

Article

Research on the Accounting and Measurement of Forestry Carbon Sinks Following the Restart of the China Certified Emission Reduction Market

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Abstract

In the context of the China Certified Emission Reduction (CCER) market restart, accounting for forestry carbon sinks faces two challenges: ambiguous theoretical classification and the absence of sound measurement standards. To address the lack of reliable value benchmarks for initial measurement and the distortion of income statements caused by subsequent value fluctuations, this paper establishes an accounting measurement system incorporating the “Environmental Value Equivalence Method” and the “Dynamic Fair Value Adjustment Method” and introduces a dedicated “Environmental Equity Reserve” account. The “Environmental Value Equivalence Method” constructs a weighted average benchmark price using observable market inputs such as CEA and CCER prices, which is then adjusted by an ecological adjustment coefficient to establish an initial valuation anchor. For subsequent measurement, the “Dynamic Fair Value Adjustment Method” is applied, under which changes in fair value are recorded directly in the “Environmental Equity Reserve” account rather than in the income statement, thereby isolating unrealized gains and losses during the holding period from current period profit or loss. Using the afforestation carbon sink project in Honghe Prefecture as a case study and drawing on actual transaction data from the CCER market, the study demonstrates the complete operational process from initial recognition and subsequent adjustments to partial disposal. The findings offer a theoretically grounded and practically feasible solution for the accounting treatment of forestry carbon sinks under China’s CCER mechanism.

Keywords: CCER; forestry carbon sinks; accounting measurement; environmental equity; case study



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1. Introduction

The national carbon market is undergoing continuous expansion. Following its re-launch, the China Certified Emission Reduction (CCER) market has embarked on a path of rapid development. The Notice on Financial Support for High-Quality Forestry Development, jointly issued by the People’s Bank of China and two other departments, explicitly proposes “exploring pledge financing for forest rights, carbon sink revenue rights, and other assets”. This policy initiative creates favorable conditions for the innovative development of forestry carbon sinks within the financial sector. Carbon removal, carbon accounting, and carbon crediting mechanisms are three interrelated yet conceptually distinct notions. Carbon removal refers to the physical process by which forests absorb carbon dioxide through photosynthesis. Carbon accounting encompasses the methodologies for

measuring, reporting, and verifying the amount removed, exemplified by CCER methodologies. Carbon crediting mechanisms, represented by the CCER system, convert verified removal quantities into tradable credits, constituting an institutional arrangement. This paper focuses on the corporate financial accounting treatment following the issuance of carbon credits, taking the verified carbon sink volume as a given premise, and explores how enterprises should recognize these carbon credits as financial statement items, how to measure them, and how to disclose them. Forestry carbon sinks hold irreplaceable value in China's pursuit of its dual carbon goals, while forest carbon trading possesses the potential to enhance China's forest carbon sequestration capacity [1]. With the further implementation of China's Dual Carbon strategy (i.e., carbon peak and carbon neutrality), forestry carbon sinks are transforming from static ecological resources to dynamic tradable assets [2,3].

Despite various policies actively supporting forestry carbon sink development, multiple constraints persist in accounting measurement. As an emerging economic resource, forestry carbon sinks' value stems both from the ecological attributes of carbon sequestration services provided by forest ecosystems and its financial attributes realized through market trading contracts. However, the practical transition of forestry carbon sinks from ecological resources to tradable assets still faces obstacles. On one hand, its value assessment lacks unified, scientific measurement standards [4,5]. On the other, despite high expectations for its market trading mechanisms, accounting recognition, measurement, and reporting standards tailored to this unique asset have long been absent [6]. CCER accounting standards for forestry carbon sinks are intrinsically linked to the United Nations Framework Convention on Climate Change (UNFCCC) national carbon accounting system. The CCER afforestation methodology, in terms of technical specifications, references the afforestation and reforestation methodologies under the UNFCCC Clean Development Mechanism (CDM) and the relevant rules for the Land Use, Land-Use Change and Forestry (LULUCF) sector under the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. Project-level measurement and national inventory compilation are methodologically homologous. The UNFCCC reporting framework requires Annex I Parties to adopt a land-based approach in compiling LULUCF inventories. Existing studies have shown that refinement in estimating national-level forest carbon stock enhances the accuracy and completeness of greenhouse gas inventory reports [7]. Consequently, if CCER carbon credit measurement standards lack a unified scientific basis, it will not only undermine the reliability of carbon asset measurement in corporate financial statements but also interfere with the data quality of national greenhouse gas inventories and compliance assessments. Therefore, establishing an accounting measurement system that scientifically reflects both its environmental attributes and market value has become an urgent task for promoting the healthy development of the forest carbon sink market.

