Transforming the financial industry with asset tokenization

Simone Taravelli

Dissertation written under the supervision of professor João Freire de Andrade.

Dissertation submitted in partial fulfilment of requirements for the MSc in Finance, at the Universidade Católica Portuguesa, 03/04/2023.

Abstract

Title of the thesis: Transforming the financial industry with asset tokenization

Author: Simone Taravelli

Keywords: FinTech, cryptocurrencies, blockchain, tokenization, trading, clearing and settlement, REPO

The adoption of blockchain technology has revolutionized the way assets are owned and transferred, with asset tokenization emerging as an effective method of representing ownership.

This research examines the impact of asset tokenization on clearing and settlement, trading, and repo functions in the financial industry. Through a mixed-methods approach that incorporates a systematic literature review and expert interviews, this study presents the potential benefits and limitations of asset tokenization within these specific functions. The key findings of this research suggest that asset tokenization can significantly enhance efficiency, transparency, and liquidity, among other factors. Nonetheless, the study reveals some noteworthy limitations, including regulatory uncertainty, the need for new technical infrastructure, and technological adoption.

Furthermore, the research provides valuable insights and recommendations for financial industry stakeholders to effectively address the challenges and opportunities of asset tokenization.

Abstract (Portuguese version)

Título da tese: Transformando a indústria financeira com a tokenização de ativos

Autor: Simone Taravelli

Palavras-chave: FinTech, criptomoedas, blockchain, tokenização, negociação, compensação e liquidação, REPO

A adopção da tecnologia Blockchain revolucionou a forma como os bens são detidos e transferidos, com a tokenização de ativos a emergir como um método eficaz de representação da propriedade

Este estudo analisa o impacto da tokenização de ativos nas funções de compensação, liquidação, negociação e operações de repo na indústria financeira. Por meio de uma abordagem constituida por métodos mistos que incorporam uma revisão sistemática da literatura e entrevistas com especialistas, este estudo apresenta os potenciais benefícios e limitações da tokenização de ativos dentro dessas funções específicas. Os principais resultados desta pesquisa sugerem que a tokenização de ativos pode melhorar significativamente a eficiência, transparência e liquidez, entre outros fatores. No entanto, o estudo revela algumas limitações notáveis, incluindo a incerteza regulatória, a necessidade de nova infraestrutura técnica e a adoção tecnológica.

Além disso, a pesquisa fornece insights valiosos e recomendações para os stakeholders da indústria financeira abordarem de forma eficaz os desafios e oportunidades da tokenização de ativos.

Table of Contents

1 Introduction

The financial industry has undergone a significant transformation in recent years, with the emergence of digital assets and blockchain technology. One of the most promising developments in the sector is asset tokenization. The emergence of cryptocurrencies, most notably Bitcoin and Ethereum, has changed the financial sector's paradigm. These digital currencies are decentralized, peer-to-peer, and their underlying blockchain technology has created new opportunities for safe, effective, and transparent transactions that have the potential to transform established financial procedures. Cryptocurrencies have gained popularity as a mean of exchange and store of value, with a total market capitalization of billions of dollars. One of the main reasons for this surge in popularity is their strong security features, based on cryptography, that make them immune to counterfeiting and double spending (Satoshi, 2018). Moreover, their decentralized nature allows for transactions to be conducted without the need for intermediaries, which can greatly reduce transaction fees and increase the speed of transactions. Blockchain technology and distributed ledgers are attracting massive attention and triggering multiple projects in different industries. However, the financial industry is seen as a primary user of the blockchain concept (Nofer et al., 2017). The blockchain consists of a network of nodes, each storing a copy of the ledger, and transactions are verified by a consensus mechanism, which ensures the integrity of the ledger. Blockchain technology is secure as it is designed to be impervious to tampering; once a transaction is registered, it is impossible to modify or delete, guaranteeing its safety. The 2008 financial crisis revealed that even for financial services it is not always possible to identify in a clear way the owner of an asset and it is even more challenging to retrace ownership over a longer chain of changing buyers in global financial transaction services (Nofer et al., 2017). Intermediation is today's dominating solution for verifying ownership of assets and transaction processing intermediaries perform the careful checking of each involved party along a chain of intermediaries. However, this is not only time-consuming and costly but also bears a credit risk in case an intermediary fail (Nofer et al., 2017).

Blockchain technology promises to overcome these critical aspects, representing ''a shift from trusting people to trusting math'' (Antonopoulos, 2015) since human interventions are no longer necessary. The tokenization of assets refers to the process of issuing a blockchain token that digitally represents a real tradable asset, in many ways similar to the traditional process of securitization, with a modern twist (Pascal et al., 2018). Tokenization is a special form of

digitization that supports fractional investment and ownership. Representing real assets as digital tokens allow issuers and holders of the tokens to achieve the benefits of cryptocurrency, that is, security, liquidity, and immutability, to real-world assets (Sazandrishvili, 2020)

In the Blockchain world, tokens have emerged as the artefact of choice to represent assets, utility, or a claim on something inherent to a specific blockchain project (Pilkington1, 2015). Therefore, tokens exist due to their usefulness in representing something digitally. Tokens' divisibility, ease of use, and tradability have turned them into ideal value containers which can be as easily tradable as executing a transfer of its ownership to another agent who now holds that same claim (Pilkington 2015). Asset tokenization can result in efficiency gains by facilitating value transfer without the need for centralized intermediaries and/or by automating processes, leading to faster, potentially cheaper, and frictionless transactions driven by disintermediation and automation. Although the impact of asset tokenization on the financial industry is still in its early stages, it has the potential to transform financial processes and revolutionize the way assets are owned and traded (OECD,2020). Tokenization can increase the liquidity of traditionally illiquid assets, such as real estate or art, by allowing for more efficient and accessible trading (2023). It has the potential to create new financial instruments and markets, providing new investment opportunities for both retail and institutional investors.

This study aims to examine the impact of asset tokenization on the financial industry, with a special focus on the clearing and settlement, trading, and REPO processes, and to identify the potential benefits and limitations for the financial industry concerning this technology. Additionally, this research's goal is to bridge the gap between the existing literature and the practical implementation of asset tokenization by examining testimonials of professionals working in this specific sector.

2 Literature review

2.1 Blockchain Overview

The technology that underlies crypto assets is called blockchain, and it is a disruptive innovation that has the potential to heavily impact many of the existing processes as we know them. It is very challenging to provide a definition of blockchain and at the same time, it is synthetic and precise. The definition provided by Sankar, Sindhu, & Sethumadhavan, 2017 is very clear and effective: "Blockchain is a technology made possible to build an immutable, distributed, an always available, secure and publicly assessable repository of data (ledgers), which relies on a distributed consensus protocol to manage this repository (e.g., to decide what valid new data to include) in a distributed manner". A blockchain consists of data sets that are composed of a chain of data packages (blocks) where a block comprises multiple transactions. Every new block added to the blockchain serves as a comprehensive record of all transactions that have taken place on the blockchain and have been cryptographically verified by the network. Each block also includes a timestamp, the hash value of the block before it, and a nonce, a random number used to validate the hash. Since changes to a block in the chain would immediately affect the corresponding hash value (a numeric value of a fixed length that uniquely identifies data), hash values are unique and can be used to successfully detect fraud. (Nofer et al., 2017).

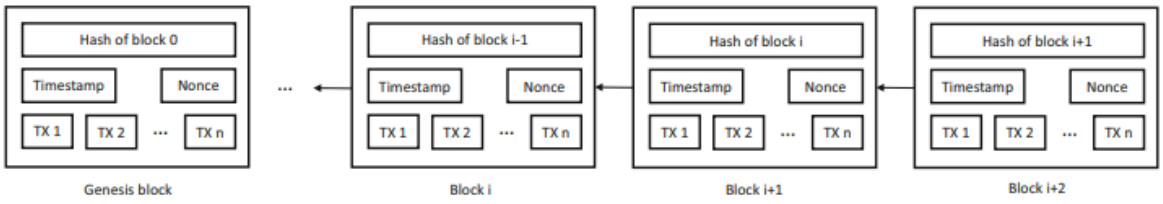

Figure. 1: Example of a blockchain (Zheng et al. 2016)

Blockchain is a breakthrough in data storage and information transmission, it might fundamentally transform the existing operating models of finance and economy, which might lead to a new round of technological innovation and industrial transformation within the FinTech industry (Guo & Liang, 2016).

2.2 Cryptocurrencies overview

Cryptocurrencies are a form of digital currencies that are built on top of blockchain existing solutions. As the name suggests, cryptocurrencies are based on cryptographic techniques because they ensure transactions are anonymous, secure, and decentralized (Mohamed, 2021). Cryptography is used by cryptocurrencies to safeguard transactions, regulate the generation of new units, and confirm the transfer of assets. Unlike traditional currencies, cryptocurrencies are entirely digital assets underpinned by blockchain-enabled encryption techniques. Cryptocurrencies may be created independently from central banks and can be utilized independently of conventional, regulated financial intermediaries, which is a key distinction between the two (Mohamed, 2021). Bitcoin was the first decentralized cryptocurrency ever created and it was created in 2009 as a response to the 2008 financial crisis. Unlike other existing cryptocurrencies, Bitcoin is not backed by companies or centralized entities, it is a distributed open-source protocol that runs continuously without interruptions. After 2009, other cryptocurrencies have been created, each of them with specific use cases and peculiarities that make them unique. As of 2023, more than 20.000 cryptocurrencies are in circulation according to the "Coinmarketcap" website (Cryptocurrency Prices, Charts and Market Capitalizations | CoinMarketCap).

