

Transformation of the legal nature of digital assets in the context of real-world asset tokenization

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Annotation. The relevance of the study is determined by the rapid development of distributed ledger technologies and the growing use of tokenization mechanisms in property and financial relations. The tokenization of real-world assets creates new models for the circulation of rights to tangible and intangible property while simultaneously raising questions regarding the legal nature of digital assets and the protection of tokenized rights.

The purpose of the article is to develop a comprehensive understanding of the transformation of the legal nature of digital assets in the context of real-world asset tokenization and to substantiate approaches to the legal recognition and protection of tokenized property rights.

Methods include system analysis, comparative legal analysis, the formal legal method, and the generalization of scientific approaches.

The study investigates the conceptual foundations of digital assets, analyzes legal mechanisms and models of asset tokenization, and identifies the transformation of ownership, transfer, and disposal rights in digital environments. It is established that tokenization enhances asset liquidity, expands investment opportunities, and creates new forms of rights management. Key challenges include legal uncertainty, regulatory fragmentation, jurisdictional complexity, and insufficient protection of token holders.

The findings confirm that tokenization is transforming traditional property relations and requires the development of coherent, technology-neutral regulatory frameworks. Future research should focus on cross-border legal issues, digital ownership in decentralized ecosystems, smart contract liability, and international approaches to the protection of tokenized rights.

Keywords: digital economy, property rights, digital ownership, distributed ledger technology, blockchain technology, smart contracts, legal regulation, investment mechanisms, decentralized systems, digital markets.

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Трансформація правової природи цифрових активів у контексті токенизації об'єктів реального світу

Анотація. Актуальність дослідження зумовлена стрімким розвитком технологій розподіленого реєстру, розширенням практики токенизації активів та зростанням ролі цифрових інструментів у сучасних майнових і фінансових відносинах. Токенизація об'єктів реального світу формує нові механізми обігу прав на матеріальні та нематеріальні активи, сприяє підвищенню ліквідності майна та створює додаткові можливості для залучення інвестицій. Водночас трансформація традиційних моделей власності актуалізує питання правової природи цифрових активів, юридичного зв'язку між токеном і базовим активом, а також забезпечення належного рівня правового захисту учасників цифрових ринків.

Метою статті є формування комплексного наукового бачення трансформації правової природи цифрових активів в умовах токенизації об'єктів реального світу та обґрунтування теоретичних і регуляторних підходів до правового визнання, реалізації та захисту токенизованих майнових прав.

Методи дослідження. Використано методи системного аналізу, правового порівняння, узагальнення наукових підходів, формально-юридичний метод, а також елементи нормативно-правового та інституційного аналізу. Застосовано комплексний підхід до дослідження взаємозв'язку між традиційними правовими інститутами та новими цифровими механізмами обігу активів.

Результати. Досліджено концептуальні засади формування цифрових активів та визначено їх основні правові характеристики в системі сучасних майнових відносин. Проаналізовано правові механізми та моделі токенизації об'єктів реального світу, а також їх вплив на обіг майнових прав у цифровому середовищі. Виявлено трансформацію змісту правомочностей володіння, користування та розпорядження активами в умовах застосування токенизаційних механізмів. Доведено, що токенизація сприяє підвищенню ліквідності активів, розширенню інвестиційних можливостей і розвитку нових форм управління майновими правами. Встановлено, що ключовими проблемами залишаються правова невизначеність статусу токенизованих активів, відсутність уніфікованих підходів до їх правового визнання, складність визначення юрисдикції, регуляторна фрагментація та недостатня врегульованість питань відповідальності в децентралізованих цифрових екосистемах.

Висновки. Доведено, що токенизація об'єктів реального світу спричиняє трансформацію традиційних підходів до реалізації та обігу майнових прав, формуючи нові моделі цифрової власності та управління активами. Обґрунтовано необхідність удосконалення правового регулювання шляхом гармонізації нормативних підходів, посилення правового захисту власників токенизованих прав та розвитку технологічно нейтральних механізмів регулювання цифрових активів.

Перспективи подальших досліджень пов'язані з вивченням колізійно-правових аспектів транскордонного обігу токенизованих активів, правового режиму цифрової власності в децентралізованих середовищах, особливостей юридичної відповідальності за функціонування смарт-контрактів та розробленням міжнародних підходів до правового визнання і захисту токенизованих майнових прав.

