Quantum Reconstruction of the Accounting Equation: From Double-Entry Bookkeeping to Superposition Bookkeeping

Authors: Zhao Huilin

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Abstract

To address key challenges inherent in the reliance of double-entry bookkeeping on the deterministic equation "Assets = Liabilities + Owners' Equity" during the measurement of complex transactions such as derivative financial instruments and digital assets—specifically, its limitation to a single state, and the disconnect between static equilibrium and dynamic business activities—this study, grounded in the core logic of "superposition–collapse–decoherence" in quantum mechanics, reconstructs the accounting equation as "quantum accounting state = asset superposition state liability superposition state owners' equity superposition state" (denotes quantum superposition). On this basis, it innovatively proposes the superposition bookkeeping method, and explicitly defines its core rules of "every state must be superposed, every superposed state must be conserved," together with a dual-account system and a dynamic measurement paradigm.

Furthermore, the study conducts a systematic comparison between superposition bookkeeping and double-entry bookkeeping from dimensions such as core logic and recording rules, and demonstrates the innovative advantages of the superposition bookkeeping method. Taking the full business cycle of a new energy enterprise in 2024 as an example, the study performs accounting treatments, financial statement preparation, and data comparison and validation under both methods. The results indicate that the superposition bookkeeping method can accurately capture the multiple attributes of business transactions, dynamically track the evolutionary trajectory of accounting elements, and significantly enhance the decision-usefulness of accounting information. The findings suggest that the superposition bookkeeping method does not negate double-entry bookkeeping; rather, it achieves inclusiveness and extension of the traditional method through quantum-based reconstruction. When a superposition state degenerates into a single state, it can automatically revert to the logic of double-entry

bookkeeping, thereby providing a novel paradigm for innovation in accounting theory and practical application in complex economic environments.

Full Text

Quantum Reconstruction of the Accounting Equation: From Double-entry Bookkeeping to Superposition Bookkeeping

Zhao Huilin
(1. Shantou University, Shantou, Guangdong 515063)

Abstract: To resolve the critical challenges of single-state limitations and the disconnect between static balance and dynamic operations inherent in the deterministic equation "Assets = Liabilities + Owner' s Equity" that underpins double-entry bookkeeping when measuring complex businesses such as derivative financial instruments and digital assets, this study reconstructs the accounting equation based on the core logic of quantum mechanics—"superposition-collapse-decoherence" —into "Quantum Accounting State = Asset Superposition Liability Superposition Owner' s Equity Superposition" (representing quantum superposition). It innovatively proposes the superposition bookkeeping method, clearly defining its core rule of "existence implies superposition, superposition implies conservation," along with a dual-account system and dynamic measurement paradigm. Simultaneously, a systematic comparison between superposition bookkeeping and double-entry bookkeeping is conducted across dimensions including core logic and accounting rules, demonstrating the innovative advantages of superposition bookkeeping. Using a full-cycle business process of a new energy enterprise in 2024 as an example, the study validates both methods through accounting treatment, financial statement preparation, and data comparison. Results show that superposition bookkeeping can accurately capture the multiple attributes of business operations, dynamically track the evolution of accounting elements, and significantly enhance the decision-making value of accounting information. The research reveals that superposition bookkeeping does not negate double-entry bookkeeping but rather achieves inclusiveness and expansion through quantum reconstruction. When the superposition state degenerates into a single state, it automatically reverts to the logic of double-entry bookkeeping, providing a novel paradigm for accounting theory innovation and practical application in complex economic environments.

Keywords: Accounting Equation; Quantum Reconstruction; Double-entry Bookkeeping; Superposition Bookkeeping; Complex Business Measurement

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Since Luca Pacioli systematically expounded double-entry bookkeeping in *Summa de Arithmetica, Geometria, Proportioni et Proportionalita* in 1494, its core rule of "for every debit there must be a credit, and debits must equal credits" and the accounting balance concept have evolved through theoretical

extensions into the complete equation system "Assets + Expenses = Liabilities + Owner' s Equity + Revenue," establishing the underlying logic of modern accounting' s rights-responsibility correspondence, dual verification, and traceable checks and balances (Miller & Napier, 1993). This method is rooted in the cognitive framework of classical physics' "determinism and single-state," which was highly compatible with the economic context of the industrial era dominated by physical assets and single-attribute transactions. Through its dual recording and balance verification mechanisms, it effectively ensured the reliability and objectivity of accounting information, becoming the core pillar supporting corporate governance and efficient capital market operation.

However, the deep penetration of the digital economy and accelerated financial innovation have normalized new business forms such as derivative financial instruments, digital assets, and blockchain cross-border transactions. These businesses exhibit inherent characteristics of multiple coexisting attributes, dynamic evolution, and the coexistence of certainty and uncertainty, making the inherent limitations of double-entry bookkeeping increasingly prominent and unable to meet the precise measurement needs of complex scenarios. The existing double-entry system faces three core dilemmas in complex business processing: First, the single-state measurement paradigm cannot fully capture multiple business attributes. For example, convertible bonds possess both debt and equity attributes, yet double-entry bookkeeping can only handle them through attribute splitting or priority measurement modes, making it difficult to simultaneously depict the dynamic evolution trajectory and interaction mechanism of dual attributes. Second, static balance logic is disconnected from business dynamic characteristics. Double-entry bookkeeping focuses on static balance at the accounting period-end, lacking the ability to track dynamic changes in accounting elements throughout the entire business process, and cannot accurately reflect the co-evolutionary relationship between fair value fluctuations of derivatives and risk exposure (Barth, 2004; Zeff, 2007). Third, deterministic assumptions fundamentally contradict uncertain businesses. Traditional accounting equations are built upon deterministic measurement, and for probabilistic businesses such as option contracts and expected credit losses, they can only be handled through simplified modes like impairment provisions and estimated liabilities, making it difficult to quantify the marginal impact of uncertainty on accounting elements (Kothari et al., 2010).

The cross-disciplinary application of quantum mechanics provides a novel analytical framework to resolve these dilemmas. The core of quantum theory is not to negate determinism but to reveal the complex system law of "coexistence of superposition and single states, dialectical unity of uncertainty and certainty," which highly aligns with the essence of complex economic businesses—a complex business can be viewed as a quantum superposition of multiple single-attribute eigenstates. At the settlement or financial statement disclosure stage (analogous to quantum observation behavior), the superposition state collapses into a single deterministic state, both fully recording process complexity and meeting the certainty requirements of result disclosure. Based on this, this paper focuses

on three core research questions: How to reconstruct the accounting equation based on quantum theory to build a superposition bookkeeping method adapted to complex businesses? What are the essential differences between superposition bookkeeping and double-entry bookkeeping in terms of core logic and rule systems? How can its innovative advantages and practical feasibility be validated through full-cycle business case studies? Simultaneously, this paper must overcome a key technical bottleneck: How to scientifically define the probability amplitudes of each eigenstate in the superposition state, reduce subjective judgment bias through quantitative tools, and enhance the academic rigor and practical operability of the method.

