商品权属通证化：第三类标准化资产市场的形成逻辑与演化路径——以黄金数字凭证体系为切入点

Commodity Ownership Tokenization: Formation Logic and Evolution Path of the Third Category of Standardized Asset Market — A Perspective from the Digital Gold Voucher System

研究领域：金融科技、货币经济学、大宗商品市场

Research Fields: Fintech, Monetary Economics, Commodity Markets

作者：郭洋洋
Author: Guo Yangyang
ORCID：0009-0006-6669-1790
Contact email：gyy-goes@foxmail.com
Publication Type: Preprint
Submission Date：October 20, 2026
Version: v1.0 Final Bilingual Edition
Preprint DOI: 10.5281/zenodo.23500874
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摘要

Abstract

数字经济背景下，以比特币为代表的无许可加密资产快速兴起，在满足跨主权储值与点对点流转需求的同时，也因缺乏实物信用锚定、监管缺位等问题对主权货币体系形成冲击。与此同时，传统金融体系中股票市场与期货市场分别承担股权融资与风险对冲职能，但现货大宗商品的权属流转始终存在效率低下、权益与实物割裂的结构性断层。

Against the backdrop of the digital economy, permissionless crypto assets

represented by Bitcoin have risen rapidly. While meeting the demand for cross-sovereign value storage and peer-to-peer transfer, they have also exerted impacts on sovereign monetary systems due to the lack of physical credit anchors and regulatory oversight. Meanwhile, in the traditional financial system, the stock market and futures market undertake equity financing and risk hedging functions respectively, yet there exists a long-standing structural gap in the ownership transfer of spot commodities: low efficiency and the separation between equity interests and physical assets.

本文基于交易成本理论、货币分层理论与金融市场演化逻辑，提出**商品权属通证化将形成继股票、期货之后的第三类标准化资产市场形态**，其核心特征是原生绑定现货实物权属、无到期约束、可颗粒化拆分与即时流转，并支持随时行权实物交割，本质是打通了“权益持有”与“实物交割”的市场断层，实现功能层面的效率跃迁。

Based on transaction cost theory, monetary hierarchy theory and the evolution logic of financial markets, this paper proposes that **commodity ownership tokenization will give rise to the third category of standardized asset market, following the stock and futures markets**. Its core features include native binding to spot physical ownership, no maturity constraint, granular divisibility, instant transferability, and on-demand physical delivery. In essence, it bridges the market gap between "equity holding" and "physical delivery" and realizes efficiency leap at the functional level.

本文以黄金作为初始适配标的，构建了“标准筑基—网络成型—零售扩容—全品类扩展”的四阶段演化路径，并从主权博弈视角论证了该体系的内生推进动力：主权国家可通过构建“法币稳定币+贵金属数字凭证”的二元数字资产体系，补全数字时代的货币职能版图，实现对无监管加密资产的合规替代，同时重构大宗商品的定价权与流转效率。最后，本文探讨了该体系的风险约束与监管框架，为后续实践与理论研究提供顶层分析框架。

Taking gold as the initial applicable asset, this paper constructs a four-stage evolution path: "standard foundation — network formation — retail expansion — full-category extension". From the perspective of sovereign game, it demonstrates the endogenous driving force of the system: sovereign states can complement the monetary function map in the digital era by building a dual digital asset system of "fiat-backed stablecoins + precious metal digital vouchers", realize compliant substitution of unregulated crypto assets, and reshape the pricing power and circulation efficiency of bulk commodities. Finally, this paper discusses the risk constraints and regulatory framework of the system, providing a top-level analytical framework for subsequent practice and theoretical research.

关键词：实物资产通证化；商品权属凭证；第三类资产市场；黄金数字化；货币主权；分布式交割网络

Keywords: Real-World Asset Tokenization; Commodity Ownership Voucher; Third Category of Asset Market; Gold Digitization; Monetary Sovereignty; Distributed Delivery Network

一、引言

I. Introduction

1.1 研究背景与问题提出

1.1 Research Background and Problem Statement

数字技术对金融体系的重构正在从支付端向资产端深化。一方面，以比特币为代表的公链加密资产凭借无中介确权、跨境点对点流转、供给刚性等特征，快速占据了数字时代跨主权储值与规避管制的需求生态位，但其价值完全依赖群体共识、无实物信用兜底、监管缺位等内生缺陷，也带来了投机炒作、洗钱风险与货币主权侵蚀等问题。另一方面，传统大宗商品市场长期存在结构性割裂：股票市场实现了股权的标准化流转，但无实物资产对应；期货市场实现了远期价格发现与套期保值，但合约有到期约束、交割门槛高，不适用于长期现货持有；传统现货贸易则存在流转成本高、确权繁琐、重复质押风险等痛点。

