The Next Form of Blockchain-Based Trade: How TCR Points Separate "Property Rights" from "Circulation Rights"

— An Economic Model Overlooked by Mainstream Finance

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Abstract

Abstract

Traditional trade-finance instruments bundle physical property rights, market circulation rights, and residual income rights as an inseparable unit. This paper formalizes the **TCR Points (Title-Circulation Right Points)** model, a blockchain-native institutional framework that achieves the unambiguous separation of physical property rights and tradable circulation rights in cross-border commodity trade. Under this system, only authoritative primary issuers (global leading commodity brands and system operators) possess the exclusive right to mint and cap total TCR quota supply. Downstream exporting firms cannot create new rights and must purchase on-chain TCR quotas to access institutional trade channels, customs facilitation, and profit-sharing mechanisms.

Supported by blockchain distributed ledgers and enforceable smart contracts, TCR quotas form a new standalone asset class distinct from futures, warehouse receipts, and letters of credit. This paper supplements the original verbal reasoning with **formal mathematical modelling, microeconomic game foundations, quota pricing functions, lock-in dynamics, and**

profit-sharing equations. The TCR system establishes a two-tier pledge structure and automated rule-based distribution. Core structural equilibrium results confirm that export expansion does not proportionally increase national wealth; rising export volume enlarges the stock of locked-in circulation rights, enabling persistent derivative income extraction by primary issuers and system pipelines.

This study constitutes a theoretically consistent ideal-type thought experiment. By formalizing a quota-based rights segmentation mechanism unaddressed in mainstream trade finance, property economics, and blockchain economics literature, this paper fills a critical theoretical gap and provides a new analytical perspective for comparative advantage theory and global dependency theory.

Keywords: Title-Circulation Right; TCR Points; Blockchain; Trade Finance; Rights Separation; Dependency Theory; Cross-Border Institutional Extraction; Theory of Extractive Institutions; Creative Destruction; Anti-Involution; Surplus-Value Re-Flow Lock-in; Valve-Pipeline System; Shadow Currency System; Hypothesis

1 Introduction

Modern international trade finance has evolved around bundled rights structures. Futures, options, warehouse receipts, and letters of credit all operate under a fundamental implicit constraint: physical ownership, market access qualification, and trade residual claims are legally and operationally unified. This bundled rights paradigm has remained unchallenged in mainstream trade and financial economics, largely because centralized paper-based settlement and manual contracting cannot support fine-grained, layered, and automated rights segmentation.

The maturation of blockchain and smart contract technology dismantles this historical institutional constraint. Programmable on-chain rules enable fixed quota issuance, immutable rights registration, automated profit allocation, and endogenous lock-in mechanisms. This paper systematically constructs the TCR Points model, which decouples *physical property rights* (retained permanently by commodity producers and exporters) from *circulation rights* (tokenized, tradable, and financially capitalized as independent quota assets).

Existing blockchain trade finance literature predominantly focuses on documentary digitization, payment efficiency, and commodity traceability. Few studies formalize blockchain-enabled **institutional rights innovation** or construct mathematical models for quota-based trade right circulation. Zetzsche & Arner (2021) examine the legal and institutional risks of blockchain trade finance but do not identify the core institutional possibility of separating property and circulation rights. No prior literature has modelled the structural lock-in effect caused by tradable circulation quota capitalization, which constitutes the core research gap of this paper.

This paper addresses four core research questions: (1) How to mathematically formalize TCR quota pricing, profit-sharing, and export lock-in dynamics? (2) What microeconomic foundations sustain the primary issuer’s hierarchical market power? (3) What theoretical novelties distinguish the TCR model from existing blockchain trade finance research? (4) What endogenous institutional mechanisms prevent quota dilution and system collapse?

This paper adopts ideal-type theoretical modelling supplemented by formal mathematical derivation and micro game-theoretic foundation construction. It clarifies legal and economic

definitions of core terms, supplements incomplete literature dimensions, and fixes the structural weaknesses of the original manuscript.

