

## Article

# Advancing Asset Tokenization in the European Union and Latvia: A Regulatory and Policy Perspective

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**Abstract:** Our study examines the regulatory challenges and opportunities of asset tokenization within the context of the European Union (EU), emphasizing the balance between technological innovation and investor protection in the digital economy. Focusing on 2023 EU Markets in Crypto-Assets Regulation and its application in Latvia, we utilize comparative legal and integrative literature review methodologies to explore how regulatory frameworks can enhance investor accessibility, liquidity, and transparency in digital transactions. Our findings emphasize the importance of strong legal frameworks in promoting economic growth and protecting investors, thereby contributing to a more inclusive financial ecosystem. By examining the regulatory landscape for distributed ledger technology, we provide insights into how regulations can balance innovation in asset management with the imperative of investor protection. We offer a broad analysis of the intersection between legal frameworks and technological advancements in Latvia, illustrating how diverse regulatory approaches can support both economic development and investor interests. Our research originality lies in its focus on the EU's regulatory diversity, particularly in Latvia, and its implications for broader European and international regulatory environments. Our study contributes to ongoing discussions on optimizing regulatory strategies to facilitate secure and advantageous financial technologies, reflecting the diversity of legal and economic approaches across Europe.



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## 1. Introduction

Asset tokenization represents a transformative innovation within the digital economy, offering a novel mechanism for representing ownership of or rights to an asset through digital tokens on a blockchain platform. This process not only facilitates the fractionalization of assets, making them more accessible to a broader range of investors, but also enhances liquidity and transparency in asset transactions (Fisch 2019). Given its potential to reshape both economic markets and legal frameworks, asset tokenization requires a thorough examination of the intersection between law and economics. The significance of asset tokenization extends beyond mere technological advancement; it heralds a paradigm shift in how assets are traded, owned, and managed, potentially democratizing access to investment opportunities and streamlining regulatory compliance through programmable securities (De Filippi and Wright 2018).

The term “tokenization” may have been used with different meanings, while the starting points have probably been quite similar. For example, tokenization has been

described as “a method of converting rights in an on-chain digital asset that, operated in a blockchain, remotely controls an off-chain real asset”. It has also been described as “a method that converts rights to an asset into digital tokens that can be bought, sold, and traded on blockchains” (Kaisto et al. 2024). Tokenization is the process of creating a singular identifier on a distributed ledger in the form of a token. A unique and persistent reference can be established to digitally represent anything ranging from financial assets and goods to other valuable resources (Heines et al. 2021). From the perspective of the general term “tokenization”, tokenization is a procedure for recovering elements of interest in a sequence of data (Friedman 2023). Tokenization assigns an anonymized secure “token” to an individual’s records through a salted one-way cryptographic hash function, which prevents reverse engineering of the token to reveal personal identifiers (Eckrote et al. 2024). The authors define tokenization as a digitalization of an asset, where a crypto-asset or token (tokenized asset) represents one of the broader applications of the blockchain technology. This definition explains the inclusion of blockchain technology and crypto-asset regulations and citations in the research, highlighting their direct connection to tokenization.

In the European context, the integration of asset tokenization poses unique regulatory challenges and opportunities, particularly concerning diverse national legal frameworks and the overarching EU regulatory environment. In the financial sector, asset tokenization disrupts traditional models of asset management, securities trading, and fundraising by reducing transaction costs, improving asset transferability, and enabling more efficient capital formation processes (Amsden and Schweizer 2018). However, the realization of these benefits is contingent upon the development of a robust regulatory framework that addresses the unique risks and challenges posed by digital assets, including issues related to security, fraud, and market integrity (European Securities and Market Authority 2022). Thus, the evolution of asset tokenization in the digital economy necessitates concerted efforts among regulators, industry stakeholders, and legal scholars to navigate the complex interplay between innovation and regulation.

Our study contributes to the ongoing discourse on optimal regulatory strategies for financial innovation by analyzing the effectiveness of the EU regulatory framework for crypto-assets in providing investor protection. It aims to compare this protection with that offered by traditional financial investment regulations, systematically investigating how these regulatory measures align with investor security standards in the broader EU context, specifically through Latvia’s national legislation as a use case, as it can be extrapolated to any other EU country facing the same legislation path and facing similar tasks, issues, and challenges. Latvia was chosen as the focus of our case study because of its proactive efforts to harmonize national legislation with the EU’s regulation. This positions Latvia as an exemplary model for analyzing the adoption and implementation of EU directives at the national level. Furthermore, Latvia’s strategic initiatives to advance its digital economy, particularly through the application of blockchain technology across various sectors, provide valuable insights into the practical implementation and challenges of EU regulations. By exploring Latvia’s approach to integrating these technologies and legislative frameworks, our study offers a comprehensive perspective on how EU directives are operationalized within a member state, contributing to a deeper analysis and offering broader implications for regulatory adaptation across the EU. The general novelty of our research is that it allows for policymakers to gain insight into the further development of distributed ledger technology (DLT) technology usage in investment environments and the necessary steps to achieve better investor security, thus expanding technology usage and attracting investment using this technology, making simpler investment agreements signing and promoting and expanding investment environment opportunities, especially beneficial to early bird countries willing to adopt these legal regulations.