The restructuring of the financial system by digital technology is deepening from the payment side to the asset side. On the one hand, public-chain crypto assets represented by Bitcoin, with features such as intermediary-free ownership verification, cross-border peer-to-peer transfer and rigid supply, have quickly occupied the niche of cross-sovereign value storage and regulatory avoidance in the digital era. However, their endogenous flaws — value fully dependent on collective consensus, no physical credit backing, and lack of regulation — have also brought about problems such as speculative hype, money laundering risks and erosion of monetary sovereignty. On the other hand, the traditional commodity market has long been structurally fragmented: the stock market realizes standardized transfer of equity without corresponding physical assets; the futures market realizes forward price discovery and hedging, but contracts have maturity constraints and high delivery thresholds, making them unsuitable for long-term spot holding; traditional spot trade suffers from high circulation costs, cumbersome ownership verification and the risk of repeated pledge.

现有实践与研究多将黄金数字化、仓单上链视为传统业务的技术升级，未从市场形态演化的层面界定其本质。本文试图回答三个核心问题：第一，实物资产通证化是否会催生独立于股票、期货的第三类标准化资产市场？第二，该市场为何以黄金为初始切入点，其演化路径遵循何种规律？第三，主权体系为何必然推进该体系建设，其底层博弈逻辑是什么？

Existing practices and studies mostly regard gold digitization and warehouse receipt on-chaining as technical upgrades of traditional businesses, without defining their essence from the perspective of market form evolution. This paper attempts to answer three core questions: First, will real-world asset tokenization give birth to a third category of standardized asset market independent of the stock and futures

markets? Second, why does this market take gold as the initial entry point, and what laws does its evolution path follow? Third, why is the sovereign system bound to promote the construction of this system, and what is the underlying game logic?

1.2 文献综述与理论基础

1.2 Literature Review and Theoretical Foundation

1.2.1 相关研究进展

1.2.1 Related Research Progress

真实资产代币化（Real World Asset, RWA）是当前金融科技领域的研究热点。国际清算银行（BIS，2025）的研究指出，大宗商品通证化可显著提升清算效率，但需警惕链下信用风险与跨境监管套利；世界黄金协会（2026）提出了批发级数字黄金的基础设施框架，论证了黄金数字化对机构市场的效率提升作用；国内学者则多聚焦于仓单通证化的技术实现与供应链金融应用。但现有研究普遍停留在技术效率与单一品类层面，未对市场形态的范式跃迁做出系统性界定，也缺乏主权博弈视角的动力机制分析。

Real-World Asset (RWA) tokenization is a research hotspot in the current fintech field. A study by the Bank for International Settlements (BIS, 2025) points out that commodity tokenization can significantly improve clearing efficiency, but off-chain credit risks and cross-border regulatory arbitrage need to be guarded against. The World Gold Council (2026) proposed an infrastructure framework for wholesale digital gold and demonstrated the efficiency improvement effect of gold digitization on institutional markets. Domestic scholars mostly focus on the technical implementation of warehouse receipt tokenization and its application in supply chain finance. However, existing studies generally remain at the level of technical efficiency and single asset category, without systematic definition of the paradigm shift of market form, and lack analysis of the driving mechanism from the perspective of sovereign game.

1.2.2 核心理论基础

1.2.2 Core Theoretical Foundations

1. **交易成本与产权理论**：科斯（Coase, 1937）与诺斯（North, 1990）的理论表明，市场效率的核心是产权的清晰界定与低成本流转。技术进步降低交易成本时，会催生新的市场组织形态。商品权属通证化本质是通过密码学与分布式账本技术，将实物资产的产权拆细、确权、上链，大幅降低现货权属的流转成本。

1. **Transaction Cost and Property Rights Theory**: The theories of Coase (1937) and North (1990) show that the core of market efficiency lies in the clear definition

and low-cost transfer of property rights. When technological progress reduces transaction costs, new forms of market organization will emerge. In essence, commodity ownership tokenization uses cryptography and distributed ledger technology to subdivide, verify and record the property rights of physical assets on the chain, greatly reducing the circulation cost of spot ownership.

2. **货币分层与商品货币理论**：从门格尔（Menger, 1892）的商品货币起源论到当代货币经济学的分层框架，货币体系天然呈现二元结构：信用货币（法币）承担计价、流通与宏观调控职能，商品货币（贵金属等）承担跨周期储值与跨主权避险职能，二者长期互补共存，而非非此即彼。

2. **Monetary Hierarchy and Commodity Money Theory**: From Menger's (1892) theory of the origin of commodity money to the hierarchical framework of contemporary monetary economics, the monetary system naturally presents a dual structure: credit money (fiat currency) undertakes the functions of pricing, circulation and macroeconomic regulation, while commodity money (precious metals, etc.) undertakes the functions of cross-cycle value storage and cross-sovereign risk hedging. The two coexist complementarily for a long time, rather than being mutually exclusive.

