using-Franklin-Templetons-BENJI-Token.

[101] https://securitize.io/learn/press/BlackRocks-BUIDL-Tokenized-by-Securitize-Accepted-as-Collateral-on-Cryptocom-and-Deribit.

services.[102] There is also growing integration of tokenized MMFs with permissionless DeFi, which purportedly is being done in such a way that the MMF is able to maintain compliance with its regulatory obligations (including with regard to the qualified purchaser requirement falling under U.S. law). This is representative of a larger trend in tokenization, which involves enabling investors in permissioned assets (e.g., securities) to use such assets more freely in DeFi.[103]

It is also noted that the Global Markets Advisory Committee (GMAC) of the CFTC, which includes industry participants and experts, has voted to recommend the use of tokenized non-cash collateral (including MMF tokens) and has advanced these recommendations to the full CFTC for consideration.[104] At the time of writing, the CFTC has not voted on or formally enacted these recommendations.

G. Summary Observations

Notwithstanding that the evolution of lifecycle activities from tokenization appears to still be quite incipient and incremental, there is evidence of growing commercial interest. The following paragraphs set out some projections regarding the trajectory of tokenization. As stated at the outset, while it is important to have an eye on the market's perception of the trajectory regarding tokenization, it is not the purpose of the Report to encourage or endorse tokenization. As will be observed below, estimates of potential tokenization growth vary across studies.

On the one hand, according to McKinsey's report of June 2024, the tokenized market capitalization across asset classes could reach about $2 trillion by 2030 (excluding cryptocurrencies and stablecoins).[105] The pessimistic and optimistic scenarios range from about $1 trillion to about $4 trillion, respectively. According to Citi, tokenization of securities is expected to reach up to $4-5 trillion in value by 2030, assuming 1% of corporate and quasi-sovereign bonds, 7.5% of real estate funds, 10% of PE/VC funds and 2% of repo, securities financing and collateral markets are tokenized.[106]

On the other hand, according to a joint report published by Ripple and BCG in April 2025, tokenization across real-world assets is projected to grow from around $0.6 trillion in 2025 to $18.9 trillion by 2033 in the midpoint

[102] As seen in the Etherscan blockchain explorer for the two BUIDL token contracts, https://etherscan.io/token/0x7712c34205737192402172409a8F7ccef8aA2AEc#balances (for Ondo) and https://etherscan.io/token/0x6a9da2d710bb9b700acde7cb81f10f1ff8c89041#balances (for USDtb and Spark). USDtb's holdings are held in three custody accounts (associated with three separate blockchain addresses) with Copper, Komainu, and Zodia: https://usdtb.money/transparency.

[103] *See, e.g.,* RWA News: Securitize, Gauntlet Bring Apollo's Tokenized Credit Fund to DeFi With Leveraged Yield Strategy. *See also* Securitize | #HyFi Meets Horizon: RWAs Go Native in DeFi.

[104] https://www.cftc.gov/PressRoom/PressReleases/9009-24.

[105] McKinsey, *supra* n.35.

[106] Citi GPS (March 2023), "Money, Tokens, and Games: Blockchain's Next Billion Users and Trillions in Value," p 15., available at: https://www.citifirst.com.hk/home/upload/citi_research/rsch_pdf_30143792.pdf.

scenario.[107] The conservative scenario postulates a size of $12.5 trillion while the optimistic scenario puts it at $23.4 trillion. Another report jointly published by Standard Chartered Bank and Synpulse posits that overall tokenized real-world assets are expected to reach up to $30.1 trillion by 2034, with trade finance assets being in the top three tokenized assets.[108]

While the precise scope, method and bases for each report varies, it suffices to note that the trajectory perceived by industry analysts and participants is generally one of growth, though the rate and scale differ.

[107] Ripple and BCG (7 April 2025), “Approaching the Tokenization Tipping Point”, available at: https://www.finews.asia/images/download/approaching-tokenization-at-the-tipping-point.pdf.

[108] Standard Chartered and Synpulse (June 2024), "Real-World Asset Tokenization: A Game Changer for Global Trade", available at: https://www.hkdca.com/wp-content/uploads/2024/07/rwa-tokenization-game-changer-global-trade-synpulse.pdf.

4. Financial Asset Tokenization and its Potential Implications

While tokenization is purported to bring about benefits across different stages of the capital markets lifecycle process, whether and how these benefits would materialize, as well as its impact on the broader financial markets, have yet to be seen. Despite this, risks can continue to manifest or be amplified in the course of adopting tokenization arrangements due to their unique characteristics as discussed in Chapter 3, along with the nascent and evolving application to financial products and services.

This Chapter discusses the issues that may arise from tokenization arrangements and their potential risk implications to market integrity and investor protection. The discussion in this section is informed by IOSCO's information gathering efforts, focusing on the observations from the analysis of existing examples in the market, and supplemented with insights gathered from industry engagements and a literature review of relevant papers on the subject.

A. General Observations

From the analysis, it is observed that there are few, if any, substantive differences in the economic substance of financial assets that are being created through tokenization arrangements as compared to financial assets created through conventional means. Likewise, the economic purpose of activities that are being conducted in relation to such tokenized financial assets are typically also the same or similar to the majority of activities that are already taking place in the conventional market.

In this regard, it follows that many of the risks present in conventional products and activities may also be present in the tokenized financial products and tokenization arrangements. The primary difference however is the use of a new technological medium such as DLT to create and represent financial assets, and to perform activities pertaining to these assets, which could improve the delivery of financial services and address current market inefficiencies.

These changes in the technologies and infrastructure used for the creation of financial assets can have wider implications for the operating environment in which these assets and services are deployed. For instance, some activities such as clearing might become less relevant in the context of atomic or near-instantaneous settlement whilst the performance of other activities such as custody might be vastly different as highlighted in Chapter 3. Tokenization can also introduce new process flows or intermediaries with new roles such as token minters, DLT platform developers, etc.

Such changes can in turn cause risks present in conventional products and activities to manifest in a different form under tokenization arrangements or result in other risks being amplified. It is therefore important to understand how such risks manifest in a

capital market specific context given the potential implications for market integrity and investor protection. Specific to this context, it is worth highlighting the following general observations from the analysis conducted:

(a) **The manner in which the risks eventually manifest likely is not uniform across tokenized assets and arrangements.** Instead, such risks are highly contextual to the use-case being contemplated and will depend upon a number of factors, including but not limited to the choice of the DLT network architecture being used, the tokenization structure adopted for the financial asset, the activities that the tokenized financial asset is being used for, and the manner in which the asset interacts with other assets and activities in a tokenized environment.

(b) **Not all the risks will eventually manifest or manifest in the form discussed.** This is given that tokenized financial assets and tokenization arrangements are still relatively nascent, and its scale and trajectory of eventual adoption is highly uncertain given that the underlying DLT and broader ecosystem is still evolving.

The diversity in the risks surfaced from the literature reviewed vis-a-vis the examples analyzed exemplifies this point. For instance, it is observed that risks from the examples tend to be product- or activity-focused, manifesting based on the tokenization application at that specific point in time. In contrast, the risks highlighted in the literature reviewed contemplate a more scaled-up future state tokenized eco-system.

The unique characteristics of tokenization arrangements that can give rise to salient issues, and the potential risk implications of these issues to market integrity and investor protection, are discussed in detail in the sub-sections below. These are grouped by issues that are observed to be more salient in the analysis of the examples vis-a-vis those that are discussed more extensively in the literature but are nascent or have yet to be observed, as this forms a natural differentiation between issues/risks that are of immediate concern to current commercial tokenization application against those where their manifestation will depend on the trajectory and scale of tokenization adoption.

B. Potential Implications Observed

The analysis shows that the nature of risks arising from the current commercial application of tokenization fall into existing risk taxonomies (chiefly legal, operational and technology risks, and to a lesser extent, credit and liquidity risks). Market participants are not unfamiliar with managing such risk types, but tokenization may also result in the manifestation of vulnerabilities and risks that are unique to the technology itself, some of which would require the introduction of new or additional controls to manage them. This has been acknowledged by issuers and operators in their publications including public prospectus documents. The issues giving rise to these risks are discussed below.

