

Digital Currency-Driven Biopharmaceutical Patent Pool Securitization: A Law and Economics Perspective on Institutional Reconstruction

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Abstract

Against the backdrop of the dual global trends of digital financial rule-of-law and intellectual property capitalization, the issue of patent financialization in the biopharmaceutical industry has become increasingly prominent. Constrained by uncertainties in underlying asset valuation, strong revenue volatility, and obstacles to cross-border financing, traditional patent securitization models struggle to effectively meet the financing demands of pharmaceutical innovation. Meanwhile, the emergence of Stablecoin and Central Bank Digital Currency (E-CNY), with their advantages in payment efficiency and traceability, provides a new institutional vehicle for patent pool securitization. This paper, from a macro perspective of digital financial rule-of-law ecosystem construction, examines the “patent pool securitization + stablecoin” model and investigates the interactive mechanism between intellectual property financialization and digital currency regulation through a law and economics lens. Through comparative analysis of institutional models including the United States (functional regulation), the European Union (MiCA unified legislation), Japan (industrial policy-oriented), and Hong Kong (dual-layer regulation), this paper constructs a theoretical framework of “institution-embedded patent financialization,” proposing a co-governance mechanism that combines a sovereign monetary credit system underpinned by central bank digital currencies with smart contract technology to achieve rule-of-law and controllability in innovation financing. Building upon this foundation, the paper proposes an institutional path with Chinese characteristics: establishing domestic/overseas linked pilot programs for “digital currency + patent pool securitization,” improving the patent value assessment system, and constructing a cross-departmental functional regulatory framework alongside a regulatory sandbox mechanism to balance the tripartite relationship among monetary sovereignty, market efficiency, and innovation incentives. The

research conclusions indicate that China is poised to develop an institutional paradigm with spillover influence in the integration of digital currency and intellectual property, offering a “Chinese solution” for global digital financial governance.

Full Text

Preamble

Digital Currency-Driven Securitization of Biopharmaceutical Patent Pools: Institutional Reconstruction from a Law and Economics Perspective

Against the backdrop of global digital financial legalization and the capitalization of intellectual property, the financialization of biopharmaceutical patents has become increasingly prominent. Traditional patent securitization models, constrained by uncertainties in underlying asset valuation, high income volatility, and obstacles to cross-border financing, have struggled to meet the financing needs of pharmaceutical innovation. Meanwhile, the rise of stablecoins and central bank digital currencies (E-CNY), with their advantages in payment efficiency and traceability, offers new institutional vehicles for patent pool securitization. This paper adopts a macro perspective on building a digital financial rule-of-law ecosystem, examining the “patent pool securitization + stablecoin” model through a law and economics lens to explore the interactive mechanisms between IP financialization and digital currency regulation. By comparing institutional models across the United States (functional regulation), the European Union (MiCA unified legislation), Japan (industrial policy orientation), and Hong Kong (dual-tier regulation), this paper constructs a theoretical framework of “institutionally embedded patent financialization.” It proposes a co-governance mechanism combining a sovereign credit system backed by central bank digital currencies with smart contract technology to achieve legalized and controllable innovation financing.

Based on this analysis, the paper proposes a China-specific institutional pathway: establishing coordinated pilot programs for “digital currency + patent pool securitization” across domestic and offshore markets, improving patent valuation systems, and constructing a cross-sector functional regulatory framework with sandbox mechanisms to balance monetary sovereignty, market efficiency, and innovation incentives. The findings suggest that China has the potential to develop an institutionally distinctive paradigm in the integration of digital currency and intellectual property, offering a “Chinese solution” to global digital financial governance.

Keywords: Digital currency; Biopharmaceutical patent pool; Securitization; Law and economics; Digital financial rule-of-law ecosystem

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Abstract

Amid the dual trends of digital financial legalization and intellectual property (IP) capitalization, the financialization of biopharmaceutical patents has emerged as a critical issue in innovation governance. Traditional patent securitization models are limited by valuation uncertainty, income volatility, and cross-border financing constraints, which impede effective support for pharmaceutical innovation. Meanwhile, the rise of stablecoins and central bank digital currencies (E-CNY), with their advantages in payment efficiency and legal traceability, provides new institutional foundations for patent-pool securitization.

Anchored in the perspective of building a digital financial rule-of-law ecosystem, this paper examines the “patent-pool securitization + stablecoin” model through a law and economics lens to explore the interaction between IP financialization and digital currency regulation. By comparing the regulatory frameworks of the United States (functional regulation), the European Union (MiCA unified legislation), Japan (industrial policy-driven approach), and Hong Kong (dual-tier regulation), the study develops a theoretical model of Institutionally Embedded Patent Financialization. It argues that a CBDC-backed sovereign credit system combined with smart contract-based co-governance can promote transparent, compliant, and innovation-driven financing.

On this basis, the paper proposes a China-specific institutional roadmap featuring coordinated pilot programs linking “digital currency + patent-pool securitization,” enhanced patent valuation mechanisms, and cross-sector functional regulation supported by sandbox supervision. The findings suggest that China can develop an institutionally distinctive paradigm for integrating digital currency and intellectual property, contributing a “Chinese approach” to global digital financial governance.

Keywords: Digital currency; Biopharmaceutical patents pool; Securitization; Law and economics; Digital financial rule-of-law ecosystem; Institutional innovation

1. Introduction

In the context of deep integration between the global knowledge economy and digital finance, IP financialization is becoming a crucial pathway for promoting

interaction between technological innovation and capital markets. Particularly in the biopharmaceutical industry, patents serve as core assets that are both the legal expression of innovation outcomes and important vehicles for capitalized financing. However, due to long R&D cycles, high risks, and enormous capital requirements, small and medium-sized pharmaceutical enterprises (SMEs) universally face financing difficulties. Traditional debt financing and venture capital models struggle to meet continuous innovation needs, making it a shared concern for both academia and practice to explore how patent financialization tools can bridge the “technology-capital-industry” chain.

In recent years, the combination of patent securitization and patent pool mechanisms has been regarded as an important institutional innovation to resolve innovation financing dilemmas. On one hand, patent pools reduce technology transaction costs and mitigate the “tragedy of the anticommons” caused by “patent thickets” through centralized licensing and unified authorization. On the other hand, patent securitization transforms future patent revenue rights into tradable financial assets through structural design, thereby enhancing the liquidity of intangible assets. Nevertheless, this model in practice remains constrained by structural obstacles such as uncertainty in post-patent revenue evaluation, insufficient legal stability of underlying assets, and low market acceptance. Traditional financial tools and existing IP financialization models struggle to effectively allocate investment risks for such assets, resulting in numerous innovative potentials being stifled during mid-stage R&D (the “valley of death”) [Figure 1: see original paper].

Meanwhile, new crypto-financial instruments represented by stablecoins have rapidly developed globally. Stablecoins are essentially institutional innovations by the market to address value transfer and payment efficiency issues in the digital economy. Their core lies in creating a new type of traceable digital debt certificate through technological means (blockchain) and legal arrangements (reserves, redemption rights). With their characteristics of anchoring asset value, improving payment efficiency, and facilitating cross-border settlement, stablecoins are regarded by some scholars and policymakers as potential financial tools to optimize the cash flow structure of IP securitization and alleviate obstacles to cross-border capital flows. Recent research indicates that the rise of stablecoins is driving the reconstruction of traditional financial regulatory paradigms, and their functions in currency substitution, capital flows, and payment systems are challenging central bank monetary policies. For instance, the U.S. Stablecoin Transparency Act and the EU’ s Markets in Crypto-Assets Regulation (MiCA) have respectively constructed differentiated regulatory frameworks—the former focusing on information disclosure and investor protection, while the latter introduces a classification system for “Asset-Referenced Tokens” (ARTs) and “E-Money Tokens” (EMTs) under a unified regulatory system. Scholars Zetzsche and Buckley point out that this “functional regulation” model demonstrates high portability in balancing innovation and financial stability.