3. **金融市场演化理论**：金融市场的发展史是非标资产持续标准化的历史。非标股权标准化催生股票市场，非标远期合约标准化催生期货市场。按照这一演化逻辑，非标现货仓单的标准化，将催生第三类专注于现货权属高效流转的市场形态。

3. **Financial Market Evolution Theory**: The history of financial markets is a history of continuous standardization of non-standard assets. The standardization of non-standard equity gave birth to the stock market, and the standardization of non-standard forward contracts gave birth to the futures market. Following this evolutionary logic, the standardization of non-standard spot warehouse receipts will give birth to a third category of market form focusing on the efficient circulation of spot ownership.

1.3 研究思路与创新点

1.3 Research Ideas and Innovations

本文采用范式辨析—路径推演—动力论证的研究框架：首先通过三类市场的范式对比，界定第三类资产市场的独立边界；其次以黄金为样本，构建分阶段演化路径；最后从主权博弈视角解释其内生推进动力。

This paper adopts a research framework of paradigm differentiation — path deduction — motivation demonstration: first, define the independent boundary of the third category of asset market through paradigm comparison of three types of markets; second, take gold as a sample to construct a phased evolution path; finally, explain its endogenous driving force from the perspective of sovereign game.

本文的核心创新点在于：

The core innovations of this paper are as follows:

1. **理论层面**：首次明确提出“第三类标准化资产市场”的范畴，系统界定其范式特征与功能边界，填补了现有研究对市场形态顶层定义的空白；

1. **Theoretical level**: For the first time, it explicitly puts forward the category of "the third category of standardized asset market", systematically defines its paradigm characteristics and functional boundaries, and fills the gap in existing research on the top-level definition of market form.

2. **路径层面**：构建了从黄金单点切入到全品类扩展的四阶段演化模型，明确各阶段的目标、主体与约束条件；

2. **Path level**: It constructs a four-stage evolution model from single-point entry of gold to full-category extension, and clarifies the objectives, participants and constraints of each stage.

3. **视角层面**：从货币主权防御与大宗商品定价权重构的视角，论证了该体系的内生推进逻辑，解释了主权体系主动布局的底层动因。

3. **Perspective level**: From the perspective of monetary sovereignty defense and restructuring of commodity pricing power, it demonstrates the endogenous promotion logic of the system and explains the underlying motivation for the sovereign system to take the initiative in layout.

二、三类标准化资产市场的范式辨析与理论边界

II. Paradigm Differentiation and Theoretical Boundaries of Three Categories of Standardized Asset Markets

2.1 传统两类标准化市场的功能定位与内在局限

2.1 Functional Positioning and Inherent Limitations of Two Traditional Standardized Markets

股票市场与期货市场是现代金融体系的两类核心标准化市场，但其功能存在明确的边界与局限：

The stock market and the futures market are two core types of standardized markets in the modern financial system, but their functions have clear boundaries and limitations:

- **股票市场**：标的为企业所有权份额，核心功能是直接融资与权益定价，无实物交割属性。其局限在于仅覆盖股权类资产，无法满足实物商品的权属流转与储值需求，投资者仅持有价格敞口，不对应底层实物资产。

- **Stock market**: The underlying assets are enterprise ownership shares. Its core functions are direct financing and equity pricing, with no physical delivery attribute. Its limitation is that it only covers equity assets and cannot meet the demand for ownership transfer and value storage of physical commodities. Investors only hold price exposure without corresponding underlying physical assets.

- **期货市场**：标的为标准化远期合约，核心功能是价格发现与套期保值，实物交割为附属功能且门槛极高。其局限在于合约有到期日，存在移仓成本，杠杆属性强，不适用于长期现货持有与储值场景。

- **Futures market**: The underlying assets are standardized forward contracts. Its core functions are price discovery and hedging. Physical delivery is an auxiliary function with an extremely high threshold. Its limitation is that contracts have maturity dates, position rolling costs and strong leverage attributes, making them unsuitable for long-term spot holding and value storage scenarios.

二者的共同断层在于：**缺乏一种同时具备“标准化可拆分、高流动性、无到期约束、原生绑定实物权属、可随时交割”的资产形态**。投资者只能在“无实物的权益凭证”和“有到期约束的合约”之间二选一，无法实现“持有即拥有现货、流转即转移权属、随时可提取实物”的完整需求。

The common gap between the two lies in the **lack of an asset form that simultaneously features standard divisibility, high liquidity, no maturity constraint, native binding to physical ownership, and on-demand delivery**. Investors can only choose between "equity vouchers without physical assets" and "contracts with maturity constraints", and cannot meet the complete demand of "holding means owning spot, transferring means transferring ownership, and physical assets can be withdrawn at any time".