2.3 Tokenization of assets and tokens

As for the definition of blockchain, it is very challenging to find a definition for "asset tokenization" that at the same time is precise and clear but the one provided by George Sazandrishvili corresponds to this description: "Asset tokenization is a development of blockchain technology that enables the purchase, sale, and exchange of digital assets on blockchains" (Sazandrishvili, 2020). Tokenization transforms the value held in a physical or intangible thing into a token that is typically manipulable using a distributed ledger technology (DLT) or blockchain system. To put it simply, tokenization allows for the conversion of virtually any asset—real or virtual—into a digital token, enabling digital transfer, ownership, and storage without the need for a central third party or intermediary. As a result, a digital token can be defined as a piece of software with a special asset reference with associated properties and/or legal rights. Even though, similar pieces of software can be done, the fact that a token

runs on DLT / Blockchain differentiate it from other digitalization methods (Stefanoski et al., 202 C.E.). Before deepening and discovering the nature of tokens and their real use cases, a distinction between fungible and non-fungible tokens needs to be done. There are essentially two types of tokenized assets:

- Fungible tokenized assets: Nowadays, the most common application of tokens that exist on DLT / Blockchains are tokens that are fungible of nature like cryptocurrencies or ingots of gold. Each unit of a thing or commodity must be interchangeable with every other unit for it to be considered fungible. Therefore, one kilogram of pure gold can be exchanged for any other kilogram of pure gold which can be divided into as many units as are specified during their issuance and is interchangeable and divisible (Rajaram et al., 08/22).

- Non-fungible tokenized assets: they represent assets that are non-transferable, irreplaceable, and exclusive (Stefanoski et al., 202 C.E.). These features are conferred by blockchain, which ensures that the peculiarities of the Non-Fungible Token will remain immutable and unique in the future. NFTs can be distinguished and identified with one serial or alphanumeric number on the blockchain but they can also be characterized by dynamic data such as the dimension, consistency, and good's location.

Besides these technical features that underlie the differences between these two categories of tokens, other characteristics are used to define tokens. One of the other ways for categorizing tokens arises with the token's utility. "Blockchain tokens can be categorized into utility and security tokens" (Guo & Liang, 2016). "Utility tokens are issued through ICOs (Chohan, 2019), a process in which issuers sell tokens in exchange for cryptocurrencies, without the governance of existing securities regulations" (Adhami et al., 2018). "Utility tokens grant their owners access to products or services that are offered by the issuing company" (Conley, 2017), the corporation that takes care of the creation, development, and advertising of the token. Tokens issued with ICOs are "created" within the blockchain and are not backed by off-chain security or other tangible or intangible assets.

Since tokens issued through ICOs are separated from the traditional, off-chain portion of the market, this has significant implications for market structure and governance purposes (OECD, 2020). Since the underlying blockchain infrastructure is the pillar of any ICO/STO ecosystem,

the ownership of tokens issued only being represented on it, and the reliance and the features of the blockchain infrastructure providers are critical (Stefanoski et al., 202 C.E.).

On the other hand, "security tokens are generated through security token offerings" (STOs) (Pauw,2019). STOs need to comply with securities regulations and must be supported by financial assets such as equity or fixed-income financial products. (Tian, Lu, et al., 2020).

An STO can be used to create a digital representation called security token. "Security tokens are assets, meaning that they could represent a share in a company, ownership of a piece of real estate, or participation in an investment fund. These security tokens can then be traded on secondary markets." (Pascal et al., 2018).

As we have seen, "while a security token is akin to a digitized stock or real estate - whereby the investor that purchases the token becomes a shareholder/owner of the entity from which they purchased the token - the value of the ICO token is derived from the use of the token within the ecosystem set up by the issuing company" (Stefanoski et al., 202 C.E.).

In contrast to IPO (Initial Public offerings) where companies that would like to be listed simply use the IPO services of the stock exchanges, for STO and ICO, this procedure is completely different. The issuing companies of STO/ICO need to take care, handle, and structure all the technical aspects of the issuing process of the token by leveraging on specialized companies such as consultancy, technology providers, and digital asset exchanges (Stefanoski et al., 202 C.E.).

As mentioned above, there are several ways of classifying tokens, and the ones that we have analyzed above only cover some of the conceptual ways of defining them. The last classification that we are going to cover is the one about the token standards on the Ethereum network since, as of 2022, 94 % of protocols are used for STOs, and the majority of the ones for ICOs are issued on the Ethereum blockchain. According to the official Ethereum website (Home | ethereum.org), we can define Ethereum as a technology for building apps and organizations, holding assets, transacting, and communicating without being controlled by a central authority. By using Ethereum, there is no need to hand over all your personal details because users can keep control of their personal data and what is being shared. Moreover, Ethereum has its own cryptocurrency, Ether (ETH), which is used to pay for certain activities on the Ethereum network. To provide an idea of the importance of Ethereum within the crypto industry, the blockchain protocol registered impressive figures in 2021 with 2970 projects built on top of the

blockchain, more than $ 11 trillion of value moved (transactions) through the Ethereum network, and $ 3.5 billion of creator earnings generated.

Before deepening into the topic of token standards, it is extremely useful to understand the functioning of a smart contract standard: “a set of rules that a smart contract must comply with to function as intended on the underlying blockchain network” (Crypto Guides for Beginners and Veterans | Crypto.com University). In a few words, these standards enable smart contracts to perform their basic functions.

By applying the same reasoning, we can say that token standards consist of a set of predefined functions and attributes that can be intentionally implemented to represent the specificities of each asset (Stefanoski et al., 202 C.E.). It is important to evaluate the asset's main properties, such as fungibility or non-fungibility, before deciding which token standard to use. The choice of the token standard is extremely important because it could change and significantly impact the use and development of the token itself.

The most popular token standards of the Ethereum blockchain are:

- ERC-20: fungible tokens standards that provide basic functionalities to transfer tokens, as well as allow tokens to be approved. They provide the possibility of exchanging value between users and authorizing someone to spend the value on one’s behalf.
- ERC-72: It is the Non-Fungible Token Standard. The main use case of this standard of token is the transfer of ownership over a specific asset between users. This specific standard of token is mostly used for representing NFTs such as digital collectibles, game items, and event tickets and for representing ownership over a real-life asset.
- ERC-777: It aims to address some limitations of ERC-20 token standards by allowing people to build extra functionality on top of tokens such as improving transaction privacy.
- ERC-1155 This standard enables more cost-effective trading of the token and the bundling of transactions. This token standard enables the creation of Non-Fungible Tokens as well as Utility Tokens like $BNB or $BAT.
- ERC-1400: It is an extension of the token standard ERC-20. the token standard used for Security tokens. These tokens serve as the blockchain's representation of any form of real-world asset and are actual securities. The standard allows for example things like forced transfers, document library management, restricted transfers, and the addition of transfer information.

Sources: (Crypto Guides for Beginners and Veterans | Crypto.com University), (Home | ethereum.org),(Learn All About Blockchain & Cryptocurrency | Binance Academy), (Stefanoski et al., 202 C.E.)

2.4 The impact of asset tokenization on the financial industry

After having deeply and technically analyzed asset tokenization and all the different types of tokens, in this chapter we are going to analyze the impact of asset tokenization on the financial industry with a special focus on the clearing and settlement, trading, and repurchase agreement function.

Asset tokenization can be used in several ways for improving and increasing the efficiency of several processes within the financial industry. According to Deloitte (Pascal et al., 2018), a new "token economy" offers the potential for a more efficient and fairer financial world by greatly reducing the friction involved in the creation, buying, and selling of securities. "Tokenization of global illiquid assets estimated to be a $16 Trillion business opportunity by 2030", this is what the Boston Consulting Group states in the report "Relevance of on-chain asset tokenization in 'crypto winter" of 2022. The same market, the one of the tokenization of global illiquid assets now capitalizes $ 0.31 trillion.

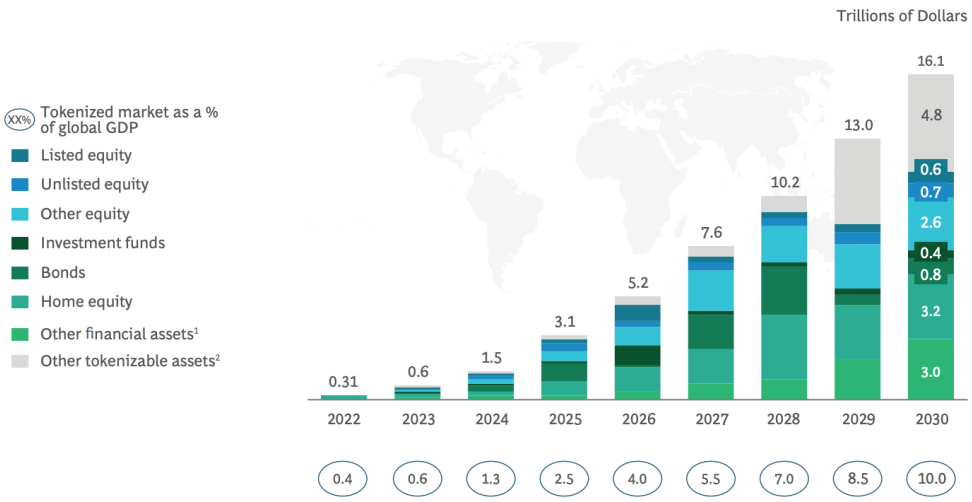

Figure 2: *Market size for security tokens, per type. (Source: World Economic Forum – Global Agenda Council, BCG Analysis)*

2.4.1 Clearing and settlement

“Blockchain technology is a type of underlying technology that can connect with a variety of scenarios. It can achieve asset tokenization and point-to-point value transfer, thereby reconstructing the financial infrastructure” (Guo & Liang, 2016). According to the same paper, asset tokenization significantly lower expenses while also improving the process efficiency of clearing and settling financial assets after transactions. As a result, it has the potential to resolve several existing issues in the banking sector. The mentioned paper points out the limitations of the traditional banking business such as the presence of intermediaries and the complex clearing processes. On the other hand, the study identifies the main benefits of the point-to-point transmission of transaction data, the disintermediation of the process, and the DLT infrastructure. As stated in the report “Blockchain application and outlook in the banking industry” by Ye Guo and Chen Liang, blockchain and tokenized assets have the potential to upgrade and transform banks' credit information and payment clearing systems by revolutionizing the underlying technology. “This sharply increases the process efficiency of the clearing and settlement of financial assets after transactions, while reducing costs” (Guo & Liang, 2016). According to Goldman Sachs (Priem, 2020), DLT could reduce transaction costs of insurance underwritings by $2–4 billion in the USA alone and the costs related to securities clearing and settlement would decrease by $11–12 billion. As stated in “The Tokenisation of Assets and Potential Implications for Financial Markets”, the biggest breakthrough of asset tokenization for the clearing and settlement function is the reduction of counterparty and operational risks (OECD,2020). The same study points out that tokenized assets can be cleared and settled using DLT-enabled systems and smart contracts, which can be used to automatically, immutably, transparently, and almost instantly verify ownership, confirm trade matching, and record transactions. The distributed ledger can serve as a counterparty to all parties engaged in transactions as well as a decentralized registry of transactional data (OECD,2020).