B.1. Representation of Financial Assets in the Form of Tokens

There are currently well-established legal constructs and structures for the treatment of financial assets created in paper certificate or book-entry form, along with the activities conducted in relation to these assets on conventional market infrastructure, to ensure

adequate protection of investor rights and interests in the event of disputes.

It can be unclear if current practices applied in the conventional market are also equally applicable to financial assets that are created or represented in the form of tokens, and the activities conducted on these tokens through the blockchain. For non-native tokens, investors can also be uncertain around what ownership of the underlying assets could mean in relation to token ownership given the range of structuring options available.

These can give rise to investor protection risk where the legality of ownership and transfers of tokenized financial assets might not be transparent or aligned with what is perceived by investors. Such risks could arise in the following situation:

(a) Legal recognition of creation and transfer of tokens – Most jurisdictions have historically mandated in their legal frameworks how ownerships and transfers of financial assets such as shares and debentures should be recorded or performed in order for it to be legally recognized [109]. The use of the DLT to record and perform such ownership and transfers might not feature or fit cleanly within these framework requirements as such technologies were not contemplated at the time the legislation was created. Investors face legal risks if ownership or transfers made using tokens on the DLT are invalidated or not recognized as envisaged. This is further complicated in cross-border transactions given the wide variation in jurisdictional approaches to recognizing DLT-based token ownership and transfer.

Given the variation in jurisdictional approaches, it has been observed from the analysis that different operators have taken different approaches to maintain the authoritative source of ownership for financial assets they have tokenized. For instance, some operators continue to maintain off-chain records as the official legal source of ownership records which takes precedence over the on-chain records; some have combined features of off-chain book-entry records on centralized systems with on-chain records as the official legal source of ownership; still others have primarily relied on on-chain records as the official legal source of ownership with off-chain records as back-up. Such differences in approaches might confuse investors investing in tokenized assets on what is the authoritative record of ownership for their asset, and potentially lead to disputes, if not properly disclosed. Please refer to Boxed Example 7 below for more details.

[109] X Lavayssière, "Legal Structures of Tokenised Assets". European Journal of Risk Regulation, available at https://doi.org/10.1017/err.2024.88.

Boxed Example 7 – Different approaches by tokenized MMFs in recording ownership

BlackRock USD Institutional Digital Liquidity Fund (BUIDL): The official record of ownership is maintained in the transfer agent's off-chain books and records.

Franklin Onchain U.S. Government Money Fund: The Fund's shares are issued directly on a blockchain, and this serves as the official record of ownership. The Fund's recordkeeping system combines features of the blockchain and a traditional book-entry record, such that the blockchain functions as an integral part of the primary record. However, the transfer agent has unilateral control over all transactions involving the securities and can, for example, take corrective measures where erroneous or impermissible transactions have occurred.

Spiko EU T-Bills Money Market Fund: The official record of ownership is maintained on distributed ledgers. It is valid as proof of ownership if there is no fraudulent activity.

There could also be uncertainties amongst issuers and market participants on whether their tokenized financial assets and activities fall within current regulatory frameworks and how the regulatory requirements would apply. On this front, regulatory authorities have considered a variety of additional regulatory measures, including risk disclosures. These are discussed further in Chapter 5.

(b) Investor rights to underlying assets of non-native tokens – The rights of investors to the underlying assets that non-native tokens are meant to represent, and the linkages between the tokens and the assets, can be subject to wide variations depending on the tokenization structure being adopted by the non-native token issuer. This might not always be made transparent to investors via appropriate disclosures, or easily understood by investors even if disclosed, hence posing significant risks where investors could mis-perceive their actual holdings in relation to their non-native token investment.

For instance, some non-native tokens could be structured to represent synthetic exposure to the assets that the token claims to represent whilst others are backed by actual exposure where the token issuer holds the underlying asset on behalf of the investor. For the former, the non-native token could merely represent a promise by the token issuer to provide token holders with monetary gains associated with fluctuations in prices or valuations of these assets and counterparty risk exposure is to the token issuer to fulfil its obligations instead of the underlying asset issuer, which might not always be clear to investors (see Chapter 3 on “stock tokens”). For the latter, such structures can be akin to conventional fractionalization or securitization arr-angements. However, token issuers might not always put the same level of

protection in place as for conventional securitized products. For example, issuers might not use bankruptcy-remote structures to hold the underlying assets to protect investors but instead hold the underlying assets on their own balance sheet. This exposes the investor to additional counterparty risk against the token issuer on top of that faced with the underlying asset issuer. In addition, investors may also be exposed to custody risks, which could include the issuer's loss of title to the underlying asset or the sale of the underlying asset without investor knowledge or recourse.

The FSB has also noted that non-native tokens can be exposed to liquidity and maturity mis-match risks,[110] which can result in redemption runs on either the underlying assets and/or non-native tokens in the event of a liquidity crunch. This can also compromise the integrity of the market, where irrational liquidity runs can lead to disorderly trading and impact proper price discovery.

Whilst the risks described above are also present in conventional markets due to the similarity between securitization and non-native tokenization arrangements, some of these risks could be further amplified in tokenization arrangements due to the unique characteristics discussed in Chapter 3. For instance, tokenization can improve product access to investors via lower costs of asset issuance and platform onboarding, increase the velocity of transactions through programmability, and support the development of a wider variety of complex products and arrangements via composability.

(c) Finality of DLT-based token transfers: Settlement finality is a legally defined moment to provide users with confidence that their transactions cannot be revoked or unwound upon final settlement. The CPMI Tokenization Report has noted that the operational transfer of tokens on the DLT coinciding with final settlement as legally defined can be unclear depending on the technology features and design choices.[111]

Even if the financial institution overseeing the governance of the DLT network clearly defines in their rules, procedures and contracts the point at which final settlement occurs in accordance with the stipulated legal frameworks, the inherent feature of probabilistic settlement embedded in the network configurations for some permissionless networks could still result in uncertainties around the settlement status of transactions on that network.

In addition, there can also be potential uncertainties for tokenization arrangements that adopt multi-layered networks. For instance, it is not always clear whether finality of settlement can be taken to be achieved when a few blocks are added to the block containing a given transaction on the Layer 2 network chain or whether this can only be considered when that block has been included in a checkpoint on the Layer 1 network.

[110] FSB Report, *supra* n.6

[111] CPMI Tokenization Report, *supra* n.6.

Investors face significant legal risks on this front as their transactions can be reversed or subject to dispute, even if the transfers of tokens have been successfully completed on the DLT network that the tokenized financial asset is hosted on. Please refer to Boxed Example 8 below for more details.

Boxed Example 8 – Different approaches towards settlement finality

Euroclear and SDX: Both operators use a private, permissioned blockchain with deterministic transaction processing, which ensures that once a transaction is recorded on the ledger, its outcome is final and cannot be changed.

Franklin Onchain U.S. Government Money Fund: Settlement finality is achieved once a transaction is validated and recorded to the blockchain, it is considered legally and operationally final, eliminating the need for downstream reconciliation or duplication in internal systems.[112]

BlackRock USD Institutional Digital Liquidity Fund: Settlement finality is achieved when a change in ownership is synchronized with the Fund's off-chain records maintained by its transfer agent which is intended to occur on a continuous and near real time basis.

Spiko EU T-Bills Money Market Fund: The Spiko MMF tokens can be issued on various public permissionless blockchains, including Layer 1 networks (such as Ethereum) and selected Layer 2 networks, which are scaling solutions of Layer 1 networks.

From the analysis, it is observed that the Spiko MMF (and also a broader tendency among market operators) considers finality to be achieved when the block containing a given transaction is added to the Layer 2 blockchain, or, at most, after a certain number of blocks have been added to that block, but still on the Layer 2 network.

These Layer 2 transactions are then bundled and sent to Layer 1, along with a proof of their correctness. In the counterpart Layer 1 blockchain, smart contracts verify the proof received. Depending on the type of Layer 2, verification of the proof (and thus of the Layer 2 transactions) occurs instantaneously in the case of zero-knowledge rollups, or only following a dispute in optimistic rollups. If the verification fails, the block is rejected by the Layer 1 and the state transition on Layer 2 is reverted.[113]

[112] GFMA Deep Dive, *supra* n.70.