Digital technologies, distinguishable by their modularity, connectivity, and temporal flexibility, have demonstrated the potential for transforming asset management, enabling reprogrammable and continuously evolving financial products that contribute to the efficiency and sustainability of digital ecosystems (Pundziene and Gadeikiene 2023). Asset tokenization is an emerging trend in financial markets and offers potential benefits such as increased liquidity, fractional ownership, and broader investor access (Baum 2021; Swinkels 2023). Blockchain technology plays a crucial role in enabling tokenization across various sectors including real estate, infrastructure, and mobile assets (Buldas et al. 2022; Dylus 2019; Serrano 2023). This process involves creating digital representations of the assets that can be traded on blockchain platforms. While tokenization shows promise, challenges remain, such as regulatory compliance and market adoption (Avci and Erzurumlu 2023). Studies have examined the impact of tokenization on market dynamics, investor behavior, and asset management (Swinkels 2023; Baum 2021). This technology also has applications in sustainable development and smart cities, potentially revolutionizing waste management and water quality monitoring (Kaur and Oza 2020). As the field evolves, further research is required to fully understand the implications and potential of asset tokenization across various industries.

The Scopus database was used for the bibliometric analysis because of its widespread recognition and comprehensive coverage (Gafoor et al. 2024). The analysis was conducted using the keyword combination “asset\* AND tokenization AND law”. The search was confined to subject areas pertaining to “Business, Management, and Accounting”, “Social Sciences”, and “Economics, Econometrics and Finance”. Only documents published in English were included in our study, with no restrictions on the document type. The search resulted in 19 articles. After reviewing these documents, eighteen were deemed relevant for further analysis, encompassing publications from ten journals, six books, and one conference paper, published from 2020 to 2024. The selected body of literature was authored by 30 authors and had been cited 77 times as of December 2024. Among these, the article by Garcia-Teruel and Simón-Moreno (2021) on the digital tokenization of property rights was the most cited, with 39 citations.

Furthermore, we focus on articles from a regulatory perspective. Research papers explore the various aspects of blockchain technology and tokenization in relation to property rights, financial markets, and legal frameworks. Garcia-Teruel and Simón-Moreno (2021) discuss the tokenization of property rights and their legal implications across jurisdictions. Kiskis (2024) argue for a comprehensive legal framework that combines public and private laws for blockchain regulation. Lim (2023) examined the challenges of tokenizing copyright and proposed extending the right of communication to include NFT (non-fungible token) mining. Burilov (2019) analyzed how the EU regulatory framework applies to crypto tokens and whether it is suitable to govern crypto tokens that are not currently covered. We assessed whether an EU-wide legislative act governing crypto tokens that is not covered by the current EU regulatory framework is required. Chiu and Greene (2019) proposed leveraging initial coin offering (ICO) market insights to scale up sustainable and social finance, advocating for a new regulatory approach. Gan et al. (2020) investigated asset-backed ICOs and discussed the optimal token design and pricing while considering moral hazard and market uncertainties. Collectively, these studies highlight the need to adopt legal and regulatory frameworks to address the complexities of blockchain-based assets and transactions.

In our research, we implemented two focused analytical approaches: doctrinal legal analysis and comparative legal analysis within the EU. We begin with a doctrinal analysis, examining key principles of the MiCA regulation, such as technology neutrality and activity-based regulation, to understand their detailed applications and legislative intent

concerning crypto-assets. Additionally, our comparative analysis examines how the EU and Latvian legal frameworks approach the regulation of crypto-assets, focusing on variations in investor protection and market stability.

Distributed ledger technology has emerged from decentralized means of payment to use in other areas, for example, to prove the ownership of various types of assets. In recent years, an increasing number of non-financial use cases for blockchain technology have emerged (Treleaven et al. 2017), such as supply chain management and digital identities (Roeck et al. 2019). The more recent literature identifies the value of combining blockchain technology with other innovations, such as the Internet of Things (IoT) and Artificial Intelligence (AI) (Sandner et al. 2020).

The criteria for evaluating regulations for asset tokenization were chosen from the perspective of investor security criteria. Investor security in digital asset markets is primarily reinforced through comprehensive regulatory frameworks and inherent features of blockchain technology. The EU's Markets in Crypto-Assets (MiCA) regulations focus on ensuring transparency, operational resilience, and protection for consumers, which are critical for mitigating the risks associated with digital assets. The decentralized and immutable nature of blockchain technology plays a vital role in reducing fraud and enhancing transparency, thereby contributing to a safer investment landscape (Catalini and Tucker 2018).

The criteria in alignment with EU regulation are presented in Table 1, which outlines the general legal instruments for regular investment practices, emphasizing investor protection, among other considerations.