The core objective of this paper lies in systematically demonstrating the theoretical rationale for recognizing forestry carbon sinks as "Tradable Environmental Assets" and designing a dynamic measurement system that precisely aligns with this classification while simultaneously capturing both their "environmental equity" foundation and "market transaction" characteristics. The innovation of this paper lies in providing a complete closed-loop framework that spans from theoretical qualification to technical quantification and from initial recognition to subsequent measurement. The three measurement innovations proposed in this paper are interrelated and collectively provide a systematic theoretical basis and methodological toolkit for the accounting recognition and measurement of forestry carbon sinks following the CCER market restart. It should be noted that the discussion in this paper is not based on hypothetical assumptions but starts from actual transaction data publicly available from the National Greenhouse Gas Voluntary Emission Reduction

Trading System. By the end of 2025, the annual trading volume of the CCER market had reached 8,844,100 tonnes, with a total transaction value of RMB 626 million and a cumulative average transaction price of RMB 70.76/tonne. The highest and lowest daily average transaction prices were RMB 107.36/tonne and RMB 50.84/tonne, respectively. These data constitute the pricing benchmark and market background parameters for the case study in this paper. Given the limited accumulation of transaction data in the early stage of the CCER market restart, this paper focuses on theoretical construction and accounting case demonstration at the methodological level, and large-sample empirical testing has not yet been conducted. Future research may empirically validate the practical effects of this framework under more mature market conditions.

The core hypothesis of this paper is that recognizing forestry carbon sinks as tradable environmental assets and applying the Environmental Value Equivalence Method and the Dynamic Fair Value Adjustment Method for initial and subsequent measurement can effectively address the measurement inaccuracies existing in the current classification system. Meanwhile, the establishment of the Environmental Equity Reserve account can buffer the impact of fair value fluctuations of carbon assets on the income statement. Based on this hypothesis, the paper proceeds with the following structure: Section 2, starting from the theoretical basis of asset classification, justifies the rationality of the tradable environmental assets classification and constructs a measurement framework incorporating the Environmental Value Equivalence Method, the Dynamic Fair Value Adjustment Method, and the Environmental Equity Reserve. Section 3, using actual CCER market transaction data and the afforestation carbon sink project in Honghe Prefecture as a case study, demonstrates the complete operational process from initial measurement to subsequent adjustments and disposal and tests the robustness of the framework through multi-scenario analysis and stress testing. Section 4 concludes the findings, discusses limitations, and outlines future research directions. The logical framework of the paper is shown in Figure 1.

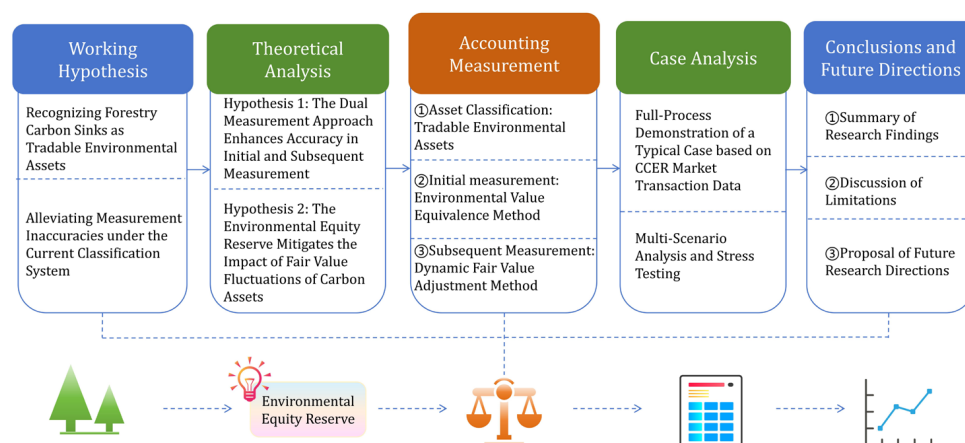


Figure 1. Research framework and logical flow of the paper.