2.2 商品权属通证市场的核心范式特征

2.2 Core Paradigm Features of the Commodity Ownership Token Market

商品权属通证市场的标的是**对应标准化实物商品的链上权属凭证**，每单位通证与固定规格、固定品级的实物商品一一对应，由合规交割库提供仓储与兑付担保。其核心范式特征可归纳为五点：

The underlying assets of the commodity ownership token market are **on-chain ownership vouchers corresponding to standardized physical commodities**. Each unit of token corresponds one-to-one to physical commodities of fixed specifications and grades, with storage and redemption guarantees provided by compliant delivery warehouses. Its core paradigm features can be summarized into five points:

1. **标的原生绑定实物权属**：通证不是价格敞口凭证，也不是远期合约，而是现货商

品的所有权份额，持有通证即对应持有对应比例的实物商品；

1. **Native binding of underlying assets to physical ownership**: Tokens are neither price exposure vouchers nor forward contracts, but ownership shares of spot commodities. Holding tokens corresponds to holding a proportional share of physical commodities.

2. **无到期约束，可长期持有**：不存在期货的到期日与移仓需求，适配长期储值、资产配置场景；

2. **No maturity constraint, available for long-term holding**: There is no futures maturity date or position rolling demand, which is suitable for long-term value storage and asset allocation scenarios.

3. **颗粒化拆分，高流动性**：可拆分为极小单位（如克级黄金），实现 7×24 小时即时流转，权属转移秒级完成；

3. **Granular divisibility and high liquidity**: It can be divided into very small units (e.g., gram-level gold), realizing 7×24 instant transfer, with ownership transfer completed in seconds.

4. **随时行权交割**：持有人累计份额达到交割门槛后，可随时向任意合规交割库申请提取实物商品，权益与实物的兑付通道原生打通；

4. **On-demand exercise and delivery**: After the holder's accumulated shares reach the delivery threshold, they can apply to any compliant delivery warehouse for physical commodity withdrawal at any time, with a natively connected redemption channel between equity and physical assets.

5. **许可型分布式架构**：采用准入制节点网络，交割库、发行机构均需持牌，监管可穿透接入，区别于无许可公链的完全去中心化。

5. **Permissioned distributed architecture**: It adopts an access-controlled node network. Delivery warehouses and issuing institutions are required to hold licenses, and regulators can have penetrating access, which is different from the complete decentralization of permissionless public chains.

2.3 三类市场的功能互补性与边界划分

2.3 Functional Complementarity and Boundary Division of Three Types of Markets

三类市场并非替代关系，而是功能互补，分别覆盖金融市场的不同核心需求：

The three types of markets are not substitutional but functionally complementary, covering different core demands of the financial market respectively:

市场形态	核心标的	首要功能	交割属性	存续周期	信用底座

Market Form	Core Underlying	Primary Function	Delivery Attribute	Duration	Credit Foundation
股票市场 Stock Market	企业所有权份额 Enterprise ownership shares	股权融资、权益定价 Equity financing, equity pricing	无实物交割 No physical delivery	与企业存续绑定 Tied to enterprise survival	企业信用与经营现金流 Corporate credit and operating cash flow
期货市场 Futures Market	标准化远期合约 Standardized forward contracts	价格发现、套期保值 Price discovery, hedging	到期附属交割，门槛高 Ancillary delivery at maturity, high threshold	固定到期日 Fixed maturity date	交易所信用与保证金制度 Exchange credit and margin system
商品权属通证市场 Commodity Ownership Token Market	现货商品权属凭证 Spot commodity ownership vouchers	现货权属流转、跨周期储值 Spot ownership transfer, cross-cycle value storage	原生随时行权交割 Native on-demand exercise and delivery	无到期约束，长期有效 No maturity constraint, valid long-term	实物资产信用+交割库监管信用 Physical asset credit + regulatory credit of delivery warehouses

可以看出，商品权属通证市场填补了“现货储值+高效流转”的市场空白，是金融市场标准化演进的必然方向，构成了继股票、期货之后的第三类独立标准化资产市场形态。

It can be seen that the commodity ownership token market fills the market gap of "spot value storage + efficient circulation", which is an inevitable direction of the standardization evolution of financial markets, and constitutes the third independent standardized asset market form following the stock and futures markets.

三、黄金作为初始标的的适配性分析

III. Adaptability Analysis of Gold as the Initial Underlying Asset

大宗商品通证化的落地需满足**标准化程度高、核验成本低、价值密度高、交割体系成熟**四大选型标准。黄金是所有大宗商品中唯一同时满足全部标准的品类，天然成为该市场形态的初始切入点。

The implementation of commodity tokenization needs to meet four selection criteria: **high standardization, low verification cost, high value density, and mature delivery system**. Gold is the only category among all bulk commodities that meets all four criteria at the same time, and naturally becomes the initial entry point of this market form.