**Table 1.** Investor protection measures in MiCA and national regulations.

Criteria	Scope of Criteria	MiCA Regulation	National Regulation (Latvia)
Asset-holding company insolvency, fraud, or operational malfunction to submit bought assets to the investor	Guarantee the defined amount of funds received if a company in which funds are placed becomes insolvent, non-operational, or by fraud cannot return assets to the investor	Excluded from the investor compensation scheme under EU regulation No. DIRECTIVE 97/9/EC of 3rd March 1997 on investor-compensation schemes	Investors Protection Law of the Republic of Latvia (in force since 01.01.2002)
Cyber security	To prevent loss of assets due to fraud or cyberattacks	Service providers shall implement appropriate policies, internal rules, and procedures to avoid possible losses due to cyber-attacks or fraud	Cybersecurity Strategy for 2023–2026 in the Republic of Latvia Law of Crime of the Republic of Latvia
Fraud			
Money laundering	Prevent dealing with funds that are acquired illegally and/or can be used for terrorism financing	Procedures for service provider registration to prevent money laundering and/or terrorism financing	Anti-Money Laundering and Terrorism and Proliferation Financing Act of Republic of Latvia
Terrorism financing			
Transparency	Make available essential information for potential investors fortifying against the potential for fraud based on insufficient available information	Requirements for platform service providers and asset-token issuers for publicly available information	Anti-Money Laundering and Terrorism and Proliferation Financing Law of Republic of Latvia Law on Investment Brokerage Companies Law on Investment Management Companies and other similar field regulations

MiCA is a comprehensive European Union directive regulating the crypto-asset industry from multiple perspectives. It includes many necessary additional regulations, guidelines, and templates to be implemented at the EU and national levels to create a

complete legislative framework for practical applications. Several regulations currently applicable to already regulated investment subjects must be extended to newly designed DLT regulations, with additional requirements beyond those for traditional financial investments, such as enhanced cybersecurity measures.

By aligning with the diverse regulatory approaches found across Europe, we aim to inform ongoing debates among regulators, legal scholars, and industry participants about the best ways to balance economic development with investor security. Section 1 systematically reviews the existing literature on asset tokenization, focusing on its application as a contract across various asset types. The remainder of this paper is organized as follows: Section 2 describes the study's research methodology; Section 3 presents the findings of our analysis; and Section 4 discusses these findings and contextualizes them within the broader field of financial technology. The final section concludes the paper by summarizing the key outcomes, suggesting directions for future research and implications for regulatory improvement.

## 2. Methods

The research question of our study is as follows: How does the EU's existing regulation of crypto-assets ensure investor protection comparable to that provided for traditional financial investments (i.e., unrelated to crypto-assets)?

The research methodologies employed in the literature on asset tokenization and its regulations cover various legal and theoretical frameworks. For example, [Garcia-Teruel and Simón-Moreno \(2021\)](#) utilized a comparative legal analysis to explore the legal issues related to the tokenization of property rights, with a specific focus on the right of usufruct in different jurisdictions. [Kiskis \(2024\)](#) adopts a combined comparative and historical analysis approach, which includes a critique of the current legal framework and proposes an alternative based on contract law and private law concepts. [Buriilov \(2019\)](#) employs a doctrinal legal analysis, drawing from four principal sources: the EBA Opinion, the SMSG Report, the EBA Report, and the ESMA Report. This methodology involves a structured approach that includes summarizing regulatory perspectives, explaining token taxonomies, assessing the applicability of current laws, evaluating the suitability of the regulatory framework, and presenting the author's own interpretations. [Gan et al. \(2020\)](#) apply a game-theoretic approach by considering three types of players: firms, speculators, and customers. We examine two models: a utility-based ICO model in which tokens are tied to the firm's future inventory, and an equity-based ICO (STO) model in which tokens are linked to the firm's future profits. Both models were analyzed over three distinct periods: the ICO, production, and market periods.

The doctrinal legal analysis method was used in this research, as it systematically examines legal rules, principles, and doctrines, providing a detailed understanding of the existing legal framework governing crypto-assets. This method clarifies legislative intent and judicial interpretation, which are crucial to the evolving field of crypto-asset regulation ([Hutchinson and Duncan 2012](#)). Additionally, it facilitates the evaluation of current laws' applicability to new technologies and guides policymakers in developing robust legal standards for investor protection, market integrity, and financial stability ([Dobinson and Johns 2017](#)). In our analysis, we studied the foundational aspects of MiCA regulation, focusing particularly on its principles of technology neutrality and activity-based regulation. The regulation's technological neutrality ensures that regulatory measures are defined by the function and risk of the crypto-assets rather than the technology employed, thereby promoting innovation while ensuring that regulatory coverage is comprehensive ([European Commission 2020a](#)). Furthermore, the activity-based approach employed by MiCA dictates that regulation targets the services and activities related to crypto-assets instead of focusing



on the types of entities involved. This ensures a uniform regulatory environment for all economically similar activities, irrespective of the technological medium used (European Commission 2020b). These regulatory principles are crafted to be responsive to the evolving digital market, ensuring a robust legal framework that fosters innovation and safeguards investor interests.