[113] For example, since it has its own consensus protocol, Polygon is typically considered a sidechain Layer 2. In Polygon, transactions are sent on Ethereum and considered final (i.e., consolidated in Polygon jargon) after the proof has been verified (see: Transaction finality - Polygon Knowledge Layer).

This issue could also be relevant for other issuers and market operators who use Layer 2 solutions.

B.2. Use of DLT-Based Infrastructure in Hosting Tokenized Financial Assets

As with all technologies, the underlying DLT-based infrastructure that hosts tokenized financial assets can also be exposed to operational vulnerabilities and risks unique to the technology itself. Such vulnerabilities and risks can broadly surface through three avenues:

(a) DLT Networks: The vulnerabilities in DLT networks can vary depending on the network type used and are exhibited via the following:

(i) **Node management:** A fundamental feature of DLT networks is that a consensus has to be reached between nodes for a transaction to be recorded on chain. Such a feature can lead to the occurrence of forking in public permissionless blockchains, where the chain is split into two, due to protocol changes or because of disagreement amongst participants on the governance of the chain. This can give rise to uncertainties around which chain is the official legal source of asset ownership, which can in turn lead to potential volatile trading of the asset or even asset loss.[114]

This feature also subjects the network to the risk of cyberattack, as malicious parties might seek to gain control of over 50% of the total consensus power of the blockchain and seek to alter transactions on the chain. Such attacks are not just restricted to public permissionless blockchains but can also impact permissioned chains.[115] This is given that nodes in permissioned chains face elevated concentration risk as the network is controlled by a defined number of parties who share the same operator vulnerabilities. Malicious parties can exploit such vulnerabilities through traditional security breaching avenues to take control of the devices that host the nodes to gain control over the entire network.

In addition, it is worth mentioning that issues with DLT infrastructure may not be immediately identifiable or identified, creating a time window of vulnerability whose effects may not be undone by off-chain business continuity and disaster recovery solutions. For instance, an off-chain payment may be completed in exchange for a tokenized security. If the transfer of the security is nullified at a later time due to a fork or other events (e.g., eclipse attacks, etc.), recovering the money of the off-chain payment may be unfeasible.

[114] BIS (2024), "Novel risks, mitigants and uncertainties with permissionless distributed ledger technologies" ("**BIS DLT Report**").

[115] HKMA (2024), "Distributed Ledger Technology in the Financial Sector: A Study on the Opportunities and Challenges" ("**HKMA 2024 Report**").

Another potential vulnerability is the exploitation of "maximal extractable value" (i.e., value that can be extracted from a blockchain transaction beyond standard fees by reordering, inserting, or censoring transactions before they are confirmed on-chain), which could negatively affect fair and orderly trading.

(ii) **Network speed and costs:** The same consensus feature can also result in public permissionless blockchains struggling to process large volumes of transactions.[116] This can cause undue delays and uncertainties around the eventual processing and settlement of transactions on the chain, which could in turn expose investors to liquidity and market risks from delayed receipt of their assets and funds.

Apart from investor risks, the payment of transaction fees for network usage on public blockchains could also expose the financial institution operating the network to various forms of risks. For instance, transaction fees can be subject to extreme volatility depending on the scale of network usage, hence resulting in significant uncertainties around operational costs projections. In addition, as transaction fee payments are made via the network's native digital asset, financial institutions are also subject to AML/CFT risks as they might have to source from and make payment using these assets to unknown individuals. Such activities can also pose regulatory risks if the digital native asset is deemed to be a regulated product and the operator is considered to be conducting regulated activities in relation to the product.

(iii) **Data:** Financial institutions operating DLT networks for tokenized financial assets can also face an inherent conundrum between data privacy and transparency.

For instance, the in-built immutability and transparency features of DLT networks, particularly for public blockchains, could cause unintended user confidentiality breaches and pose compliance issues with jurisdictional specific data requirements such as the EU's GDPR "right to forget" requirements.[117] Research has also indicated that the transparency of public chains can cause liquidity and market integrity risks where visible transaction flows can exacerbate redemption runs, with a case in point being the Terra/Luna crash.[118]

At the same time, DLT networks can enhance pseudonymity; by replacing identifying information with an

[116] Hillary J. Allen (2023), "Hearing on Next Generation Infrastructure: How Tokenization of Real-World Assets Will Facilitated Efficient Markets" ("**Allen**"), available at: https://docs.house.gov/meetings/BA/BA21/20240605/117392/HHRG-118-BA21-Wstate-AllenP-20240605.pdf.

[117] WEF Report, *supra* n.25.

[118] BIS DLT Report, *supra* n.114.

artificial identifier, which can complicate KYC checks. Besides potentially exposing financial institutions to non-compliance with AML/CFT and sanctions regulations, this can also amplify market integrity risks as a trader can easily engage in self-dealing and wash trading by quickly buying and selling the same asset from different addresses to generate fictitious volumes and temporarily inflate prices. [119]

(iv) **Interoperability:** The proliferation of DLT networks that are competing and non-interoperable can cause assets and users to be fragmented, result in liquidity being locked up across multiple networks, leading to liquidity bifurcation and fragmented trading across different venues.[120] Fragmentation also creates a need for more bilateral linkages between networks, which can give rise to heightened operational and technological risks similar to those faced in conventional markets. For instance, the use of APIs and smart contracts (which "lock up" tokenized assets) as bridges between networks can be a source of potential vulnerability which malicious actors can target for cyber-attacks.

Besides introducing additional market inefficiencies and undermining the benefits that tokenization is purported to achieve, the same risks described above can also apply if current infrastructure and DLT networks operate in a fragmented and non-interoperable manner.

At present, there has been a wide proliferation of DLT networks to support tokenized financial products and activities,[121] with financial service entities having adopted at least 72 distributed or programmable ledgers and driven 10 market forces that are accelerating the deployment of individual networks based on WEF statistics collated as May 2025. [122] The OECD also notes that the majority of entities have leveraged private permissioned DLT networks, and not all of these networks are inter-operable.[123]

In this regard, there has been growing recognition by the industry of the risks and challenges that fragmentation poses to the scaling up of tokenization initiative, with solutions emerging to address the issue.

Please refer to Boxed Example 9 and Boxed Example 10 below for more details.

[119] Le Pennec et al.(2021) "Wash trading at cryptocurrency exchanges", available at: https://www.sciencedirect.com/science/article/abs/pii/S1544612321000635.

[120] IMF 2025 Report, *supra* n.6.

[121] WEF Report, *supra* n.25.

[122] WEF Report, *supra* n.25.

[123] OECD 2025 Report, *supra* n.17.

Boxed Example 9 – Interoperability between traditional and DLT infrastructure

AIIB bond issued on Euroclear: The D-SI is part of the D-FMI initiative connected to the traditional securities settlement system of Euroclear Bank for settlement of transactions conducted OTC or on trading venues, granting investors full access to trading venues and liquidity management facilities. The AIIB bond as DNN is listed on the Luxembourg Stock Exchange and is admitted to trading on the regulated market of Luxembourg Stock Exchange.

The DNNs are cleared and settled through the D-FMI. The DNNs are immobilized in the Securities Wallet of Euroclear in its capacity as central securities depository. The bonds are then held by Euroclear for investors holding and transferring interests in the DNNs through the securities clearance accounts of direct participants in the conventional non-D-FMI component of the Euroclear System.

Clearing is also possible on the Hong Kong Monetary Authority's Central Moneymarkets Unit (**CMU**) and SIX Swiss Exchange which have an account at Euroclear Bank as investor CSDs. Leveraging traditional CSD links, CMU and SIX are able to make the DNNs available at their securities settlement system without the need to interact with the D-FMI.