China has adopted a prudent regulatory approach in the digital finance domain,

implementing strict restrictions on virtual currencies and offshore stablecoins while actively promoting a legal digital currency system centered on the digital yuan (e-CNY). The People's Bank of China's white paper on digital yuan development states that e-CNY will possess "legal tender status, controlled anonymity, and programmability," and is expected to become public payment infrastructure in the digital economy era. Recent empirical studies also show that digital yuan helps enhance monetary policy transmission and cross-border payment efficiency. Against this backdrop, exploring institutional innovation in "patent pool securitization + stablecoin (or digital yuan)" not only helps improve the liquidity and financing availability of pharmaceutical patent assets but also promotes the deep integration of China's digital currency system and IP financial system.

At the theoretical level, existing research primarily focuses on single domains: such as legal risks and institutional obstacles in patent securitization, the legal attributes and risk regulation of stablecoins, or national legal construction of digital currencies. However, systematic research on the cross-cutting issue of "patent pool securitization + stablecoin" remains a blank area. This topic is both interdisciplinary (financial law, IP law, monetary law) and urgently relevant (pharmaceutical innovation financing and digital currency regulatory coordination), possessing significant research and policy value.

This paper adopts law and economics and comparative law methodologies to systematically analyze the feasibility, legal obstacles, and institutional innovation pathways of combining patent securitization with stablecoins. It focuses on comparing regulatory models in the United States, European Union, Japan, and Hong Kong, and proposes institutional design solutions tailored to China's national conditions. The study aims to explore: Under the theoretical framework of law and economics, how can this new institutional arrangement correct capital market failures in the biopharmaceutical field? What lessons can China draw from the globally divergent regulatory paths for digital assets? Based on China's digital financial regulatory system and the actual development of its biopharmaceutical industry, how should it design a localized pathway that can both stimulate innovation vitality and maintain national financial security? To systematically answer these questions, this paper adopts the argumentative structure of "macro problem introduction → theoretical/legal depth analysis → current situation/empirical dilemma analysis → international experience comparison → localized countermeasures combined with national conditions," aiming to provide an institutional solution with both theoretical depth and practical feasibility for the integration of China's biopharmaceutical industry development and digital financial rule-of-law ecosystem construction.

2. Theoretical Foundations of Patent Pool Securitization and Stablecoins

This chapter unfolds across five levels: concept—mechanism—risk—regulation—theoretical framework. It first defines patent pools and patent securitization and

reveals their practical constraints, then systematically reviews the nature, types, and regulatory trends of stablecoins. Subsequently, supported by patent pool securitization theory, it proposes an institutional integration logic centered on transaction cost minimization, laying the analytical foundation for subsequent international comparisons and China's pathway.

2.1 Concepts, Mechanisms, and Practical Dilemmas of Patent Pools and Patent Securitization

Traditional civil law theory treats patent rights as integrated intangible “property rights,” emphasizing their in rem nature and exclusivity. A patent pool is an institutional arrangement where multiple patent holders collectively manage and uniformly license patents related to the same technology field or standard through contractual agreements. Its core function lies in reducing transaction costs by eliminating duplicate licensing and patent cross-blocking, thereby promoting technology diffusion and industrial innovation. Classic research indicates that patent pools can significantly reduce the “tragedy of the anticommons” in technology standardization processes and improve innovation efficiency (Heller & Eisenberg, 1998). However, they may also trigger competition law risks, particularly when rights are highly concentrated, leading to de facto monopolies.

At the financial level, patent pool securitization refers to the transformation of future expected revenues from individual patents in a pool into securitized products, achieving financing through structural design and risk diversification. This model emerged in the United States in the 1990s, marked by David Bowie's music copyright securitization and later introduced to the pharmaceutical patent field by Royalty Pharma. The patent pool securitization process typically includes: identification and portfolio assembly of underlying assets; cash flow forecasting and structural tranching; establishment of a special purpose vehicle (SPV); and issuance of asset-backed securities (ABS) and revenue distribution.

Nevertheless, existing patent pool securitization faces three major practical dilemmas: First, uncertainty in patent pool valuation. Patent revenues depend on future market performance and technical validity, resulting in high volatility of underlying asset prices and difficulty in accurately quantifying credit risk. Second, incomplete legal systems for patent pools. In bankruptcy, pledge, and transfer processes, the property attributes of patent rights have not been fully integrated with securities law systems, leading to legal enforcement risks. After forming a patent pool, there are no relevant legal provisions for individual patent withdrawal, separate trading, collective pledging, and transfer. Third, information asymmetry between the whole and individual patents in the pool and insufficient investor protection. Due to opaque revenue information for each patent in the pool, pricing and rating of securitized products lack uniform standards.

Based on this, scholars advocate introducing blockchain and digital financial technologies to improve patent asset liquidity and transparency through “patent

tokenization” : distributed ledger technology can achieve property rights confirmation, revenue traceability, and automatic settlement via smart contracts in IP financing, thereby significantly reducing transaction costs.

2.2 Nature, Risks, and Regulatory Framework of Stablecoins

As embedded payment and clearing infrastructure, stablecoins precisely meet the institutional needs of patent pool securitization in cross-border transactions, traceability, and automatic performance. Therefore, it is necessary to systematically clarify their legal-economic attributes, types, and regulatory trajectories.

2.2.1 Legal and Economic Attributes of Stablecoins Stablecoins aim to overcome the excessive price volatility of general crypto assets like Bitcoin, performing quasi-monetary functions in payment, settlement, and value storage. Academia generally defines them as “crypto tokens that anchor certain assets to maintain stable value,” with stability derived from pegging to external assets or algorithmic mechanisms. From a law and economics perspective, stablecoins possess dual attributes as both payment media and financial products: their monetary function relies on credit anchoring mechanisms, while their security nature stems from the connection between investment and return expectations. According to Brunnermeier and Niepelt’ s “redistribution model of the three functions of digital currency,” stablecoins may compete with central bank money in value storage and payment medium functions, meaning they simultaneously possess multiple attributes as “investment products,” “currency,” and “assets.”

Consequently, the U.S. Securities and Exchange Commission (SEC) stated in its financial risk assessment report: “If stablecoin issuance involves investment contract characteristics, it should be included in the securities regulatory framework.” This definition reflects the “hybrid” nature of stablecoins—they may be payment tools or regulated investment products.

2.2.2 Main Types and Operating Mechanisms of Stablecoins Current mainstream stablecoins can be divided into three categories based on their collateral mechanisms:

- (1) **Fiat-collateralized:** These stablecoins are backed by legal tender or highly liquid assets held by issuing institutions to guarantee a 1:1 redemption ratio. Representative projects include Tether (USDT) and USD Coin (USDC). This model’ s advantage lies in strong stability and clear redemption mechanisms, but risks include insufficient information transparency of issuing institutions and inadequate reserve auditing, which have become regulatory priorities.
- (2) **Crypto-collateralized:** These stablecoins use crypto assets (such as Ethereum) as collateral and are issued through smart contract mechanisms. For example, the DAI stablecoin is generated by the MakerDAO

system, where users lock ETH or other crypto assets into a Vault (collateral warehouse) and issue DAI at a certain collateral ratio (typically over 150%). Its decentralized characteristics enhance regulatory resistance, but due to high volatility of collateral assets, issues such as “difficulty in maintaining over-collateralization” and “liquidity spiral risk” exist.