This paper holds significant theoretical and practical value. First, it breaks through the classical cognitive limitations of traditional accounting by introducing quantum superposition logic into the core reconstruction of the accounting equation for the first time, establishing a "Quantum Accounting State" analytical framework that fills the research gap in the basic theory of complex business accounting. Although existing studies have applied quantum principles to social sciences (Haven & Khrennikov, 2013), they have not touched upon the fundamental reconstruction of accounting equations and bookkeeping methods. This paper achieves deep integration between quantum theory and accounting basic theory. Second, it constructs a multi-scenario adaptable probability amplitude quantification model system. By integrating tools such as the B-S option pricing model, delta indicators, and the entropy weight method, it transforms probability amplitude determination from subjective judgment to quantitative calculation, solving the core technical bottleneck of superposition bookkeeping. It establishes a compatibility mechanism between traditional and quantum accounting, clarifies the degeneration conditions for superposition bookkeeping to revert to double-entry bookkeeping, and demonstrates the inherent relationship of "inclusive coexistence rather than opposition and substitution," enhancing the extensibility of the accounting theoretical system to new business forms. Finally, at the practical level, this paper provides triple value support: It offers enterprises a new bookkeeping tool for handling complex businesses, effectively solving measurement challenges for multi-attribute businesses such as convertible bonds, option contracts, and digital collectibles, significantly improving the completeness and decision relevance of accounting information. It optimizes financial statement disclosure quality through dual disclosure of superposition state process information and single-state result information, balancing information users' dual needs for business evolution processes and final outcomes, providing comprehensive information support for investment decisions and risk management. It promotes the adaptation of the accounting system to digital economic development trends, helping enterprises address accounting challenges in emerging fields such as blockchain and the metaverse, and strengthening the adaptability of accounting information to new business forms.

The main innovations of this paper are reflected in three aspects: First, theoretical innovation: Based on quantum superposition logic, it reconstructs the accounting equation, establishing a dynamic analytical framework of "Quan-

tum Accounting State = Asset Superposition Liability Superposition Owner' s Equity Superposition" (representing quantum superposition), and clarifies degeneration conditions to achieve seamless compatibility between the two systems. Second, methodological innovation: It creates superposition bookkeeping, establishing the core rule of "existence implies superposition, superposition implies conservation, observation implies collapse,"building a dual-account system of "superposition accounts + single accounts" and a dynamic measurement paradigm. The key breakthrough lies in avoiding subjective judgment bias through integrated application of quantitative models. Third, practical innovation: Using a new energy enterprise' s 2024 full-cycle business as a case study, it completes accounting treatment, financial statement preparation, and data comparison for both bookkeeping methods, systematically validating the practical feasibility of superposition bookkeeping and providing a directly implementable operational paradigm.

Quantum Theoretical Foundations and Accounting Equation Reconstruction

Core Logic of Quantum Mechanics and Traditional Accounting Limitations

The core logic of quantum mechanics provides a novel cognitive dimension for complex accounting business processing, with its core concepts demonstrating theoretical rationality in adapting to the essence of complex accounting businesses. Superposition, as the core principle of quantum mechanics, refers to an unobserved quantum system being in a linear superposition of multiple eigenstates (Bohr, 1934). Its standard mathematical expression is $|\psi = \Sigma c |\phi$, where $|\phi$ represents single quantum eigenstates and c are complex probability amplitudes that must satisfy the normalization condition $\Sigma|c|^2 = 1$ (Dirac, 1930) —this condition ensures probability conservation in quantum state evolution, while observation behavior triggers the collapse of the superposition state into a single eigenstate, with $|c|^2$ corresponding to the collapse probability of each eigenstate. Heisenberg' s uncertainty principle reveals the coexistence relationship between "uncertainty appearance and deterministic evolution laws" in the microscopic world (Heisenberg, 1927): The time evolution of particle wave functions strictly follows the deterministic Schrödinger equation, yet microscopic states still possess multiple possibilities. Decoherence theory further points out that after quantum systems interact with the external environment, quantum coherence gradually decays and superposition states spontaneously degenerate into classical single states (Zurek, 1991), a characteristic that provides core theoretical support for compatibility between quantum and traditional accounting systems.

In contrast, the traditional accounting system with its "Assets = Liabilities + Owner' s Equity" equation is built upon static single-attribute assumptions, only reflecting the total balance of accounting elements at specific points in time,

unable to capture the dynamic evolution processes of complex businesses such as convertible bonds (debt-equity dual attributes) and digital assets (multiple attributes of intangible assets, commodities, and financial assets). The core rule of double-entry bookkeeping, "for every debit there must be a credit, and debits must equal credits," exposes three fundamental limitations in digital economy scenarios: First, the single-account architecture cannot carry multiple attributes of businesses, leading to partial accounting information. Second, static balance logic is disconnected from the full-cycle dynamic evolution of businesses, making it difficult to reflect real-time changes in attribute weights. Third, the deterministic recording paradigm has inherent contradictions with the uncertainty characteristics of complex businesses, unable to balance both relevance and reliability of accounting information, and cannot meet the accounting needs brought by financial innovation and the rise of digital assets.

Adaptability of Quantum Theory and Principles for Equation Construction

The adaptability of quantum theory to accounting system reconstruction is not a simple transplantation of physical laws but rather a logical transformation and theoretical fusion based on the essence of complex businesses, specifically manifested in three perspectives: First, the business attribute dimension. The multiple coexisting attributes characteristic of complex accounting businesses highly aligns with quantum superposition states. For example, convertible bonds' dual attributes of debt and equity, and digital collectibles' attributes of display (intangible assets), transaction (commodities), and fair value changes (financial assets) can directly correspond to the multi-eigenstate superposition characteristics of quantum systems, thereby achieving quantitative splitting and synchronous recording of attributes. Second, the evolution logic dimension: The complete process from business occurrence to settlement has natural consistency with the quantum logic of "superposition evolution-observation collapse." Specifically, businesses exist in a multiple-attribute superposition state when they occur, attribute weights (probability amplitudes) dynamically adjust during the holding period with external conditions (such as stock price fluctuations and market demand), and collapse into a single-attribute state at settlement or period-end disclosure (observation behavior). This approach both fully records process complexity and ensures result certainty. Third, the measurement objective dimension. The core logic of quantum mechanics— "coexistence of uncertainty and determinism" —precisely matches the dual objectives of accounting information: "relevance and reliability." Superposition state recording can track attribute changes in real-time, enhancing information relevance, while single-state collapse ensures disclosure certainty, safeguarding information reliability.

Based on the above adaptability logic, quantum accounting equation construction should follow three core principles. The first is the superposition principle: Accounting elements can be decomposed into linear superpositions of multiple eigenstates, with probability amplitudes quantifying each attribute' s weight to

comprehensively reflect the multiple value components of complex businesses. The second is the conservation principle: The sum of squared modulus of eigenstate probability amplitudes within each accounting element always satisfies the normalization condition, with elements maintaining overall balance through co-evolution, inheriting the balance core of traditional accounting while adapting to dynamic adjustment needs. The third is the degeneration principle: When business attributes become singular, observation conditions are met (such as business settlement or period-end disclosure), or the impact of multiple attributes becomes negligible, the quantum accounting equation automatically degenerates into the traditional accounting equation "Assets = Liabilities + Owner' s Equity," ensuring seamless connection between old and new accounting systems and continuity in business processing.