Boxed Example 10 – Interoperability between DLT infrastructures

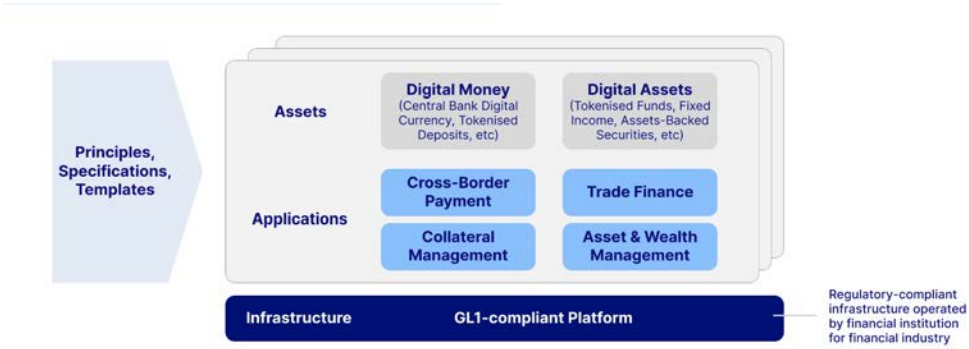
Canton network: The Canton network is designed as a "network of networks" for smart contract applications. With Canton, the entire ledger for a network of applications is not replicated across parties on the network and thus not publicly available. Instead, each user of an application maintains a ledger of only the data it is permissioned to see by that application. The Canton protocol ensures that this data is valid and current. As a result, everyone works from a unified ledger without being in possession of the entire ledger. Instead, each user is only in possession of their portion of the ledger.

This is useful in financial workflows, where a unified ledger can eliminate costly reconciliation but where user application data nonetheless needs to be private. Canton enables the synchronization of data and transactions across independently operated applications and synchronizers, while implementing privacy and control capabilities.

Canton is being used by financial institutions to reduce issuance time of securities, reduce settlement risk, and increase efficiency. One example is the processing of over $1.5 trillion of repo transactions per month.[124]

Global Layer One: Global Layer One (GL1) is a collaborative initiative[125] between the public and private sectors to foster the development of open, interoperable, shared ledger infrastructures for hosting tokenized financial assets and applications.

Given the complexity of global markets, no single infrastructure could realistically serve the financial industry's diverse needs. Therefore, GL1 focuses on building an ecosystem of compatible platforms. In collaboration with policymakers and financial institutions across jurisdictions, GL1 aims to develop common principles, specifications and templates for platforms, to enable interoperability between platforms and the seamless flow of tokenized assets across networks (see diagram below).

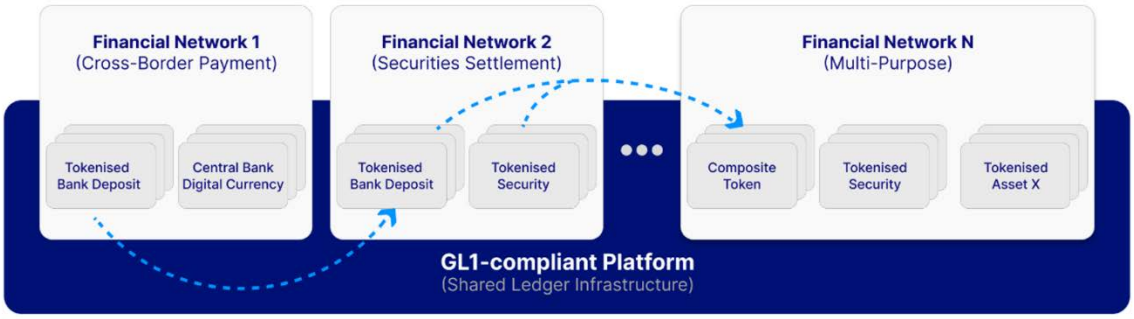


GL1 will provision core functionality and common libraries that can be leveraged upon by the financial industry, such as: (i) GL1's Programmable Compliance Toolkit, which provides a framework for automated compliance checks and the enforcement of policy and regulatory requirements, such as capital flow management and anti-money laundering measures, in real-time; (ii) GL1's Market Infrastructure Toolkit, which provides a framework for financial institutions and market infrastructure providers to validate their services against internationally recognised principles and regulatory requirements.

Platforms that meet these specific data and operational standards will be designated as GL1 compliant. As can be seen in the diagram below, multi-asset and multi-currency transactions could be executed between different financial networks on platforms designated as GL1-compliant, with new applications also being able to be composed by building upon applications originating from multiple financial networks.

[124] Manoj Ramia (2024), "Canton Coin: A Responsible Approach to Digital Tokens".

[125] Further details on the initiative can be found on the GL1 website at the following link: https://global-layer-one.org/.



(b) Smart contracts: Smart contracts are an important part of tokenization arrangements to enable programmability and automation, but their use also comes with risks.

Firstly, inadequately designed smart contracts or errors in the coding process can result in missing essential functionalities or performance issues that might result in transactions not executing as intended. Due to the speed of execution brought about by programmability, existing operational and market risks can be amplified if such deficiencies and errors remain undiscovered upon smart contract deployment, with this not being easily rectified particularly for public permissionless blockchains.

Secondly, bugs and loopholes in the smart contract code deployed on public blockchains can also make them susceptible to exploitation by malicious actors. As the functioning of some smart contracts place reliance on information outside the chain, such as external price feeds, through the involvement of service providers known as oracles, this creates exposure to a single point of failure or corruption where the oracles can be subject to manipulation, fraud or control by unknown parties who are not subject to third-party audit or evaluation.[126]

Thirdly, there can also be variations across jurisdictions in the legal status of smart contracts that are written in code. This creates uncertainties around the enforcement of such contracts once executed, posing risks to the legal rights of investors that place reliance on such contracts.[127]

(c) Tokens: As highlighted in Chapter 3, the custody of tokenized financial assets deployed on DLT networks is conceptually and operationally different from that of conventional markets, as tokens stored on-chain can be transferred only through private keys. In

[126] HKMA 2024 Report.

[127] DTCC, Clearstream, Euroclear (2024), Building the Digital Asset Securities Ecosystem, Digital Asset Control Principles: A Framework for Adoption.

turn, these private keys are stored in digital wallets.

Tokenized asset custodians are responsible for the safeguarding of these private keys, with such activities giving rise to different manners in which risks can manifest. For instance, investors holdings can be compromised through a variety of situations including through fraud or theft where malicious actors exploit security vulnerabilities to gain control over the private keys, or due to the loss or destruction of private keys arising from human oversight, hardware failure or inadequate back-up systems.

That being said, the impact of the loss of private keys in the context of tokenized financial assets might not always be as severe as compared to crypto assets where such loss typically signifies a loss in the asset given the bearer nature of the crypto token. This is given that most tokenized financial assets are issued in registered form where the official legal source of ownership of the asset is recorded via a register instead of through mere bearing of a token. Nevertheless, loss of private keys still poses significant operational disruption and can result in a loss of confidence from investors as they will not be able to gain access or initiate transactions in relation to their asset whilst recovery measures are being initiated, which could take some time.

B.3. Settlement Assets on DLT-Based Infrastructure

There has been overwhelming consensus in the literature and from industry engagement feedback that without the availability of reliable on-chain settlement assets,[128] the scaling of tokenized assets will be challenging as simultaneous and seamless DvP cannot be conducted at the post-trade stage of tokenized transactions. Significant risks are also posed to investors if this increases their exposure to less reliable payment mediums as compared to conventional transactions.

At present, options for on-chain settlement assets are still in development. Whilst central bank money would serve as an ideal riskless settlement asset,[129] a scaled roll-out of wholesale central bank digital currencies would require central banks to address the operational considerations around the mode of such a roll-out, as well as the broader governance and policy questions around its provision.[130]

Although tokenized deposits could serve as a viable alternative similar to how commercial bank money is currently used in conventional payment systems and financial market infrastructure, there are challenges that come with their use. For instance, there is a high likelihood of market fragmentation where every bank seeks to launch on different private chains with their own bespoke

[128] WEF Report, *supra* n.25.

[129] According to the CPMI/IOSCO Principles for Financial Markets Infrastructures (PFMIs) a financial market infrastructure (FMI) should conduct its money settlements in central bank money, where practical and available, and if central bank money is not used, an FMI should use a settlement asset with little or no credit or liquidity risk, such as commercial bank money.

[130] OECD 2021 Report, *supra* n.6; CPMI Tokenization Report, *supra* n.6.

standards[131] given the lack of interoperability and common standards in the space, leading to significant operational risks as described in Section 4B.2.