3.1 黄金的标准化与信用优势

3.1 Standardization and Credit Advantages of Gold

黄金是全球标准化程度最高的大宗商品：LBMA（伦敦金银市场协会）与各大期货交易所已形成全球统一的交割标准，对金条成色、重量、溯源规则有明确规范，一次质检即可实现全球通用，核验成本极低。同时，黄金具备跨文明、跨政权的价值共识，其物理属性构成天然的供给约束——开采、运输、仓储均有真实成本，无法零成本凭空增发，这使其成为跨越千年的储值载体，信用底座不依赖任何单一主权主体。

Gold is the most standardized bulk commodity in the world: the London Bullion Market Association (LBMA) and major futures exchanges have formed a globally unified delivery standard, with clear specifications on gold bar fineness, weight and traceability rules. A single quality inspection can achieve global universal recognition with extremely low verification costs. Meanwhile, gold has cross-civilization and cross-regime value consensus. Its physical attributes constitute natural supply constraints — mining, transportation and storage all have real costs, and zero-cost 凭空 issuance is impossible. This makes it a value storage carrier spanning thousands of years, with a credit foundation independent of any single sovereign entity.

3.2 黄金数字化的需求基础

3.2 Demand Foundation for Gold Digitization

一方面，数字时代跨主权储值、资产配置的需求持续上升，而传统黄金存在流转不便、拆分门槛高、托管成本高的痛点；另一方面，无许可加密资产的投机性与监管风险凸显，市场迫切需要具备实物兜底的合规数字储值资产。黄金数字凭证既保留了黄金的储值信用，又具备数字资产的流转便利性，刚好承接这一需求缺口。

On the one hand, the demand for cross-sovereign value storage and asset allocation continues to rise in the digital era, while traditional gold suffers from inconvenient

circulation, high splitting thresholds and high custody costs. On the other hand, the speculative nature and regulatory risks of permissionless crypto assets have become prominent, and the market urgently needs compliant digital value storage assets with physical backing. Digital gold vouchers not only retain the value storage credit of gold, but also have the circulation convenience of digital assets, which just fills this demand gap.

从演化逻辑看，黄金的高价值密度、成熟交割体系与广泛共识，使其成为验证商品权属通证模式的最优试验田；模式跑通后，可向白银、工业金属、能源等其他标准化大宗商品横向扩展。

From the perspective of evolutionary logic, gold's high value density, mature delivery system and broad consensus make it the optimal test field for verifying the commodity ownership token model. Once the model is validated, it can be horizontally extended to other standardized bulk commodities such as silver, industrial metals and energy.

四、黄金数字凭证体系的分阶段演化路径

IV. Phased Evolution Path of the Digital Gold Voucher System

基于金融市场演化的渐进性规律，结合当前全球实践进展，本文将黄金数字凭证体系的落地划分为四个阶段，各阶段目标、参与主体与核心约束如下：

Based on the gradual law of financial market evolution and combined with current global practical progress, this paper divides the implementation of the digital gold voucher system into four stages. The objectives, participants and core constraints of each stage are as follows:

4.1 第一阶段：底层标准筑基与单场景业务闭环（启动期，1-2年）

4.1 Stage 1: Foundation of Underlying Standards and Single-Scenario Business Closed Loop (Start-up Period, 1-2 Years)

核心目标：完成黄金全链路数字化确权，跑通“实物入库—仓单上链—通证发行—机构划转—实物交割”的最小业务闭环，验证链上凭证与链下实物一一对应的可信度。

Core Objective: Complete the full-link digital ownership verification of gold, and run through the minimum business closed loop of "physical warehousing — warehouse receipt on-chaining — token issuance — institutional transfer — physical delivery",

so as to verify the credibility of one-to-one correspondence between on-chain vouchers and off-chain physical assets.

参与主体：标准层由 LBMA、世界黄金协会与头部期货交易所主导，执行层为持牌金库与头部贵金属机构，监管层采用沙盒模式封闭推进。

Participants: The standard layer is led by LBMA, the World Gold Council and leading futures exchanges; the execution layer consists of licensed vaults and leading precious metal institutions; the regulatory layer adopts a sandbox model for closed promotion.

核心约束与卡点：一是链下资产保真机制，需通过金条唯一身份标识、全流程溯源、第三方独立审计杜绝虚增仓单与重复质押；二是行业数据标准统一，形成通用的数字化仓单协议；三是内嵌合规机制，在许可链架构中原生嵌入 KYC/AML 规则。

Core Constraints and Bottlenecks: First, the off-chain asset authenticity mechanism: it is necessary to eliminate inflated warehouse receipts and repeated pledges through unique gold bar identifiers, full-process traceability and independent third-party audits. Second, the unification of industry data standards to form a general digital warehouse receipt protocol. Third, embedded compliance mechanisms: natively embed KYC/AML rules in the permissioned chain architecture.

当前全球进展：LBMA 金条诚信溯源系统上线、香港黄金中央清算系统试点，标志着全球整体处于该阶段末期。

Current Global Progress: The launch of the LBMA Gold Bar Integrity (GBI) traceability system and the pilot of the Hong Kong Gold Central Clearing System indicate that the world as a whole is at the end of this stage.