Mathematical Expression, Dynamic Balance, and Core Features of the Quantum Accounting Equation

The quantum accounting equation breaks through the static framework of traditional accounting, constructing a theoretical system based on dynamic superposition. Its basic expression is:

$$|\Psi\rangle = |A\rangle \oplus |L\rangle \oplus |OE\rangle$$

where $|\Psi\rangle$ represents the quantum accounting state, depicting the overall financial condition of an enterprise at a certain point in time; $|A\rangle$, $|L\rangle$, and $|OE\rangle$ are the quantum superposition states of assets, liabilities, and owner' s equity respectively; $\oplus$ is the quantum superposition operator, representing the co-evolutionary relationship among the superposition states of each element, distinct from the simple algebraic summation of traditional accounting, highlighting the dynamic correlation among elements.

Each accounting element can be further subdivided into linear combinations of multiple eigenstates, all satisfying normalization conditions. Taking the asset superposition state as an example, its mathematical expression is:

$$|A\rangle = \sum_{i=1}^{n} c_i |A_i\rangle, \quad \sum_{i=1}^{n} |c_i|^2 = 1$$

where $|A_i\rangle$ represents specific eigenstates of assets (such as current asset state, fixed asset state, financial asset state, etc.), c_i are the complex probability amplitudes corresponding to eigenstates, and $|c_i|^2$ quantifies the contribution degree of each attribute to total asset value. Similarly, the expressions for liability superposition state and owner' s equity superposition state are:

$$|L\rangle = \sum_{j=1}^{m} d_j |L_j\rangle, \quad \sum_{j=1}^{m} |d_j|^2 = 1$$

$$|OE\rangle = \sum_{k=1}^{p} e_k |OE_k\rangle, \quad \sum_{k=1}^{p} |e_k|^2 = 1$$

The above expressions quantify multiple attributes of elements through probability amplitudes, achieving refined accounting for complex businesses.

The dynamic balance of the quantum accounting equation, distinct from the static total balance of traditional accounting, is primarily manifested as probability amplitude conservation during superposition state evolution. Its time evolution equation is:

$$\frac{d}{dt}\left(|c_i|^2 + |d_j|^2 + |e_k|^2\right) = 0$$

This equation indicates that during business evolution, the probability amplitude proportions of eigenstates within each accounting element can be adjusted in real-time (for example, the probability amplitudes of debt and equity states of convertible bonds change with stock price fluctuations), but the sum of squared modulus of probability amplitudes for the three major elements always remains at 3 (each element satisfies normalization conditions separately). This both aligns with quantum system conservation logic and continues the core kernel of traditional accounting' s "total balance." The degeneration conditions clarify the compatibility path with traditional accounting systems, reverting to "Assets = Liabilities + Owner' s Equity" when any condition is met: First, business attribute singularization, where the squared modulus of one eigenstate' s probability amplitude equals 1 and others are 0. Second, observation conditions are met, such as business settlement or period-end financial statement disclosure triggering superposition state collapse. Third, quantum effects are negligible, where the impact of multiple attributes in complex businesses is minimal and the superposition state can be approximated as a single state, achieving seamless connection between old and new systems.

The core breakthroughs of the quantum accounting equation are mainly reflected in three aspects, fully demonstrating its expansion and upgrade of traditional accounting equations. First, the dynamic characteristic: Through time evolution of probability amplitudes, it can track attribute changes throughout the entire process from business occurrence to settlement in real-time. For example, during the holding period of convertible bonds, the probability amplitudes of debt and equity states dynamically adjust with conversion possibility until conversion occurs (collapsing to equity state) or maturity payment (collapsing to debt state), completely reflecting the evolution trajectory of business value. Second, the superposition characteristic: This breaks through the limitations of traditional single-state measurement, enabling synchronous recording of multiple attributes of accounting elements. Taking digital collectibles as an example, it can quantify the proportion of each attribute through $|A_1\rangle$ (intangible asset

state), $|A_2\rangle$ (commodity state), and $|A_3\rangle$ (financial asset state), precisely depicting their diversified value composition and effectively solving the problem of attribute omission in complex businesses. Third, the compatibility characteristic: This builds a comprehensive coverage system of "traditional scenario adaptation—complex scenario expansion." When business attributes are singular, the system automatically reverts to double-entry bookkeeping logic; in complex scenarios, it uses superposition state measurement to improve information quality. This is not a subversive change to traditional accounting methods but an inclusive and symbiotic theoretical upgrade, providing solid theoretical support for the accounting system' s adaptation to the digital economy and financial innovation.

Construction of Superposition Bookkeeping: Rules, Accounts, and Probability Amplitude Quantification Models

Core Assumptions and Rules

(1) Core Assumptions

Superposition bookkeeping, with the quantum accounting equation as its theoretical core and based on the essential characteristics of complex businesses, establishes three core assumptions to build a complete bookkeeping framework, providing logical premises for subsequent rule design and model construction. The first is the quantum accounting state assumption, which posits that an enterprise' s financial condition is not a static combination of single elements but a co-evolutionary process of superposition states of various accounting elements. Complex businesses naturally possess the characteristic of "multiple attributes coexisting," and this attribute superposition is not a simple parallel classification but an organic whole of interconnection and dynamic influence, which is also the core logical starting point of superposition measurement. The second is the superposition conservation assumption, which connects with the balance core of traditional accounting, requiring that the sum of squared probability amplitudes of superposition states within each accounting element always satisfies the normalization condition ($\sum |c_i|^2 = 1$), and the sum of squared probability amplitudes of the overall quantum accounting state remains constant, ensuring amount balance and logical consistency throughout the entire bookkeeping process. When the superposition state of one element is adjusted, the state distribution of corresponding elements must be synchronized and calibrated to avoid breaking the balance relationship. The third is the observation collapse assumption, which clarifies specific scenarios of "observation behavior," including business settlement, period-end financial statement disclosure, and external audit verification. At these points, the superposition state collapses into a single deterministic state due to external intervention, both meeting the certainty requirements of accounting information disclosure and achieving connection between complex business processing and traditional reporting systems.

(2) Core Rules

Based on the above assumptions, superposition bookkeeping breaks through the single-rule limitation of double-entry bookkeeping' s "for every debit there must be a credit, and debits must equal credits," establishing three core rules to build a bookkeeping logic adapted to complex businesses while maintaining compatibility with traditional businesses.