2. Construction of the Accounting and Measurement System for Forestry Carbon Sinks

2.1. Recognition of Forestry Carbon Sinks

2.1.1. Limitations of Existing Classifications of Forestry Carbon Sinks

At the international level, neither IFRS nor US GAAP provides explicit accounting guidance for carbon credits. A systematic analysis of the carbon credit accounting policies of the world's top 100 greenhouse gas emitters found that carbon credits are most frequently classified as inventories in practice, followed by intangible assets, with significant and persistent heterogeneity across firms [8]. A case study of the Brazilian carbon market

revealed that firms recognized carbon credit assets as inventories, intangible assets, and financial assets, respectively, yet the characteristics of carbon credits do not fully align with any existing asset category [9]. An accounting practice study of Australian carbon credit providers further demonstrated that the asset classification of carbon credits varies due to differences in market requirements and economic uncertainty [10]. This suggests that the diversity of accounting classification of carbon credits has become a common international issue, and the practical differences caused by the absence of accounting standards are not unique to China.

In this international context, domestic scholars have formed three representative views regarding the asset classification of forestry carbon sinks: first, the “intangible asset perspective,” which emphasizes their lack of physical form and their origin in forestry activities [11–15]; second, the “financial asset perspective,” which focuses on their tradable nature and price volatility as investment attributes [16,17]; and third, the “inventory perspective,” which views them as “finished goods” awaiting sale after project development [18].

One notable omission in the existing discussion is that Harvested Wood Products (HWPs) have not yet been incorporated into the measurement scope of carbon sink assets. Under the LULUCF accounting framework, HWPs constitute a long-term carbon pool alongside forest biomass. The carbon stored in biomass is not released immediately after harvesting but is transferred to wood products, where carbon sequestration continues [19]. Cross-comparisons based on global forest sector models further reveal that HWPs represent a significant source of long-term carbon sequestration, with changes in their carbon stock influenced by both timber markets and climate policies [20]. If only carbon credits themselves are considered, while the pathways of carbon transfer and delayed release represented by HWPs are overlooked, the physical integrity of carbon sink asset measurement will be compromised due to the omission of this important carbon flow.

Traditional asset classifications all reveal limitations when applied to forestry carbon sinks. Regarding intangible assets, IAS 38 explicitly excludes intangible assets held for sale in the ordinary course of business from its scope of application. CCER carbon credits are held for trading rather than for use, and therefore the intangible asset standard does not apply to them. China Accounting Standard No. 6—Intangible Assets similarly excludes assets held for sale, and the two standards are logically consistent on this point. Regarding financial assets, carbon credits do not constitute cash, equity instruments of other entities, or contractual rights to receive cash and thus do not meet the definition of financial assets under IAS 32. China Accounting Standard No. 22—Financial Instruments: Recognition and Measurement adopts a definition of financial assets that is substantially converged with IAS 32, leading to the same conclusion. Regarding inventories, while the holding purpose of CCER carbon credits satisfies the “held for sale” criterion under IAS 2, the inventory perspective fails to capture the distinctiveness of carbon credits as warrant-like assets and their highly uncertain value, which fundamentally differentiates them from ordinary goods held for sale. China Accounting Standard No. 1—Inventories provides a similar definition of inventories and suffers from the same limitation. The ISAR framework defines environmental assets as environmental costs capitalized for environmental protection and restoration purposes, which is fundamentally different from the nature of forestry carbon sinks held for trading. The intangible asset perspective struggles to account for their trading purpose; the financial asset perspective downplays their fundamental reliance on physical ecological processes; and the inventory perspective fails to adequately address their nature as certificates of rights and the high uncertainty of their value. As a new form of capital that integrates ecological and financial attributes, the value of forestry carbon sinks transcends the scope of traditional assets.