- (3) **Algorithmic:** Algorithmic stablecoins do not rely on collateral but maintain price pegs by automatically adjusting supply through algorithms. The typical representative is TerraUSD (UST). Its mechanism design is: when UST exceeds \$1, the system destroys Luna tokens to reduce supply; when below \$1, it issues additional UST to restore the peg. However, UST’s collapse in 2022 proved that algorithmic stablecoins face “confidence-dependent” risks: when market confidence is lost, both price and algorithmic cycles may collapse simultaneously. Scholars believe the UST incident demonstrates that “algorithmic stability” is essentially an illusion of collateral, and its legal and financial attributes require redefinition.

Comparison of Mechanism Characteristics and Regulatory Differences Among Three Types of Stablecoins

2.2.3 Main Risk Types of Stablecoins The core advantages of stablecoins lie in their payment efficiency and cross-border circulation, making them widely used in international clearing and digital asset transactions. However, their institutional risks are equally significant: First, **depegging risk:** If reserve assets are insufficient or liquidity management is improper, stablecoins may lose their peg, triggering systemic risks. For instance, both the October 2022 USDT death spiral and the 2018 UST instantaneous depegging incident triggered immediate liquidity crises, followed by regulatory upgrades. Second, **regulatory arbitrage and compliance risk:** Some issuing institutions evade financial regulation through “gray areas,” easily forming potential channels for money laundering and capital flight. Third, **monetary policy interference:** When stablecoins are widely adopted in cross-border payments, they may weaken national monetary policy independence and capital control effectiveness. Fourth, **technical vulnerabilities:** Algorithmic stablecoins or smart contract vulnerabilities may lead to systemic failures.

2.2.4 Stablecoin Regulation and International Trends The United States and the European Union represent two typical models in stablecoin regulation, while China has adopted a strict prohibition approach. The U.S. employs a “function-oriented regulation” logic, categorizing stablecoins according to their actual functions under the jurisdiction of the SEC (securities attributes), CFTC (commodity attributes), and FinCEN (anti-money laundering). Currently, the U.S. Congress is reviewing the Stablecoin Transparency Act, aiming to require reserve disclosure and auditing. The EU has established a unified framework through the Markets in Crypto-Assets (MiCA) Regulation, clearly defining Asset-Referenced Tokens (ARTs) and E-Money Tokens (EMTs)

and their obligations. Research shows that this tiered regulatory model has strong scalability and legal transplantability, providing an institutional template for combining digital financial tools with IP securitization.

China currently adopts a prohibitive stance toward offshore stablecoins, banning their domestic trading or substitution for legal tender functions. Simultaneously, with the digital yuan (e-CNY) as the only legal form of digital currency, China achieves comprehensive regulation of the digital currency system through central bank centralized issuance and management. This model reflects China's digital currency policy legislative philosophy of prioritizing monetary sovereignty and financial security: by excluding offshore stablecoin risks while creating institutional space for "digital yuan + financial innovation."

This paper argues that the essence of stablecoins is a financial innovation of "anchored credit," with legal status between currency and securities. Different underlying collateral mechanisms lead to differences in stability and risk characteristics: fiat-collateralized types emphasize compliance and custody, crypto-collateralized types highlight decentralization and algorithmic governance, and algorithmic types represent extreme experiments in market confidence and mechanism design. From a regulatory perspective, future trends are evolving toward functional identification, cross-sector coordination, and international coordination. For China, the key lies in constructing a new institutional balance between monetary sovereignty and technological innovation, laying a secure foundation for IP financialization and digital yuan application.

2.3 Patent Financialization and Patent Pool Securitization Concepts in the Biopharmaceutical Field

Unlike copyright or single IP securitization, patent financialization in the biopharmaceutical field must take "patent pool securitization" as its institutional prerequisite. Conceptually, patent financialization refers to the process of embedding patents as capital assets into the financial system, aiming to endow IP with financing and investment functions through market mechanisms, thereby integrating innovation activities into capital logic and achieving two-way flow between technological achievements and financial resources. Patent securitization, as the institutional carrier of this financialization, transforms illiquid assets into tradable securities to achieve risk transfer and financing efficiency enhancement. The relationship between the two is: financialization is the concept and goal, while securitization is the mechanism and tool. However, the unique legal and industrial characteristics of biopharmaceutical patents determine that financialization cannot rely on direct securitization of individual patents.

First, biopharmaceutical patents exhibit significant revenue postponement and high value uncertainty. Patents for drugs, treatment methods, and medical devices only possess potential technical value in the early R&D stage and must undergo rigorous clinical trials, regulatory approval, and marketing authorization procedures before realizing economic value. This approval chain is lengthy

and high-risk, making patent validity highly susceptible to invalidation declarations, technological iteration, and infringement disputes. Second, the rights structure of biopharmaceutical patents is highly fragmented with synergistic revenue path dependencies. The same drug often involves multiple patents covering compounds, formulations, dosage forms, and production processes, with diverse ownership entities and complex revenue structures, making it difficult for a single patent to generate continuous, stable, and quantifiable cash flows. In contrast, music copyrights or single IP patents have more independent and immediate revenue streams, thus enabling capitalization through single asset securitization.

In this context, the patent pool mechanism becomes the institutional hub for transforming biopharmaceutical patent financialization into securitization. Patent pools reduce ownership fragmentation risks, stabilize revenue expectations, and achieve rights clarification and revenue stratification structuration through contractual arrangements, thereby meeting the legal requirements of securitization for underlying assets to be “confirmable, predictable, and divisible.” Meanwhile, the institutional introduction of stablecoins and sovereign digital currencies (CBDC) enables cross-border settlement and credit enhancement in smart contract environments. As Ahmed and Aldasoro (2025) reveal, stablecoins are gradually evolving into “quasi-safe assets,” and their reserve transparency and traceability can provide credit support for liquidity management in patent pool securitization. In other words, the “financialization feasibility” of biopharmaceutical patents depends on the co-governance integration of patent pools rather than the technical innovativeness of individual patents. Only when patent portfolios enter pooled and structured governance systems can financialization be implemented through securitization paths, achieving property rights reconstruction and capital transformation in the law and economics sense.

2.4 Summary

In summary, according to Coase’s transaction cost theory, in an ideal world with zero transaction costs, market players can always negotiate optimal resource allocation. However, the practical dilemmas of patent pool securitization precisely stem from high transaction costs in the real world, where single rules cannot achieve Pareto improvement. This paper argues that the combination of patent pool securitization with stablecoins/e-CNY and smart contracts can simultaneously reduce costs and increase efficiency across three dimensions: search and negotiation, verification, and enforcement. The former reduces negotiation and pricing costs through centralized authorization and structural stratification, while the latter suppresses adverse selection and moral hazard through on-chain rights confirmation, traceability, and automatic performance. The core objective is to reduce transaction costs of innovation financing through institutional design while supporting continuous financing and revenue distribution for biopharmaceutical innovation through regulable, accountable, and auditable digital

financial rule-of-law arrangements, thereby achieving embedded reconstruction and incentive alignment in the law and economics and institutional economics sense.

3. International and Extraterritorial Experience Comparison: Models of the United States, European Union, Japan, and Hong Kong

Different jurisdictions' regulatory choices are not random technical decisions but reflections of deep-seated economic philosophies, legal traditions, and institutional path dependencies. This chapter deeply analyzes the regulatory models of the United States, European Union, Japan, and Hong Kong, revealing their underlying economic logic to provide references for China's institutional design.