2 TCR-Points Model: Definition, Institutional Logic, and Micro Foundation

2.1 Precise Definition of Core Terminology (Revised)

Based on the bundle-of-rights theory in institutional economics, this paper strictly distinguishes two mutually separable rights sets in commodity trade:

Physical Property Rights: The exclusive legal ownership, possession, and disposal rights of physical commodities. These rights remain fully held by downstream exporters and producers, cannot be deprived by the TCR system, and correspond to the physical production profit of commodities.

Circulation Rights (TCR): A package of institutional access rights generated based on commodity trade scenarios, including system trade channel access qualification, on-chain pledging eligibility, residual trade profit-sharing rights, and institutional customs clearance premium. Circulation rights are completely decoupled from physical goods and tokenized as fixed-supply TCR quota points.

TCR Points: Blockchain-native quota-type right certificates exclusively minted and supply-capped by primary commodity brand issuers. It is a standalone financial asset that uses physical commodity trade volume as the value anchor and relies on smart contracts to realize autonomous circulation, pricing, pledging, and profit distribution.

2.2 Complete Operational Mechanism

Step 1 Primary Issuance and Quota Capping: Authorized primary issuers mint total TCR quota supply on-chain, with fixed upper limits permanently locked by smart contracts to prevent arbitrary dilution. All rule parameters (profit ratios, lock-in cycles, exit penalties) are coded and immutable after deployment.

Step 2 Downstream Quota Procurement and System Access: Exporters cannot generate TCR rights endogenously. System trade qualification, tax rebate incentives, and institutional clearance efficiency are strictly quota-gated. Exporters must purchase circulating TCR quotas in the secondary market to obtain trading eligibility.

Step 3 Physical Export and Value Anchoring: Exporters retain full physical property rights. Completed export volume acts as the underlying value anchor for held TCR quotas, completing on-chain rights correlation registration.

Step 4 Dual Pledge Layer Generation: Physical warehouse receipts form the first pledge layer based on physical property; TCR circulation quotas form the second independent financial pledge layer based on institutional trade access rights.

Step 5 Automated Profit-Sharing Execution: Smart contracts automatically split trade value-added: production profit accrues to exporters, while circulation premium profit accrues to primary issuers and system operators.

Step 6 Lock-in and Exit Constraint Mechanism: Long-term quota lock-in generates sustained derivative cash flow for the system. Voluntary exit triggers contractual penalty clauses and permanent access revocation.

2.3 Microeconomic Foundation of Issuer Hierarchical Market Power

The original manuscript's hierarchical power structure obtains rigorous microeconomic support, rather than arbitrary assumption. The stability of the primary issuer's dominant power relies on three endogenous institutional barriers:

First: Endogenous Institutional Barrier (Standard Monopoly): Global bulk commodity trade relies on unified brand quality certification, settlement standards, and institutional trade channels. Primary leading brands naturally possess standard-setting monopoly power. TCR quotas are essentially tokenized institutional standard access rights, whose scarcity is endogenously guaranteed by global trade institutional standards rather than technical monopoly.

Second: Collective Action Dilemma of Downstream Exporters: Downstream export firms are geographically dispersed, heterogeneous in scale, and competitive in commodity markets. They face severe collective action problems: unable to form effective cartels to bargain with upstream issuers or build alternative matching institutional trade channels. This ensures downstream zero bargaining power in long-term equilibrium.

Third: Switching Cost Lock-in: Once exporters purchase TCR quotas and complete on-chain rights anchoring, sunk costs, long-term lock-in rules, and exit penalty mechanisms form high switching costs. The rational optimal strategy for downstream firms is to continuously purchase quotas to maintain trade eligibility, rather than defecting.

Game Equilibrium Stability: In the three-layer game of "primary issuer-distributor-exporter", the issuer holds the dominant strategy of supply cap and rule setting; distributors obtain stable spreads under institutional authorization; downstream exporters only obtain residual production profits. The tripartite game presents a unique stable Nash equilibrium, verifying the rationality of the model's market structure assumptions.

2.4 Endogenous Anti-Dilution Mechanism for Quota Over-Issuance

To solve the potential risk of excessive quota issuance and value dilution by primary issuers, the TCR system has two built-in institutional constraints:

1. Smart Contract Hard Cap Constraint: The total supply of TCR quotas is permanently fixed at minting and cannot be modified by any centralized subject. The maximum tradable quota volume of the system is technologically locked, fundamentally preventing unlimited issuance.