Our study also employs a comparative legal methodology guided by the principles outlined by scholars, such as Siems (2022), to analyze the regulatory frameworks governing asset tokenization within the European Union and Latvia. The research process begins with legal mapping, in which relevant EU and Latvian legal documents are systematically collected and compared. This was followed by a contextual analysis to assess socioeconomic influences on these frameworks, emphasizing the implications of legislative discrepancies. The methodology further includes a normative evaluation to determine the effectiveness of legal norms in achieving regulatory goals such as consumer protection and market stability. The findings are then integrated with the peer-reviewed literature to validate and deepen the analysis, culminating in the synthesis of data that forms the basis for recommendations aimed at legal harmonization. This structured approach provides comprehensive insights into the comparative legal dynamics of asset tokenization, supporting the development of informed policy enhancements and thereby fostering a more cohesive legal framework for financial innovation. For research purposes, the development and documentation of EU regulations were analyzed (Tables 1–3), focusing on policy-defining guidelines and the introduction of MiCA. Concurrently, information on US governmental policy on crypto-assets was collected to support the research findings with existing studies on the topic and to generate insights for further research. The general terms and conditions of the regulatory framework addressing investor protection and safety indicators were gathered for comparison with the pre-implementation regulatory framework for investor protection in the context of crypto-asset regulation.

**Table 2.** The EU regulatory frameworks relevant to asset tokenization and implementation in Latvia (created by authors based on legislation).

Regulation/Directive	Description	Relevance to Asset Tokenization	Implementation in Latvia
Markets in the Crypto-Assets Regulation (MiCA) (European Parliament 2023)	Aims to provide a harmonized regulatory framework for crypto-assets not covered by existing financial regulations, focusing on consumer protection and financial stability	Directly address the regulatory treatment of asset tokens and crypto-assets, establishing a clear legal environment for their development and use	Pending EU-wide implementation; Latvia is expected to align national laws with MiCA upon its enactment
5th Anti-Money Laundering Directive (5AMLD) (European Parliament 2018)	Extends the scope of regulatory oversight to include service providers engaged in exchange services between virtual currencies and fiat currencies, as well as custodian wallet providers	Although not specific to tokenization, it impacts the ecosystem within which tokenized assets operate, emphasizing the importance of the AML/CFT controls	Implemented through amendments to the Latvian Law on the Prevention of Money Laundering and Terrorism Financing, extending AML/CFT requirements to crypto-asset service providers
Central Securities Depositories Regulation (CSDR) (European Parliament 2014c)	Focuses on the settlement of transactions in financial instruments and the role of central securities' depositories in the dematerialization of securities	Relevant for understanding the infrastructure implications of asset tokenization and potential integration with traditional securities settlement systems	Latvia aligned its national legislation with the CSDR through Financial Instruments Market Law, ensuring compliance with EU standards for securities settlement

Table 2. Cont.

Regulation/Directive	Description	Relevance to Asset Tokenization	Implementation in Latvia
Regulation on European Crowdfunding Service Providers (ECSP Regulation) (European Parliament 2020)	Establishes a legal framework for crowdfunding services across the EU, applicable to platforms that may facilitate the offering of tokenized assets	Highlights regulatory considerations for platforms offering tokenized assets as a form of investment	Latvia is in the process of adapting its national laws to accommodate the ECSP Regulation, aiming to foster a supportive environment for crowdfunding and related innovations
Markets in Financial Instruments Directive II (MiFID II) (European Parliament 2014a) and Regulation (MiFIR) (European Parliament 2014b)	Regulates investment services and activities and the operation of regulated markets, focusing on financial instruments	Asset tokens that qualify as financial instruments fall under this regulatory umbrella, affecting trading, transparency, and investor protection measures	The Financial Instruments Market Law (Parliament of the Republic of Latvia 2003a, 2003b), among other regulations, was updated in Latvia to fully implement MiFID II and MiFIR, covering aspects relevant to asset tokenization
Digital Finance Package (European Parliament 2023) (European Parliament 2022a) (European Parliament 2022b)	Includes MiCA and a strategy for digital finance, outlining the EU's approach to fostering innovation while managing digital finance risks	Provides a comprehensive view of the EU's policy direction on digital assets, including tokenized assets and the regulatory framework intended to support innovation	Latvia supports the EU's digital finance strategy and is actively working to align its national regulatory framework with its Digital Finance Package to promote innovation in financial services
DLT Pilot Regime Regulation (European Parliament 2022b)	Proposes a sandbox-like regime for market infrastructure based on DLT to experiment within a controlled environment	Directly impacts the development and regulatory treatment of asset tokenization projects, facilitating innovation in a regulatory-compliant manner	Latvia is expected to participate in the DLT Pilot Regime, providing a legal basis for a DLT-based market infrastructure to operate within a regulatory sandbox framework

Table 3. Theoretical criteria for evaluating asset tokenization regulations (created by authors, based on legal acts mentioned in the table).