2.4.2 Trading

The report “Tokenization of assets” from EY (202 C.E.) suggests that the advent of asset tokenization will significantly increase market liquidity by reducing the illiquidity of specific asset classes such as listed equity, unlisted equity, investment funds, bonds, home equity, and other financial assets. “Tokenization could improve the liquidity of infrastructure assets in EMDEs (emerging markets and developing counties) by facilitating trading in secondary markets and unlocking global markets to capture the lower cost of capital and higher return from this illiquid asset class.” (Tian, Adriaens, et al., 2020). The same paper suggests that asset tokenization turns illiquid EMDE infrastructure assets into liquid digital tokens (security tokens) that can be traded twenty-four hours a day, seven days a week on traditional capital market exchanges that support trading in security tokens or in on-chain secondary markets. The improvement of liquidity is not the only positive effect that asset tokenization could provide to financial and non-financial markets. George Sazandrishvili in "Asset tokenization in plain English" stated that besides the effect of fractional ownerships that is directly interconnected with the liquidity benefit, asset tokenization could offer other benefits such as global access to investments by increasing market participation, faster transactions, transparency, and improved global access to investments.

Moreover, the trading function could be streamlined and automated due to the absence of a central trusted authority or middleman that is required to verify a relationship between two transacting parties. DLTs enable transactions where trust is spread throughout the network's nodes. This degree of automation is granted by smart contracts embedded at every stage of the trading processes that automatically monitor and cross-validate processes based on predetermined rules (Dai & Vasarhelyi, 2017). Investors can serve as their own broker-dealers, and in exchange for a transaction fee, members of the decentralized network will validate and confirm transactions (OECD,2020). According to the same report from OECD, the potential implications of tokenization for trading and pricing are faster repo, securities lending, and a potential shift from the market-making model. Through asset tokenization, it becomes possible to initiate and build a global standardized interoperable database on the blockchain, which enables a larger group of participants to interact and gain access to data in a frictionless manner without intermediaries (Kshetri 2017). Trading in a tokenized environment would benefit from enhanced transparency provided in DLT-based networks.

Another important benefit of asset tokenization that is associated with “improved transparency is a reduction in information asymmetries, and this, in turn, has the potential to improve the price discovery mechanism, providing investors with incentives to increase their participation and bring additional liquidity in the market, also improving competition conditions in the market” (OECD, 2020).

2.4.3 Repurchase agreement (REPO)

According to “The Tokenisation of Assets and Potential Implications for Financial Markets” written by OECD, a potential take-off in tokenization could also have an impact on repo activity for the funding of positions and securities lending activities used in trading strategies, enabling faster and easier collateral unwinding, easier collateral mobilization across security pools, better balance sheet utilization, and lower capital intensity.

As fewer steps are required in the process and the transfer or unwinding of collateral is direct and immediate; moving the repurchase process on-chain may result in securities lending that is quicker and less expensive. This might result in the overnight repo market turning into an almost "instantaneous" market, the same report suggests.

Furthermore, asset tokenization and enhanced liquidity levels could bring advantages to the broader market by releasing and utilizing collateral held in distinct accounts worldwide and engaged in the same network of securities pools. By using the blockchain infrastructure, asset ownership, and transactions are recorded on a distributed ledger, therefore all the participants have access to real-time information on the asset's location, making it possible to track and transfer collateral seamlessly throughout the system. (OECD, 2020)

2.5 Limitations of asset tokenization in the financial industry

In parallel to benefits, we have limitations. The existing literature highlights key factors that are crucial in driving the advancement and acceptance of asset tokenization within the financial industry. According to "Finance infrastructure through blockchain-based tokenization" written by Yifeng Tian, Zheng LU, Peter Adriaens, R. Edward Minchin, Alastair Caithness, and Junghoon Woo, the main barriers are represented by regulations uncertainties (legal challenges and compliance), technical challenges and limited public awareness. George Sazandrishvili in "Asset tokenization in plain English" stated that although there is a significant number of difficulties associated with technology, the main problem is the absence of regulation by the government and industry. While regulators in many countries are elaborating regulations for trading cryptocurrencies and tokens, a few of them have well-developed and defined legal frameworks for asset tokenization. George Sazandrishvili believes that to overcome this problem, some sort of centralization is needed. Another limitation that his paper outlined is that demand is straining supply in terms of workforce meaning that it is very difficult to find business partners that could help companies and institutions in deploying these services. Moreover, the paper highlights the importance of compliance and its costs, especially if businesses engaged in asset tokenization may need to follow several regulatory frameworks and procedures, such as AML, KYC, and MiFID. Lastly, one more limitation that "blockchain-based businesses" need to face is cybersecurity issues since they represent a complex and expensive topic for companies (Sazandrishvili, 2020).

3 Methodology

3.1 Introduction to methodology

Asset tokenization is a very particular topic because the interest in this technology and its use cases grows parallel to crypto-markets dynamics. Hence, it is challenging to find recent and trustworthy information that we can analyze since most of these studies have been conducted during the crypto-euphoric markets of 2017 and 2021. Although the number of academic papers that have been published about crypto and asset tokenization is substantially lower than any other finance-related topic, this study aims to determine how asset tokenization is transforming the financial industry.

The main research question of this study is: *"What is the impact of asset tokenization on the financial industry?"*

To find an answer to this question, I decided to focus my attention and limit my study to the financial practices that according to the outstanding literature could be impacted the most by the advent of asset tokenization. These practices include clearing and settlement, trading, and REPO.

3.2 Methodology

A qualitative methodology approach has been conducted to collect data. Pursuing the goal of providing a real and accurate answer to my main research question, I adopted a strongly different approach from a normal systematic literature review methodology (SLR). Besides the study of the empirical evidence, the methodology that I used involves the analysis and the evaluation of one-to-one interviews with individuals that are playing a relevant role in the global adoption of asset tokenization within the financial industry. The systematic literature review methodology that I performed consisted of the study and analysis of several academic papers that have been published in the database of Google Scholars. The selected papers cover a period of 15 years: from 2008 to 2022.

As previously mentioned, the number of studies on this topic represented one of the main issues and constraints for my study since the outstanding literature is very limited. To provide a more comprehensive understanding of this topic and to offset the lack of empirical evidence, I also implemented in my analysis other publications such as reports, articles, and findings published by reliable and trustworthy companies and organizations such as Ernest & Young, the Boston Consulting Group and OECD just to name a few. The research has been conducted by using secondary data collected from researchers, companies, and organizations that are actively dealing and operating with asset tokenization and blockchain. Considering that it is essential to gain a comprehensive understanding of blockchain technology, extensive research has been conducted also on this topic.

Furthermore, I conducted nine individual semi-structured interviews with professionals that are actively working for companies and institutions involved in the asset tokenization industry. The interviews aimed to access the impact of asset tokenization on the financial practices listed above. The interviewed individuals did not represent their respective companies in any capacity.

Interviewed sample	*Insistution/company*	*Description of the company*
Antonio Moreno	Chainalysis	Chainalysis offers cryptocurrency investigation and compliance solutions to global law enforcement agencies, regulators, and businesses as they work together to fight illicit cryptocurrency activity. Backed by Benchmark and other leading names in venture capital, Chainalysis builds trust in blockchains.
Dean Demellweek	BNB Paribas	BNP Paribas is a leading bank in Europe with an international presence. It operates in 74 countries with over 192,000 employees, of which more than 146,000 are in Europe. The group holds key positions in its three main business areas: Domestic Markets and International Financial Services, with retail banks and financial services grouped under the Retail Banking & Services division, and Corporate & Institutional Banking, dedicated to corporate and institutional clients. BNP Paribas supports its clients (individuals, associations, entrepreneurs, SMEs, large companies and institutions) to help them achieve their projects, offering financing, investment, savings and custody services. In Europe, the group operates in four domestic markets (Belgium, France, Italy and Luxembourg) and BNP Paribas Personal Finance is number one in the European market for personal financing.
Hugo olz oliveira	Instituto new economy	It is ollaborative association of industry leaders, professionals and citizens who wish to increase Portugal's global standing and its participation in the digital economy. They host educational events, publish research papers and form committees for best practices and ethical considerations for new and emerging technologies.
Nuno Cortesão	Zharta	An instant loan protocol with Liquidation Protection for your NFT collateral, bundling capabilities, and a UX polished by user feedback.
João Matos Cruz	Jedi3 and Unicambio	Jedi3´s mission is to support companies on the journey to assess relevant opportunities and enter the Blockchain/Web3 sphere with a tailormade strategy. Unicâmbio is the oldest and largest currency exchange agency in Portugal, is celebrating 30 years of dedicated service to its customers. The company began its journey with two branches in the Algarve, focusing on currency exchange, and has since expanded its services to include partnerships with companies such as Western Union and EML Payments, and agreements with Euronet and Worldline for ATM installation and payment solutions. Unicâmbio has also established branches in Angola, Morocco, and Germany, and offers additional services such as purchasing used
Jeffrey Hartjes	Deutsche Börse	Deutsche Börse Group provides investors, financial institutions and companies access to global capital markets. Our business covers the entire financial market transaction process chain, ranging from securities and derivatives trading, clearing, settlement and custody, to market data and the development and operation of electronic trading systems. As a technology company, we develop state-of-the-art IT solutions and offer IT systems all over the world.
Marco Romei	Banca sella	Banca Sella is the commercial bank of the group, recognized in the industry for its excellence in innovation of payment systems, e-commerce, and private banking; one of our main strengths is the reliability of the digital solutions we offer.
Salvatore Grisanti	Banca Sella	
Anonymous*	Anonymous *	-

**The interviewed individual requested didn't want to disclose his identity and the company he is working for.*

Figure 3: Company and description of the company of the interviewed sample.