Ключові слова: цифрова економіка, майнові права, цифрова власність, розподілені реєстри, блокчейн-технології, смарт-контракти, правове регулювання, інвестиційні механізми, децентралізовані системи, цифрові ринки.

Introduction

The rapid development of distributed ledger technologies and the expansion of tokenization mechanisms are fundamentally transforming established approaches to the legal regulation of property rights and digital assets. The conversion of real-world assets into digital tokens enables the circulation of rights to tangible and intangible property within decentralized digital environments, creating new models of ownership, investment, and asset management. At the same time, the legal nature of tokenized assets remains insufficiently defined, as traditional legal categories often fail to fully reflect the hybrid characteristics of digital tokens that simultaneously incorporate elements of property rights, contractual claims, financial instruments, and digital records. This situation generates significant challenges for determining ownership, transferability, legal protection, jurisdiction, and regulatory oversight of tokenized assets. The problem acquires particular practical importance in the context of the growing integration of tokenization into investment, financial, real estate, and intellectual property markets, where legal uncertainty may constrain innovation and increase transactional risks. Consequently, the study of the transformation of the legal nature of digital assets in the context of real-world asset tokenization represents an important scientific and practical task aimed at developing coherent legal approaches capable of ensuring legal certainty, investor protection, and the sustainable development of digital asset ecosystems.

A review of contemporary scholarly literature demonstrates the growing interdisciplinary nature of research on digital assets, the tokenization of property rights, and the legal implications of transferring real-world assets into digital environments. A substantial body of research focuses on defining the legal nature of tokenized assets, transforming ownership rights, and developing new mechanisms for the circulation of property rights within the digital economy.

I. V. Makaliuk et al. examine the specific features of securities tokenization, considering it as an instrument for the modernization of financial markets and the digital transformation of investment relations in Ukraine [1]. M. Riabokin and Yu. Kotukh further develop these ideas through the concept of real-world asset tokenization (Real-World Assets, RWA), substantiating mechanisms for the digital representation of tangible and intangible assets and their role in the development of the digital economy [2]. I. Fedorenko analyzes the economic transformations resulting from the proliferation of tokenized assets, emphasizing changes in ownership, exchange, and investment models within digital environments [5].

A separate research stream is devoted to the legal protection of property rights and the maintenance of the principle of legality under conditions of digitalized legal relations. S. S. Kostetskyi investigates mechanisms for preventing violations of legality in administrative judicial proceedings, the provisions of which may serve as a foundation for legal safeguards protecting the rights of digital asset owners and holders of tokenized property [3]. N. Bulavina explores the development of non-fungible tokens (Non-Fungible Tokens, NFTs) as a distinct category of digital assets in the field of contemporary art, demonstrating practical forms of interaction between digital technologies and intellectual property objects [4].

A significant contribution to the development of the theoretical and legal foundations of tokenization has been made by international scholars. R. M. Garcia-Teruel and H. Simón-Moreno examine the digital tokenization of property rights from a comparative legal perspective, substantiating the possibility of transforming traditional property rights through the use of blockchain technology [6]. E. Prévost analyzes the issue of determining the law applicable to digital representations of off-chain assets, emphasizing the complexity of conflict-of-law issues within private international law [7].

The legal regulation of tokenized assets at the national level is comprehensively examined in the works of A. K. Layr, who investigates the issuance and circulation of security tokens in the legal systems of Liechtenstein and Switzerland, demonstrating practical models for the legal recognition of tokenized property rights [8]. M. Zheng and P. Sandner analyze the tokenization of real estate in European countries as a mechanism for democratizing investment access and increasing asset liquidity [9]. P. Kasprzak studies the tokenization of residential real estate within the emerging token economy, emphasizing the transformation of ownership structures and the emergence of fractional ownership models [10]. G. Sazandrishvili considers asset tokenization as a new stage in the evolution of financial markets that facilitates the transition from traditional forms of asset registration to digital mechanisms for verifying ownership rights [11]. A. Kowalski and T. Nowak expand the discussion beyond traditional tokenization models by examining ownership of digital assets in virtual reality environments, highlighting the legal and ethical challenges associated with establishing, transferring, and protecting ownership rights in increasingly immersive digital ecosystems [12].