Thus far, it appears that stablecoins have gained the most momentum in the market as a potential on-chain settlement asset. However, they can expose investors to additional risks as compared to conventional settlement processes. For instance, the OECD has noted that stablecoin transactions are private initiatives which might lack proper audit and assurance over the availability of funds.[132] Amongst other issues, the BIS has also pointed out that stablecoins are not being settled in central bank monies, and investors can be exposed to price fluctuations given their availability for trading.[133] Where such risks are not properly managed, these could expose investors to significant counterparty and market risks, which are potentially exacerbated through concentration exposure to a single or few stablecoin issuers due to network effects. The CPMI and IOSCO have jointly issued guidance on the application of the Principles for Financial Market Infrastructures (PFMI) to systemically important stablecoin arrangements. Under this guidance, stablecoins used as alternative settlement assets in financial market infrastructures should also fulfil the key considerations of Principle 9 on cash settlement.

Whilst use-cases have emerged where off-chain payment rails are connected and used to settle against on-chain tokenized assets, it has been observed that this creates additional operational complexities and risks to the process and introduces frictions that negates some of the intended purported efficiencies from adopting tokenization.

C. Additional Issues that Could Arise as Tokenization Scales

To ensure a holistic discussion of the issues and risk implications from tokenization, this sub-section sets out a high-level discussion of the additional issues noted from IOSCO's analysis work that could bear further monitoring.

The majority of these issues have been surfaced from the review of the relevant literature and relate to broader potential changes in market activities and structure which could potentially materialize more saliently with a wider-scale shift towards adoption of tokenized financial assets and DLT-based infrastructure. It is worth noting that such materialization and the eventual form that it would take might not be as what is being discussed, given that the scale and trajectory of tokenization adoption is still evolving and highly uncertain.

C.1. Changes in Market Activities

Tokenization could bring about changes to how current market activities are conducted, which may in turn give rise to changing forms

[131] Zennon Kapron (2025), "Tokenized Deposits vs Stablecoins: The Quiet War for Cross-Border Money," *Forbes*.

[132] OECD 2021 Report, *supra* n.6; CPMI Tokenization Report, *supra* n.6.

[133] CPMI Tokenization Report, *supra* n.6.

of risk. Two examples of such activities are highlighted below:

(a) Trading: The trading of financial assets has typically taken place through centralized exchanges which facilitate the matching of orders between buyers and sellers. However, the hosting of both assets and investors on a common DLT network with programmable features can give rise to different manners in which trading activities with respect to tokenized financial assets can be conducted.

One such example is the automated market maker (**AMM**) model, which has its origins in crypto-asset trading but could also facilitate the trading of tokenized assets. Under such a model, liquidity pools are formed where liquidity providers contribute assets to the pool, which are in turn used as liquidity for trades with traders. Instead of trading bilaterally, traders trade against the pool where the price of assets is determined using a stipulated formula based on demand and supply.

The purported benefits that are not present in conventional trading models and that AMMs seeks to bring about include: liquidity provision in a disintermediated environment, where AMMs can ensure liquidity is always available to traders given the formation of a liquidity pool; and counterparty risk reduction, as trading is carried out against the liquidity pool eliminating the need for trust between buyers and sellers. However, this comes with its attendant trade-offs and risks which can manifest in a different form from conventional trading models where a study conducted by the Bank of Canada and the Ontario Securities Commission has shown that AMM models can cause investor harm and comprise market integrity through unique and complex channels.[134]

Whilst the adoption of AMM models for trading activities has yet to be widely observed in current tokenization initiatives, their development could warrant further monitoring where there might be merits to evaluate if the risks are adequately addressed through existing regulatory frameworks if such models are observed to be adopted at scale.

(b) Clearing and Settlement: Although atomic or near instantaneous settlement can currently be achieved with current infrastructure, tokenization could potentially enable this process at a lower cost hence changing how clearing and settlement activities are being conducted.

Whilst some of the purported benefits of doing so could include decreased settlement risks and reduced intermediation which could in turn reduce costs, the CPMI Tokenization Report has also noted that it can also inadvertently make liquidity management more complex due to the need for the pre-positioning of assets and the elimination of netting arrangements, [135] hence

[134] Bank of Canada, Ontario Securities Commission (2024), "The Ecology of Automated Market Makers, Staff Discussion Paper 2024-12".

[135] CPMI Tokenization Report, *supra* n.6.

amplifying liquidity and operational related risks.

From the analysis,[136] it does not appear that tokenization would lead to a substantive increase in adoption of atomic or instantaneous settlement at this juncture. Instead, this is still likely to be subject to considerations that might evolve over time as the tokenization landscape is still developing and could depend on factors including whether tokenization arrangements evolve to address current limitations in the pre-position of assets and netting of assets[137] and/or whether there are certain asset classes or activities that could benefit from the increased programmability and velocity features that tokenization arrangements bring (e.g. short term or intra-day collateral and repo transactions).

Adoption could scale if participants assess the benefits brought about from atomic or instantaneous settlement, such as the increased availability of assets and funds due to faster transaction velocity, outweighs the liquidity and operational challenges and could likewise be an area of monitoring to evaluate the risks and implications from such a scaling up.

C.2. Changes in Market Structure

Tokenization could also bring about broader-based changes in current market structure as follows:

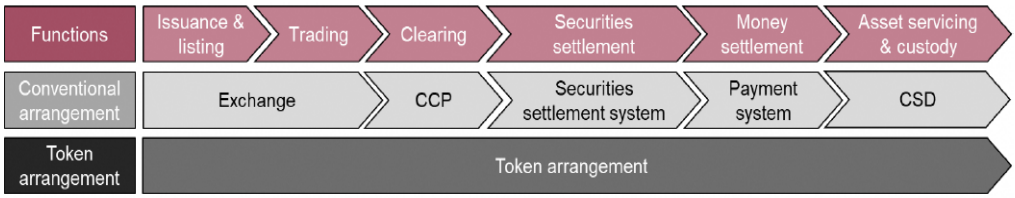
(a) Integration of Existing Functions: The hosting of both assets and investors on a common DLT network could also make the collapsing of segregated and distinct capital markets functions into a continuous arrangement more operationally feasible (see diagram extracted from the CPMI Tokenization Report).[138]

[136] For instance, the analysis of SDX shows that market participants prefer to transact on traditional infrastructure for various reasons (e.g. network effects, liquidity availability) instead of through leveraging on the atomic settlement features made available through trading on DLT based infrastructure.

[137] For instance, this could include whether it would be possible for settlement assets to be made available only at point of trade execution or for settlement assets to earn yield up till the point of execution to offset the costs of pre-positioning via programmability features.

[138] CPMI Tokenization Report, *supra* n.6.

Figure 1. Financial market functions and conceivable arrangements[6]



CCP = central counterparty; CSD = central securities depository.
Source: Adapted from BIS, SIX and SNB (2020) and GFMA (2023).

On the one hand, doing so could result in changes to the current market structure and the role of existing market intermediaries, hence reaping efficiency gains. On the other hand, these changes could also potentially give rise to unmanageable conflicts of interests when inherent controls in place through segregation are removed, such as when actors trade on their own account and settle their own transactions as well as transactions of other participants. [139] Concentration and competition risks can also be significantly exacerbated where investors are exposed to singular entities for the conduct of activities across the entire value chain.

(b) Introduction of New Roles: Tokenization could also give rise to new intermediaries and roles to support the asset lifecycle process.[140]

The OECD has noted that it can be difficult to ascertain with certainty whether such intermediaries are currently captured within the regulatory perimeter given the novel nature of these roles and the processes.[141] If not captured, it bears consideration on whether existing regulatory frameworks will have to be expanded to capture such intermediaries given the nature of the risks involved.

Gaps in regulatory treatment could give rise to regulatory arbitrage within and across jurisdictions and expose investors to the risks of forgoing protection under the regulatory frameworks for dealing with non-regulated entities. In this regard, some jurisdictions have expanded their regulatory perimeter to capture new intermediaries that provide DLT-related services for tokenized financial assets[142] amongst other additional regulatory measures taken, some of which are discussed in Chapter 5.