"Whereas the unstructured interview is conducted in conjunction with the collection of observational data, semi-structured interviews are often the sole data source for a qualitative research project and are usually scheduled in advance at a designated time and location outside of everyday events" (DiCicco-Bloom & Crabtree, 2006)

The interviews had an average length of approximately 37.5 minutes and were conducted using the frameworks provided by Bryman & Bell, 2011 and DiCicco-Bloom & Crabtree, 2006.

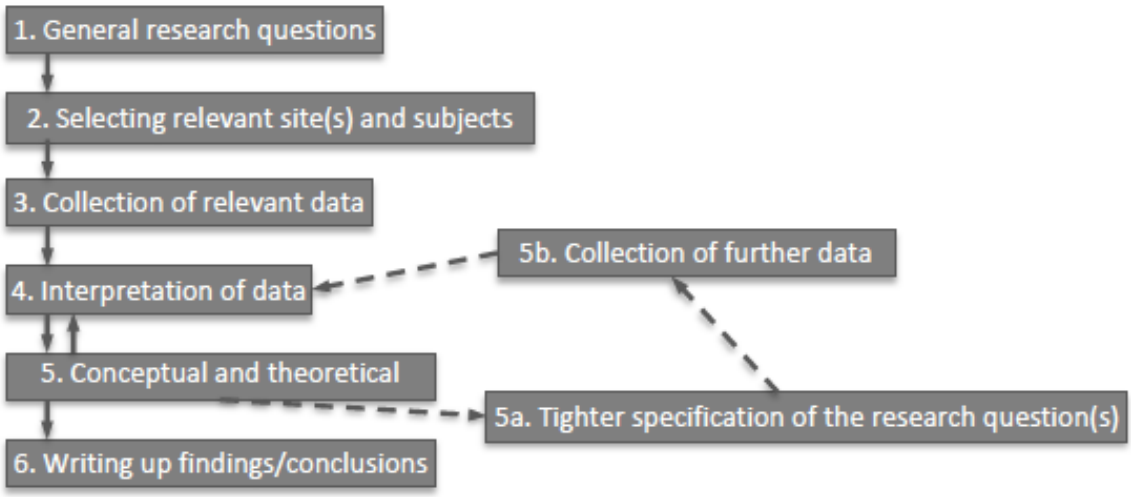

Figure 4: *Main steps of qualitative research, Source: Bryman & Bell 2011).*

In the first part of my interview, I qualitatively assessed the extent to which asset tokenization influences the financial practices mentioned above while the second section's objective was to understand the impact, opportunities, and limitations that asset tokenization could bring to the analyzed financial functions.

This decision was made based on the identification of a significant gap between the outstanding empirical evidence and the practical use cases implemented by financial institutions and companies.

"Whereas there are rules on how to analyze quantitative data, there are no such explicit rules for qualitative ones" (Bryman & Bell 2011).

Quantitative	Qualitative
Numbers	Words
Point of view of researcher	Points of view of participants
Researcher distant	Researcher close
Theory testing	Theory emergent
Static	Process
Structured	Unstructured
Generalisation	Contextual understanding
Hard, reliable data	Rich, deep data
Macro	Micro
Behaviour	Meaning
Artificial settings	Natural settings

Table 5: *Contrast between quantitative and qualitative research, Source: Bryman & Bell 2011: 410*

4 Results

4.1 The impact of asset tokenization on the clearing and settlement function

After analyzing the collected data, it appears that the clearing and settlement function is the financial process that will be affected the most by asset tokenization. According to the interviewed sample, the on-chain clearing and settlement process with tokenized assets would represent a valid alternative to the traditional clearing and settlement procedure.

4.1.1 The advantages that asset tokenization could bring to the clearing and settlement function

There are several noteworthy advantages associated with the use of asset tokenization for the clearing and settlement functions. It emerged from the interviews that these advantages are the scalability, the security, and the improved transparency of this procedure. The first advantage that I decided to analyze is the scalability of this process. According to the interviewed sample, asset tokenization could significantly decrease the settlement time, increase efficiency, reduce counterparty risk, enhance interoperability, and improve accessibility. The decrease in the settlement time has been considered the best advantage from the interviewed sample since by moving the clearing and settlement process on chain, the transactions could be executed in near real-time due to the specific technological features of blockchain technology. The traditional clearing and settlement market for advanced countries (European and North America) normally elaborates the transactions in T+1 or T+2 according to the nature of the transaction. Way different is the situation for the less developed countries where the same procedure takes more time, in some cases also in T+4 or T+5. Therefore, the interviewed sample agreed that the impact of this technology on the clearing and settlement function varies according to the geographical area where the activity is carried from.

The second-best advantage that has been selected by the interviewed sample is the gain in terms of operational efficiency related to the removal of the intermediary companies from the clearing and settlement process. This gain would arise from a decreased centralization, complexity, cost of the process, and enhanced operability. The current clearing and settlement market is heavily centralized because a few dominant intermediary companies control a big share of the market.

This centralization represents a potential single point of failure that could lead to systematic risks and slower settlement time. According to the interviewed participants, moving the clearing and settlement function on-chain would remove these intermediaries from the clearing and settlement procedure and make this financial procedure less complex since the DLT would automatically confirm the nature of the transactions. The sample also stated that the cost associated with this process would substantially decrease since financial entities would not pay anymore the high service fees charged by the intermediary companies.

The complexity of the process and the relatively limited number of intermediary companies bring us to the next advantage related to scalability: interoperability. With asset tokenization the assets would be standardized; this implies that asset tokenization would create a standard form of representing assets making the interaction between intermediaries and the integration processes simpler than the existing procedure. Moreover, the gain in interoperability would also be positively impacted by the execution of smart contracts on top of blockchain technology. The smart contracts would enable different systems to automatically execute complex transactions without the need for manual procedures when specific conditions are triggered. The last advantage concerning the scalability of asset tokenization for the clearing and settlement function is greater accessibility. This last benefit has been quantified as less impactful than the other advantages mentioned above with a relatively low positive effect on market participation.

The next advantage that emerged from the interviews has been security. The advantages are directly associated with blockchain technology. Asset tokenization would be implemented by using blockchain technology, thus by using an immutable ledger of transactions that cannot be modified or deleted. The creation of a tamper-proof registry that records the legitimacy of the funds and the transaction history would significantly improve the security of the clearing and settlement processes. Moreover, from a technological point of view, every type of blockchain (public or private, centralized or decentralized) has its own consensus mechanism. This means that for modifying the consensus mechanism and therefore approving the transactions that occur on the blockchain, the interested entity should take the control of the network, a very difficult and resource-consuming practice due to the cryptography features of blockchain technology.

The last advantage related to the use of asset tokenization for the clearing and settlement function is the positive effect that this technology would have on transparency. The gains in transparency would be the real-time access to data, the openness of the traditional clearing and

settlement procedure, and the potential creation of digital identities. As already stated above, DLT is a public technology, which means that participants have real-time access to data that could use to easily monitor and track the status of their funds. The openness advantage, on the other hand, is related to the creation of a direct relationship between sender and receiver or seller and buyer by avoiding possible fraudulent activities of the intermediaries. To conclude, the creation of digital identities on top of blockchain solutions would make possible a verification of the identity of the participants and reduce the risk associated with fraudulent activities.

4.1.2 The limitation of asset tokenization for the clearing and settlement function

All the opportunities listed above make it evident that this technology will significantly impact the existing clearing and settlement function. Alongside these opportunities, we have some limitations that could negatively impact the future use and adoption of this technology within the clearing and settlement function. These limitations include regulatory compliance, integration with the existing systems, the counterparty and settlement risk, the preferences for the settlement time, the network effect, and the communicational issues.

The regulatory and compliance limitation, as for the other financial practices, is the one that has been considered the most important by the interviewed sample. The regulatory framework is still at an early stage of development and there is a lack of consistency and clarity concerning the rules and regulations that govern the industry. The implementation of asset tokenization for the clearing and settlement function requires adherence to strict regulatory requirements and security standards. Regulators should act proactively to provide valid frameworks for financial entities by understanding the needs of the market by supporting innovation. These regulations represent a significant challenge for financial entities because they need to be compliant with local and international regulations.

The second limitation is the counterparty and settlement risk. The counterparty risk refers to the risk associated with the risk of default of one of the parties involved in a transaction. In the context of clearing and settlement with tokenized assets, this occurs when one of the parties is unable to completely fulfill the obligation of delivering the tokens to the other interested party. The settlement limitation refers to errors that could occur during the tokenized clearing and settlement process. It includes the risk that a transaction could be settled on a different price,

date, or in case of failure of the transaction itself. This risk may arise due to several factors such as operational mistakes and failures of the systems. Overall, the sample agreed that a tokenized clearing and settlement process could be more complex to manage due to the unique operational risks and challenges related to the use of blockchain technology.