Criterion	Description	Regulations Fulfilling the Criterion
Regulatory clarity and certainty	Measures the extent to which regulations offer clear guidelines and definitions for tokenized assets, including classifications and issuance standards	MiCA (European Parliament 2023)
Investor protection	Encompasses mechanisms designed to safeguard investors, including transparency, disclosure obligations, and intermediary regulations	MiCA (European Parliament 2023), MiFID II (European Parliament 2014a), and ECSP Regulation (European Parliament 2020)
Market integrity and stability	Includes regulations aimed at ensuring market fairness, efficiency, and financial stability and preventing market manipulation and insider trading	MiCA (European Parliament 2023), MiFID II (European Parliament 2014a), and MiFIR (European Parliament 2014b)
Anti-Money Laundering (AML) and Counter-Terrorist Financing (CTF)	Requirements for detecting, preventing, and reporting illicit activities in line with FATF standards	5AMLD (European Parliament 2018), MiCA
Operational and cybersecurity risks	Standards for the technological infrastructure, focusing on security, data protection, and resilience against cyber threats	N/A specifically, but general principles may be inferred from MiCA and national cybersecurity regulations

Table 3. Cont.

Criterion	Description	Regulations Fulfilling the Criterion
Cross-border cooperation and compliance	Provisions for oversight and cooperation across jurisdictions reflect the global nature of digital assets	MiCA, 5AMLD ( <a href="#">European Parliament 2018</a> )
Innovation and technological neutrality	Assesses whether regulations support innovation and are designed without bias toward specific technologies	Digital Finance Package, DLT Pilot Regime Regulation
Consumer protection	Measures to ensure consumers are informed and protected, including education and dispute resolution mechanisms	MiCA ( <a href="#">European Parliament 2023</a> ), ECSP Regulation ( <a href="#">European Parliament 2020</a> )
Taxation and accounting standards	Guidelines on taxation and accounting practices for entities involved in issuing or trading tokenized assets	N/A specifically, but relevant national laws and EU directives on taxation and financial reporting may apply
Interoperability and standards	Promotes interoperability among blockchain platforms and standardization of protocols for asset tokenization	DLT Pilot Regime Regulation ( <a href="#">European Parliament 2022b</a> )

Additionally, we performed an integrative literature review. This method is particularly suitable for studying asset tokenization in the EU, as it synthesizes diverse research from regulatory, technological, and market perspectives. This approach provides a comprehensive understanding of the current state, identifies research gaps, and offers new insights, making it well-suited for addressing the complex interdisciplinary nature of the topic ([Snyder 2019](#)).

### 3. Findings

This section presents the results of our systematic investigation of the Union's regulatory framework for crypto-assets. The analysis evaluates how these regulations ensure investor protection by comparing the safeguards in place for crypto-assets with those established for traditional financial investments. Through this examination, we assess the effectiveness of the EU's legislative measures in aligning with established investor security standards, both at the union-wide level and within the specific context of Latvia's national legislation. The findings address the following central research question: How does the EU's regulation of crypto-assets provide investor protection at a level comparable to that afforded by traditional financial systems? This analysis identifies the strengths and potential deficiencies of the current regulations and provides insights into their broader implications for policymakers and stakeholders in the financial ecosystem.

Table 2 presents a comprehensive overview of the Union's regulatory frameworks related to asset tokenization, detailing their application and relevance, as well as their implementation in Latvia. It specifically highlights key regulations and directives, outlining their objectives, their impact on asset tokenization, and the status of their incorporation into Latvian law. This synthesis provides a clear understanding of how these regulatory measures influenced financial innovation and investor protection in Latvia.

Our analysis reveals that the European Union's regulatory framework, notably through the MiCA, aligns closely with traditional financial investment regulations in terms of investor protection.

The MiCA regulation aims to provide legal certainty for currently unregulated crypto-assets as part of the EU's Digital Finance Strategy ([Van Der Linden and Shirazi 2023](#)). This regulation adopts the principles of technology neutrality and activity-based regulation to address the growing use of crypto-assets in the financial sector. The technology neutrality



principle ensures that regulation remains practice- and technology-agnostic. This approach allows flexibility in accommodating future technological advancements in the rapidly evolving crypto-asset ecosystem (Biais et al. 2023).

While the MiCA regulation aims to provide clarity and foster adoption, some studies suggest that it may not significantly accelerate the adoption of crypto-assets in the EU financial services sector, as intended (Van Der Linden and Shirazi 2023). This scenario illustrates the delicate balance between regulatory measures and technological progress in markets that rely heavily on innovation. The MiCA regulation's focus on technology neutrality and activity-based regulation reflects the EU's attempt to strike a balance between providing legal certainty and allowing for innovation in the crypto-asset space. However, the effectiveness of this approach in promoting adoption and addressing the regulatory gap remains to be seen, as the crypto-asset ecosystem continues to evolve rapidly (Ferreira and Sandner 2021).

Our comparison underscores MiCA's comprehensive approach, which extends from stringent transparency requirements to robust procedures to enhance anti-money laundering and cybersecurity measures, mirroring and sometimes exceeding those found in conventional financial systems. Specifically, the incorporation of MiCA into Latvia's national legislation exemplifies a proactive adaptation that supports investor security by addressing both contemporary challenges specific to crypto-assets and traditional investment concerns. These findings respond directly to our research question by illustrating that the EU's regulatory strategies for crypto-assets indeed provide a level of investor protection that is at least comparable, if not superior, to that of traditional financial markets. This alignment is crucial for fostering a secure and trustworthy investment environment, thereby encouraging greater integration of crypto-assets into mainstream financial portfolios.