2.1.2. Establishment of the “Tradable Environmental Assets—Forestry Carbon Sinks” Account

Based on property rights theory and holding objectives, and drawing on ISAR’s (2003) definition of environmental assets as well as existing research on new environmental asset accounts [21], this paper argues that forestry carbon sinks possess clear tradability and investment characteristics. Therefore, the classification proposed by Zhang Yalian et al. (2024) to recognize them as “Tradable Environmental Assets” is more appropriate [22].

For developers of or investors in carbon sink projects whose primary objective is to generate profits through sales—such as forestry enterprises and specialized carbon asset management companies—the forestry carbon sink assets they hold are clearly intended for trading and are supported by an active market. Simply classifying them under “Environmental Assets” fails to reflect their intent to “hold for trading.” The establishment of the “Tradable Environmental Assets—Forestry carbon sinks” account more reasonably reflects their tradable characteristics.

Tradable Environmental Assets are not an exclusive classification under the CCER framework. The core prerequisite for their recognition is the existence of a market system that provides pricing and trading platforms for forestry carbon sink emission reductions. On this basis, this classification applies to any market mechanism that provides a tradable platform for forestry carbon emission reductions. Internationally comparable cases include eligible emission units recognized under CORSIA and forestry carbon credits verified by international standards such as Verra under the voluntary carbon market. China’s CCER market has been included in the list of CORSIA-eligible programs, indicating that its carbon credits are institutionally positioned for potential integration with international markets. Although trading rules vary across different markets, the “held for trading” attribute of assets and the underlying accounting recognition logic remain consistent. This paper takes the CCER market as the research setting, with relevant transaction data serving as the basis for subsequent measurement analysis. This is a matter of research design choice rather than a limitation on the classification logic itself.

This account records forestry carbon sinks held by an enterprise for the purpose of near-term sale, which have been generated through the management of forest resources and have been verified and issued. According to the Measures for the Administration of Voluntary Greenhouse Gas Emission Reduction Trading (Trial), the development of CCER projects must sequentially undergo project implementation, third-party validation and verification, carbon sink volume certification, and project registration and emission reduction registration. Project implementation is still at the input stage, during which neither carbon sink volume is generated nor are tradable certificates available, thus lacking the measurement basis for asset recognition. Third-party validation and verification merely provide an opinion on the methodological compliance of the project design and monitoring plan, and such opinions do not constitute legal titles to carbon credits. Carbon sink volume certification confirms the emission reduction effect but does not yet provide administrative authorization for tradable credit certificates. Project registration is a confirmation only of the compliance of the project itself, rather than a legal recognition of emission reductions. Only when the emission reductions have been verified by a verification body, reviewed and approved by the registry, and formally registered—that is, upon the issuance of CCER credits—do the emission reductions acquire the legal status of certified voluntary emission reductions in the registration system. At this point, they are technically measurable, legally tradable, and capable of bringing expected economic benefits to the enterprise, satisfying all the criteria for asset recognition. Therefore, this paper takes emission reduction registration, i.e., the issuance of CCER credits, as the triggering event for the recognition of forestry carbon sinks as Tradable Environmental Assets.