(c) Increased Financialization and Investor Access: The composability features of tokenization could lead to an increased financialization of assets, [143] whilst also

[139] IOSCO (2023), "Policy Recommendations for Crypto and Digital Asset Markets: Final Report".

[140] See section 5.3 of WEF Report, *supra* n.25.

[141] OECD 2021 Report, *supra* n.6.

[142] *Ibid*.

[143] Allen, *supra* n.116.

resulting in the creation of more complex financial products that can be less transparent or easily understood (see discussion in section 4B.1).

At the same time, the increased digitalization of financial services from tokenization can enable retail investors to conduct self-directed trading of tokenized financial assets on DLT-based networks without needing to go through an intermediary, similar to the crypto-asset markets. The IMF has observed that this could exacerbate retail investor internalities, where such investors are more likely to insufficiently diversify idiosyncratic risks from their portfolios when making trading decisions, as they will be less incentivized to seek the advice of qualified intermediaries given the additional search effort and costs involved.[144]

This combination of factors could lead to amplified investor protection risks compared to conventional markets, as investors will be more exposed to engage in excessive risk-taking activities given enhanced access to trading in markets without advice and coupled with the increased variety of and complexity of financial products available that lack transparency or are not easily understood.

C.3. Increased Dependencies and Interconnectedness

Lastly, the hosting of both assets and investors on common DLT networks will also increase dependencies and interconnectedness between stakeholders, leading to amplification of risks currently faced in the conventional markets.

(a) Third party dependencies: As the use of DLT leverages on specialized infrastructure and intermediaries for service delivery, this could subject financial market participants to higher operational risks given their exposure to a smaller group of service providers. Where public chains are used, operational risks are concentrated in the market participant itself as there will not be a contractual third party available to place reliance on, and alternative solutions might not be viable in the event of infrastructure down times or disruptions.[145]

(b) Financial market interconnectedness: The literature has also noted that tokenization characteristics such as programmability and composability could also give rise to greater interconnectedness between financial market participants which exacerbate transmission channels for market related shocks,[146] which can harm investors and compromise market integrity.

Tokenization could also lead to closer inter-linkages with the crypto market. Early signs of these were observed, with tokenized financial assets such as MMFs increasingly being used as stablecoin reserve assets or collateral for crypto-related transactions. This could eventually

[144] IMF 2025 Report, *supra* n.6.

[145] FSB Report, *supra* n.6; IMF 2025 Report, *supra* n.6.

[146] FSB Report, *supra* n.6; IMF 2025 Report, *supra* n.6.

lead to the transmission of crypto-related volatilities and shocks to conventional financial assets and markets.

D. Summary

Based on the analysis above, it is observed that the risks may evolve for financial institutions that elect to adopt and transition from their current systems and infrastructure to the use of new technologies such as DLT.

This transition is likely to take place at a more evolutionary, instead of revolutionary, pace as the process of integration might take some time. In the meantime, both existing and new infrastructures are likely to continue to co-exist for the foreseeable future, and as the transition progresses and asset tokenization scales up, risks will continue to evolve.

5. Steps that Authorities have Taken to Manage Risks and Regulatory Concerns

IOSCO surveyed its Members on regulatory responses to the tokenization of capital markets products in their jurisdictions. This section provides an overview of existing and proposed responses of surveyed IOSCO Members.[147] Although this section highlights those responses, it does not endorse any particular approach or make policy recommendations.

Most Members surveyed indicated that they applied existing regulatory frameworks to tokenized capital markets products and their associated activities. This is because most Members generally sought to adopt a technology-neutral approach, where the focus is on examining the underlying economic substance of the product offered, rather than evaluating the specific technology or manner used to issue or represent the product. As outlined in Chapter 3, empirical observations suggest that tokenization, in its current stage of development, has not substantially changed the nature of the products offered nor the associated activities conducted at this juncture.

Some Members reported that they have also taken initiatives and steps to complement their existing regulatory frameworks. For example, these include developing:

(a) Specific guidance to clarify existing regulatory frameworks;

(b) Sandbox regimes; and

(c) New or amended laws and regulations.

A.1. Specific Guidance

Although tokenized capital markets products and their associated activities fall within the regulatory perimeter of existing regulatory frameworks, some Members have issued guidance to either:

(a) Clarify the application of existing regulatory frameworks to tokenized capital markets products, or

(b) Address how the risks arising from tokenized capital markets products can be mitigated for the purposes of meeting regulatory obligations under existing frameworks.

A.2. Sandbox Regimes

Some Members have adopted sandbox regimes to facilitate the development of DLT-based capital market activities while creating a pathway to full regulatory compliance. This allows regulators to better understand whether existing regulatory requirements

[147] Further details of the survey findings can be found in the Annex.

remain relevant, or whether changes are needed to address any legal and regulatory gaps.

In this regard, Members may develop a temporary regulatory framework to allow sandbox entities to experiment with tokenized financial products within a limited scope such as the following:

(a) Controlled environment: This typically means there are defined to the scale of the sandbox entity's activities (e.g. caps on the number of users and transaction volumes of the sandbox entity). This may also include a time-bound limit to the sandbox experimentation.

(b) Limited period: Sandbox entities may be required to meet regulators at defined points during the sandbox duration to review the progress of the sandbox entity's experimentation as well as its ability to comply with regulatory requirements.

A.3. New or Amended Laws and Regulations

Some Members indicated that they had implemented or considered implementing new laws and regulations, in addition to existing regulatory frameworks, that are applicable to tokenized capital markets products and their associated activities.

Members indicated a number of reasons for issuing new laws and regulation:

(a) To remove impediments or provide clarity on the regulatory treatment of tokenized capital markets products;

(b) To scope in and/or include a definition of tokenized capital markets products;

(c) To scope in participants and activities involving tokenized capital markets products; and

(d) To address risks arising from tokenized capital markets products and their associated activities.

Some Members have also adopted hybrid approaches by combining complementary measures from the different approaches. For example, some jurisdictions have issued new laws to establish a certain legal basis for tokenized capital market products while also implementing a sandbox regime to facilitate the development of DLT-based financial market infrastructure.

Overall, the measures that some Members have undertaken beyond their existing regulatory frameworks in response to tokenization are consistent with the findings in Chapter 4 on the risks and issues arising from tokenization. In particular, the purported intent for such additional measures has primarily been to address risks and issues particular to the use of DLT and tokenization which have already manifested, namely those relating to the legal recognition and/or structuring of tokenized financial assets using DLT, and/or operational issues in relation to use of DLT based infrastructure.

Please refer to Appendix B for examples of the steps mentioned in this section.

6. Conclusion

A. State of Development

A.1. Adoption of Tokenization

This Report observes how tokenization of financial assets continues to grow steadily. Several tokenized products have been issued in select jurisdictions, in compliance with regulatory frameworks and with increasing investment amounts.

A growing body of financial institutions is becoming familiar with the use of DLT for tokenization. These institutions have served in various capacities – as issuers, intermediaries and investors in tokenized financial assets.

At present, tokenization arrangements remain a small part of the financial sector. While there is some evidence of broader investor access, many of the promised benefits — particularly concerning secondary market liquidity — appear not to be fully achieved for now.

A.2. Tokenization Across Lifecycle Activities

The impact of tokenization on lifecycle activities varies depending on the implementation model and the degree of integration with DLT, as follows:

(a) While creation and issuance processes of digital tokens to represent financial assets have evolved, the impact of tokenization on distribution and secondary trading activities has been limited and largely continues to rely on conventional financial infrastructure and intermediaries, due to accessibility and liquidity concerns regarding DLT platforms.

(b) In clearing and settlement activities, while DLT-based settlement infrastructure enables faster settlement times, it appears that market participants continue to favor the use of traditional settlement infrastructure. This is possibly due to a variety of factors, such as the lack of familiarity with the use of DLT-based infrastructure, vulnerabilities that may stem from the digital nature (operational or cyber) or the operation of network effects present in traditional infrastructure.

(c) In asset servicing activities, the FTF observed implementation of digital custody and improvement in collateral mobility (e.g., intraday repo transactions)

A.3. Tokenization of Money Market Funds

MMFs are typically tokenized at the fund level, with tokens issued on blockchains representing ownership of fund shares or units, while the fund's assets are managed in the same manner as conventional funds.