First, "Existence Implies Superposition, Superposition Requires Separate Account Recording." This rule's core is to distinguish business attribute types and match corresponding bookkeeping modes. When a business occurs, its attribute characteristics are first judged: If it is a complex business (with two or more attributes that significantly impact value measurement), it must be decomposed into multiple independent eigenstates, with each eigenstate' s amount, quantified probability amplitude, and probability proportion recorded separately in corresponding superposition accounts to fully reflect the composition and weights of multiple attributes. If it is a traditional single-attribute business (such as monetary fund receipts/payments, settlement of non-derivative receivables/payables), traditional single accounts and double-entry bookkeeping rules are directly applied without superposition processing, maximizing the continuity and stability of traditional business processing. For example, when an enterprise issues 1 million yuan in convertible bonds, due to their dual attributes of debt (fixed interest payments, maturity redemption obligations) and equity (conversion options), they must be recorded separately in "Bonds Payable—Debt State" and "Other Equity Instruments—Equity State" superposition accounts, simultaneously annotating probability amplitudes and proportions calculated through the Black-Scholes (B-S) model. When an enterprise receives customer payments, as it only reflects the single-attribute conversion between monetary funds and accounts receivable, it is directly recorded in "Bank Deposits" and "Accounts Receivable" single accounts.

Second, "Superposition Implies Conservation, Probability Amplitudes Must Be Normalized." This rule is the core guarantee of the balance relationship in superposition bookkeeping, running through the entire bookkeeping process. The probability amplitudes of eigenstates within each accounting element must strictly satisfy the normalization condition, meaning the sum of squared probability amplitudes of all eigenstates equals 1. Dynamic adjustments of probability amplitudes must maintain normalization as a prerequisite. For example, during the holding period of convertible bonds, if stock price fluctuations increase conversion possibility, raising the equity state proportion, the debt state proportion must decrease synchronously, with the sum of squared probability amplitudes of both states remaining 1 after adjustment. Simultaneously, overall accounts must maintain amount balance, with the total debit and credit amounts of superposition accounts consistent with actual business amounts, ensuring superposition measurement does not deviate from the economic substance of accounting businesses.

Third, "Observation Implies Collapse, Degeneration Returns to Tradition." This rule clarifies the conversion logic from superposition state to single

state. When observation conditions are met, the collapse state amount must be calculated by weighting according to each eigenstate' s probability proportion using the formula $M = \sum(M_i \times |c_i|^2)$, where M is the total amount, M_i is each eigenstate amount, and $|c_i|^2$ is the corresponding probability proportion. The detailed records of superposition accounts are then converted into aggregated data of traditional single accounts, completely reverting to double-entry bookkeeping logic. This rule both retains multidimensional records of complex business processes and meets the single-deterministic-data requirements of statement disclosure and audit verification, achieving seamless connection between quantum accounting and traditional accounting.

Dual-Account System Construction: Coordinated Design of Superposition and Single Accounts

Superposition bookkeeping constructs a "superposition accounts + single accounts" dual-account system that both adapts to the multiple-attribute recording needs of complex businesses and maintains compatibility with traditional accounting account systems, without requiring reconstruction of enterprises' existing accounting frameworks, thereby reducing practical application costs. Single accounts serve as the basic account type, undertaking traditional business bookkeeping needs; superposition accounts serve as the innovative account type, carrying complex business measurement functions, with both operating collaboratively to form a complete account system.

Single accounts fully align with traditional accounting accounts in name, classification, and structure, primarily used for recording economic businesses with single attributes and no multiple measurement dimensions, involving common accounting subjects such as monetary funds, non-derivative accounts receivable/payable, and (non-composite attribute) fixed assets. The account structure adopts the classic three-column format of "debit-credit-balance," with bookkeeping rules identical to double-entry bookkeeping, following the principle of "for every debit there must be a credit, and debits must equal credits," thereby ensuring continuity in enterprises' traditional business processing and avoiding accounting confusion caused by introducing new bookkeeping methods. For example, when an enterprise purchases raw materials, completes inspection and warehousing, but has not yet made payment, it directly records the corresponding amount in the debit of "Raw Materials"and the credit of "Accounts Payable," completely consistent with traditional accounting treatment without requiring additional adjustments.

Superposition accounts are the newly added core account type, specifically designed for recording complex businesses with multiple attributes. Their account structure adds three columns– "Eigenstate Type," "Quantified Probability Amplitude," and "Probability Proportion" –to the traditional three-column format, forming a six-column structure (as shown in Table), with the new dimensions precisely capturing the attribute distribution and weight relationships of complex businesses. Superposition accounts are classified and set up according to

accounting elements, with specific eigenstate subsidiary accounts established underneath to achieve refined accounting at the attribute dimension: Asset superposition accounts can be subdivided into "Digital Assets—Intangible Asset State," "Digital Assets—Commodity State," "Digital Assets—Financial Asset State," etc.; Liability superposition accounts can be subdivided into "Bonds Payable—Debt State," "Bonds Payable—Equity State," etc.; Owner' s equity superposition accounts can be set up according to the characteristics of hybrid equity instruments, ensuring precise correspondence between each eigenstate record and business attributes.

Table : Superposition Account Structure Table

Note: Probability amplitudes are quantitatively calculated through the B-S model, satisfying $0.9487^2 + 0.3162^2 = 0.9 + 0.1 = 1$, complying with the normalization condition; the total credit amount of 1 million yuan is consistent with the actual convertible bond issuance amount, both fully reflecting the distribution of dual debt and equity attributes and maintaining the accounting balance relationship. The detailed records of superposition accounts can trace the amount changes and probability amplitude adjustment trajectories of each eigenstate, providing data support for subsequent dynamic adjustments and observation collapse, while disclosing such information in statement footnotes to enhance accounting information transparency.

Two-Stage Measurement Paradigm and Five-Step Accounting Process

Superposition bookkeeping centers on the "superposition state measurement—collapse state measurement" two-stage model, supported by a five-step closed-loop accounting process. Through differentiated probability amplitude quantification models, it solves complex business measurement bottlenecks while maintaining compatibility with traditional accounting systems. The measurement attributes adopt a multi-adaptation framework of "historical cost + fair value + replacement cost," where historical cost adapts to physical-form, stable-attribute eigenstates (such as commodity state, fixed asset state), fair value adapts to financially significant, frequently fluctuating eigenstates (such as financial asset state, convertible bond equity state), and replacement cost adapts to non-financial eigenstates like intangible asset state that lack active market quotations, precisely matching the measurement needs of different business attributes.

Superposition state measurement covers the entire cycle from business occurrence to pre-observation, with the core being determining each eigenstate' s amount and probability amplitude through scenario-specific quantification models to avoid subjective judgment bias. Quantifiable financial businesses rely on mature financial engineering models: The equity state essence of convertible bonds is an embedded call option, with option value calculated through the B-S model, using the proportion of option value to total convertible bond fair value as the equity state probability proportion, then converted to probability

amplitude ($c = \sqrt{P}$), with debt state probability proportion and amplitude derived inversely to ensure normalization conditions are met. Option hedging businesses center on the delta (Δ) indicator, with $\Delta = N(d_1)$ directly serving as the hedging effective state probability proportion, both aligning with the core criterion for hedging effectiveness and avoiding subjectivity in artificially dividing effective and ineffective portions. Difficult-to-quantify non-financial businesses such as digital assets construct a three-dimensional primary indicator system of "purpose attribute proportion, liquidity, value volatility," with four secondary indicators including display purpose proportion, transaction purpose proportion, market transaction activity, and fair value volatility rate. After forward standardization processing to eliminate dimensional differences, the entropy weight method calculates indicator weights, which are then combined with each indicator' s contribution degree to different eigenstates (0-1 interval) through weighting to obtain eigenstate probability proportions and amplitudes, achieving quantitative transformation of subjective judgment.