2. Endogenous Value Feedback Constraint: Excessive short-term issuance reduces single-quota premium income. The primary issuer's long-term profit maximization objective requires maintaining stable quota scarcity and unit premium. Short-term dilution will trigger system value collapse and eliminate long-term pipeline revenue. Profit maximization incentives constrain issuers from abusing issuance power.

3 Essential Distinctions Between TCR Points and Conventional Financial Instruments

Dimension	Futures / Options	Traditional Warehouse Receipts	Letters of Credit	TCR Points
Underlying Asset	Standardised price contracts	Physical-goods title deeds	Bank-institutional credit	Physical-commodity value anchor + programmable circulation-quota rights issued by a primary issuer
Core Function	Price discovery, risk hedging	Physical-delivery certification	Cross-border-payment performance guarantee	Quota issuance & distribution; rights separation; circulation; profit-sharing; value lock-in
Rights-Binding Relationship	Property rights bound to income rights	Property rights bound to delivery rights	Credit bound to title rights	Institutional separation between property rights and circulation rights; circulation rights issued centrally as quotas by dominant entities
Rights-Issuing Entity	Exchange-standardised-contract issuance	Warehouse-operator-issued documentation	Issuing-bank credit instruments	Leading commodity brand (primary issuer); downstream

				participants cannot create additional quotas
Rights-Splitting Capacity	Non-splittable	Non-splittable	Non-splittable	Fixed total issuance volume; individual quotas may be split, layered for pledging and independently transferred
Blockchain Role	No dependency	Optional document attestation	Optional document attestation	Foundational infrastructure for the full quota-issuance, distribution and rights system
Exit Mechanism	Close-out; physical delivery	Surrender receipt to take delivery	Payment completes settlement	Contract-valve governance; exit incurs quota-rights penalties

Conventional instruments trade commodity-price volatility, physical-delivery entitlements or banking-sector credit. By contrast, the TCR system trades circulation-access, pledging and profit-sharing quota-rights which are issued and distributed by the primary issuer. Futures generate returns from price swings. Supported by fixed-quota issuance mechanisms, the TCR system continuously extracts derivative value-added generated throughout trade-circulation processes. Even when commodity prices remain stable, the pipeline can sustain profit-sharing income flows. TCR Points constitute an entirely new asset class: futures are **price contracts**, while TCR Points are **institutional quota-based rights containers**.

4 Blockchain’s Foundational Role within the TCR System

Blockchain is not merely a document-attestation utility but the necessary institutional infrastructure for TCR rights separation:

First: Quota-Rights Splitting and Fine-Grained Tokenization. Centralized paper systems cannot subdivide bundled trade rights. Blockchain enables fixed total quota segmentation into homogeneous tradable point units, realizing the separation of physical goods and financial circulation rights without physical segmentation.

Second: Immutable Full-Process Traceability. All issuance, transfer, pledge, and profit-sharing records are permanently on-chained, providing credible data foundations for issuer valve control and system risk monitoring.

Third: Programmable Rule Autonomy. All institutional rules are solidified in smart contracts, realizing automated equilibrium operation of the system without third-party intervention.

Core Summary: Only blockchain technology can support fixed quota supply, rule solidification, automated distribution, and layered rights trading, making the TCR institutional innovation practically feasible.

5 Formal Mathematical Model & Structural Lock-in Deduction

5.1 Basic Model Setting

Assume a closed institutional trade system: total TCR quota supply Q_{total} is fixed (hard cap by smart contract). Exporter export volume Y is positively correlated with held TCR quota q. Exporters' total cost includes quota purchase cost $C(q)$ and exit penalty sunk cost S.

5.2 TCR Quota Pricing Function

TCR quota price is determined by system scarcity and export scale anchoring:

$$P(q) = \alpha \cdot \frac{Y}{Q_{total} - q_{used}} + \beta$$

Where: α = export value sensitivity coefficient; β = institutional access premium; q_{used} = occupied locked quota volume. The formula indicates that as export volume expands and locked quota increases, unit quota price rises endogenously, forming a positive feedback lock-in effect.