Depending on the specific case, the blockchain records may serve as proof of ownership or merely as a back-up record. Issuers and transfer agents typically have the ability to correct blockchain records where needed, such as in the case of fraud.

While tokenized MMFs may be issued on public blockchains, secondary trading of

tokenized MMFs is limited and restricted to whitelisted investors. For transaction settlement, the use of Layer 2 solutions may improve efficiency but also create ambiguity for settlement finality.

A.4. Tokenization of Bonds

Tokenized bonds are typically issued directly on the blockchain, with the tokens issued on blockchains representing ownership of the bonds. Tokenization operators appear to have taken steps to provide greater assurance of settlement finality, such as through the involvement of regulated CSDs.

Nonetheless, the trading and post-trade activities of tokenized bonds are also integrated with traditional exchanges and clearing houses to provide investors with the option to use traditional financial infrastructure. In practice, investors continue to exhibit a preference for the traditional financial infrastructure.

A.5. Interlinkages with Traditional Finance

In line with the findings of other international organizations, such as the FSB, this Report identifies early signs of inter-linkages between the crypto asset sector and the traditional finance sector.

Particularly, tokenized MMFs are increasingly being used as reserve assets in "stablecoins" or as collateral for crypto-related transactions.

A.6. Structural Challenges

The key structural challenges faced in scaling up of tokenization are the lack of interoperability across blockchains and the lack of high-quality settlement assets.

There are ongoing experiments aimed at addressing these challenges. For example, Project Agora and Global Layer One seek to build shared ledger infrastructure upon which financial institutions can develop their tokenization applications; Project Helvetia and SGD Testnet allow settlement of tokenization transactions with wholesale central bank digital currency. These experiments were beyond the scope of this review.

B. Regulatory Considerations

The analysis found that the economic substance and risks from financial assets created through tokenization are similar to conventional financial assets (chiefly legal, operational and technology risks, and to a lesser extent, credit and liquidity risks), although risks could manifest differently due to their different structures. Tokenization may also result in the manifestation of vulnerabilities and risks that are unique to the technology itself.

With this in mind, members studied generally applied existing regulatory frameworks, with some complementing existing frameworks by taking additional measures to address risks arising from the commercial application of tokenization.

In accordance with the principle of "same activities, same risks, same regulatory outcomes", members may consider the applicability of IOSCO's Objectives and Principles for Securities Regulation and relevant supporting IOSCO standards, recommendations, and good practices, as appropriate, to tokenized financial assets and tokenization arrangements, taking into consideration their domestic contexts.

For example, given that **IOSCO's Recommendations for Crypto and Digital Asset Markets** were developed in the context of the use of blockchain technology and address the specific investor protection and market integrity risks arising from its use, members may consider their applicability in the context of tokenized financial assets.

Furthermore, while the analysis showed that relevant regulatory authorities continued to be able to identify responsible persons for the various roles in the value chain and to impose the necessary regulatory requirements, members may consider **IOSCO's Recommendations for Decentralized Finance** in identifying the persons and entities who are responsible for the regulated activities in the tokenization value chain.

7. Appendix

A. Terminology

As noted in the Report, this is a list of working definitions for common terminology. The definitions are not intended to be comprehensive or exhaustive – indeed, it is acknowledged that given the present state of tokenization, it is difficult to definitively settle on a singular, universally accepted definition. For the purpose of this Report, it is more important to understand the key concepts rather than a set of strictly defined terms.

In relation to the type of tokens issued as part of a tokenization arrangement:

(a) **"Native tokens**" refer to tokens that are issued solely on the distributed ledger on-chain. [148]

(b) "**Non-native tokens**" or "**digital twins**" refer to tokens that are issued on the distribution ledger and are digital representations of physical assets or existing assets that were originally issued off-chain.

In relation to the type of blockchains used for tokenization:

(a) "**Programmable platforms**" refer to technologies that allow eligible participants to develop and execute applications that update a common ledger. Blockchains are one example.

(b) "**Private blockchains**" refer to blockchains which restrict access to authorized participants and are typically governed by rules agreed by, and that apply to, all users.

(c) "**Public blockchains**" refer to blockchains where data are openly accessible and readable by the public, and which can be further categorized as either "permissioned" or "permissionless".

  (i) "**Public permissioned blockchains**" refer to public blockchains with certain permissions and controls in place that can vary by design (e.g., authentication is used to restrict writing and validation privileges to pre-determined users only).

  (ii) "**Public permissionless blockchains**" refer to public blockchains with no other permissions and controls in place (e.g. anyone can participate in the consensus process).

In relation to the type of technological layers involved in tokenization:

[148] In the context of tokenization arrangements, "native tokens" should be distinguished from other blockchain-native tokens that are not issued as part of a tokenization arrangement, such as ETH or BTC.

(a) "**Access layer**" or "**application layer**" refers to the layer that governs how end users and applications interact with the blockchain. This layer includes wallets, API gateways, and user interfaces.

(b) "**Service layer**" or "**smart contract layer**" refers to the layer where on-chain logic is executed, enabling additional functionalities such as identity verification, compliance checks and transaction processing through smart contracts. "**Smart contract**" refers to a collection of code and data (sometimes referred to as functions and state) that is deployed using cryptographically signed transactions on the blockchain network. The smart contract is executed by nodes within the blockchain network; all nodes must derive the same results for the execution, and the results of execution are recorded on the blockchain.

(c) "**Asset layer**" or "**token layer**" refers to the layer where the digital tokens that represent real world or native digital assets are created and managed.

(d) "**Platform layer**" or "**settlement layer**" refers to the layer responsible for maintaining the blockchain's consensus state (e.g., recording transactions, storing account balances and enabling interaction between participants and smart contracts), which include:

    (i) "**Layer 1**" or "**foundation layer**", which forms the foundation of the distributed ledger network, providing the core protocols, consensus mechanisms, and network architecture enabling the creation and maintenance of the distribution ledger.

    (ii) "**Layer 2 solutions**", which operate on top of Layer 1 and aim to address scalability and efficiency issues by enabling off-chain or parallel transaction processing, with final settlement anchored to the underlying Layer 1 blockchain.

B. Examples of Steps Taken by Authorities

Specific Guidance

Below are some examples that illustrate how various jurisdictions have issued guidance to address the application of existing regulatory frameworks and risks arising from tokenized capital markets products:

(a) **Hong Kong:**

(i) On 2 November 2023, the SFC issued its Circular on intermediaries engaging in tokenized securities-related activities ("Tokenized Securities Circular").[149] The Tokenized Securities Circular reaffirmed the position that the existing legal and regulatory requirements governing the traditional securities markets will continue to apply.

(ii) The SFC also highlighted certain new risks to be managed that are not typically associated with traditional securities, including: (i) how ownership interest relating to tokenized securities is transferred and recorded; and (ii) technology risk in activities involving tokenization.

(iii) For custodial arrangements, intermediaries should take into account certain additional features and risks in deciding on the appropriate custodial arrangements.

(iv) On 2 November 2023, the SFC also issued its Circular on tokenization of SFC-authorized investment products ("Tokenized Products Circular").[150] The Tokenized Products Circular set out the requirements under which the SFC would consider allowing tokenization of investment products authorised by the SFC under Part IV of the Securities and Futures Ordinance for offering to the public in Hong Kong.

(b) **Canada:**

(i) CSA Staff Notice 46-308, "Securities Law Implications for Offering of Tokens", was issued by Canadian regulatory authorities in 2018, in response to inquiries on the applicability of securities laws to offerings of tokens.[151] The Notice provides guidance that the offering of tokens may involve the distribution of securities, because the offering involves the

[149] *Tokenised Securities Circular*, available at: https://apps.sfc.hk/edistributionWeb/gateway/EN/circular/doc?refNo=23EC52.

[150] *Tokenised Products Circular*, available at: https://apps.sfc.hk/edistributionWeb/gateway/EN/circular/doc?refNo=23EC53.

[151] *CSA Staff Notice 46-308 "Securities Law Implications for Offering of Tokens"*, available at: https://www.osc.ca/en/securities-law/instruments-rules-policies/4/46-308/csa-staff-notice-46-308-securities-law-implications-offerings-tokens.

distribution of an investment contract, and/or the offering and/or the tokens issued are securities. The Notice emphasizes that businesses and their professional advisors should assess the economic realities of the offering as a whole, with a focus on substance over form.