4.2 第二阶段：分布式交割网络构建与机构级流通（成长期，2-3 年）

4.2 Stage 2: Construction of Distributed Delivery Network and Institutional-Level Circulation (Growth Period, 2-3 Years)

核心目标：从单金库扩展为多节点许可网络，实现通证在不同交割库之间的通用互认，建成机构级的跨库划转与清算网络，形成分布式交割的信用体系。

Core Objective: Expand from a single vault to a multi-node permissioned network, realize universal mutual recognition of tokens among different delivery warehouses, build an institutional-level cross-vault transfer and clearing network, and form a credit system for distributed delivery.

参与主体：节点层涵盖各国期货交易所交割库、央行储备金库、商业银行托管金库；清算层由区域黄金清算机构与跨国结算银行构成；监管层建立跨机构联合审计与风险处置机制。

Participants: The node layer covers delivery warehouses of national futures exchanges, central bank reserve vaults, and commercial bank custody vaults; the clearing layer consists of regional gold clearing institutions and cross-border settlement banks; the regulatory layer establishes cross-institutional joint audit and risk disposal mechanisms.

核心约束与卡点：一是跨机构仓单互认，需统一不同司法辖区的品级折算、调运损耗与交割规则；二是单点风险隔离，需设计跨库备付与风险准备金机制，避免单库违约扩散至全网；三是跨境管制壁垒，初期仅能在同一关税区与监管框架内落地。

Core Constraints and Bottlenecks: First, cross-institutional warehouse receipt mutual recognition: it is necessary to unify grade conversion, transportation loss and delivery rules in different jurisdictions. Second, single-point risk isolation: it is necessary to design cross-vault reserve and risk reserve mechanisms to avoid the spread of single-vault default to the entire network. Third, cross-border regulatory barriers: in the initial stage, it can only be implemented within the same tariff zone and regulatory framework.

阶段价值：该阶段完成后，机构级跨主权储值与结算需求将被合规体系覆盖，无许可加密资产的机构生态位将被实质性挤压。

Stage Value: After the completion of this stage, institutional-level cross-sovereign value storage and settlement demands will be covered by the compliant system, and the institutional niche of permissionless crypto assets will be substantially squeezed.

4.3 第三阶段：零售端开放与多品类横向扩展（扩容期，3-5年）

4.3 Stage 3: Retail Opening and Multi-Category Horizontal Expansion (Expansion Period, 3-5 Years)

核心目标：向合格零售用户开放小额持有通道，完成白银、铂金等贵金属品类的接入，形成“机构为主、零售补充”的市场格局，验证普惠性储值场景的可行性。

Core Objective: Open small-value holding channels to qualified retail users, complete the access of precious metal categories such as silver and platinum, form a market pattern of "institution-led, retail-supplemented", and verify the feasibility of inclusive value storage scenarios.

参与主体：发行层为持牌银行与合规数字资产服务商，渠道层覆盖银行财富管理平台与持牌交易平台，监管层出台专门的实物通证监管细则。

Participants: The issuance layer consists of licensed banks and compliant digital asset service providers; the channel layer covers bank wealth management platforms and licensed trading platforms; the regulatory layer issues special regulatory rules for physical tokens.

核心约束与卡点：一是小额交割的成本平衡，采用“累计达标交割”机制，平衡零售拆分与实物交割的成本矛盾；二是税务规则明确，界定通证转让与实物交割的税务处理，避免双重征税；三是多品类适配成本，不同贵金属的仓储、质检规则差异需逐一适配。

Core Constraints and Bottlenecks: First, the cost balance of small-value delivery: adopt the "cumulative threshold delivery" mechanism to balance the cost contradiction between retail splitting and physical delivery. Second, clear tax rules: define the tax treatment of token transfer and physical delivery to avoid double taxation. Third, multi-category adaptation costs: differences in warehousing and quality inspection rules of different precious metals need to be adapted one by one.

4.4 第四阶段：全品类生态与跨市场互联互通（成熟期，长期演进）

4.4 Stage 4: Full-Category Ecosystem and Cross-Market Interconnection (Maturity Period, Long-Term Evolution)

核心目标：将通证体系从贵金属扩展至工业金属、能源、粮食等核心大宗商品，实现与股票、期货、信贷市场的制度打通，最终形成独立的标准化实物通证市场。

Core Objective: Extend the token system from precious metals to core bulk commodities such as industrial metals, energy and grain, realize institutional connectivity with stock, futures and credit markets, and finally form an independent standardized physical token market.

参与主体：产业层涵盖大宗商品交易所、供应链核心企业与质检机构；金融层覆盖证券、期货、信贷机构；监管层形成全球多部门协同的治理框架。

Participants: The industrial layer covers commodity exchanges, core supply chain enterprises and quality inspection institutions; the financial layer covers securities, futures and credit institutions; the regulatory layer forms a global multi-sector collaborative governance framework.