Further development of this research field is associated with the integration of legal and technological mechanisms for the exercise of property rights. E. Ferro et al. substantiate the use of smart legal contracts and smart contracts as instruments for managing rights to digital assets, enabling the automation of legally significant actions and providing effective control over the circulation of tokenized property [13].

Despite the growing interest in digital assets and tokenization, the legal consequences of transforming traditional property rights into tokenized forms remain insufficiently explored. Existing studies predominantly address technological and financial aspects of tokenization, whereas the impact of these processes on the legal nature of ownership and other property rights has not received comprehensive scientific substantiation.

The unresolved nature of these issues is attributable to the rapid evolution of digital technologies and the absence of unified legal approaches to the recognition of tokenized rights. This creates legal uncertainty regarding the exercise, transfer, and protection of rights associated with tokenized assets, thereby necessitating further research into the transformation of property relations in the context of digitalization and the development of appropriate regulatory approaches.

Purpose of the article is to develop a comprehensive understanding of the transformation of the legal nature of digital assets in the context of real-world asset tokenization and to substantiate theoretical and regulatory approaches to the legal recognition and protection of tokenized property rights.

Objectives of the article:

1. To determine the legal nature and key characteristics of digital assets in the context of contemporary property relations.
2. To analyze the impact of real-world asset tokenization on the circulation and exercise of property rights.
3. To identify the principal legal challenges of tokenized assets and substantiate directions for improving their legal regulation and protection.

Results

Digital assets have become an integral element of the digital economy, influencing the transformation of property relations, investment mechanisms, and commercial transactions. Their development is closely associated with the expansion of distributed ledger technologies, which enable the creation, storage, transfer, and verification of rights in digital environments. Unlike traditional assets, digital assets derive their legal significance from the rights, interests, or claims embedded within digital records rather than from physical possession. Consequently, they represent a new category of legal objects situated at the intersection of property law, contract law, financial regulation, and information technologies.

The increasing economic importance of digital assets has generated a need to clarify their legal nature and establish criteria for their classification within existing legal systems. Contemporary regulatory approaches generally recognize that digital assets may perform diverse legal functions, including the representation of ownership rights, contractual claims, investment interests, or access rights to digital services. As a result, their legal qualification increasingly depends on the substantive rights attached to a digital asset rather than on the technological infrastructure through which it is created and transferred [14–16] (table 1).

Table 1

Conceptual foundations and legal characteristics of digital assets

Conceptual component	Legal essence	Key characteristics	Significance for legal relations
Digital representation of value	Existence of economic value in digital form	Electronic recording, transferability, verifiability	Recognition as an object of legal circulation
Property rights component	Reflection of ownership or economic interests	Possession, transfer, disposal rights	Establishment of proprietary claims
Technological infrastructure	Operation through distributed ledger systems	Immutability, transparency, decentralization	Ensures reliability of transactions
Contractual nature	Embodiment of rights and obligations within digital environments	Smart contracts, automated execution	Facilitates performance and enforcement of agreements
Investment function	Representation of investment opportunities and financial interests	Fractional ownership, enhanced liquidity	Expands participation in capital markets
Regulatory dimension	Subject to legal oversight and compliance requirements	Licensing, disclosure, consumer protection	Supports legal certainty and market integrity

Source: compiled by the author based on [1; 2, c. 140; 5, c. 180; 6; 11, p. 69].

The legal and economic significance of digital assets extends beyond the technological sphere, affecting the structure of contemporary property relations and the circulation of rights across global markets. In practical terms, digital assets increasingly serve as instruments through which ownership interests, investment rights, and contractual entitlements can be represented and transferred in a more efficient manner than under conventional transactional models [1]. Their growing adoption demonstrates a gradual transition from document-based systems of rights verification toward digitally authenticated mechanisms capable of supporting high-volume and cross-border transactions.

Particular importance is attached to the ability of digital assets to represent rights associated with tangible and intangible property. Real estate, corporate shares, commodities, intellectual property rights, and financial instruments are increasingly being incorporated into digital ecosystems through token-based structures [2, c. 140]. Such arrangements enable the division of ownership into smaller transferable units, thereby improving market accessibility and liquidity while reducing transactional friction. In this context, the digital asset functions not merely as a technological record but as a legally relevant mechanism through which rights may be exercised, transferred, and protected.