3.1 United States: Pluralistic Regulatory Framework and Functional Review Logic

3.1.1 Regulatory Structure and Institutional Characteristics The United States is a dual pioneer in global patent securitization and stablecoin regulation. On one hand, the U.S. patent asset securitization market is relatively mature, built upon capital market risk stratification and information disclosure systems. A typical case is Royalty Pharma's pharmaceutical patent revenue securitization project, which effectively achieved capital marketization of intangible assets by packaging drug patent future licensing revenues into asset-backed securities (ABS). Research indicates that this securitization path based on "patent revenue rights" relies on efficient IP evaluation systems and legal enforcement mechanisms. On the other hand, the U.S. has adopted a "function-based regulation" model for stablecoins, where different regulators are responsible based on stablecoins' substantive market functions: 1) If stablecoins have "investment contract" characteristics, they fall under the Securities Act of 1933 and the Securities Exchange Act of 1934, regulated by the SEC; 2) If they involve derivatives trading or commodity attributes, they fall under the CFTC's jurisdiction; 3) If they involve payment and anti-money laundering issues, FinCEN enforces the Bank Secrecy Act (BSA) and Anti-Money Laundering Act (AML/KYC).

In 2023, the U.S. Congress proposed the Clarity for Payment Stablecoins Act, attempting to establish a unified regulatory framework through clear issuance licensing and reserve disclosure requirements. SEC Chairman Gary Gensler explicitly stated in Senate Banking Committee testimony: "If stablecoin expected returns derive from others' efforts, they should be identified as securities and registered accordingly." This position strengthens the "substance over form" regulatory philosophy, reflecting the common law tradition of substantive judgment.

However, the U.S. model also faces fragmented regulation issues. With regulatory authority dispersed among the SEC, CFTC, and FinCEN, stablecoin

projects must simultaneously comply with multiple legal provisions, resulting in high regulatory coordination costs. Scholar Zaring points out that while this “regulatory overlap” provides institutional flexibility in the short term, it may weaken innovation incentives in the long run (Zaring, 2021).

At the IP securitization level, the success of the U.S. market depends on high market transparency and judicial predictability. U.S. courts confirmed the assignability of IP future revenue rights in the “Music Royalty Trust” series of cases, providing a judicial foundation for subsequent patent securitization. The SEC guidance (2020) stated that “effective IP revenue streams meet the ‘independent revenue’ requirement for ABS,” and the revised UCC §9-408 (2023) requires establishing independent transfer rules for IP revenue rights.

3.1.2 Law and Economics Analysis: Transaction Costs and Legal Elasticity The U.S. regulatory model implies law and economics logic in its institutional design. The SEC’s functional characterization of stablecoins essentially achieves market correction by reducing information asymmetry and externality costs. In other words, this is a “regulation as transaction cost correction” approach that aligns with the revised version of the Coase Theorem in the real world. Due to high information asymmetry and trust risks in stablecoin transactions, regulatory intervention is needed to establish market signals.

Simultaneously, the U.S. legal system possesses certain “law’s elasticity”: when facing rapid cryptocurrency development, the SEC can adjust the Howey Test’s application scope through “interpretation” to adapt to new stablecoin forms. For example, after 2021, the SEC included yield-bearing stablecoins in securities regulation, reflecting the adaptability of the financial law system. This also aligns with scholar Pistor’s (2021) concept of “law’s elasticity,” which argues that legal elasticity is a key mechanism of financial rule of law, and that U.S. financial regulation maintains institutional adaptability through “interpretive enforcement.”

However, legal elasticity also brings institutional uncertainty and systemic risks: first, regulatory fragmentation—due to overlapping responsibilities among the SEC, CFTC, and FinCEN, some stablecoin projects must simultaneously comply with multiple regulations, sharply increasing compliance costs; second, compliance uncertainty—as the U.S. Congress has not yet passed a unified Digital Assets Act, states have inconsistent stablecoin regulatory standards, such as differences between New York and Wyoming, forcing enterprises to bear dual compliance costs and weakening innovation incentives. Cases like Tether (USDT) and Circle (USDC) show the need to face multi-jurisdictional audits and dual regulation. Finally, uncertainty and instability from legal elasticity and functionality: if issuers’ reserve structures are opaque or audits are inadequate, they may be unable to perform under redemption pressure, causing user trust collapse. A 2024 study noted that during the SVB collapse, USDC’s high transparency disclosure enabled rapid redemption during liquidity shocks, while USDT’s low-frequency disclosure somewhat mitigated this shock.

3.1.3 Institutional Risks and Cases U.S. institutional risks concentrate in three aspects: First, regulatory ambiguity—lack of coordination among multiple agencies leads to overlapping and gaps; second, reserve risk—Tether (USDT) was investigated by the New York Attorney General for incomplete reserve disclosure and fined \$18.5 million in 2021; third, systemic risk transmission—if stablecoins are widely embedded in payment systems, depegging events can trigger chain runs through financial intermediaries; fourth, declining innovation incentives—excessive enforcement uncertainty drives DeFi protocol developers to move offshore.

In summary, the U.S. model reflects a trade-off between flexibility and uncertainty. It provides maximum freedom for market innovation but at the cost of high “legal discovery” transaction costs and “regulatory ambiguity” and “compliance uncertainty.” This uncertainty itself inhibits risk-averse capital from entering. The U.S. system’s advantage lies in flexibility and innovation, but it suffers from regulatory fragmentation and legal uncertainty.

3.2 European Union: MiCA Unified Regulation and IP Financial Policy Coordination

The EU adopts a “top-down” unified legislative model in digital financial governance, with its core document being the Markets in Crypto-Assets (MiCA) Regulation, which officially took effect in 2023.

3.2.1 Regulatory Structure and Institutional Characteristics MiCA establishes a function-based regulatory framework that classifies crypto assets into: Asset-Referenced Tokens (ARTs), E-Money Tokens (EMTs), and other ordinary crypto assets. MiCA requires both ART and EMT issuers to obtain authorization within the EU (registered with the European Banking Authority) and comply with reserve requirements (2%), information disclosure obligations, and governance standards. For “significant tokens,” daily transaction limits and liquidity emergency plans are also required. The legislative objective is to “ensure financial stability and consumer protection while promoting financial innovation.”

As scholars Zetsche and Buckley (2023) point out, MiCA’s institutional features lie in “tiered supervision,” “cross-jurisdictional coordination mechanisms,” and the “principle of proportionality.” It forms a layered and coordinated regulatory system through the European Banking Authority (EBA) and the European Securities and Markets Authority (ESMA), thereby balancing consistency and flexibility at the institutional level.

Regarding IP and financial integration, the EU’s IP Action Plan (2020) first included “IP securitization” in the EU Capital Markets Union (CMU) strategy, proposing to promote IP asset financing through High-Quality Securitization (HQS) standards. Some EU member states (such as Germany and the Netherlands) are exploring blockchain registration and circulation mechanisms based

on IP revenue rights, laying institutional groundwork for future “patent securitization + crypto settlement” models. Therefore, the EU model’s characteristics can be summarized as threefold: first, unified legislation and regulatory coordination ensuring institutional certainty; second, emphasis on information disclosure and investor protection to reduce market risks; third, reserving technologically neutral space while balancing financial innovation in the regulatory system. Its institutional shortcomings lie in slower innovation response speed and significant implementation differences among member states.

3.2.2 Law and Economics Analysis: Coordination Efficiency and Ex Ante Regulation The EU’s regulatory economic logic reflects “coordination efficiency theory” and “ex ante regulation” thinking. Its institutional objective is to reduce cross-border compliance transaction costs (Williamson, 1985) and prevent regulatory arbitrage through unified rules. MiCA’s “single license + passporting” mechanism allows stablecoin issuers to circulate freely among EU member states, significantly enhancing market efficiency. However, from a law and economics perspective, this “institutional coordination priority” design sacrifices flexibility. As scholars like Zetzsche point out, MiCA’s ex ante regulation may lead to “excessive institutional rigidity,” inhibiting startup entry.