The third limitation that emerged from the interviews has been the integration with the existing clearing and settlement system. Even if the interviewed participants agreed that the asset tokenization will have a long-term disruptive impact on the clearing and settlement market, they also agreed that a slow and steady integration of this technology is required before shifting to a complete clearing and settlement on-chain process. Asset tokenization needs to be seamlessly integrated with the currently existing infrastructures and systems used by financial institutions to minimize the complete disruption of the market.

The third limitation is the preference for settlement time. As discussed in the advantages section above, the decrease in the settlement time has been considered the best advantage from the interviewed sample. On the other hand, it emerged that some interviewed individuals defined this factor as a possible limitation as well. According to some interviewed professionals, even if transactions could be settled almost in real-time, there would not be a real need on the markets because different clients could have different preferences concerning the settlement time. These preferences are normally related to several factors such as market practices, the nature of the settled asset, and other specific needs of the financial institutions. Therefore, financial institutions need to consider this limitation when exploring this solution.

The next limitation of asset tokenization for the clearing and settlement function is the so-called network effect. The interviewed sample believes that the network effect will be considered one of the main limitations for the future development of this specific process. With the "network effect", the sample refers to the number of financial entities involved in the on-chain clearing and settlement process. It emerged that important financial players are already experimenting in this field but they are facing some difficulties in scaling these projects alone. They agreed that this factor is crucial for the development of this process because the impact of this shift will be proportional to the number of financial players that will join the tokenized and on-chain clearing and settlement network. In this regard, some of the interviewed people believe that it would be easier to create and build this new financial infrastructure from scratch as it is happening for decentralized finance rather than simply trying to modify the traditional clearing and settlement market due to a lack of financial institutions willing to join the network and to

the high investments required. According to the interviewed sample, the creation of the above-mentioned tokenized and decentralized clearing and settlement market is still very far from being adopted.

The last limitation that emerged from the interviews has been the communication issue. This limitation has been considered by the interviewed sample as a minor limitation compared to the ones analyzed above and it is related to a lack of standardization. The tokenized clearing and settlement market would potentially include several participants such as centralized and decentralized exchanges, brokers, and custodians. In the first stage of this transition, another stakeholder that would be involved is the list of participants in the clearing houses. This lack of standardization may create delays and inefficiencies in settlement processes due to the use of different systems and communication protocols used by the involved parties of the network.

4.2 The impact of asset tokenization on the trading function

From the analysis of the existing literature review, the trading function was considered one of the most affected processes by asset tokenization. The results obtained during the interviews are quite interesting because they underline slight differences between the gathered data and the outstanding literature review and research about the topic. The answers of the interviewed sample were aligned in most of the cases but some interviews specifically addressed topics that were not covered by the outstanding literature or by the rest of the interviewed sample. Out of the three specific functions that I analyzed in my study, the trading function represents the second financial practice that, according to the interviewed sample, will be impacted the most by asset tokenization.

4.2.1 The advantages that asset tokenization could bring to the trading function

The impact on this specific financial process will be mainly represented by a significant improvement in transaction efficiency, transparency, and a positive effect on private markets. The interviewed participants agreed that these advantages are strictly connected to the technical features of blockchain technology. Both decentralized and centralized blockchains could represent an alternative or an improved version of the current market-making model infrastructure. In line with the "The Tokenisation of Assets and Potential Implications for Financial Markets" by OECD, all the people interviewed agreed that the distribution of efficiency gains among network participants is contingent on various factors, including the level of decentralization (whether it's a fully decentralized network or centralized exchanges), the type of distributed ledger technology used (permissioned or permissionless), the validating mechanisms and verification process employed for transaction confirmation, the presence or absence of mining, and the use of smart contracts. Another advantage that emerged from the interviews is the positive effect on market liquidity, making assets easier to transfer, and enhancing market participation. Concerning the benefits associated with market liquidity, instead of exclusively analyzing the infrastructural shift of the trading process, the investigation that I performed was also aimed to analyse the impact of tokenized securities on the trading activity. The tokenization of financial securities would boost market liquidity due to a fractionalization of the security itself. By offering this option, retail investors would have increased investment opportunities, as economic barriers to entry would be lowered, enabling

them to participate in financial markets and trade securities that might otherwise be too expensive. As mentioned above, all the interviewed professionals agreed that the tokenization of the securities would also increase market efficiency due to the market liquidity-participation relationship.

Another but secondary advantage that exclusively emerged from the interviews is the tokenization of private markets. This development holds promise for small and medium-sized enterprises (SMEs) seeking access to equity markets on a similar footing to larger corporations, thus enhancing the efficiency of financial markets and providing a new financing source for small and medium enterprises. According to the interviewed sample, SMEs form the bedrock of the European economy, and financing remains a perennial challenge for these entities. Therefore, tokenization and equity markets could prove beneficial to SMEs by providing them with greater access to equity capital.

4.2.2 The limitation of asset tokenization for the trading function

On the other hand, the main limitations that affect the impact of asset tokenization for the trading function are of legal, technological, and adaptational nature.

It emerged that legal limitation is a common issue that negatively affects the development and adoption of this technology. Specifically, the legal limitation is a factor that is geographically affecting the development of asset tokenization for the trading function. All the interviewed professionals agreed that every jurisdiction is actively influencing the ongoing development and adoption of this technology within financial institutions. Moreover, they noted that northern European countries are more willing to create and/or modify existing legal frameworks to adapt to innovation. It also emerged that a seamless integration of asset registries is required for the successful adoption of asset tokenization for the trading function. Asset registries create a transparent and reliable record of ownership and transfer of assets; specific legal frameworks need to be implemented to prevent fraud, reduce transaction costs, and increase confidence in the market.

The other primary limitations are represented by technology and adoption. The technological issue has been considered a major limitation since blockchain technology is complex and implementing it can demand a substantial amount of resources and expertise. It emerged that

expertise is a relevant factor in determining the successful implementation of tokenized processes because it requires employees to have a clear understanding and familiarity with blockchain technology and asset tokenization. The interviewed sample believes that a significant upskilling or reskilling of workers across the financial industry should be necessary to successfully implement asset tokenization within the businesses.

The issue of adaptational nature is a common limitation that emerged from interviewing the sample. They believe that using tokenized assets or implementing an on-chain market-making model would result in low usage of service offers due to technological barriers that the end users would face.

4.3 The impact of asset tokenization on the REPO function

The last function and the one that has been evaluated as the less impacted function by the interviewed sample is the repurchase agreement function. Although not as significant as the clearing and settlement and trading functions, this function remains highly important, and asset tokenization could yield numerous benefits. The benefits that appeared from the interviews are very similar to ones that emerged with the other functions, notably: increased transparency, automation, efficiency improved liquidity and cost, and management efficiency.

4.3.1 The advantages that asset tokenization could bring to the REPO function

As occurred for the other two analyzed functions, the increased transparency of the repurchase activity has been determined as one of the most interesting advantages that asset tokenization could bring to this specific financial procedure. The immutability of transactions offered by asset tokenization allows for improved transparency, which is a valuable feature in the financial industry. All repo transactions would be recorded on the blockchain, making them public and traceable. The enhanced transparency would provide the possibility to market participants to monitor and track the repo activity more accurately and easily. The interviewed sample agreed that it would also be possible to track and monitor the types of assets that will be used as collateral, the terms of the repurchase agreement, and the parties involved in the transaction.

Another benefit associated with transparency is the traceability of the assets, making it easier to prevent fraud and providing greater clarity in the case of legal proceedings or disputes. Given that the REPO market can also occur over-the-counter (OTC) (Anbil et al., 2021), utilizing a public blockchain for this activity would result in a significant portion of the repurchase agreement market being publicly visible to entities and individuals that require transparency and accountability.

The second advantage is improved automation and efficiency. As already discussed in the previous sections, the improved automation and efficiency advantage would be strictly connected to the use of smart contracts to execute and settle transactions in repurchase agreement markets. The interviewed sample believes that smart contracts could substantially

improve the whole repurchase agreement process, from the initial agreement to the final settlement while improving the precision and speed of the processes.

The third advantage related to the impact of asset tokenization on the repurchase agreement market is improved liquidity. It emerged from the interviews that there would also be the possibility of tokenizing repurchase agreements, making it possible to create a more tradable and liquid instrument. As we discussed above, the repurchase agreements are mostly traded OTC and are not easily tradable. However, by creating a tokenized version of the repurchase agreements, they could be traded within a circuit, making it a more tradable instrument, thereby improving its liquidity. By signing a contract for a repurchase operation, it would become tradable within the circuit, and the current contract could be adjusted with another party, which would further benefit the liquidity within the circuit. To conclude, the tokenization of repurchase agreements has the potential to lead to improved liquidity by making it easier to trade and transfer ownership of these agreements.

The last advantage that emerged from the interviews for this specific function is cost and management efficiency. The cost efficiency is related again to the reduction of transaction costs by cutting off intermediaries and streamlining processes. On the other hand, the advantage related to management efficiency is connected to the management of certain specific manual processes. The gain under this specific factor would mainly arise from the execution of predefined actions that would be automatically executed by smart contracts. Moreover, the use of asset tokenization and smart contracts could provide a more granular and customizable understanding and control over the terms of the agreements such as the duration of the agreement, the size of the collateral, and the interest rate.

4.3.2 The limitation of asset tokenization for the REPO function

The limitations that emerged from the interviews are in line with the limitations that we analyzed for the other financial practices. Legal, technological, liquidity, and adoption are the main challenges that play a big role in the development of this technology.