Recent regulatory developments indicate a broader shift toward technology-neutral approaches that focus on the legal substance of digital assets rather than on their technical form. This trend reflects the practical necessity of ensuring legal certainty in situations where

identical technological solutions may represent fundamentally different categories of rights [6]. Consequently, the legal nature of digital assets is increasingly determined by the economic and legal interests embodied within them, reinforcing their role as a distinct and evolving category within contemporary systems of property and economic relations.

Real-world asset tokenization represents a legal and technological process through which rights associated with physical or intangible assets are converted into digital units capable of circulation within distributed digital environments. Unlike digital assets in general, tokenized assets maintain a direct connection with a specific underlying object, thereby creating a legal link between the digital record and the corresponding property right. This approach enables the fragmentation, transfer, and management of rights through digital infrastructures while preserving their economic and legal value [14–20] (table 2).

Table 2

Legal mechanisms and models of real-world asset tokenization

Tokenization model	Underlying asset category	Method of rights representation	Legal effect on asset circulation
Direct ownership tokenization	Real estate, movable property	Token reflects ownership interest in the asset	Facilitates transfer and division of ownership rights
Equity-backed tokenization	Corporate shares and business interests	Token represents participation rights in a legal entity	Expands investment accessibility
Debt-based tokenization	Loans, bonds, receivables	Token certifies creditor claims	Simplifies transfer of financial obligations
Commodity tokenization	Precious metals, energy resources, agricultural products	Token linked to a specified quantity of assets	Enhances market liquidity and traceability
Intellectual property tokenization	Copyrights, patents, trademarks	Token represents exploitation or licensing rights	Improves commercialization opportunities
Revenue-sharing tokenization	Infrastructure and investment projects	Token grants entitlement to future income streams	Creates alternative financing mechanisms

Source: compiled by the author based on [6; 7, p. 289; 8, p. 50; 9; 10, p. 24; 12, p. 40].

The practical relevance of tokenization becomes most visible in sectors where the transfer of rights has traditionally been associated with significant administrative costs, limited liquidity, or complex registration procedures. In real estate markets, tokenization enables the division of ownership interests into smaller digital units, thereby facilitating broader investor participation while preserving a legal connection between token holders and the underlying property. Such approaches correspond to the broader recognition of digital assets as legally relevant objects of economic circulation reflected in contemporary regulatory frameworks [14, 15].

A similar transformation is taking place in capital markets, where tokenized shares, bonds, and other investment instruments increasingly perform functions that were historically reserved for conventional financial intermediaries. In this context, tokenization does not alter the substance of the right itself but changes the manner in which that right is evidenced, transferred, and exercised. This approach is consistent with the principles underlying the legal recognition of digital records and electronically transferable rights developed within international legal instruments [17; 20].

Particularly noteworthy are developments in the field of intellectual property. Tokenization allows copyright holders, patent owners, and other rightsholders to structure licensing arrangements, royalty distribution mechanisms, and revenue-sharing models through programmable digital instruments. As a result, economic rights may circulate more

efficiently while remaining legally linked to the protected intellectual asset. Such practices demonstrate that tokenization increasingly functions as a mechanism for enhancing the commercial exploitation of intangible assets rather than merely as a technological innovation [17].

These developments indicate that the principal legal challenge is no longer the creation of digital tokens themselves but the establishment of enforceable links between tokenized rights and the underlying assets to which they relate. Consequently, current regulatory initiatives focus on ensuring legal certainty regarding ownership, transferability, priority of claims, and protection of token holders in situations involving cross-border transactions or conflicts between digital records and traditional registries.

The expansion of tokenization technologies is contributing to a gradual transformation of the legal mechanisms through which ownership, transfer, and disposal rights are exercised. While traditional property relations are generally based on centralized registration systems, documentary evidence, and intermediary participation, tokenized environments enable rights to be exercised through digital infrastructures that facilitate the management and circulation of legally significant interests. As a result, the legal status of an asset increasingly depends not only on the existence of a recognized right but also on the manner in which that right is represented and administered within digital ecosystems [14; 15; 17] (table 3).