3.2.3 Institutional Risks and Cases The EU system’s main risks include: First, innovation restrictions—MiCA’s high thresholds cause small and medium-sized innovative enterprises to exit the market; second, sovereignty conflicts—private stablecoins may weaken the euro’s position in cross-border payments; third, implementation difference risks—uneven resources and regulatory capabilities among member states may create regulatory “lowlands.” A 2022 European Central Bank report noted that before MiCA implementation, about 70% of stablecoin transactions were completed through non-EU platforms, indicating that regulatory “uniformity” had not yet translated into “market integration.” The EU model has advantages in financial security but at the economic cost of declining innovation vitality and market concentration tendencies.

3.3 Japan: Prudent Innovation Under Licensing System

3.3.1 Institutional Structure and Regulatory Logic Japan adopts a dual-track parallel model of “industrial policy + legal system” in digital currency and patent financialization. In 2022, Japan passed the Revised Payment Services Act, first establishing the legal status of stablecoin issuance, stipulating that stablecoins must be issued by banks or trust companies and fully backed by fiat reserves. In 2023, Japan’s Financial Services Agency (FSA) released the Revised Payment Services Act Implementation Rules, further clarifying that stablecoin issuance requires registration and prohibiting unlicensed cross-border stablecoin circulation.

On this basis, the Japanese government promotes application experiments of blockchain in finance, IP, and medical data through the “Fintech Regulatory

Sandbox” and “Digital Agency” mechanisms. Scholars note that the core of Japan’s regulatory framework lies in “compliance with experimentation,” allowing limited institutional innovation while ensuring financial security. Additionally, Japan’s Ministry of Economy, Trade and Industry (METI) supports establishing cross-enterprise “pharmaceutical patent pool and patent securitization experimental projects,” attempting to improve drug licensing fee settlement efficiency through stablecoin payments and smart contract mechanisms. This government-driven industrial coordination mechanism gives Japan unique institutional advantages in combining patent financialization with digital currencies. Overall, Japan’s model features: (1) government leadership and industrial coordination; (2) clear regulatory systems but limited innovation space; (3) balancing risk and technological development under an “experimental regulation” framework.

3.3.2 Law and Economics Analysis: Risk Ring-Fencing and Policy Incentives Japan’s regulatory mechanism reflects the risk ring-fencing model. Through licensing and trust mechanisms, it separates stablecoin operational risks from the banking system, thereby preventing systemic spillovers. This aligns with Williamson’s theory of “matching governance structures with asset specificity” –when transaction asset specificity is high, centralized governance can reduce uncertainty. Additionally, METI’s “IP Finance” strategy incorporates blockchain and stablecoin settlement mechanisms into technology industrial policy, achieving “regulation-innovation” synergy. This “policy-driven model” strengthens institutional coordination. However, Japan’s system also faces risks including rigid entry barriers, technology dependency risks, regulatory ambiguity for algorithmic stablecoins, and innovation outflow risks.

3.4 Hong Kong: Gradual Sandbox Regulation as a “Super Connector”

3.4.1 Institutional Design and Regulatory Objectives The Hong Kong Monetary Authority (HKMA) released the Discussion Paper on Crypto-assets and Stablecoins in 2023, proposing a “risk grading + function-oriented” regulatory system: only fiat-anchored stablecoins are allowed (algorithmic stablecoins are prohibited); reserves must be 100% backed by highly liquid assets; a mandatory licensing system for Virtual Asset Service Providers (VASP) is implemented; and risk information disclosure and cross-border regulatory coordination mechanisms are required.

3.4.2 Law and Economics Analysis: Regulatory Arbitrage and Institutional Equilibrium The Hong Kong model can be viewed as an application case of “second-best regulation equilibrium.” Between complete freedom and strict prohibition, HKMA maximizes regulatory efficiency through differentiated licensing systems. From a transaction cost perspective, this function-oriented regulation achieves institutional equilibrium between openness and security. Its institutional design also features “institutional interoperability” : it both interfaces with EU MiCA and forms technical compatibility with the mainland

digital yuan (e-CNY) system, providing legal interfaces for cross-border payment pilots.

3.4.3 Institutional Risks and Cases The 2022 Terra-UST collapse event directly impacted Hong Kong regulation. HKMA research indicates that UST’s “death spiral” caused algorithmic stablecoin market value to plummet 99%, creating chain reactions in USDT and USDC market liquidity. Hong Kong’s institutional risks include: first, cross-border compliance risk—offshore projects may use Hong Kong registration to evade other countries’ regulations; second, technical vulnerability risk—smart contract errors may cause payment system failures; third, financial stability risk—if HKD-pegged stablecoins decouple from monetary policy, they may affect the linked exchange rate system.

3.5 Summary: Differences Among Models and Institutional Implications for China

Comparatively, the U.S. model emphasizes market-driven and functional regulation, being flexible but fragmented; the EU model focuses on legislative unification and systematic coordination, ensuring legal certainty but lacking innovation elasticity; Japan’s model reflects government leadership and policy pilots, promoting application experiments under risk-controllable conditions; Hong Kong’s model represents eclecticism, leaning toward equilibrium pursuit and serving as China’s external window.

For China, the implications are mainly: drawing on the function-oriented regulatory logic of the U.S. and Hong Kong to establish stablecoin review standards centered on usage and risk; absorbing the EU’s unified legislative experience to form a tiered classification system in digital yuan and crypto asset regulation; learning from Japan and Hong Kong’s regulatory sandbox mechanisms to ensure flexibility and security in innovation pilots combining patent financialization with digital currencies.

Comparison of Institutional Regulatory Structures, Law and Economics Logic, Core Objectives, and Typical Risks: United States, European Union, Japan, Hong Kong, and Mainland China

The ultimate goal should be to construct a “digital financial rule-of-law ecosystem” that conforms to China’s legal context, promoting IP capitalization and international innovation cooperation while maintaining monetary sovereignty and financial security, and building a “compliance + innovation” digital financial governance system.

4. Theoretical Reconstruction of China's Patent Pool Securitization—Reflections Based on Policy Reality and Law and Economics

In the global fintech reconstruction, the evolution of digital currency systems is profoundly influencing IP financialization pathways. The emergence of stablecoins has broken traditional monetary boundaries, while sovereign digital currencies (CBDC) have redefined the legal boundaries of “legal payment instruments” through state credit.

Against this backdrop, patent pool securitization, as an advanced form of IP financialization, is no longer merely “patent revenue capitalization” but an institutional coordination process embedded within the digital currency system. On one hand, China's pharmaceutical industry faces obvious financing constraints and innovation imbalances, with small and medium-sized biopharmaceutical R&D enterprises characterized by “many patents, little capital.” On the other hand, the rise of digital currencies and stablecoins provides new payment and circulation mechanisms for patent revenue rights securitization, but under China's regulatory framework, this mechanism exhibits three theoretical and policy tensions: first, the institutional conflict between monetary sovereignty and monetary liberalization; second, the balance between property incentives and market efficiency; third, the law and economics tension between innovation-driven and regulatory rigidity.

Therefore, this paper proposes that a systematic law and economics analytical framework should be used to theoretically reconstruct “patent pool securitization with Chinese characteristics”: ensuring sovereign monetary order while promoting pharmaceutical industry innovation financing through property rights clarification and market incentive mechanisms.

4.1 Policy Feasibility Analysis: Tension Between Financial Innovation and Legal Constraints

China has already undertaken preliminary reforms in IP financialization, such as patent pledge financing and IP securitization pilots, but these remain at the policy experimentation and partial exploration stage. Although patent pool securitization provides new financing pathways for small and medium-sized pharmaceutical enterprises, obvious institutional constraints remain in regulatory frameworks, asset valuation, and market mechanisms.