Collapse state measurement initiates when observation conditions are met, with the core being transforming multidimensional superposition states into single deterministic states. The collapse amount is calculated by weighting according to the formula $M = \sum(M_i \times |c_i|^2)$. For example, a digital asset with intangible asset state of 1 million yuan (40%), commodity state of 750,000 yuan (30%), and financial asset state of 825,000 yuan (30%) collapses to 872,500 yuan after weighting. After collapse, superposition account details are simultaneously transferred to single accounts, with unified measurement attributes of fair value or historical cost, achieving seamless connection between complex process recording and traditional statement disclosure.

The five-step closed-loop process ensures standardized full-cycle processing: First, business identification and attribute decomposition, clarifying eigenstate division criteria, measurement attributes, and applicable models to lay the foundation for subsequent bookkeeping. Second, account registration, where complex businesses are recorded in superposition accounts and traditional businesses in single accounts, simultaneously maintaining amount balance and probability amplitude normalization. Third, dynamic adjustment, where probability amplitudes are recalculated according to business volatility (monthly/quarterly) to calibrate each eigenstate amount, ensuring synchronization with business evolution. Fourth, observation collapse, completing the conversion from superposition accounts to single accounts and reverting to double-entry bookkeeping logic. Fifth, statement preparation and disclosure, where traditional statements are prepared based on single accounts, with footnotes supplementing quantification parameters, adjustment trajectories, and collapse conditions, balancing information determinacy and relevance.

Systematic Comparison: Superposition vs. Double-entry Bookkeeping

To highlight innovative advantages, a comparison system is constructed across several core dimensions (Table), clarifying that superposition bookkeeping does not subvert but rather inclusively expands double-entry bookkeeping. Superposition bookkeeping breaks through static frameworks with quantum symbiotic thinking, innovates a dual-balance mechanism of "amount + probability amplitude," adds superposition accounts to carry multiple attributes, enhances uncertainty business processing precision through quantification models, forms a dual-disclosure mode of "result + process," and adapts to complex digital economy scenarios. Double-entry bookkeeping focuses on traditional single-attribute businesses, relying on mature debit-credit balance logic to ensure basic accounting stability. The core difference lies in the cognition and recording dimensions of business attributes. Superposition bookkeeping supplements the dynamic measurement shortcomings of complex businesses while being able to degenerate and revert to double-entry bookkeeping without requiring reconstruction of existing systems.

Table : Comparison Between Double-entry and Superposition Bookkeeping

Dimension	Double-entry Bookkeeping	Superposition Bookkeeping	Innovative Advantages of Superposition Bookkeeping
Theoretical Basis	Static single-state balance based on classical deterministic thinking	Dynamic superposition evolution based on quantum symbiotic thinking	Shifts from static recording to dynamic reflection, adapting to complex business evolution
Core Rules	For every debit there must be a credit, debits equal credits (single balance)	Existence implies superposition, superposition implies conservation (dual balance)	Dual-balance mechanism enhances bookkeeping rigor
Account System	Only single accounts, classified by accounting elements	Superposition accounts + single accounts, accommodating both business types	Solves multi-attribute business recording problems

Dimension	Double-entry Bookkeeping	Superposition Bookkeeping	Innovative Advantages of Superposition Bookkeeping
Probability Amplitude	None (single state requires no probability amplitude)	Quantitative calculation via B-S model, delta, entropy weight method, etc.	Quantification replaces subjective judgment, reducing bias
Measurement Attributes	Single-attribute measurement (historical cost/fair value)	Two-stage measurement, dual attributes	Fully records multiple attributes, improving information completeness
Application Scenarios	Industrial era, traditional businesses with single attributes	Digital economy, financial innovation, and other complex business scenarios	Adapts to new business forms, expanding accounting applicability

In summary, superposition bookkeeping, through core technological innovation and compatible design with traditional systems, forms significant advantages in complex business measurement, risk information disclosure, and dynamic process tracking, while retaining double-entry bookkeeping' s adaptability for traditional businesses. It constructs a comprehensive bookkeeping system of "traditional scenario fallback—complex scenario breakthrough," providing a feasible paradigm for accounting method innovation in the digital economy era.

Case Study: Dual Bookkeeping Comparison Validation Based on a New Energy Enterprise

Case Background and Data Description

This paper selects Enterprise X, a major manufacturer of new energy vehicle power batteries, as the research object. The enterprise's 2024 business covers five cycles: procurement, production, sales, investment/financing, and derivative financial instruments, including both traditional single-attribute businesses such as raw material procurement and product sales, and three typical complex businesses—convertible bond issuance, digital asset transactions, and option hedging. These businesses all possess the characteristic of "multiple coexisting attributes and dynamic value evolution," perfectly matching the comparative validation needs of superposition and double-entry bookkeeping, and comprehensively testing the applicability of both methods across different business scenarios.

Case data is simulated based on new energy industry practical characteristics,

balancing business authenticity and data rationality: Probability amplitude quantification for complex businesses strictly follows the previously constructed paradigm, with convertible bonds using the Black-Scholes (B-S) option pricing model, option hedging using the delta (Δ) indicator method, and digital assets using the entropy weight method combined with expert scoring. Both bookkeeping methods strictly follow *Enterprise Accounting Standards* and superposition bookkeeping core rules, where double-entry bookkeeping is based on specific standards for financial instrument presentation, hedge accounting, and intangible assets, while superposition bookkeeping achieves dynamic quantification on the basis of standard compliance, ensuring fairness and rigor in comparison.

Core Business Dual Bookkeeping Process Comparison and Analysis

1. Convertible Bond Issuance Business: Dynamic Quantification vs. Static Splitting On January 10, 2024, Enterprise X issued 100,000 convertible bonds with a 3-year term, 100 yuan face value per bond, total issuance amount of 10 million yuan, 4% coupon rate, and 20 yuan/share conversion price. At issuance, the enterprise' s stock price was 18 yuan/share, the risk-free rate (using the same-term government bond annual yield) was 3%, stock price volatility (annualized over the past 12 months) was 25%, and the remaining conversion period was 3 years. The core difference of this business lies in that superposition bookkeeping dynamically tracks stock price impact on conversion possibility through models, while double-entry bookkeeping only statically splits components at issuance.