Table 3

Transformation of ownership, transfer, and disposal rights in tokenized asset environments

Category of legal right	Conventional legal approach	Digital implementation model	Implications for legal relations
Ownership entitlement	Acquisition and confirmation through legal title	Digital representation of ownership interests	Expansion of alternative ownership structures
Transfer authority	Transfer through contracts and registries	Transfer through token transactions	Increased speed and accessibility of transactions
Disposal competence	Independent decision-making regarding an asset	Programmable execution through digital protocols	Greater flexibility in asset management
Economic participation	Income derived from ownership or investment	Automated allocation of revenues and returns	More efficient distribution of economic benefits
Governance involvement	Participation through corporate or contractual mechanisms	Token-based voting and governance rights	New forms of collective decision-making
Access and exploitation rights	Exercise of rights through individual agreements	Digital management of usage permissions	Enhanced adaptability of legal arrangements

Source: compiled by the author based on [3, c. 70; 7, p. 300; 8, p. 67; 12, p. 44; 13].

The transformation of legal rights associated with tokenized assets extends beyond the mere digitalization of existing legal processes. In practice, tokenization increasingly separates economic interests from traditional forms of ownership and allows individual components of a legal right to circulate independently. A notable example can be observed in real estate markets, where ownership interests may be divided into multiple tokenized units, enabling investors to acquire participation rights without obtaining exclusive ownership of the entire property. Such structures create opportunities for broader market access while simultaneously altering conventional understandings of co-ownership and asset control [15; 18].

Changes are equally visible in the exercise of disposal rights. Through smart contract architectures, specific conditions governing transferability, voting rights, revenue distribution, or asset management may be predefined and automatically executed once predetermined requirements are satisfied. Consequently, certain functions historically performed by notaries, registrars, trustees, or other intermediaries can be partially transferred to technological systems operating within legally recognized frameworks [15].

The tokenization of intangible assets demonstrates an additional dimension of legal transformation. Copyrights, patents, trademarks, and related economic rights may be structured so that exploitation rights, licensing rights, and revenue entitlements circulate independently from formal ownership. This enables rights holders to commercialize intellectual assets more efficiently while preserving legal protection of the underlying object. In such cases, tokenization does not replace existing legal institutions but creates new mechanisms for exercising and allocating rights within them [17].

These developments indicate that contemporary property relations are increasingly characterized by a distinction between legal ownership, economic participation, and digital control. The growing recognition of tokenized rights within regulatory frameworks reflects an attempt to adapt traditional legal concepts to emerging forms of digital asset circulation while maintaining legal certainty, enforceability, and protection of legitimate interests in both physical and digital environments [14; 15; 17].

The rapid expansion of tokenized asset markets has revealed a number of unresolved legal, regulatory, and jurisdictional issues that constrain the broader integration of tokenization mechanisms into economic circulation. One of the most significant challenges concerns the legal qualification of tokenized assets. Depending on their structure and economic function, tokens may simultaneously exhibit characteristics of property rights, securities, contractual claims, investment instruments, or digital records, making it difficult to determine the applicable legal regime and the scope of rights attached to a particular asset [14, 15].

An additional problem relates to the absence of a harmonized approach to the legal recognition of tokenized rights. Regulatory frameworks differ considerably across jurisdictions, resulting in situations where a tokenized asset may be recognized as a legally protected object in one jurisdiction while remaining insufficiently regulated or legally uncertain in another. Such fragmentation complicates cross-border transactions, increases compliance costs, and creates barriers to the international circulation of tokenized assets [15, 17].

The legal relationship between a digital token and the underlying asset remains another area of uncertainty. In many cases, ownership of a token does not automatically confer ownership of the associated physical or intangible asset [3, c. 70]. The enforceability of rights depends on contractual arrangements, registration mechanisms, and the degree to which legislation recognizes the legal effect of tokenized representations. This issue is particularly relevant in relation to real estate, corporate rights, intellectual property, and other assets for which ownership is traditionally confirmed through formal legal procedures [14, 17].