First, at the financial regulation level, China currently adopts a “prohibitive regulation” approach toward virtual currencies, explicitly excluding stablecoins and other crypto assets from the legal payment system. While this policy has legitimacy in maintaining financial security, it also creates an “institutional vacuum for digital financial innovation” —the time lag between technological innovation and regulatory response prevents some controllable innovations from entering the pilot system (see Table 3).

Second, at the securitization operation level, the legal attributes of patent pool assets have not been fully integrated into securities law logic. Although Article 2 of China's Securities Law (2020 Revision) permits "securitized products issued based on asset earnings," it does not explicitly define the securitization standards for intangible assets, particularly IP. This results in a lack of uniform rules for asset confirmation, revenue forecasting, and risk rating in patent pool securitization.

Third, at the monetary and payment level, China's foreign exchange management system has not yet allowed cross-border capital settlement through stablecoins or crypto assets. According to the State Administration of Foreign Exchange's 2022 report, cross-border payments still primarily rely on SWIFT and the Cross-Border Interbank Payment System (CIPS). Therefore, if patent pool securitization products need to attract international investors, new regulatory interfaces must be constructed within the central bank digital currency (e-CNY) cross-border payment system.

China's Main Virtual Currency Regulatory Policies Timeline

Overall, China currently has an innovation foundation at the policy level, but institutional design remains constrained by the macro regulatory logic of "prioritizing monetary sovereignty and financial security." To promote the combination of patent pool securitization and stablecoins, a controllable innovation pathway must be explored within the compliance framework.

4.2 Theoretical Dialogue: Reinterpretation Under Three Core Theoretical Frameworks

In the law and economics system, the goal of institutional design is to minimize transaction costs and achieve efficient resource allocation through legal rules. Based on this, the theoretical reconstruction of "patent pool securitization with Chinese characteristics" can be developed across three dimensions: monetary sovereignty, property incentives, and market incentives.

4.2.1 Chinese Reconstruction of Monetary Sovereignty Theory: State Credit and Institutional Boundaries

Monetary sovereignty in law and economics manifests as the state's exclusive control over payment instruments and clearing systems. Pistor (2021) points out that the monetary legal order is a "coding of power," with its core function being to maintain trust and enforceability. In the digital economy context, stablecoins, as a competitive combination of "private law credit" and "state credit," challenge traditional monetary sovereignty boundaries. Therefore, China achieves "digital extension of legal payment" institutionally through sovereign digital currency (e-CNY), replacing offshore stablecoin settlement functions and preventing financial risk diffusion from capital liberalization. This aligns with the "sovereignty-constrained efficiency model" in law and economics: the state ensures efficiency improvements within controllable risk ranges through institutional constraints.

4.2.2 Chinese Reconstruction of Property Incentives Theory: Incentives and Coordination in Patent Pool Securitization From a law and economics perspective, the key to patent pool securitization lies not in “formal innovation” but in property incentives within legal structures and achieving efficiency maximization and fairness balance. China’s IP system has long focused on “protecting innovation incentives,” but support for financialization and securitization means such as liquidity, pricing, and enforceability of rights remains insufficient. As empirical research finds: “In China, financial innovation can effectively alleviate information asymmetry and negative spillover effects in IP protection, promoting technological development of regulated enterprises. IP pledge financing helps regulated enterprises fund innovation activities by replacing high fault-tolerance institutional investors, effectively incentivizing innovation.” This demonstrates that a coordination mechanism of “dual reconstruction of technological trust and legal trust” can ensure patent pool securitization practice, forming a new IP innovation incentive framework: legal trust ensures rights stability and enforceability, while technological trust guarantees transaction transparency and automatic performance.

In the biopharmaceutical field, where patent value realization is highly uncertain, balance between incentives and coordination must rely on technological and legal trust: first, concentrating patent rights and unified licensing mechanisms to reduce negotiation costs; second, securitizing revenue rights to front-load future innovation earnings and enhance corporate cash flow; third, ensuring transparent distribution through smart contract automatic allocation to reduce opportunistic behavior. In law and economics terms, this is a three-dimensional composite structure of “property incentives + contract governance” : designing an enforceable contractual architecture, utilizing technology for operation and protection, to supplement the incompleteness of property systems in innovation incentive processes. This paper argues the core of biopharmaceutical patent pool securitization is: patent pool securitization is precisely a mechanism that optimizes property structures, uses computer technology to guarantee contracts, and achieves redistribution of innovation returns.

4.2.3 Chinese Reconstruction of Market Incentives (Market Efficiency): Legal Elasticity and Innovation Efficiency Coase and Posner’s law and efficiency theory states that the function of legal systems is not static balance but dynamic adjustment, enabling optimal allocation of innovation and risk within institutional elasticity. The core of global stablecoin regulation lies in preventing currency substitution and financial risk spillovers. In the context of combining digital currency with IP, market incentive mechanisms can be achieved through: first, using offshore stablecoins bound to e-CNY as settlement media to reduce cross-border transaction costs—stablecoins entering the central bank digital currency (e-CNY) system achieve controllable innovation in digital payment through state credit endorsement and distributed ledger control; second, achieving instant redemption and compliance regulation through smart contracts; third, establishing a “limited elasticity” regulatory

model that allows controlled innovation while preventing systemic risks.

This institutional elasticity reflects the unique advantages of China's rule-of-law system: through administrative guidance and pilot mechanisms, it maintains both policy flexibility and legal constraint stability.

4.2.4 Three-Dimensional Structure of Patent Pool Securitization with Chinese Characteristics Observed from a law and economics perspective, this three-dimensional model (see figure below) reveals the “endogenous logic” of China's institutional innovation: achieving optimal coordination among monetary governance, IP incentives, and market efficiency within limited sovereign boundaries through legal system design. In institutional evolution, this coordination is not spontaneous equilibrium but an “embedded equilibrium”—the state achieves dual objectives of innovation-driven and risk-controllable through coupling digital currency infrastructure, IP legal systems, and financial regulatory systems.

Therefore, patent pool securitization is not only a financial innovation but also an institutional experiment under the sovereign monetary rule-of-law system, reflecting “structural adaptation” and “functional elasticity” in the law and economics sense.

[Figure 2: see original paper] Three-Dimensional Structure of Law and Economics

4.3 Institutional Evolution Path of Chinese-Style Biopharmaceutical Patent Pool Securitization

Under the law and economics analytical framework, Chinese-style “patent pool securitization” is not an isolated financial innovation but an institutional evolution phenomenon reflecting interactive adjustments among monetary sovereignty, property incentives, and market mechanisms. To reveal this evolutionary logic, this paper constructs the “institutional evolution” pathway shown below, based on law and economics institutional efficiency theory and legal elasticity theory to explore the dynamic operation mechanism (see Figure 3 [Figure 3: see original paper]).

4.3.1 Input Layer: Three-Element Structure of Sovereign Currency, Property Incentives, and Market Efficiency The initial layer of institutional evolution is the input layer, whose core includes three institutional elements: First, **monetary sovereignty**. The state establishes the priority of legal tender in financial settlement and payment systems through the issuance and circulation of central bank digital currency (e-CNY), binding offshore stablecoin issuance, thereby ensuring that patent securitization activities do not deviate from the monetary sovereignty framework. The institutional function of monetary sovereignty lies not only in payment stability but also in establishing

“compliance boundaries” for capital flows to prevent “sovereignty spillover risks” in digital financialization.