核心约束与卡点：一是跨市场制度对接，明确通证的法律属性与合格抵押品地位；二是全品类标准化适配，构建分层分类的通证标准体系；三是全球治理共识，破解跨境贸易、外汇、海关等主权壁垒。

Core Constraints and Bottlenecks: First, cross-market institutional docking: clarify the legal attribute of tokens and their status as qualified collateral. Second, full-category standardization adaptation: build a hierarchical and classified token standard system. Third, global governance consensus: break through sovereign barriers such as cross-border trade, foreign exchange and customs.

五、主权博弈视角下的内生推进逻辑

V. Endogenous Promotion Logic from the Perspective of Sovereign Game

黄金数字凭证体系的落地并非单纯的技术创新，而是数字时代主权博弈的必然选择，其内生动力来源于三个层面：

The implementation of the digital gold voucher system is not a mere technological innovation, but an inevitable choice of sovereign game in the digital era. Its endogenous driving force comes from three levels:

5.1 货币主权补位：二元数字资产体系对加密资产的功能替代

5.1 Monetary Sovereignty Complementation: Functional Substitution of Crypto Assets by the Dual Digital Asset System

数字时代的货币职能呈现分化：法币稳定币承接计价、流通、结算职能，对应传统纸币的数字化；而跨周期储值、跨主权避险的职能，需要具备实物锚定的资产载体承接。若主权体系仅推进法币数字化，而放弃数字储值赛道，等于主动将该生态位让渡给无监管加密资产，形成平行于主权体系的资金流转网络，长期侵蚀法币的主导地位。

Monetary functions show differentiation in the digital era: fiat-backed stablecoins undertake pricing, circulation and settlement functions, corresponding to the digitization of traditional paper money; while the functions of cross-cycle value storage and cross-sovereign risk hedging need to be undertaken by asset carriers with physical anchors. If the sovereign system only promotes the digitization of fiat currency and abandons the digital value storage track, it is equivalent to actively ceding this niche to unregulated crypto assets, forming a capital circulation network parallel to the sovereign system, which will erode the dominant position of fiat currency in the long run.

因此，构建“法币稳定币+贵金属数字凭证”的二元数字资产体系，是主权体系的必答题：其本质是将现实世界运行数千年的“信用货币+商品货币”二元结构，完整复刻到数字世界，补全数字时代的货币职能版图，用合规、可控的数字储值工具，替代无许可加密资产的主流需求。

Therefore, building a dual digital asset system of "fiat-backed stablecoins + precious metal digital vouchers" is a must for the sovereign system: its essence is to fully replicate the dual structure of "credit money + commodity money" that has operated in the real world for thousands of years into the digital world, complement the monetary function map in the digital era, and replace the mainstream demand for

permissionless crypto assets with compliant and controllable digital value storage tools.

5.2 定价权重构：流转网络的标准主导权

5.2 Restructuring of Pricing Power: Standard Dominance of the Circulation Network

大宗商品的定价权不仅取决于交易规模，更取决于流转网络与标准规则的主导权。商品权属通证化将重构全球大宗商品的流转体系：谁掌握了通证标准、清算网络与交割节点的主导权，谁就掌握了下一代大宗商品的定价话语权。

The pricing power of bulk commodities depends not only on transaction scale, but also on the dominance of circulation networks and standard rules. Commodity ownership tokenization will restructure the global bulk commodity circulation system: whoever holds the dominance of token standards, clearing networks and delivery nodes will hold the pricing discourse power of the next generation of bulk commodities.

当前全球各金融中心加速布局黄金数字化基础设施，本质是对数字时代大宗商品定价权的争夺。通过构建自主可控的黄金数字凭证体系，可摆脱对单一清算体系的依赖，提升在全球贵金属市场的规则影响力。

At present, major global financial centers are accelerating the layout of gold digital infrastructure, which is essentially a competition for the pricing power of bulk commodities in the digital era. By building an independent and controllable digital gold voucher system, countries can get rid of their dependence on a single clearing system and enhance their rule influence in the global precious metal market.

5.3 金融深化效率：实物资产的抵押品价值激活

5.3 Financial Deepening Efficiency: Activation of the Collateral Value of Physical Assets

实体经济中大量大宗商品作为存货沉睡，其抵押融资流程繁琐、核验成本高、处置效率低，制约了供应链金融的发展。商品权属通证化后，链上仓单可实现即时质押、即时清算、即时处置，大幅提升实物资产的流动性与抵押品效率，降低企业融资成本，赋能实体经济。这也是主权体系推动该模式落地的重要实体经济动因。

In the real economy, a large number of bulk commodities lie dormant as inventory. Their pledge financing process is cumbersome, verification costs are high, and disposal efficiency is low, which restricts the development of supply chain finance. After commodity ownership tokenization, on-chain warehouse receipts can realize instant pledge, instant clearing and instant disposal, greatly improving the liquidity and collateral efficiency of physical assets, reducing corporate financing costs, and

empowering the real economy. This is also an important real economic motivation for the sovereign system to promote the implementation of this model.