(1) Complete Superposition Bookkeeping Process. Centered on B-S model quantification of probability amplitudes, it achieves full-cycle coverage of "issuance registration–dynamic adjustment–period-end collapse." **Step 1: Calculate Option Value (Core of Equity State).** Substituting parameters $S_t = 18$ yuan (current stock price), $K = 20$ yuan (conversion price), $r = 3\%$ (risk-free rate), $\sigma = 25\%$ (volatility), $t = 3$ years (remaining term), we derive $d_1 = 0.1550$, $d_2 = -0.2780$, corresponding to standard normal distribution cumulative probabilities $N(d_1) = 0.5616$, $N(d_2) = 0.3907$. Single bond option value $C = 18 \times 0.5616 - 20 \times e^{-0.03\times 3} \times 0.3907 = 2.9968$ yuan, total option value 299,680 yuan. **Step 2: Determine Probability Proportion and Amplitude:** Equity state probability proportion $P_{\text{equity}} = 299,680/10,000,000 \approx 3\%$, probability amplitude $c_{\text{equity}} = \sqrt{0.03} = 0.1732$; debt state probability proportion $P_{\text{debt}} = 97\%$, probability amplitude $c_{\text{debt}} = \sqrt{0.97} = 0.9849$, satisfying normalization conditions. **Step 3: Superposition Account Registration (Table),** recording separately by dual states: debt state credit 9.7 million yuan, equity state credit 300,000 yuan, corresponding to bank deposits debit 10 million yuan, clearly reflecting initial attribute distribution.

Table : Convertible Bond Issuance Superposition Account Registration (Unit: Yuan)

Step 4: Mid-term Dynamic Adjustment: On June 30, 2024, the stock

price rose to 22 yuan/share, increasing conversion possibility. Recalculation yields $d_1 = 0.8210$, $d_2 = 0.3880$, $N(d_1) = 0.7941$, $N(d_2) = 0.6510$, single bond option value 5.4002 yuan, total option value 540,020 yuan. Equity state proportion rises to 5.4%, probability amplitude 0.2324; debt state proportion 94.6%, probability amplitude 0.9726. Superposition account amounts are adjusted synchronously, with equity state increasing to 540,000 yuan and debt state decreasing to 9.46 million yuan, maintaining the total of 10 million yuan, precisely capturing business dynamic evolution. **Step 5: Period-end Collapse:** On December 31 (the observation node for statement disclosure), collapse occurs according to the latest probability amplitudes: collapse amount $= 9.46 \times 94.6\% + 0.54 \times 5.4\% = 8.98832$ million yuan (the difference being interest adjustment, compliant with standards). Superposition accounts are transferred to single accounts with the entry: Debit: Bonds Payable—Debt State 9,460,000, Other Equity Instruments—Equity State 540,000; Credit: Bonds Payable—Face Value 10,000,000, achieving seamless integration with traditional reporting systems.

(2) Double-entry Bookkeeping Process. According to *Accounting Standard for Business Enterprises No. 37*, it only statically splits debt and equity components at issuance: Debt component fair value $= 10,000,000 \times (P/F, 4\%, 3) + 10,000,000 \times 4\% \times (P/A, 4\%, 3) = 9.5238$ million yuan (discounted at coupon rate), equity component $= 10,000,000 - 9.5238 = 0.4762$ million yuan. The accounting entry is: Debit: Bank Deposits 10,000,000, Bonds Payable—Interest Adjustment 476,200; Credit: Bonds Payable—Face Value 10,000,000, Other Equity Instruments 476,200. At period-end, only interest adjustment is amortized using the effective interest method to calculate debt component interest expense, while the equity component maintains its initial amount without adjustment for stock price fluctuations, unable to reflect changes in conversion possibility.

(3) Process Comparison and Advantage Highlighting. The core difference lies in "dynamic tracking vs. static fixation" : Double-entry bookkeeping' s splitting ratio is based on the issuance time point, with no subsequent adjustment mechanism. Even after stock price increases, the equity component remains recognized at the initial 476,200 yuan, resulting in insufficient information relevance. Superposition bookkeeping dynamically updates probability amplitudes through the B-S model, with the equity state proportion rising from 3% to 5.4% as stock price increases, completely recording attribute weight changes, with each adjustment supported by quantitative models to avoid subjective judgment. Simultaneously, superposition bookkeeping' s "superposition—adjustment —collapse" mechanism both retains process information and maintains compatibility with traditional statements, solving the problem of balancing complex business dynamic measurement with standard compliance.

2. Digital Asset Transaction Business: Multi-state Coverage vs. Single Classification On March 20, 2024, Enterprise X purchased digital collectibles for 5 million yuan, possessing triple attributes of display (intangible

asset state), sales (commodity state), and fair value changes (financial asset state). On June 30, the collectibles' fair value rose to 5.5 million yuan, and on December 10, 50% was sold for 3 million yuan. The core difference of this business is that superposition bookkeeping achieves parallel multi-state measurement, while double-entry bookkeeping is limited to single-attribute classification, resulting in information incompleteness.

(1) Double-entry Bookkeeping Process. It requires selecting a single attribute between intangible assets and financial assets for accounting, creating inherent defects. **If classified as intangible assets:** The March 20 purchase entry is "Debit: Intangible Assets—Digital Collectibles 5,000,000; Credit: Bank Deposits 5,000,000." On June 30, measured at historical cost, no fair value change (500,000 yuan appreciation) is recognized. On December 10, when selling 50%, the entry is "Debit: Bank Deposits 3,000,000; Credit: Intangible Assets 2,500,000, Asset Disposal Gain 500,000," ignoring value fluctuations from financial attributes. **If classified as financial assets:** The 500,000 yuan fair value change on June 30 must be recognized, but the intangible asset attribute corresponding to display purposes cannot be reflected, and profit/loss accounting at sale cannot split contributions from multiple attributes, resulting in insufficient information completeness.

(2) Superposition Bookkeeping Process. It uses the entropy weight method + expert scoring to quantify multi-state probabilities, achieving full-attribute coverage and dynamic adjustment. **Step 1: Business Decomposition:** Through entropy weight method-calculated indicator weights and expert scoring-confirmed attribute contributions, the intangible asset state proportion is 40% (amount 2 million yuan), commodity state 30% (1.5 million yuan), and financial asset state 30% (1.5 million yuan), with corresponding probability amplitudes 0.6325, 0.5477, and 0.5477, satisfying the normalization requirement $0.6325^2+0.5477^2+0.5477^2=1$. **Step 2: Purchase Registration (Table),** recording corresponding amounts by three states and crediting bank deposits 5 million yuan, clearly showing each attribute' s initial distribution.

Table : Digital Collectibles Purchase Superposition Account Registration (Unit: Yuan)

Step 3: Fair Value Change Adjustment: On June 30, the collectibles' total appreciation is 500,000 yuan, allocated according to the financial asset state proportion of 30%, corresponding to 150,000 yuan appreciation, with the entry: Debit: Digital Assets—Financial Asset State 150,000; Credit: Fair Value Change Profit/Loss 150,000. After adjustment, the financial asset state amount is 1.65 million yuan, while intangible asset and commodity states maintain historical cost, with total amount 5.15 million yuan, consistent with the 5.5 million yuan fair value proportion, balancing different attribute measurement rules. **Step 4: Sale Collapse Processing:** On December 10, selling 50% splits sale amounts by state (intangible asset state 1 million yuan, commodity state 750,000 yuan, financial asset state 825,000 yuan), collapsing to 2.575 million yuan weighted by probability proportions, with the entry: Debit: Bank Deposits 3,000,000; Credit:

Digital Assets–Intangible Asset State 1,000,000, Commodity State 750,000, Financial Asset State 825,000, Asset Disposal Gain 425,000. The remaining 50% continues to be recorded in superposition state, continuously tracking attribute evolution, achieving flexible "partial settlement–remaining tracking" processing.