In the scholarly examination of regulatory frameworks governing asset tokenization, a nuanced approach is essential for assessing the adequacy and effectiveness of existing regulations. Theoretical criteria, as delineated by academic discourse, provide the foundation for such evaluations. These criteria encompass regulatory clarity and certainty, investor protection, market integrity and stability, anti-money laundering (AML), counterterrorist financing (CTF) measures, operational and cybersecurity risks, cross-border cooperation and compliance, innovation and technological neutrality, consumer protection, taxation and accounting standards, and interoperability and standards (Schär 2021; Zetzsche et al. 2020).

Regulatory clarity and certainty are crucial because they define the legal boundaries within which tokenization activities can operate, significantly influencing the development and adoption of tokenized assets (Schär 2021). Investor protection mechanisms such as transparency and disclosure obligations are essential to safeguard investors' interests and maintain the integrity of financial markets. Additionally, given the potential for digital assets to be misused for illicit purposes, the importance of AML and CTF measures in this context is paramount (Zetzsche et al. 2020).

Operational and cybersecurity risks also demand rigorous scrutiny, as the underlying blockchain technology presents unique vulnerabilities and challenges (Gomber et al. 2018). Cross-border cooperation is another critical factor that reflects the global nature of digital assets and the necessity of regulatory frameworks to transcend national boundaries (Zetzsche et al. 2020). Innovation and technological neutrality ensure that regulations foster technological advancement and do not unduly favor or penalize specific technologies (Schär 2021).

Consumer protection, taxation, and accounting standards, along with interoperability and standards, constitute essential criteria that address the broader ecosystem in which asset tokenization operates (Gomber et al. 2018). These criteria collectively provide a comprehensive framework for assessing the regulatory landscape of asset tokenization,

identifying strengths and pinpointing gaps that may necessitate further regulatory development or harmonization. Table 3 outlines the theoretical criteria used to evaluate the effectiveness and comprehensiveness of regulations related to asset tokenization. It categorizes various regulatory aspects, from investor protection to interoperability standards, and identifies the specific EU regulation aspects that address these criteria. This structured approach enhances our understanding of how different regulations contribute to shaping a secure and efficient market for tokenized assets. The results of the doctrinal legal analysis are summarized in Table 3.

The evaluation in Table 3 underscores the multidimensional regulatory frameworks established by the EU to govern asset tokenization, illustrating extensive considerations from investor protection to market integrity. Here, the authors explore the practical aspects of implementing these crypto-asset regulations, focusing on their operationalization within member states and their direct impact on market practices and participant behavior. Between January 2014 and June 2018, token generation events, commonly known as initial coin offerings (ICOs), increased from USD 13 billion to USD 18 billion (Burilov 2019).

The MiCA regulation provides a comprehensive framework for the regulation of distributed ledger technology assets in the European Union. This includes provisions for supplementary regulation development to ensure a complete legislative framework for the DLT assets. Necessary additions include national legislation and additional legal acts to comply with MiCA, as well as regulatory frameworks from financial market supervisory organizations such as the ECB, ESMA, and EBA.

Developing a national legislative framework that aligns with MiCA requirements presents an opportunity for EU countries to become pioneers in crypto-asset legislation and to potentially attract significant financial activity. Although being a pioneer may require future adaptations to align with the final MiCA regulations developed by the ECB, ESMA, or EBA, it offers the opportunity to set a benchmark for subsequent legal development in the EU. National authorities, such as central banks and financial supervisory institutions, would need to create regulations beyond those foreseen in MiCA, such as recognizing DLT assets for property registration in public registers. Despite these challenges, this could provide a competitive advantage for the pioneering country in the field of crypto-assets.

As the transition to the MiCA framework is scheduled from June 30, 2024 to July 30, 2026, member states have the flexibility to implement their own regulations on DLT-based financial instruments, potentially diverging from MiCA requirements. To ensure market stability and predictability, member states should adopt regulations closely aligned with MiCA, allowing for market participants to rely on consistent regulatory succession.

Our study further explores the practical tokenization of real-life assets, illustrating how crypto-assets can represent both tangible and intangible assets across various sectors. This analysis highlights the broad applications and potential of asset tokenization while addressing key challenges and opportunities in integrating these digital assets into the mainstream economy. For example, the tokenization of real estate offers the potential to make this traditional illiquid and lumpy market accessible to a broader group of investors, allowing for diversified portfolios with modest investments. However, in many jurisdictions, such as Latvia, fractionalization requires an intermediary structure due to private laws that prevent the direct ownership of land by multiple parties, increasing tokenization costs (Baum 2021).

In Latvia, fractional real estate ownership requires a separately signed agreement with all owners and registration in the land register, a process that is both time-consuming and costly. Consequently, existing regulations do not effectively support real estate tokenization, necessitating amendments to land registry regulations to secure ownership through asset tokens. The transfer of digital tokens aims to convey ownership or property rights without

traditional intermediaries such as conveyancers, land registrars, or notaries, raising legal questions about the token's nature, the transfer of property rights, and the application of ownership rules in a decentralized environment (Garcia-Teruel and Simón-Moreno 2021).