However, this study finds that existing research lacks a systematic conceptual framework and rigorous argumentation regarding how the “trading” and “environmental” attributes can be organically integrated at the level of accounting elements. The diversity of accounting classification of carbon credits has been well documented in the international literature. However, existing discussions remain largely confined to classification choices within single markets and have not adequately addressed the accounting recognition challenges in cross-border contexts. Medeckytė-Žydėlė (2026) points out that the absence of specific guidance on carbon offsets under IFRS leaves firms with inconsistent justifications for choosing between inventories and intangible assets [23]. This predicament becomes more pronounced in cross-border transactions, where the same carbon credit may be recognized as different types of assets across jurisdictions, giving rise to comparability issues that impede the interconnection of carbon markets. Although Article 6.2 of the Paris Agreement provides an accounting framework for internationally transferred mitigation outcomes, the accounting basis for cross-border mutual recognition has yet to be established. Guo and Zheng (2023) further observe that the institutional environment for cross-border carbon trading has undergone a fundamental shift from the CDM era to the Paris Agreement era, and the corresponding policy framework remains in transition, with institutional barriers still impeding the cross-border circulation of carbon assets [24]. These studies suggest that the existing asset classification system neither adequately captures the dual nature of forestry carbon sinks nor adequately addresses the accounting recognition challenges in cross-border contexts. It is precisely in response to this conceptual gap that this paper, having proposed the classification of Tradable Environmental Assets, shifts its focus to the design of measurement methods, attempting to reflect both the intrinsic ecological value and the market trading characteristics within a unified measurement system through the coordinated application of the Environmental Value Equivalence Method and the Dynamic Fair Value Adjustment Method. Furthermore, while macroeconomic frameworks such as the System of Environmental-Economic Accounting (SEEA) have been designed to integrate environmental data with national economic accounts [25], equivalent systematic principles have yet to be translated into entity-level financial reporting standards. Meanwhile, the integration of forest carbon accounting with the broader climate governance framework remains a critical yet underdeveloped area, and there is an urgent need to establish a unified analytical framework capable of bridging ecological dynamics, market mechanisms, and regulatory systems [26]. These gaps leave questions unanswered: How should the intrinsic value rooted in the ecosystem be measured? And how can both its intrinsic ecological value and external market fluctuations be reflected simultaneously within a single measurement system? These questions are precisely the core issues this paper seeks to address.

2.2. Core Measurement Methods

The traditional historical cost method fails to reflect the value of forestry carbon sinks; currently, the fair value method is primarily used for measurement [11,27,28]. In the early stages following the CCER market restart, the market was characterized by low trading frequency, insufficient depth, and significant price volatility, all of which constrain the reliability of fair value measurement. Under conditions of illiquidity, a small number of transactions cannot adequately represent the true fair value of the assets. Individual transactions may deviate from equilibrium prices due to compliance urgency, and once such prices are used as valuation benchmarks, the price signal becomes distorted. When trading intervals are excessively long, price signals fail to reflect market changes in a timely manner, resulting in a significant lag in valuation information.

The determination of fair value hierarchy requires flexible adjustment to market conditions. The current CCER market does not yet possess the characteristics of an active

market as defined by IFRS 13, and Level 1 inputs are largely inapplicable. When trading is active, observable market quotes—that is, Level 2 inputs—may be used; when trading is thin or no observable transactions exist, valuation techniques—that is, Level 3 inputs—must be applied. The boundary between Level 2 and Level 3 inputs depends on whether the frequency and volume of observable transactions within a given reporting period are sufficient to form an identifiable price range.

Based on the above market realities, this paper proposes two measurement methods to be used in coordination. The Environmental Value Equivalence Method, anchored to the certified volume of carbon sink projects, provides a valuation anchor that does not rely on market prices during periods of market disruption or when no observable transactions exist, thereby ensuring measurement continuity and verifiability. The Dynamic Fair Value Adjustment Method, under normal market conditions, bases subsequent measurements on observable prices. The two methods are dynamically applied according to input reliability: the latter dominates when trading is active, while the former serves as a supplement during market downturns.

This paper introduces the Environmental Equity Reserve account to accommodate fair value fluctuations. When fair value declines, the change is recorded in this account rather than in profit or loss, thereby insulating the income statement from the direct impact of market illiquidity and short-term price distortions. At the same time, changes in the balance of this account can convey signals to investors regarding the value fluctuations of carbon assets.

2.2.1. Environmental Value Equivalence Method

The core value of forestry carbon sinks lies in their ability to sequester carbon through ecosystem functions. However, in the early stages of the CCER market's development, obtaining reliable and active market pricing directly presents certain challenges. If historical cost accounting is used, it will overlook the ecological value of these sinks, resulting in inaccurate financial reporting. In the field of environmental and resource economics, a comprehensive theoretical and methodological framework has been established to address the challenges of valuing such non-market benefits. Its core logic involves the scientific quantification of ecological benefits through the construction of standardized “equivalence” [29].