Jurisdictional questions present further challenges. Decentralized digital infrastructures often operate across multiple countries simultaneously, making it difficult to identify the applicable law, competent courts, and appropriate dispute resolution mechanisms. Conflicts may arise when issuers, token holders, custodians, technological service providers, and underlying assets are located in different jurisdictions, creating uncertainty regarding legal protection and enforcement of rights [17].

The protection of token holders also remains insufficiently developed. Existing legal systems do not always provide effective remedies in cases involving unauthorized transfers, cybersecurity incidents, fraudulent token issuances, smart contract vulnerabilities, or loss of access credentials. The decentralized nature of many tokenized ecosystems may further complicate the identification of responsible parties and the allocation of legal liability when losses occur [15, 18].

Regulatory fragmentation represents an additional obstacle to market development. Differences in licensing requirements, disclosure obligations, investor protection standards, anti-money laundering procedures, and taxation rules increase legal complexity for market participants and limit the interoperability of tokenized asset ecosystems. As a result, businesses operating internationally frequently encounter overlapping compliance requirements and inconsistent regulatory expectations [15, 18].

Emerging technological developments generate further legal concerns. The increasing use of smart contracts, automated governance mechanisms, and artificial intelligence in tokenized environments raises questions regarding accountability, legal responsibility for automated decisions, and the validity of actions performed without direct human intervention. Existing legal doctrines remain only partially adapted to such technological arrangements, creating uncertainty in situations involving algorithmic errors or autonomous system failures [17].

The effective development of digital asset markets and tokenized property rights requires the establishment of a coherent legal framework capable of ensuring legal certainty while preserving the flexibility necessary for technological innovation. Regulatory approaches should focus on the legal nature of the rights embodied in digital assets rather than on the technological mechanisms used for their creation and circulation. Such an approach would facilitate more consistent legal qualification of tokenized assets and reduce uncertainty regarding the application of existing legal norms.

An important direction for improving legal regulation involves the formal recognition of legal links between digital tokens and the underlying tangible or intangible assets they represent. Clear legislative provisions defining the legal consequences of ownership, transfer, and disposal of tokenized rights would strengthen legal certainty and improve the enforceability of rights within digital environments.

Further regulatory development should prioritize the harmonization of national legislation with emerging international standards governing digital assets and distributed ledger technologies. Greater compatibility between regulatory frameworks would facilitate cross-border transactions, support legal interoperability, and contribute to the development of more integrated digital markets.

Particular attention should be devoted to strengthening the legal protection of token holders. This includes the development of effective mechanisms for dispute resolution, the allocation of liability for technological failures, the protection of investors against fraudulent practices, and the establishment of transparent requirements regarding the rights and obligations associated with tokenized assets.

The legal regulation of smart contracts and automated governance mechanisms also requires further refinement. Clear rules concerning the legal validity of automated transactions, responsibility for algorithmic decisions, and procedures for addressing technological malfunctions would reduce legal uncertainty and strengthen confidence in digital asset ecosystems.

The implementation of these measures would contribute to the formation of a balanced regulatory environment capable of supporting innovation while ensuring legal predictability, effective protection of rights, and the sustainable development of tokenized property relations within the digital economy.

Conclusions

The study establishes that the tokenization of real-world assets is transforming the legal nature of digital assets by creating new mechanisms for exercising ownership, transfer, and disposal rights within digital environments. It has been demonstrated that tokenized assets combine elements of property, contractual, corporate, and financial relations, which complicates their legal qualification within traditional legal frameworks. The findings confirm

that tokenization enhances asset liquidity, expands investment accessibility, and facilitates more efficient circulation of rights in the digital economy.

The principal challenges identified include the lack of harmonized legal approaches to tokenized assets, uncertainty regarding the legal relationship between tokens and underlying assets, jurisdictional conflicts in cross-border transactions, regulatory fragmentation, and insufficient protection of token holders. Additional concerns arise from the growing use of smart contracts and automated governance mechanisms, for which existing legal doctrines provide only limited guidance.

The proposed recommendations emphasize the need for technology-neutral regulation, stronger legal recognition of tokenized rights, greater regulatory harmonization, and enhanced mechanisms for investor protection and dispute resolution. Future research should focus on conflict-of-law issues, the legal status of digital ownership in decentralized ecosystems, liability for autonomous technological systems, and the development of internationally coordinated frameworks for the recognition and protection of tokenized property rights.

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