(3) Process Comparison and Advantage Highlighting. Double-entry bookkeeping inevitably has information incompleteness due to single-attribute classification: either fair value changes are ignored or intangible asset attributes are concealed, with profit/loss accounting unable to reflect contributions from multiple attributes. Superposition bookkeeping, through the "multi-state splitting–dynamic adjustment–partial collapse" mechanism, both follows measurement standards for different attributes and completely records value fluctuations and attribute distributions, making profit/loss accounting more precise (the 425,000 yuan disposal gain includes the impact of previously recognized fair value changes), with significantly superior information completeness compared to double-entry bookkeeping.

3. Option Hedging Business: Quantified Allocation vs. Artificial Division On July 1, 2024, to hedge against price fluctuation risks for purchasing 100 tons of power battery raw materials at 50,000 yuan/ton in October, Enterprise X purchased call options, paying a premium of 100,000 yuan, with an exercise price of 52,000 yuan/ton and expiration date of October 31. The underlying asset volatility is 20%, risk-free rate 3%, and remaining term 4 months. The core difference of this business is that superposition bookkeeping uses delta indicators to quantify hedging effectiveness, while double-entry bookkeeping artificially divides effective/ineffective portions with strong subjectivity.

(1) Double-entry Bookkeeping Process. According to *Accounting Standard for Business Enterprises No. 24*, it classifies and accounts based on hedging effectiveness, relying on subjective judgment. **Step 1: Pay Option Premium:** The entry is Debit: Derivative Instruments–Call Options 100,000; Credit: Bank Deposits 100,000. **Step 2: Exercise Settlement:** The option' s fair value change is 200,000 yuan ($(5.5 - 5.2) \times 100 - 10$), with artificial division of effective portion 140,000 yuan and ineffective portion 60,000 yuan, with the entry: Debit: Raw Materials 5,500,000; Credit: Bank Deposits 5,200,000, Derivative Instruments–Call Options 100,000, Fair Value Change Profit/Loss 60,000, Raw Materials 140,000. The entire process lacks quantitative basis, with effectiveness division heavily influenced by accountants' subjectivity and unable to dynamically reflect market price fluctuation impacts on hedging effectiveness.

(2) Superposition Bookkeeping Process. It uses delta indicators to quantify probability amplitudes, achieving dynamic tracking and objective allocation of hedging effectiveness. **Step 1: Calculate Delta Value:** Substituting $S_t = 50,000$ yuan/ton, $K = 52,000$ yuan/ton, $r = 3\%$, $\sigma = 20\%$, $t = 0.333$ years, we derive $d_1 = -0.2095$, $N(d_1) = 0.4168$, meaning delta $\Delta = 0.4168$. **Step 2: Determine Probability Proportion and Amplitude:** Hedging effective state proportion 41.68% (approximately 42%, amount 42,000 yuan),

probability amplitude $c_{\text{effective}} = \sqrt{0.4168} = 0.6456$; ineffective state proportion 58.32% (approximately 58%, amount 58,000 yuan), probability amplitude $c_{\text{ineffective}} = \sqrt{0.5832} = 0.7636$. **Step 3: Purchase Registration (Table),** recording corresponding amounts by dual states and crediting bank deposits 100,000 yuan, clearly showing initial hedging effect distribution.

Table : Call Option Purchase Superposition Account Registration (Unit: Yuan)

Step 4: Pre-exercise Dynamic Adjustment: In October, market price fluctuations improved hedging effectiveness, with recalculation showing effective state proportion at 80%, probability amplitude 0.8944, and ineffective state proportion 20%, probability amplitude 0.4472. Adjusting each state amount, effective state increases to 80,000 yuan and ineffective state decreases to 20,000 yuan, with the entry: Debit: Derivative Instruments–Hedging Effective State 10,000; Credit: Derivative Instruments–Hedging Ineffective State 10,000, objectively reflecting hedging effect changes. **Step 5: Exercise Collapse:** The 200,000 yuan fair value change is allocated by probability proportion, with effective state change 160,000 yuan and ineffective state change 40,000 yuan. The post-collapse entry is: Debit: Raw Materials 5,500,000; Credit: Bank Deposits 5,200,000, Derivative Instruments–Hedging Effective State 80,000, Hedging Ineffective State 20,000, Fair Value Change Profit/Loss 40,000, Raw Materials 160,000, completely based on quantitative results without subjective intervention.

(3) Process Comparison and Advantage Highlighting. The core defect of double-entry bookkeeping is that hedging effectiveness division lacks quantitative basis, is highly subjective, and cannot be dynamically adjusted. Superposition bookkeeping uses delta indicators as the core, transforming hedging effectiveness into quantifiable probability amplitudes, with both initial division and mid-term adjustments supported by models, making fair value change allocation more objective and risk information disclosure more precise, effectively reducing human bias in accounting treatment.

4. Traditional Business Compatibility Verification To test superposition bookkeeping' s adaptability to traditional businesses, three typical businesses of Enterprise X in 2024 were selected: raw material procurement, product sales, and fixed asset depreciation. Taking the April 1 procurement of raw materials for 1 million yuan (including tax, 13% tax rate) as an example, superposition bookkeeping directly uses single accounts for recording due to single business attributes, with entries completely consistent with double-entry bookkeeping: "Debit: Raw Materials 884,955.75, Tax Payable–VAT Payable (Input Tax) 115,044.25; Credit: Accounts Payable 1,000,000." Product sales and fixed asset depreciation businesses also follow this logic, with superposition bookkeeping automatically degenerating to double-entry bookkeeping mode without requiring additional adjustment processes, ensuring continuity and stability in traditional business processing and demonstrating the design advantage of "com-

patible with tradition, adapted for innovation."

Financial Statement Data Comparison and Case Conclusions

Based on full-cycle business processing, core items from Enterprise X' s 2024 balance sheet and income statement are compiled to compare information output differences between the two methods (Table , Table), further validating superposition bookkeeping' s practical value.

Table : Balance Sheet Core Items Comparison (Unit: 10,000 yuan)

Item	Double-entry	Superposition (Post-collapse)	Difference	Cause Analysis
Digital Assets	250.00	257.50	+7.50	Superposition bookkeeping recognizes digital asset fair value change of 150,000 yuan, deducting 75,000 yuan difference from sold portion
Bonds Payable	952.38	946.00	-6.38	Convertible bond debt state amount dynamically adjusted via B-S model, reflecting stock price fluctuation impact
Other Equity Instruments	47.62	54.00	+6.38	Corresponding convertible bond equity state adjustment, offsetting bonds payable difference to maintain balance

Item	Double-entry	Superposition (Post-collapse)	Difference	Cause Analysis
Retained Earnings	—	—	+7.50	Fair value change profit/loss difference flows to owner's equity

Note: This data is simulated data, only used to illustrate differences and calculation logic between the two bookkeeping methods.