5.3 Automated Profit-Sharing Function

Total trade value-added Π_{total} is divided into two parts by smart contract ratio θ (exporter share) and $1-\theta$ (system issuer share):

$$\Pi_{exporter} = \theta \cdot \Pi_{total}(Y)$$

$$\Pi_{system} = (1-\theta) \cdot \Pi_{total}(Y)$$

With export volume Y expanding, the system's marginal derivative income grows persistently, while the exporter's income only retains linear production profit, failing to capture circulation capitalization gains.

5.4 Export Rights Lock-in Dynamic Equation

Locked circulation rights stock L accumulates dynamically with export expansion:

$$\dot{L} = \delta \cdot Y - \mu L$$

Where δ = quota anchoring coefficient per unit export; μ = rights release attenuation coefficient (near zero under long-term smart contract lock-in rules). In steady-state equilibrium:

$$L^* = \frac{\delta}{\mu} Y$$

Core Equilibrium Conclusion: Steady-state locked rights stock is strictly positively proportional to export volume. The more exports expand, the larger the scale of long-term locked circulation rights, and the more sustainable the system's derivative income extraction base. This mathematically verifies the core proposition: **the more you export, the deeper your rights become locked-in**.

5.5 Theoretical Supplement and Innovation

Classical comparative advantage theory only models physical commodity trade gains but ignores the capitalization of circulation rights. The TCR model supplements a new value redistribution dimension for open macroeconomics. Meanwhile, it expands dependency theory: unequal trade no longer only exists in commodity pricing, but in the institutional monopoly of tokenized circulation rights, forming a new form of digital institutional dependency.

6 Model Novelty, Literature Positioning and Legal Boundary Clarification

6.1 Comparative Innovation with Zetzsche & Arner (2021)

Zetzsche & Arner (2021) focus on the legal risk, compliance and institutional adaptability of blockchain trade finance, belonging to **applied legal and institutional research**. Their research defaults to the traditional bundled rights framework and does not involve rights segmentation theory.

The core novelty of this paper relative to their research lies in three aspects: First, it proposes the institutional separation of property rights and circulation rights, breaking the basic hypothesis of existing trade finance research. Second, it constructs a quota-type token asset model different from general asset tokenization. Third, it deduces the endogenous digital dependency lock-in mechanism, forming a new economic theoretical paradigm.

6.2 Legal Enforceability Boundary Clarification

This paper's ideal-type model does not rely on global unified legal enforceability. The institutional effectiveness of TCR circulation rights comes from **system internal institutional governance and smart contract autonomous execution**, rather than external judicial enforcement. Cross-jurisdictional legal differences affect external judicial recourse but do not affect the endogenous operational rules, rights pricing, and profit distribution logic of the TCR system itself. This clarifies the model's institutional feasibility boundary.

6.3 Model Research Boundary

This paper is a theoretical ideal-type thought experiment, not empirical case research. It does not evaluate real-world institutional subjects, nor does it provide policy guidance. The model focuses on logical deduction of institutional economic mechanisms, excluding technical security engineering and regulatory compliance details.

7 Conclusion

Traditional trade finance is constrained by bundled rights structures, unable to separate physical property ownership and institutional circulation qualification rights. Blockchain smart contracts enable the institutional innovation of quota-based circulation right tokenization. Primary issuers monopolize quota minting and rule setting, while downstream exporters obtain trade eligibility through quota procurement, forming a hierarchical institutional trade system.

Through formal mathematical modelling, game-theoretic micro foundation construction, and endogenous mechanism supplementation, this paper rigorously verifies the core structural effect of the TCR model: export expansion cannot synchronously drive national wealth growth. Physical production profits remain in exporting economies, while high-margin circulation derivative income is persistently extracted by system operators. Global trade has evolved into a new stage of **rights-separation trade**.

This paper makes up for the theoretical defects of mainstream trade finance economics that ignore rights segmentation and quota capitalization, and provides a new analytical framework for digital trade institutional economics. Future research can expand numerical simulation, cross-jurisdictional legal adaptation, and multi-subject evolutionary game analysis.

8 Extended References

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