The regulatory frameworks for tokenized assets are still evolving and they are under the power of every jurisdiction. Therefore, the creation of standardized regulations that could be used by the same financial entity that operates in different countries and continents is still very far. This

regulatory challenge undermines the operations of the financial entities while creating uncertainty and potential legal risks.

The technological challenge is mainly related to the cost and the complexity of the infrastructure and technology required for asset tokenization due to maintaining several components such as blockchain networks, smart contracts, and digital wallets. The performed interviews emphasize that the current infrastructure to facilitate the tokenization of assets for the REPO function is not well-developed and would necessitate substantial investment and expertise to establish and sustain.

The last two limitations are liquidity and adoption. These two factors are connected and represent big challenges for the use of asset tokenization for the clearing and settlement function. I analyzed the impact of asset tokenization on the repurchase agreement markets, but I didn't address the problems that could arise from a lack of liquidity in the market. As for the clearing and settlement function, the amount of liquidity in the circuit is determined by the number of participants in the market. According to the interviewed sample, if most of the financial institutions choose not to move this activity onto the blockchain, the so-called network effect could negatively impact liquidity. As fewer entities participate in the on-chain circuit, there may be limitations and reduced benefits for those financial institutions that do opt to conduct their repurchase agreements on the blockchain. This could potentially disincentivize participation in the on-chain system, leading to further reductions in liquidity. Therefore, financial institutions must consider the long-term benefits of adopting blockchain technology and evaluate the potential network effects that may arise from their decision to participate in or abstain from on-chain activities. The limited adoption of this practice would directly and negatively affect the liquidity of the tokenized clearing and settlement market.

5 Conclusion

This study aims to analyze and access the impact of asset tokenization on the clearing and settlement, trading, and repurchase agreement function and to demonstrate how these financial processes are affected by asset tokenization.

The results show that the use of asset tokenization from financial institutions is aligned with the use cases suggested by the literature review. However, the collected data have revealed supplementary and diverse potential applications of this technology beyond the scope of the literature review.

In line with the finding of Guo & Liang (Guo & Liang, 2016), the use of asset tokenization for clearing and settlement functions provides several advantages, including scalability, security, and improved transparency. The scalability advantage is particularly noteworthy, as it could significantly decrease settlement time, increase efficiency, reduce counterparty risk, enhance interoperability, and improve accessibility. The removal of intermediary companies from the clearing and settlement process would lead to gains in operational efficiency, less centralization, and decreased costs. Interoperability between trading parties would be positively impacted by the standardization of assets and the execution of smart contracts incorporated in the blockchain. Another advantage that emerged from the study that is in line with the report of OECD (OECD,2020) is that the utilization of asset tokenization would not only enhance the security of the process but also create an immutable ledger that records the legitimacy of funds and transaction history, thereby minimizing tampering risks. Furthermore, asset tokenization would foster transparency by enabling real-time access to data, enhancing the openness of the processes, and generating digital identities.

Nonetheless, several limitations pose potential hindrances to the adoption and future usage of this technology in the process at hand. Regulatory and compliance issues, integration with existing systems, counterparty and settlement risks, settlement time preferences, network effects, and communicational challenges are significant challenges that require attention. All factors that have been pointed out by George Sazandrishvili (Sazandrishvili, 2020) and Tian and Lu (Tian, Lu, et al., 2020). To overcome these limitations, financial institutions need to work together with regulators to develop consistent regulatory frameworks and security standards. Financial institutions also need to integrate this technology slowly and seamlessly with the current systems, while considering settlement time preferences and the so-called

“network effect”. Standardization of communication protocols may help to minimize delays and inefficiencies in settlement processes.

The study has demonstrated that asset tokenization has a significant impact also on trading activity, providing a marked improvement in transaction efficiency and transparency, as well as a positive effect on private markets. The technical features of blockchain technology and asset tokenization are considered critical to achieving these advantages, with both decentralized and centralized blockchains offering the potential for an alternative or improved version of the current market-making model infrastructure, a finding aligned with the one of Dai & Vasarhelyi (Dai & Vasarhelyi, 2017). However, the distribution of efficiency gains among the network participants is contingent on various factors, including the level of decentralization, the type of distributed ledger technology, and the use of smart contracts. Additionally, in line with the findings of the report of EY (202 C.E.), the tokenization of securities offers benefits such as enhanced market liquidity and increased investment opportunities for retail investors. Furthermore, the study underlines the potential advantages of the tokenization of private markets for small and medium-sized enterprises (SMEs) seeking greater access to equity capital, thus providing an additional financing option for these companies; an advantage emerged exclusively from my research.

The research identifies several limitations, including legal, technological, and adaptational barriers, that limit the impact of this technology on the trading function. Legal frameworks need to be adapted and standardized to ensure seamless integration of asset registries, prevent fraud, and increase market confidence. The complexity of blockchain technology and the need for specialized expertise pose significant technological barriers, requiring upskilling or reskilling of employees across the financial industry. Furthermore, the adaptational nature of the technology represents a common limitation, where end-users face technological hurdles that restrict the use of tokenized assets or on-chain market-making models.

In conclusion, the potential benefits of asset tokenization on the repurchase agreement market are noteworthy and partially support the findings published in the report of OECD (OECD, 2020). The increased transparency and traceability enabled by the immutability of transactions on the blockchain can provide valuable advantages for market participants. The improved automation and efficiency resulting from the use of smart contracts can enhance the precision and speed of the repurchase agreement market processes. Asset tokenization and the tokenization of repurchase agreements can also lead to improved liquidity by making them

tradable and transferable. Finally, the cost and management efficiency resulting from the reduction of transaction costs and the automation of manual processes can further improve the performance of the repurchase agreement market.

The limitations that emerged from the interviewed sample concerning this financial function are in line with the limitations analyzed for other financial practices, including legal, technological, liquidity, and adoption. The regulatory framework for tokenized assets is still evolving, creating uncertainty and potential legal risks for financial entities operating across different jurisdictions while the technological challenges are related to the cost and complexity of the infrastructure required for asset tokenization, including blockchain networks, smart contracts, and digital wallets. To conclude, the limited liquidity and a scarce adoption of the technology could negatively impact the efficacy of asset tokenization for the clearing and settlement function, as fewer participants in the on-chain circuit could lead to further reductions in liquidity.

5.1 Limitations of the study

Despite the results and the findings mentioned above, some limitations must be taken into consideration in my study. The study has been completed in seven months and therefore the results of the interviews could have been different if performed at the end of the period due to possible changes in existing legal and technological frameworks that would have modified the answers of the interviewed sample. Another limitation is the geographical distribution of the interviewed sample, all the interviewed people work for European companies, therefore, the results may have been different if the same study would have been performed in a specific country or on other continents. Moreover, the limited number of interviews represents another limitation since additional data could have shown different results. The underlying study leaves enough room for further research activities, which refers to the inclusion of the above-mentioned limitations to provide a more comprehensive and detailed analysis of the impact of asset tokenization on the financial industry.

6 References

Adhami, S., Giudici, G., & Martinazzi, S. (2018). Why do businesses go crypto? An empirical analysis of initial coin offerings. *Journal of Economics and Business*, *100*, 64–75. https://doi.org/10.1016/j.jeconbus.2018.04.001

Anbil, S., Anderson, A., & Senyuz, Z. (2021). Are Repo Markets Fragile? Evidence from September 2019. *Finance and Economics Discussion Series*, *2021*(026), 1–58. https://doi.org/10.17016/FEDS.2021.028

Antonopoulos, A. M. (2015). *Mastering Bitcoin* (First edition). O'Reilly.

Chiu, J., Ozdenoren, E., Yuan, K., & Zhang, S. (2023). *On the Fragility of DeFi Lending*. https://doi.org/10.34989/SWP-2023-14

Dai, J., & Vasarhelyi, M. A. (2017). Toward Blockchain-Based Accounting and Assurance. *Journal of Information Systems*, *31*(3), 5–21. https://doi.org/10.2308/isys-51804

DiCicco-Bloom, B., & Crabtree, B. F. (2006). The qualitative research interview. *Medical Education*, *40*(4), 314–321. https://doi.org/10.1111/j.1365-2929.2006.02418.x

Guo, Y., & Liang, C. (2016). Blockchain application and outlook in the banking industry. *Financial Innovation*, *2*(1), 24. https://doi.org/10.1186/s40854-016-0034-9

Lambert, T., Liebau, D., & Roosenboom, P. (2022). Security token offerings. *Small Business Economics*, *59*(1), 299–325. https://doi.org/10.1007/s11187-021-00539-9

Li, J., & Mann, W. (2018). Initial Coin Offering and Platform Building. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3088726

Marikyan, D., Papagiannidis, S., Rana, O. F., & Ranjan, R. (2022). Blockchain: A business model innovation analysis. *Digital Business*, *2*(2), 100033. https://doi.org/10.1016/j.digbus.2022.100033

McWaters, R. J., & Galaski, R. G. (2017). *Beyond Fintech: A Pragmatic Assessment Of Disruptive Potential In Financial Services* (p. 197). World Economic Forum. https://www3.weforum.org/docs/Beyond_Fintech_-_A_Pragmatic_Assessment_of_Disruptive_Potential_in_Financial_Services.pdf

Mohamed, H. (2021). Decentralizing Finance via Cryptocurrencies and Tokenization of Assets and Peer-to-Peer Platforms. *International Journal of Islamic Economics*, *3*(1), 1. https://doi.org/10.32332/ijie.v3i1.3128

Nofer, M., Gomber, P., Hinz, O., & Schiereck, D. (2017). Blockchain. *Business & Information Systems Engineering*, *59*(3), 183–187. https://doi.org/10.1007/s12599-017-0467-3