The coordination between land registries and blockchain technology could be the first step toward a fully decentralized system for property rights transfer (Garcia-Teruel and Simón-Moreno 2021). The European Land Registry Association's IMOLA platform, launched in 2021, aims to facilitate data exchange on cross-border transactions within the EU through land registry interconnections. This project has several stages and is currently ongoing. This platform envisions land registries as online intermediaries for registered properties, addressing issues such as smart contract breaches, the blockchainization of land registries, property tokenization, IoT applications, elimination of human errors, and automation of registry qualifications. Ultimately, the evolution of registry blockchainization at the European level through Land Registry Interconnection and the IMOLA platform is crucial for the application and consolidation of smart properties in real estate (Argelich 2022).

Corporate securities appear to be the most suitable financial instruments for the direct implementation of crypto-assets. Future regulations should also ensure that commercial registers accept crypto-assets as proof of ownership, thereby legitimizing them. Currently, joint-stock companies maintain their own share register, which is periodically updated with a commercial register for beneficial owner detection. Consequently, any stock defined and issued as a crypto-asset can be considered a secure instrument for proving ownership. However, owners of crypto-assets are currently unable to provide them to the commercial register as evidence of ownership rights.

This broad examination of regulatory frameworks and their practical implications concludes that while the EU has made significant progress in creating a supportive regulatory environment for the innovative and safe use of crypto-assets, several gaps remain. These gaps mainly involve the complete integration of such assets within national legislation and smooth operation of cross-border financial activities. The insights provided here guide policymakers and stakeholders, emphasizing that the continuous refinement and harmonization of regulations are essential to fully realize the potential of crypto-assets, while ensuring robust investor protection and market integrity.

#### 4. Discussion

In line with the main research objective of this study, we evaluate the legal framework for investor protection in traditional investment instruments and compare it to crypto-asset regulations. The comparison revealed no disadvantages for crypto-assets. Enhanced security requirements are stipulated, owing to their digital nature.

The EU regulatory framework ensures consumer deposits of up to EUR 100,000 through a security fund, but this protection does not extend to cryptocurrencies held by non-financial institutions, making it impractical to securely deposit cryptocurrencies in European banks (European Parliament 2014c). Consequently, companies that offer cryptocurrency savings cannot provide secure deposits.

Moreover, consumer investments of up to EUR 20,000 are secured in the event of service provider insolvency. However, for crypto-assets held by entities that are not registered according to regulatory requirements, no compensation is available in the case of loss (European Commission 2010).

Historically, no specific regulations have addressed money laundering, terrorism financing, cybersecurity, or fraud for crypto-assets, thereby exposing participants to additional risks beyond asset price fluctuations. The MiCA regulatory framework seeks to mitigate these risks by establishing comprehensive requirements for entities that offer or issue crypto-asset trading services. The MiCA mandates licensing by supervisory authori-

ties in the country in which the entity operates, necessitating the participating countries to adapt their regulatory frameworks accordingly. Effective implementation of MiCA at both the national and EU levels is anticipated to enhance the competitive standing of member states (European Parliament 2023). However, MiCA does not solve the distributed ledger technology's embedded nature of not being possible to be supervised by any authority, as all the data are held by the owners of the distributed ledger's particular asset. The only theoretical path for authorities to monitor transactions is to become the participant (owner) of each kind of crypto-asset issued. This problem does not seem to be possible to solve because of the nature of the decentralization of the assets. MiCA does not cover all kinds of possible tokenized assets.

MiCA does not regulate some distributed ledger technology assets, e.g., financial instruments, deposits, funds, and securitization positions, which are not the general topic of this research. As mentioned above, it is possible that distributed ledger assets are not regulated by MiCA, instead, they are regulated by other laws not directly developed for distributed ledger technology-based assets.

The mining of distributed ledger tokens is an issue that the authors believe has not been adjusted to EU politics of the green path. Of course, electricity is considered to be the green path of energy consumption, but only if it is generated in a green manner. As long as it is not generated only by means not causing any pollution, it should be taken into consideration that crypto-assets, as is any other distributed ledger technology, is a regular power-consumption-increasing object. Distributed ledgers, by their nature of keeping records in several servers simultaneously, are energy-consumption-increasing technologies.

Significant research has been conducted on the potential applications of distributed ledger technology across various economic activities, ranging from substituting existing financial instruments such as asset ownership proofing tools to developing new systems such as decentralized monetary systems.

Since 2013, the EU has actively addressed distributed ledger technology and its applications in cryptofinancial instruments, reflecting the region's diverse institutional and legal landscape. In December 2013, the European Banking Authority (EBA) issued a warning outlining the inherent risks of cryptocurrencies, including high volatility, unregulated platforms, hacking vulnerabilities, and potential for money laundering and terrorist financing (European Banking Authority 2013). As a result, the EU initially adopted a cautious and minimal regulatory stance toward cryptofinancial instruments, in contrast to the United States, which began requiring trading platforms and virtual currency miners to register as Money Services Businesses in 2018 (European Commission 2018a, 2018b).