The valuation framework proposed in this paper is not intended to replace the project methodologies employed under the existing carbon credit system. The CCER afforestation methodology, the VCS VM0047 afforestation/reforestation methodology, and the CDM afforestation/reforestation methodology have each established a complete technical procedure from baseline carbon stock measurement to emission reduction issuance. The determination of baseline carbon stock follows the carbon layer stratification and sample plot measurement protocols prescribed by the respective methodologies. Additionality is assessed using the relevant tools under the Guidelines for the Design and Implementation of Voluntary Greenhouse Gas Emission Reduction Projects within the CCER framework or the dynamic performance benchmark approach under the VCS framework. Leakage risks are strictly excluded under the applicable conditions of the CCER afforestation methodology, with leakage assumed to be zero. Permanence risks are addressed by deducting a certain percentage of risk rate from the emission reductions. The above procedures constitute the complete production chain of certified carbon sink volumes, encompassing baseline surveys, emission reduction accounting, third-party validation, and verification, culminating in the issuance of tradable credits by the carbon crediting mechanism—that is, the completion of CCER emission reduction registration.

This paper directly takes the carbon sink volume verified and issued through the above procedures as a given premise and uses it as the starting point for measurement, focusing on how to assign an initial monetary value to it in the financial statements. Project

methodologies address the question of the quantity of emissions reduced. This paper addresses the question of how much that reduction is worth in accounting terms. The two functions operate in an upstream-downstream division of labor, rather than being substitutes for one another. The “Environmental Value Equivalence Method” proposed in this study represents a creative adaptation and accounting application of this macro-level assessment concept. Wang (2017), in a study on environmental value accounting, further noted that traditional measurement models in the accounting field are limited in scope and cannot adequately capture the full value of environmental assets [30]. A systematic reconstruction of measurement methods is therefore necessary, with due consideration given to both the natural and market characteristics of environmental resources. In the early stages of the CCER market’s relaunch, when trading has not yet fully picked up, relying solely on market quotes for initial measurement may be unreliable. The “Environmental Value Equivalence Method” aims to establish a scientific and robust initial valuation model to address the critical issue of “how to record” forestry carbon sinks during the initial recognition phase. Its core logic lies in anchoring the asset value to the equivalent of verifiable environmental rights it embodies and converting this into monetary value through scientifically sound valuation standards [30]. This method is positioned for the initial measurement of emission reductions that have been verified and issued, and it operates in coordination with the Dynamic Fair Value Adjustment Method. The former provides a valuation benchmark when no observable market quotes are available, while the latter bases measurement on market quotes when the market provides observable inputs.

The certified carbon sink volume Q , after third-party validation and verification, is formally issued by the carbon crediting mechanism. It constitutes a standardized environmental credit unit measured in tonnes of carbon dioxide equivalent (tCO_2e) and serves as an objective and verifiable measurement basis for the recognition of forestry carbon sink assets. Under current regulations, CCER transactions may be conducted through exchange trading (ET) and over-the-counter (OTC) trading. ET includes listed trading and auction trading, both of which generate observable market quotes. OTC trading, conducted through block trading, is priced via bilateral negotiation and does not generate public quotes. This distinction is important because accounting treatment and valuation dynamics may differ substantially depending on the trading venue. When Q is traded through ET and public quotes are available, fair value measurement may rely directly on observable inputs. When the transaction is completed through OTC trading or when the market lacks active trading, valuation techniques—such as the Environmental Value Equivalence Method—are required to determine the measurement amount. Regardless of the trading method adopted, the asset attribute of Q as certified voluntary emission reductions remains unchanged, and the records in the registration system constitute the sole basis for asset ownership.