Second, **property incentives**. The patent pool system clarifies and securitizes patent revenue rights through centralized authorization and revenue-sharing mechanisms, thereby reducing transaction costs. According to Demsetz’ s property rights theory, the clarity of property rights definition is positively correlated with transaction efficiency, and improved property systems help form predictable investment incentives and innovation return mechanisms.

Third, **market efficiency**. Market mechanisms in patent pool securitization are strengthened through smart contracts and cross-border payment systems. Using offshore stablecoins + digital yuan as payment media, combined with blockchain accounting mechanisms, not only reduces transaction costs but also enhances transparency and security of cross-border flows. This enables patent pool securitization to transcend local capital markets and possess international circulation potential.

4.3.2 Coordination Layer: Legal Elasticity and Institutional Integration The second layer of institutional evolution is the coordination layer—the legal reconciliation and institutional adaptation among monetary sovereignty, property systems, and market mechanisms. Its core lies in achieving institutional integration and legal elasticity.

Legal elasticity (Pistor, 2021) means legal rules have sufficient adaptability to accommodate technological and market changes while maintaining institutional stability. China’ s current financial regulatory system enables digital financial innovation within safe boundaries through a dual mechanism of “functional regulation + regulatory sandbox.” This aligns with Posner’ s “efficiency-oriented legal adjustment theory,” which argues that legal systems must balance efficiency and predictability to prevent institutional rigidity from inhibiting innovation.

Under this framework, China’ s regulatory coordination mechanism should be divided into three categories: First, regulatory adaptation—resolving legal attribute definition and transaction compliance issues for patent securitization products through integration of financial law and IP law; second, technology governance—achieving traceability of cross-border payments and regulation through digital yuan infrastructure; third, incentive compatibility—ensuring synchronized revenue distribution and risk prevention through automatic execution of smart contract terms. This layer’ s institutional characteristic is “embedded coordination,” where markets and law achieve two-way interaction through state regulatory mechanisms.

4.3.3 Output Layer: Efficiency and Sovereign Security Synergy Optimization Under the Chinese Model The output layer represents the final outcome of institutional evolution—the formation of the “Chinese patent pool securitization model.” This model’ s characteristics manifest in three aspects: First,

innovation financing efficiency. Under the sovereign currency system, securitized products based on patent revenues can achieve faster liquidity and capital recovery, alleviating financing difficulties for SMEs. Second, **legal stability and sovereign security.** Through e-CNY's compliant payment mechanism, the state can control cross-border capital flows and prevent "spillover effects" on financial sovereignty. This embodies "sovereignty-constrained equilibrium" in institutional economics—states maintain macro stability through regulatory power. Third, **cross-border financial integration.** Drawing on the MiCA experience, China can promote international alignment of digital financial rules and enhance international competitiveness by issuing offshore compliant stablecoins anchored to digital yuan (e-CNY) while maintaining regulatory sovereignty.

From a law and economics perspective, this model's core is not simply pursuing innovation efficiency but achieving "synergy optimization of efficiency and sovereign security" through institutional evolution. This reflects China's new legal logic in global digital economy governance—achieving balance between innovation incentives and market integration under sovereign constraints through institutional adaptation and legal elasticity.

[Figure 3: see original paper] Evolution Pathway Diagram

4.4 Model Construction: Biopharmaceutical Patent Pool Securitization Model Under Sovereign Digital Currency + Stablecoin

4.4.1 Model Logic: Patent Pool →Securitized Product →Offshore (Sandbox) Stablecoin + Onshore Digital Yuan Payment/Settlement →Revenue Distribution The basic logic of patent pool securitization lies in concentrating revenue expectations from multiple patent holders to form predictable cash flows, then conducting risk stratification and securitized issuance through structured financial instruments. However, traditional patent securitization faces limitations such as insufficient liquidity, cross-border payment obstacles, and high transaction costs. Therefore, introducing stablecoins as settlement and distribution mechanisms can construct a closed-loop structure of "patent pool—securitized product—stablecoin settlement—revenue distribution," which also aligns with the technological innovation system theory in economics: "patent pool—securitized product—stablecoin settlement—revenue distribution—R&D investment feedback (patent formation)—new patent pool."

The first stage is patent pool formation. Pharmaceutical enterprises, research institutions, and investors collectively manage relevant drug patents through contracts or trusts, reducing transaction friction from "patent thickets" and achieving revenue unification. This stage's core lies in IP rights confirmation and standardization of licensing revenues. Research shows that in industries with high R&D costs and high failure rates, patent pools can significantly reduce licensing negotiation costs and transaction friction.

The second stage is securitized product design. A special purpose vehicle (SPV) packages future licensing revenues from the patent pool into underlying asset

pools, which after credit rating and risk stratification issue securitized products (ABS/IP-Backed Securities). This process must comply with the Securities Law, Trust Law, and related disclosure obligations.

The third stage is stablecoin payment and settlement. Using a dual currency structure of offshore stablecoins anchored to onshore central bank digital currency (e-CNY) as transaction and redemption media can achieve high efficiency and low cost in cross-border settlement (Odintsov & Zyryanova, 2022). Simultaneously, smart contracts can automatically trigger revenue distribution, enhancing transparency and enforceability.

The fourth stage is revenue distribution and refinancing. Cash flows generated by securitized products can be automatically distributed to investors' wallets through smart contracts, with some stablecoins reinvested into new patent pool projects, forming a circular financing mechanism. This model achieves integration of "innovation assets—financial instruments—payment mechanisms," enhancing the sustainability of IP financialization (see Figure 4 [Figure 4: see original paper]).

[Figure 4: see original paper] Biopharmaceutical Patent Pool Investment Cycle Diagram

4.4.2 Model Innovation: Cross-Border Applications Supported by Smart Contracts + Stablecoin and Digital Yuan In this model, the embedding of smart contracts + offshore stablecoins and onshore digital yuan (e-CNY) constitutes the core of institutional innovation. Smart contracts automatically execute revenue distribution, redemption, collateral release, and other operations when predetermined conditions are met. They not only enhance automation and transparency of financial transactions but also provide real-time data support for judicial supervision and compliance auditing.

The People's Bank of China explicitly stated in the "Digital Yuan Development Progress White Paper" (2021) that e-CNY possesses both legal tender status and controlled anonymity, enabling payment transparency and compliance supervision in cross-border scenarios. If e-CNY is incorporated into the patent securitization settlement system, it can reduce the potential risk asset attributes of offshore stablecoins while safeguarding legal tender status and AML compliance.

Therefore, at the monetary settlement level, China can explore a two-tier system with parallel central bank sovereign digital currency (CBDC) and offshore compliant stablecoins: first, the **onshore layer**—dominated by e-CNY for domestic patent pool revenue settlement and distribution to ensure regulatory control; second, the **offshore layer**—issuing offshore compliant stablecoins (similar to USDC, EURE) to participate in cross-border financing and settlement to attract international capital. This system's key lies in issuance classification, functional division, and regulatory mutual recognition, balancing sovereign security and cross-border liquidity through "tiered regulation of monetary functions."

Thus, embedding smart contracts and digital yuan + stablecoins in patent securitization not only helps improve capital circulation efficiency but also legally achieves a traceable, accountable, and auditable financial ecosystem.

4.4.3 Comparison with Traditional Models: Liquidity, Transparency, and Risk Management Compared with traditional patent securitization, the “stablecoin + digital yuan + patent pool” model has advantages in three dimensions: First, **enhanced liquidity**: On-chain settlement of stablecoins and digital yuan facilitates cross-border capital flows, reducing foreign exchange and clearing costs, which is particularly relevant for cross-border financing of small and medium-sized pharmaceutical enterprises. Second, **improved transparency**: Blockchain ledgers and smart contracts record the entire transaction process, making patent revenue distribution transparent and traceable, reducing information asymmetry. Third, **optimized risk management**: Automated risk control through algorithmic rules and smart contract mechanisms, combined with the legal attributes of central bank digital currencies, enhances transaction security.