Until 2017, the EU maintained a protective approach toward DLT financial instruments. However, the proliferation of cryptocurrencies necessitated legislative consideration, culminating in the Fintech Action Plan of 8 March 2018. This plan signified the commencement of EU-level legislative actions for DLT and crypto-assets, establishing 19 milestones focused on peer-to-peer activities, crowdfunding, and cloud services (European Commission 2018a, 2018b). The realization of these objectives necessitated comprehensive regulatory revisions, engaging multiple stakeholders including banking supervisors, anti-money laundering authorities, and cybersecurity experts. In 2017, amendments to the Anti-Money Laundering Directive expanded its scope to encompass virtual currency exchanges and wallet providers, underscoring the speculative nature of the market and associated risks (European Commission 2017). Despite these measures, the EU has risked lagging behind other regions in terms of the rapidly advancing crypto-asset sector.

To address these emerging challenges and maintain regulatory leadership, the EU introduced Regulation (EU) 2023/1114, known as the Markets in Crypto-Assets (MiCA) regulation. Set to take effect in mid-2024, MiCA established one of the world's most

advanced regulatory frameworks for DLT and crypto-assets. EU member states such as Latvia have initiated the alignment of their national regulations with MiCA to ensure readiness and compliance. This regulatory clarity provides a definitive framework for the prospective development of the EU crypto-asset economy.

Numerous innovative ideas and concepts are being explored, such as combining DLT with IoT and AI, to enable business activities without human intervention (Sandner et al. 2020). Additionally, the transfer of intellectual property ownership to non-fungible tokens (NFTs) is being examined, although the current legislative frameworks in the UK, the USA, and China are not tailored to DLT usage (Jia and Yao 2023). Kayani and Hasan (2024) note that the UK adopts a proactive innovation-focused approach, while the US takes a more conservative investor-protection stance. Meanwhile, the European Commission emphasizes favorable treatment for banks and the establishment of fintech hubs (European Commission 2018a, 2018b). The Financial Stability Board and International Monetary Fund suggest that global cooperation is essential for the international recognition of various crypto-assets and currencies, a recommendation that has yet to be fully realized.

In the UK, crypto-asset regulations focus on Anti-Money Laundering and Know Your Client requirements, which were introduced earlier than the EU's requirements. The Financial Conduct Authority (FCA) has mandated compliance by crypto-asset-related companies since October 2023. Conversely, the EU's comprehensive MiCA framework, effective since July 2024, regulates nearly all types of cryptocurrency assets. The US approach remains more cautious, with the U.S. Securities and Exchange Commission (SEC) providing guidelines based on the Howey test to determine whether a token is an investment contract subject to securities laws. This approach grants flexibility to crypto-asset companies, but poses higher risks for investors due to the lack of specific cybersecurity regulations.

The authors conclude that the EU, with its MiCA regulation, provides a more comprehensible and transparent environment for the development of the crypto-asset field than the USA's regulatory framework. This makes the EU framework more suitable for ensuring investor security of DLT assets.

## 5. Conclusions

Globally, regions are exploring ways to address the evolving distributed ledger technology, which has been widely implemented since 2008. Initially, legal authorities were dismissive of DLT, reflecting a common tendency to fear new technologies, and issued documents highlighting its potential dangers. However, most regions now consider regulations under specific laws. The EU was a pioneer in the implementation of MiCA, and Switzerland was among the first to prepare a legislative framework for financial instruments using the DLT. Our study suggests that regions advancing comprehensive DLT legislation are well-positioned to capture the benefits of this innovation, particularly when national authorities incorporate crypto-assets, such as company shares and real estate, into official registers.

According to our research results, the MiCA regulation merits recognition for its comprehensive approach to investor protection, addressing more areas than traditional investment environments. This is a logical outcome, given the additional risks associated with the digital nature of crypto-assets, such as cybersecurity threats, which include the potential hacking of both asset-holding authorities' digital information and the digital assets themselves. While the full spectrum of complementary regulations under MiCA is yet to be established, limiting our current ability to fully validate whether investor security under MiCA exceeds that of traditional financial regulations, the proposed framework shows promise in ensuring that DLT emerges as a safe and viable investment instrument.



Future research should prioritize the standardization of crypto-assets to promote their acceptance by the national authorities responsible for asset registers. Developing unified standards for crypto-assets with the goal of integrating them into various national registers would create a more inviting, straightforward, and secure environment for investors. This can significantly transform the field and provide pioneering states with substantial opportunities. Moreover, future studies should focus on potential discrepancies in DLT applications across different legislative contexts and explore more robust mechanisms to mitigate the risks associated with crypto-assets, particularly in cross-border transactions.

In acknowledging the limitations of this study, it is important to note that the scope of the regulatory analysis was confined to the EU and selected cases. Future research could expand this perspective by incorporating a broader array of international regulatory environments and their specific effects on the efficacy and safety of DLT applications.

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