Table : Income Statement Core Items Comparison (Unit: 10,000 yuan)

Item	Double-entry	Superposition	Difference	Cause Analysis
Operating Revenue	12,500.00	12,500.00	0.00	Traditional business revenue accounting is consistent; complex businesses do not affect revenue recognition
Asset Disposal Gain	50.00	42.50	-7.50	Superposition bookkeeping had previously recognized partial fair value change of digital assets; disposal gain includes 150,000 yuan digital asset fair value change, deducting 20,000 yuan option ineffective portion difference

Item	Double-entry	Superposition	Difference	Cause Analysis
Fair Value Change Profit/Loss	5.00	13.00	+8.00	Includes 150,000 yuan digital asset fair value change, deducting 20,000 yuan option ineffective portion difference
Total Profit	2,500.00	2,501.00	+1.00	Net impact of fair value change profit/loss and asset disposal gain difference

1. Core Causes of Statement Differences. Differences between the two methods' statements stem from fundamentally different capabilities in capturing complex business information: First, digital asset measurement differences—superposition bookkeeping fully recognizes fair value changes, while double-entry bookkeeping omits this information due to single classification, causing 75,000 yuan differences in assets and owner' s equity. Second, convertible bond structure disclosure differences—superposition bookkeeping dynamically adjusts debt and equity components, optimizing statement structure and more truthfully reflecting financial conditions despite no impact on total equity. Third, option profit/loss allocation differences—superposition bookkeeping allocates fair value changes based on quantitative models, avoiding subjective bias in double-entry bookkeeping and making profit/loss accounting more objective.

2. Superposition Bookkeeping Statement Information Advantages. Compared with double-entry bookkeeping, superposition bookkeeping' s statement information possesses three advantages: First, completeness—through footnote disclosure of quantification model parameters (such as B-S model volatility, delta indicator calculation process), it supplements process information missing in double-entry bookkeeping, helping users fully understand complex business evolution. Second, relevance—precise accounting of fair value changes makes statement data better reflect actual asset values, providing reliable basis for investment decisions. Third, rationality—the liability and equity structure after dynamic adjustment more truthfully reflects enterprise potential risks and returns, reducing decision-making risks for statement users.

3. Case Conclusions. Through Enterprise X' s 2024 full-cycle business validation, superposition bookkeeping demonstrates significant practical value and innovative advantages: First, the probability amplitude quantification model system (B-S model, delta indicator method, entropy weight method, and expert

scoring) solves the core technical bottleneck of determining complex business attribute weights, enabling superposition bookkeeping to move from theory to practical implementation. Second, the "superposition state—dynamic adjustment—collapse state" mechanism completely captures the dynamic evolution process of multi-attribute businesses, thoroughly solving the information omission problem of double-entry bookkeeping' s single-state measurement. Third, the degeneration compatibility feature ensures complete connection with existing accounting systems and standard requirements without reconstructing accounting processes, significantly reducing enterprise application costs. Fourth, statement information completeness, relevance, and objectivity are substantially improved, providing a feasible paradigm for accounting of complex businesses in the digital economy era.

In summary, superposition bookkeeping does not negate double-entry bookkeeping but rather expands and upgrades it while retaining its advantages in traditional business processing, constructing a comprehensive bookkeeping system of "traditional scenario fallback—complex scenario breakthrough" that adapts to new demands for accounting methods from the digital economy and financial innovation.

Research Conclusions and Outlook

Based on quantum mechanics' core principles of superposition, collapse, and decoherence, this paper completes the quantum reconstruction of the accounting equation and innovatively proposes superposition bookkeeping. The reconstructed quantum accounting equation "$|\Psi\rangle = |A\rangle \oplus |L\rangle \oplus |OE\rangle$" (where Ψ is the quantum accounting state, $|A\rangle$, $|L\rangle$, $|OE\rangle$ are asset, liability, and owner' s equity superposition states respectively, and $\oplus$ represents quantum superposition) breaks through the static limitations of traditional equations. Superposition bookkeeping establishes the core bookkeeping rule of "existence implies superposition, superposition implies conservation, observation implies collapse," supporting the construction of a "superposition accounts + single accounts" dual-account system and a "superposition state measurement (business process) + collapse state measurement (business result)" two-stage measurement paradigm. By constructing a multi-scenario probability amplitude quantification model system to solve technical bottlenecks, and through theoretical construction, cross-method comparison, and new energy enterprise full-cycle case validation, core conclusions are formed. The static single-state logic of traditional accounting equations and double-entry bookkeeping has adaptability defects with the multi-attribute coexistence and dynamic evolution characteristics of complex businesses such as derivative financial instruments and digital assets. The correspondence between quantum theory and accounting systems—business multiple attributes corresponding to superposition states, full-process evolution corresponding to quantum state evolution, and final results corresponding to collapse states—provides logical support for theoretical innovation. The reconstructed quantum accounting equation breaks through traditional static limita-

tions, can capture dynamic balance through element superposition state depiction and probability amplitude quantification, and can degenerate to traditional equations under specific scenarios, forming a "quantum-classical"inclusive framework. Superposition bookkeeping, with its exclusive rules as the core, constructs a dual-account, two-stage measurement paradigm. Its differentiated quantification path reduces subjective bias, showing obvious advantages in complex business information capture and dynamic tracking, while being compatible with traditional businesses, featuring "incremental innovation." Its practical feasibility and decision-making value have been validated by cases.

Based on research conclusions and digital economic development trends, implementing superposition bookkeeping requires constructing an "enterprise-standards-technology" collaborative system. At the enterprise level, enterprises with intensive complex businesses can pilot first, building dedicated superposition accounts and parameter standard libraries for businesses such as convertible bonds and digital assets, optimizing footnote disclosure to supplement key information like superposition states and probability amplitudes, enhancing decision support value. At the standards level, quantum accounting innovation should be followed up, clarifying quantification model applicable boundaries and parameter selection principles, integrating superposition state concepts into relevant standard revisions to compensate for existing standards' shortcomings in depicting complex businesses. At the technology support level, accounting information systems should be upgraded to develop integrated modules for quantification calculation and dynamic management, combined with blockchain for full-linkage certification, reducing application costs and enhancing information credibility to solidify the foundation for large-scale implementation.

This study has certain limitations that can be targeted for deepening and expansion in follow-up work. On one hand, the industry universality of quantification models is suboptimal, having only been validated in new energy enterprises, not yet covering characteristic businesses in finance, culture, metaverse, and other industries, with the logic for differentiated parameter system adjustments requiring further verification. On the other hand, the depth of parameter sensitivity analysis is insufficient, with the impact degree and transmission paths of core parameter changes on results not systematically quantified, and model robustness needing enhancement. Future work can expand industry adaptation scenarios, optimize differentiated parameter systems and operational guidelines; use tools such as Monte Carlo simulation for parameter sensitivity analysis to establish dynamic adjustment early warning mechanisms; simultaneously construct audit verification frameworks and regulatory rules adapted to superposition bookkeeping, clarify responsibility boundaries, promote its standardized application, and help the accounting system fully adapt to digital economy and financial innovation needs.

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