Pascal, M., Bauwens, M., & Vanoverschelde, J. (2018). *Triannual inside from deloitte* (No. 19; pp. 100–103). Deloitte. https://www2.deloitte.com/content/dam/Deloitte/lu/Documents/about-deloitte/Inside/lu-inside19-full.pdf

Pilkington1, M. (2015). *Blockchain Technology: Principles and Applications*. SSRN. https://deliverypdf.ssrn.com/delivery.php?ID=313027093103006065101088089108071095029078064077029082029098016075115103102017007103006022018042109022044119082027085110024111006076043087080121000115031115091024061030047104068030089081122026127065117006117069111124023108122082120124127092007120003&EXT=pdf&INDEX=TRUE

Priem, R. (2020). Distributed ledger technology for securities clearing and settlement: Benefits, risks, and regulatory implications. *Financial Innovation*, *6*(1), 11. https://doi.org/10.1186/s40854-019-0169-6

Rajaram, S., Sumit, K., Darius, L., Kronfellner, B., & Aaditya, K. (. 08/22). *Relevance of On-chain Asset Tokenization in 'Crypto Winter'* (pp. 1–22). Boston Consulting Group. https://web-assets.bcg.com/1e/a2/5b5f2b7e42dfad2cb3113a291222/on-chain-asset-tokenization.pdf

Satoshi, N. (2018). *Bitcoin: A Peer-to-Peer Electronic Cash System*. https://www.ussc.gov/sites/default/files/pdf/training/annual-national-training-seminar/2018/Emerging_Tech_Bitcoin_Crypto.pdf

Sazandrishvili, G. (2020). Asset tokenization in plain English. *Journal of Corporate Accounting & Finance*, *31*(2), 68–73. https://doi.org/10.1002/jcaf.22432

Stefanoski, D., Sahin, O., Banusch, B., Fuchs, S., Andermatt, S., & Quertramp, A. (202 C.E.). *Tokenization of Assets, Decentralized Finance (DeFi)* (pp. 63–66). EY. https://assets.ey.com/content/dam/ey-sites/ey-com/en_ch/topics/blockchain/ey-tokenization-of-assets-broschure-final.pdf

Tian, Y., Adriaens, P., Minchin, R. E., Chang, C., Lu, Z., & Qi, C. (2020). Asset Tokenization: A blockchain Solution to Financing Infrastructure in Emerging Markets and Developing Economies. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3837703

Tian, Y., Lu, Z., Adriaens, P., Minchin, R. E., Caithness, A., & Woo, J. (2020). Finance infrastructure through blockchain-based tokenization. *Frontiers of Engineering Management*, *7*(4), 485–499. https://doi.org/10.1007/s42524-020-0140-2

OECD (2020), The Tokenisation of Assets and Potential Implications for Financial Markets, OECD, Blockchain Policy Series, www.oecd.org/finance/The-Tokenisation-of-Assets-and-Potential- Implications-for-Financial-Markets.htm

Bryman A. & Bell E. (2011). *Business research methods* (3rd ed.). Oxford University Press.

John P. Conley, (2017) "Blockchain and the Economics of Crypto-tokens and Initial Coin Offerings", Vanderbilt University Department of Economics Working Papers, VUECON-17-00008

Crypto Guides for Beginners and Veterans | Crypto.com University. (n.d.). Crypto Guides for Beginners and Veterans | Crypto.com University. https://crypto.com/university

Home | ethereum.org. (n.d.). ethereum.org. https://ethereum.org

Learn All About Blockchain & Cryptocurrency | Binance Academy. (n.d.). Binance Academy. https://academy.binance.com/en

Cryptocurrency Prices, Charts And Market Capitalizations | CoinMarketCap. (n.d.). CoinMarketCap. https://coinmarketcap.com/

W. (2023, March 28). *The State of Asset Tokenization In 2023*. Medium. https://medium.com/coinmonks/the-state-of-asset-tokenization-in-2023-50b93baeb75d

7 Appendix

Interviewed sample	*Institution/company*	*Position*
Antonio Moreno	Chainalysis	Software engineer
Dean Demellweek	BNB Paribas	CIB Digital transformation leader
Hugo olz oliveira	Instituto new economy	Secretary and foundiing member
Nuno Cortesão	Zharta	Co founder and CEO
João Matos Cruz	Jedi3 and Unicambio	Board advisor and Co-founder
Jeffrey Hartjes	Deutsche Börse	Technical Blockcahin analyst
Marco Romei	Banca sella	Head of innovation streams
Salvatore Grisanti	Banca Sella	Project Manager - open finance innovation
Anonymous*	Anonymous *	Transformation manager

Figure 6: *Interviewed sample, company of the interviewed individual, and working position.*

Interviewed sample	*Interview duration (in minutes)*
Antonio Moreno	25
Dean Demellweek	34
Hugo olz oliveira	34
Nuno Cortesão	22
João Matos Cruz	38
Jeffrey Hartjes	42
Marco Romei	52
Salvatore Grisanti	47
Anonymous*	43

Figure 7: *Interviewed sample and length of the interview.*

Interviewed sample	*Summary of the participants (Interviews and LinkedIn profiles)*
Antonio Moreno	Antonio is a Solutions Architect at Chainalysis Inc., working as a pre-sales for SEMEA. He also worked for Chainalysis as Senior Software Engineer in the United Kingdom for almost 2 years, where he worked on the latest part of their ETL pipeline using Spring Boot, PostgreSQL, AWS, Terragrunt, and Kubernetes. Furthermore, he worked at Amazon Web Services (AWS) in Cambridge, UK, as a Software Development Engineer for 7 months.
Dean Demellweek	He is currently the CIB Digital Transformation Leader at BNP Paribas CIB, a position he has held since September 2017. Prior to this, Dean served as the Digital Solutions & Digital Client Engagement Leader for Global Markets at BNP Paribas, and as Digital Product Marketing and Communication Manager for Fixed Income for 7 years and 6 months. He also worked as a Digital Marketing and Branding Consultant for 3 years. Dean has extensive experience in digital solutions, product marketing, branding, and communication in the financial industry.
Hugo olz oliveira	Hugo has extensive professional experience in various fields, including branding and communication, innovation, digital transformation, and crypto policy. Currently, he is a Co-Host at The Reg3 Conference in Lisbon, where he helps shape the regulation of the crypto economy. He is also a Secretary and Founding Member at Instituto New Economy, where he works on economic policy issues. Previously, he was the Head of Operations at Mesh Agency, where he led a team of ten designers and creatives in several branding and communication projects. Hugo was also the Head of Transformation at Chain Reaction, where he led teams in projects focused on strategy, innovation, and agile transformation for major corporations in Portugal. Before that, he worked as a Lead Analyst at London Block Exchange.
Nuno Cortesão	Nuno has over 5 years of experience in the field of blockchain, with expertise in solution architecture, growth strategy, and blockchain monetization. He is currently the Co-Founder & CEO of Zharta, a Lisbon-based blockchain company, where he has been working since July 2021. In addition, he has been working as a freelance blockchain advisor for Celfocus since August 2021, where he provides advisory services and generates pre-sales for blockchain solutions. Before this, he worked as the Head of Blockchain at Accenture Portugal from March 2019 to October 2020, where he worked on multiple end-to-end project proposals with a focus on conceptual architectures, technological stacks, and revenue uptakes
João Matos Cruz	Joao's work experience includes several leadership roles in the business and consulting fields. Currently, he is a co-founder and managing partner at Jedi3, a web 3 and strategic consulting company. He is also a board advisor at Unicâmbio, a Portuguese business consultancy, and a vice-president at ANIPE, a national association of payment and electronic currency institutions. Previously, he served as an executive board member at UniTransfer Angola, where he managed payments and teams, and as a country manager at MoneyGram International, where he oversaw operations in Angola, Mozambique, and São Tomé and Príncipe.
Jeffrey Hartjes	Jeffrey has been working in the payments industry for the last four years at Deutsche Börse. He has experience in digital assets, project management, and digital transformation. In addition, he is a technical blockchain analyst and has worked on various projects involving Python programming, capital markets, and business intelligence. Jeffrey was also a part-time cash market development analyst and a junior account manager at Omnia Retail
Marco Romei	Marco has worked in various roles across different companies in Italy and the UK. Currently, he is the Head of Innovation Streams at Banca Sella, where he manages innovation streams related to WEB3, Corporate Venture Capital, and Open Innovation Center. He is also an advisor for the same area at Banca Sella, working part-time. Prior to this, Marco was the Co-Founder and CEO of Vineurs, a web3 fine wine exchange for brands and investors, for three years. Additionally, he has worked part-time as a Board Member and Advisor to the President at Forbes Italia, covering the digital business of the group. Marco has also worked as an Advisor to the Chief Executive Officer in various companies, including Notarify, Greenchic, Cliking Investment Ltd, BOOM, Tinaba, and Zehus S.p.A., covering various areas such as organization, business development, and internationalization. Finally, he worked as the Country Manager for Italy at Secret Escapes for one year.
Salvatore Grisanti	Salvatore has over 6 years of professional experience in the banking and financial services industry. Currently, he is a Business Development/Project Manager for Open Finance and Innovation at Banca Sella. His responsibilities include the commercial development of independent consultancy services, managing projects related to the development of a wealth management platform, collaborating on the evolution of custodian bank services, and creating and developing banking products. Prior to his current role, he was a Project Manager/Business Development for Banking as a Service at Banca Sella, where he managed the commercial development of independent consultancy services, collaborated on the development of a wealth management platform, and managed projects related to the evolution of custodian bank services. Salvatore also has experience working as a Digital Consultant for Accenture Interactive and as a Business Analyst for Objectway Spa, where he analyzed and documented functional requirements for advisory and portfolio management solutions
Anonymous*	*** has several years of working experience at an important European banking institution that offers crypto services. He has relevant experience in Information technology, prograamming and business development.