However, the model also has shortcomings: First, stablecoin “depegging” or algorithmic failure risks may still cause systemic liquidity crises. Second, smart contracts face technical vulnerabilities and attack risks, requiring strict code auditing and formal verification, plus a “smart contract lifecycle management framework,” with judicial governance and technical standards jointly advancing risk control in blockchain finance. Third, legally, cross-border payments involve complex issues such as foreign exchange controls, monetary sovereignty, and judicial jurisdiction conflicts, requiring clear regulatory boundaries.

Therefore, patent pool securitization should prioritize using central bank digital currency (e-CNY) bound to compliant stablecoins within regulatory sandboxes (such as Hong Kong) to ensure capital safety and policy controllability.

4.4.4 Summary: Chinese-Style Biopharmaceutical Patent Securitization Model Through law and economics retrospection, the Chinese-style biopharmaceutical patent securitization model demonstrates a logic of “institutionally embedded innovation” : achieving collaborative equilibrium between innovation incentives and rule-of-law order through institutional elasticity under sovereign constraints. This model can be summarized as a “tripartite balance model” (see Table 4). From a law and economics perspective, this institutional innovation not only responds to the practical needs of IP financialization but also reflects the structural self-evolution of China’s rule-of-law system in the digital era. It does not pursue isomorphism through institutional transplantation but emphasizes institutional adaptation under sovereign logic, which is precisely the core value of Chinese-style digital financial rule-of-law innovation.

Tripartite Balance Model

5. Conclusion

5.1 Research Review and Core Findings

This paper examines biopharmaceutical patent pool securitization as an entry point, exploring the interactive relationship between patent pool securitization and digital currency institutional innovation from a law and economics perspective. Based on comparative analysis of institutional experiences in the United States, European Union, Japan, and Hong Kong, combined with China's regulatory environment and policy logic, the paper proposes a law and economics reconstruction framework for Chinese-style biopharmaceutical patent securitization.

The study finds that China's current institutional environment presents “three structural tensions”: first, the tension between sovereign logic and market logic—financial regulation's strong sovereign orientation ensures systemic stability but somewhat inhibits innovation efficiency and cross-border capital flows; second, the fragmentation tension of the legal system—IP law, securities law, and financial regulatory law have not yet achieved coordination at institutional boundaries, leading to ambiguous legal attributes of innovative assets; third, the functional misalignment between policy and market—policy focuses on risk prevention and compliance review, while market mechanisms have not yet formed sufficient incentive structures.

Against this backdrop, this paper constructs a “tripartite synergy model of monetary sovereignty—property incentives—market efficiency” through a law and economics analytical framework, proposing “institutionally adaptive innovation under sovereign constraints” as the core theoretical proposition for China's pathway. This model reveals that the uniqueness of China's institutional innovation does not stem from complete marketization or legal isomorphism but from achieving dynamic balance between innovation and security through legal elasticity and institutional coordination within a strong sovereign system.

5.2 Theoretical Significance: From Institutional Transplantation to Institutional Genesis

At the theoretical level, this paper expands and integrates existing research on IP financialization and digital currency regulation, with main innovations in three aspects:

First, it breaks through the limitations of the “institutional transplantation” perspective. Previous research on patent securitization mostly borrowed from the U.S. Royalty Pharma model or EU High-Quality Securitization (HQS) system without fully considering China's unique regulatory logic and monetary system. This paper emphasizes “institutional genesis” rather than simple imitation, achieving a Chinese-style financial innovation framework through adaptive reconstruction of existing institutions.

Second, it constructs a three-dimensional law and economics analytical frame-

work. Using monetary sovereignty, property incentives, and market efficiency as three pillars, the paper reveals the “embedded coordination mechanism” in China’s financial legal system. This framework inherits Posner’s “efficiency-oriented rule of law” theory and Demsetz’s property rights evolution logic, demonstrating that the core function of legal systems lies in reducing transaction costs and maintaining institutional predictability. Through analysis of the digital yuan (e-CNY) and patent pool securitization combination mechanism, the paper further verifies the practical applicability of the law and economics proposition of “sovereignty-embedded markets.”

Third, it proposes a Chinese model of “coexistence of institutional elasticity and functional regulation.” In regulatory theory, the paper advocates replacing “entity classification regulation” with “functional regulation,” granting institutional elasticity through regulatory sandboxes and tiered authorization mechanisms to cope with rapid iteration of digital finance.

Therefore, China’s biopharmaceutical patent securitization system should not be viewed as “delayed imitation” of Western legal structures but understood as an institutional innovation form endogenously generated within the sovereign financial order.

5.3 Institutional Significance: From Financial Security to Innovation Governance

Institutionally, this paper demonstrates that Chinese-style biopharmaceutical patent securitization is not merely financial innovation or IP policy reform but a comprehensive institutional engineering project whose goal is to achieve macro balance among “security—efficiency—innovation”: first, at the financial security level, the sovereign currency framework centered on digital yuan, combined with a dual-tier currency structure of offshore sandbox stablecoins, ensures controllability and compliance of cross-border settlement, preventing offshore stablecoins from directly impacting the national monetary system; second, at the innovation incentive level, the patent pool securitization mechanism achieves IP capitalization and risk sharing, providing new financing channels for pharmaceutical SMEs; third, at the institutional coordination level, the combination of smart contracts and regulatory sandboxes achieves integration of “technological governance and legal governance,” forming a dynamically adjustable institutional ecosystem.

The significance of this institutional model lies in being the first to incorporate sovereign currency, offshore stablecoins, IP, and financial regulation into a unified institutional framework, achieving an institutional leap “from sectoral coordination to systematic integration.” This not only provides a sample for domestic rule-of-law modernization but also offers Chinese solutions to global digital financial governance.

5.4 Outlook: From Institutional Coordination to Chinese Solutions for Global Governance

Looking forward, China's biopharmaceutical patent securitization system needs to further achieve balance between institutional openness and risk controllability. This paper suggests three directions for institutional optimization and theoretical deepening:

First, promote cross-border institutional mutual recognition. China can connect with EU MiCA and Hong Kong VASP systems under the Belt and Road Initiative and Guangdong-Hong Kong-Macao Greater Bay Area framework to form international digital financial rule mutual recognition mechanisms, laying legal foundations for international circulation of biopharmaceutical patent pool securitization.

Second, construct a multi-level IP financial market. China should promote a multi-layer capital system covering IP pledge financing, securitization products, and risk reinsurance, drawing on U.S. IP market experience to establish a national-level IP trading center.

Third, improve the digital financial rule-of-law system. China needs to promptly enact foundational legislation such as the Digital Finance Law, clarifying the legal status of digital assets and finance, and establishing a rule-of-law framework with both elasticity and constraints.

From a broader perspective, in constructing the “digital yuan + regulatory sandbox stablecoin + patent securitization” institutional system, China is exploring a new global financial governance logic: using sovereign currency as the institutional anchor, offshore sandbox stablecoins as the leverage, IP financialization as market momentum, and legal adaptability as governance tools, ultimately achieving symbiosis and co-prosperity among rule-of-law order, technological innovation, and international coordination.

As American legal scholar Katharina Pistor states in *The Code of Capital: How the Law Creates Wealth and Inequality*: “The power of law lies in its ability to construct capital, and the wisdom of law lies in its ability to maintain order amid change.” This proposition is precisely the theoretical fulcrum for China's institutional innovation to move toward the center of global digital economy governance.

Note: Figure translations are in progress. See original paper for figures.

Source: ChinaXiv – Machine translation. Verify with original.