六、风险约束与适配性监管框架

VI. Risk Constraints and Adaptive Regulatory Framework

6.1 核心风险维度

6.1 Core Risk Dimensions

1. **链下信用风险**：这是该体系的核心内生风险。链上凭证可实现绝对保真，但链下仓储、质检、交割环节始终存在造假、挪用、物理损耗的可能，这是实物通证与纯链上加密资产的本质区别。

1. **Off-chain credit risk**: This is the core endogenous risk of the system. On-chain vouchers can achieve absolute authenticity, but there are always possibilities of fraud, embezzlement and physical loss in off-chain warehousing, quality inspection and delivery links, which is the essential difference between physical tokens and pure on-chain crypto assets.

2. **跨境监管套利风险**：通证的跨境流转便利性，可能成为规避外汇管制、跨境洗钱的通道，带来资本流动监管压力。

2. **Cross-border regulatory arbitrage risk**: The convenience of cross-border token circulation may become a channel for evading foreign exchange control and cross-border money laundering, bringing regulatory pressure on capital flows.

3. **市场与投资者风险**：零售端开放后，存在价格波动风险、投资者适当性匹配不足的问题，可能引发投机炒作与金融纠纷。

3. **Market and investor risks**: After the retail end is opened, there are risks of price fluctuation and insufficient investor suitability matching, which may trigger speculative hype and financial disputes.

6.2 适配性监管原则

6.2 Adaptive Regulatory Principles

针对上述风险，监管框架应遵循三大原则：

In response to the above risks, the regulatory framework should follow three principles:

1. **内嵌式合规**：在许可链架构中原生嵌入身份核验、交易溯源、大额预警等机制，

实现监管穿透，而非事后补救；

1. **Embedded compliance**: Natively embed mechanisms such as identity verification, transaction traceability and large-value early warning in the permissioned chain architecture to realize penetrating supervision rather than ex-post remedy.

2. **分级准入管理**：对机构端与零售端、大额与小额实施差异化准入，零售端设置持仓限额与适当性要求，交割环节实施严格的身份核验；

2. **Hierarchical access management**: Implement differentiated access for institutional and retail ends, and for large and small amounts. Set position limits and suitability requirements on the retail side, and implement strict identity verification in the delivery link.

3. **跨区域监管协同**：建立多边监管合作机制，统一合规标准与数据共享规则，防范跨境监管套利。

3. **Cross-regional regulatory coordination**: Establish a multilateral regulatory cooperation mechanism, unify compliance standards and data sharing rules, and prevent cross-border regulatory arbitrage.

七、结论与未来研究展望

VII. Conclusion and Future Research Prospects

7.1 研究结论

7.1 Research Conclusions

1. 商品权属通证化不是传统业务的简单技术升级，而是金融市场标准化演进的必然结果，将形成继股票、期货之后的第三类标准化资产市场，填补现货权属高效流转的市场空白；

1. Commodity ownership tokenization is not a simple technical upgrade of traditional businesses, but an inevitable result of the standardization evolution of financial markets. It will form the third category of standardized asset market following the stock and futures markets, filling the market gap of efficient circulation of spot ownership.

2. 黄金因标准化程度高、信用共识强、交割体系成熟，天然成为该市场形态的初始切入点，其演化遵循“标准筑基—网络成型—零售扩容—全品类扩展”的渐进路径；

2. Due to its high standardization, strong credit consensus and mature delivery system, gold naturally becomes the initial entry point of this market form, and its evolution follows the gradual path of "standard foundation — network formation — retail expansion — full-category extension".

3. 该体系的推进具有内生的主权博弈动力：是数字时代主权国家补全货币职能版图、防御无监管加密资产冲击、争夺大宗商品定价权的必然选择。

3. The promotion of this system has endogenous sovereign game motivation: it is an inevitable choice for sovereign states in the digital era to complement the monetary function map, defend against the impact of unregulated crypto assets, and compete for the pricing power of bulk commodities.

7.2 未来研究展望

7.2 Future Research Prospects

后续研究可从三个方向深化：一是实证层面，量化分析黄金数字凭证对市场流动性与定价效率的影响；二是制度层面，研究不同司法辖区下通证的法律属性与税务规则；三是宏观层面，探讨商品权属通证体系对货币政策传导、跨境资本流动的长期影响。

Subsequent research can be deepened in three directions: first, at the empirical level, quantitatively analyze the impact of digital gold vouchers on market liquidity and pricing efficiency; second, at the institutional level, study the legal attributes and tax rules of tokens in different jurisdictions; third, at the macro level, explore the long-term impact of the commodity ownership token system on monetary policy transmission and cross-border capital flows.

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