Figure 8: *Interviewed sample and summary of the description of the professional experience of the interviewed person.*

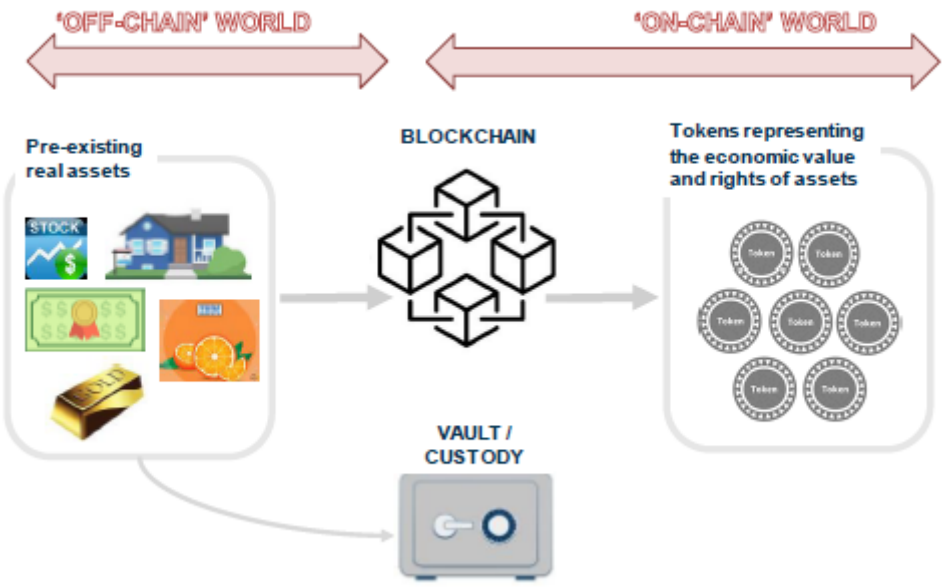

Figure 9: *Tokenisation of real assets that exist off-the-chain (OECD)*

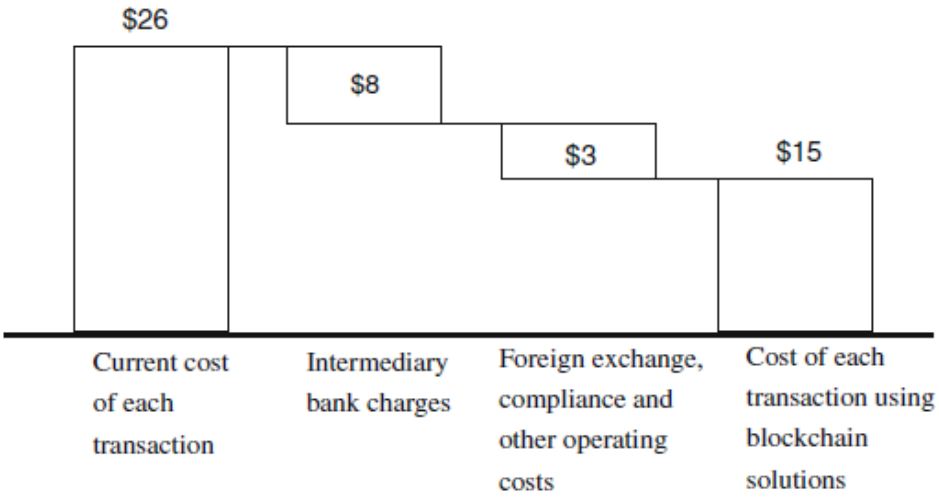

Figure 10: *Application of Blockchain in Cross-Border Payments. Source: McKinsey (Report by McKinsey: Blockchain—- Disrupting the Rules of the Banking Industry, 2016-05.)*

	Public blockchains	Consortium blockchains	Private blockchains
Degree of centralization	Decentralized	Multi-centralized	Decentralized
Participants	Anyone can freely participate and leave	Specific group of people who agree to enter an alliance	Central controller decides members that can participate
Credit mechanism	Proof of work	Collective endorsement	Self-endorsement
Bookkeeper	All participants	Participants decide in negotiation	Self-determined
Incentive mechanism	Needed	Optional	Not needed
Prominent advantage	Self-established credit	Efficiency and cost optimization	Transparency and traceability
Typical application scenario	Bitcoin	Clearing	Audits
Load capacity	3–20 times/second	1000–10000 times/second	-

Source: Blockchain Laboratory, Research Institute of Chuancai Securities Co., Ltd.

Figure 11: *Public, consortium, and private blockchain.*

Origination	**Digitization**	**Distribution**	**Exchange**	**Post-Tokenization Management**
Due diligence Design deal structure Determine the terms and conditions of the digital token backed by infrastructure assets Code legal and regulatory requirements into smart contracts File documents	Appraise infrastructure assets Establish SPV Select technology platform Program smart contracts Transfer transactional information onto the blockchain	Evaluate investors KYC/AML Price tokens Distribute tokens to primary investors in exchange for investment capital Store transactional information automatically onto the blockchain without the participation of intermediaries	Manage whitelist Trade on secondary markets (token exchange or traditional capital markets) Peer-to-peer transfer	Distribute dividend Enable shareholder voting Reporting Taxing Accounting

Figure 12**:** Infrastructure asset tokenization process., Yifeng TIAN et al. Finance infrastructure through blockchain-based tokenization.

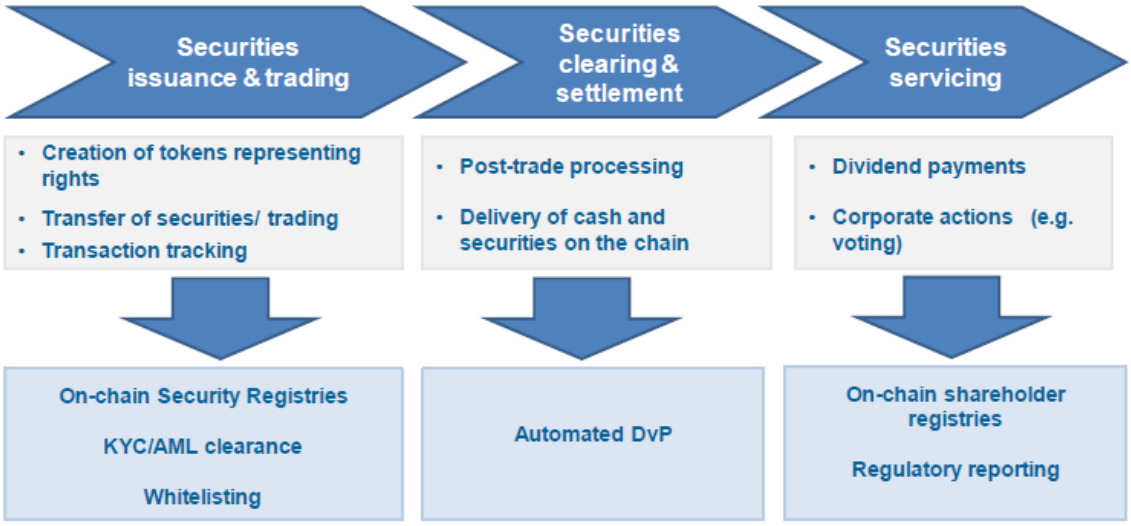

***Figure 15**: Areas in securities markets with DLT use-cases and potential Mechanics of on-chain asset tokenization*, source: OECD

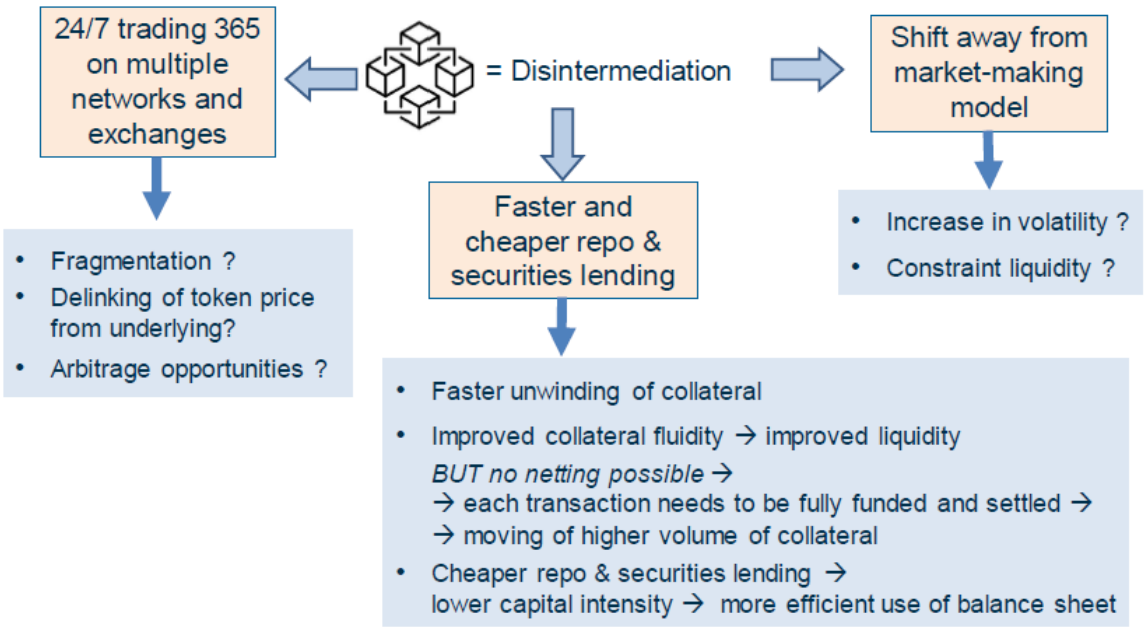

Figure 16: Potential implications of tokenization for trading and pricing