(ii) The Notice also clarifies that the distribution of tokens that involve the distribution of securities would be subject to relevant prospectus requirements and persons dealing in such tokens would be subject to relevant dealer registration requirements under securities laws.

Sandbox Regimes

Below are examples of how various jurisdictions have employed sandbox regimes to achieve different regulatory objectives:

(a) **European Union:**

(i) The DLT Pilot Regime entered into force in June 2022 and opened for applications in March 2023.[152] It was developed in response to perceived and actual regulatory barriers in the context of digital securities infrastructure.[153]

(ii) The DLT Pilot Regime is structured as an EU-wide regulatory framework that allows certain market infrastructure providers to apply for greater regulatory flexibility. It aims to enable regulated institutions to develop DLT-based infrastructure for the trading and settlement of securities.

(iii) Eligible applicants (broadly authorized investment firms, market operators and CSDs) may apply for exemptions from certain requirements under EU financial services regulations that are specifically identified in the DLT Pilot Regime, where those requirements are incompatible with the proposed use-case. Unauthorized firms can apply for temporary authorizations alongside their applications to the DLT Pilot Regime.

(b) **Singapore:**

(i) The Fintech Regulatory Sandbox was launched by MAS in 2016 to facilitate live experimentation with innovative financial products or services in a live but controlled environment. Under this regime, the sandbox is open to any entity that is looking to apply

[152] EU DLT Pilot Regime, available at: https://www.esma.europa.eu/esmas-activities/digital-finance-and-innovation/dlt-pilot-regime.

[153] For example, the requirement under the Central Securities Depositories Regulation (EU) No 909/2014 ("CSDR") that a transferable security that is traded on a trading venue must be cleared at a CSD and the general restriction that a CSD may not also be a trading venue.

technology, including but not limited to tokenization, in an innovative way to provide new financial services and products that are regulated by MAS.[154]

(ii) Importantly, the sandbox allows MAS to provide clarity to sandbox entities on how existing rules and regulations would be applied to the proposed financial services and products being tested.[155]

(iii) A sandbox entity that succeeds in its experimentation and is able to fully comply with the relevant legal and regulatory requirements would be able to deploy its services on a broader scale. Conversely, the sandbox will be discontinued if the sandbox entity is unable to fully comply with the relevant requirements at the end of the sandbox period.

(c) **United Kingdom:**

(i) The Digital Securities Sandbox (DSS) is the UK's first Financial Market Infrastructure (FMI) sandbox and will facilitate the use of developing technology such as DLT in the trading and settlement of traditional securities.[156] The applicant would need to be applying to operate a trading venue and/or carry out central securities depositary activities (i.e., notary, maintenance or settlement).

(ii) It does so by allowing participating firms to operate under a temporarily modified legislative and regulatory framework. This includes a relaxation of certain regulatory requirements, but also strict limits on trading volumes. Where legislation is unchanged, participating entities will need to meet the same regulatory requirements as currently in place

(iii) Although the DSS is by its nature a temporary regime (limited to five years), it is the shared intention of the regulators and HMT that a smooth transition should be available for successful sandbox entrants into any new permanent regime introduced when the DSS closes.

New or Amended Laws and Regulations

Below are examples of how jurisdictions have issued new laws and regulations:

[154] MAS Fintech Regulatory Sandbox, available at: https://www.mas.gov.sg/development/fintech/regulatory-sandbox.

[155] For example, in relation to a sandbox entity that was experimenting with an Automated Market Maker (AMM) business model to facilitate the exchange of tokenized capital market products, the sandbox allowed the relevant supervisory teams to understand the nature and risks of the AMM, in order to determine that MAS' markets regime was best suited to addressing the risks that arose from such a model; and to assess that the AMM manifested certain risks (e.g. market integrity risks) differently from traditional financial markets. The DSS therefore clarified the kinds tools the entity was expected to have in place to mitigate risks in order meet regulatory requirements to which traditional financial markets were also subject.

[156] Digital Securities Sandbox, available at: https://www.fca.org.uk/firms/innovation/digital-securities-sandbox.

(a) **Germany:**

(i) The German Act on Electronic Securities in 2021 introduced the category of "electronic securities" and, amongst others, allows for the issuance of bearer bonds, registered shares and fund units on DLT.[157] A key principle of the new law is to give the owners of electronic securities the same comprehensive protection as owners of physical securities, especially in cases of insolvency and foreclosure.

(ii) The Act also established a regime for registrars for electronic securities entered into a DLT-based register. A financial service license requirement to act as the registrar was introduced. As a consequence, the security registrar is subject to the existing prudential supervision.

(b) **Japan:**

(i) Following amendments to the Financial Instruments Exchange Act (FIEA) in 2020, security tokens (which represent shares, bonds or fund interests in tokens) are deemed to be securities under the FIEA.[158] The existing legal and regulatory requirements governing the traditional securities markets will continue to apply.

(c) **Italy:**

(i) The Fintech Decree (Decree n. 25/2023), which was issued in March 2023, introduced into Italian law a new regime for the issuance and circulation of financial instruments, an alternative to the existing ones. The new regime applies to financial instruments issued through distributed ledger technologies, so-called "digital financial instruments".

(ii) The Fintech Decree establishes that the issuer's verification of entitlement to exercise the rights associated with digital financial instruments is performed on the basis of the entries in the register.

(iii) Digital financial instruments must be registered on a DLT market infrastructure pursuant to the EU DLT Pilot Regime if they are intended for trading on a trading venue provided for by EU Directive 65/2014. For digital financial instruments not registered on a DLT market infrastructure, the Fintech Decree provides that the issuance must take place on a distributed ledger held by a "Registry Manager".

(iv) The "Registry Manager" is a legal entity subject to supervision that is responsible for ensuring the integrity and security of the system and that can carry out its activity only

[157] German Act on Electronic Securities, available at: https://www.bafin.de/SharedDocs/Veroeffentlichungen/EN/Fachartikel/2021/fa_bj_2107_eWpG_en.html.

[158] FIEA, available at: https://www.fsa.go.jp/en/laws_regulations/index.html.

after having obtained registration in a public register from CONSOB (the Italian Securities and Markets Authority).

(v) Obtaining this registration is subject to verification by CONSOB of compliance with a series of requirements (including on the characteristics of the distributed ledger used) established by the Fintech Decree.

(d) **Spain:**

(i) The Securities Markets and Investment Services Act, which was issued in 2023, replaced the existing law governing Spanish securities markets and investment services to adapt the legal framework to consider new technological and economic realities, such as digitization.

(ii) In particular, the Act introduces a legal regime for securities represented or registered through DLT systems and allows for the issuance, registration, transfer and custody of such securities through DLT systems.

(iii) Issuers of securities represented or registered through DLT systems are required to designate an entity responsible for the safekeeping and administration of these financial instruments for the accounts of clients. Such entities will, among other functions, manage the identification of the holders of the rights over the DLT Securities, and will be subject to the supervision of the Spanish National Securities Market Commission.

(e) **Switzerland:**

(i) The DLT Act, which came into force in 2021, enables the introduction of ledger-based securities that are represented on a blockchain.[159] In particular, "registered uncertificated securities", which are securities that are registered in a DLT protocol and transferred within this protocol, have been enshrined into law. Under this new law, tokens can be issued and transferred as registered uncertificated securities within the token's register and DLT system without the need for such a procedure, providing a legal basis for the ownership and transfer of rights through electronic registers.

(ii) To facilitate the secondary trading of such securities, a new regime for DLT facilities was introduced in the Financial Market Infrastructure Act (FMIA). While generally subject to similar rules and regulations as other trading facilities, a key aspect of this new license category is that DLT trading facilities under the FMIA are also permitted to provide custody and settlement services for registered uncertificated securities on a DLT protocol, without needing additional licensing. This is in contrast to conventional trading facilities, which typically rely on a central securities depository to perform such functions.

[159] Swiss DLT Act, available at: https://www.sif.admin.ch/en/blockchain-dlt-en.