The Comprehensive Value Equivalent denotes the monetary value per unit of carbon sink (RMB/ tCO_2e). In line with international accounting norms, fair value derived from active market transactions is prioritized for initial measurement. In the absence of an active market, prior studies have explored alternative valuation techniques, including opportunity cost and comprehensive cost methods [5,31–33]. However, these conventional approaches inherently fail to capture the unique ecological attributes and dynamic market dynamics of forestry carbon sinks, leading to potential biases in value measurement. To address this critical gap, this study employs the “Environmental Value Equivalence Method,” which synthesizes a weighted average benchmark price from two core carbon market signals—the national carbon market (CEA) average price and the voluntary carbon market (CCER) reference price—and incorporates an ecological adjustment coefficient to quantify the synergistic ecological benefits (e.g., soil conservation, water retention) that are inherent to forestry carbon sinks but not reflected in conventional carbon pricing.

The specific calculation formula is as follows:

$$CA_0 = V_{CCS} \times CVE \quad (1)$$

$$CVE = P_{WAB} \times \alpha \quad (2)$$

where CA_0 is the initial carrying amount, V_{CCS} is the certified carbon sink volume, CVE is the comprehensive value equivalent, P_{WAB} is the weighted average benchmark price, and α is the ecological adjustment coefficient.

Notably, the weighted average benchmark price integrates two dominant carbon market price signals, with weight assignment guided by the “information quality orientation” principle to prioritize more reliable price information. The ecological adjustment coefficient is specifically designed to capture the multi-dimensional synergistic ecological benefits of forest ecosystems—benefits that are typically omitted in traditional carbon pricing mechanisms. The applicability of this valuation framework is not limited to the CCER system. From the perspective of the formula structure, Equations (1) and (2) reflect a general logic: certified emission reductions are input variables that can be provided by various carbon crediting mechanisms, and the Comprehensive Value Equivalent can be reconstructed using comparable price benchmarks from the target market. International applicability depends on two conditions: whether a reliable pricing benchmark exists in the target market and whether the ecological adjustment coefficient can be reasonably calibrated to local ecological conditions. This paper uses the CEA price of China’s national carbon emissions trading market as the pricing benchmark; other markets may substitute this with comparable allowance prices that have sufficient liquidity.

At the institutional level, this valuation framework would benefit from additional discussion regarding its compatibility with Article 6 mechanisms under the Paris Agreement and Internationally Transferred Mitigation Outcomes (ITMOs). Article 6.2 allows countries to engage in bilateral agreements for the transfer of ITMOs, while Article 6.4 establishes the Paris Agreement Crediting Mechanism, under which emission reductions, once authorized by the host country, may also be used as ITMOs. The International Civil Aviation Organization has also confirmed that emission units generated under the UNFCCC and the Paris Agreement mechanisms are eligible for use under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). Although these mechanisms differ in their governance structures, they all rest on three common foundations—certification, tradability, and the avoidance of double counting—which are consistent with the basic premise of this framework. The authors should clarify whether the proposed framework could remain applicable under internationally transferred carbon units and linked carbon markets. For ITMOs that are transferred across borders, this framework can provide a logical starting point for initial measurement, but issues such as exchange rate treatment and differences in accounting standards in cross-border transactions fall beyond the scope of this paper and are left for future research. This integrated measurement framework effectively circumvents the limitations of single-dimensional approaches relying solely on historical cost or volatile initial market prices, thereby ensuring that the initial measurement of forest carbon sink assets is both scientifically rigorous and practically equitable, advancing the standardization of carbon sink asset accounting. The initial measurement framework is summarized in Figure 2 for clarity.

2.2.2. Dynamic Fair Value Adjustment Method

For forestry carbon sinks recognized as “Tradable Environmental Assets,” subsequent measurement must reflect changes in market value. The core of the “Dynamic Fair Value Adjustment Method” proposed in this paper lies in ensuring the conservatism of financial

statements through innovative accounting account design while adhering to fair value measurement. The “Dynamic Fair Value Adjustment Method” serves as a guideline for the subsequent measurement of forestry carbon sinks; it upholds fair value measurement to ensure the relevance of information while simultaneously ensuring the conservatism of the income statement through the establishment of innovative accounting accounts.

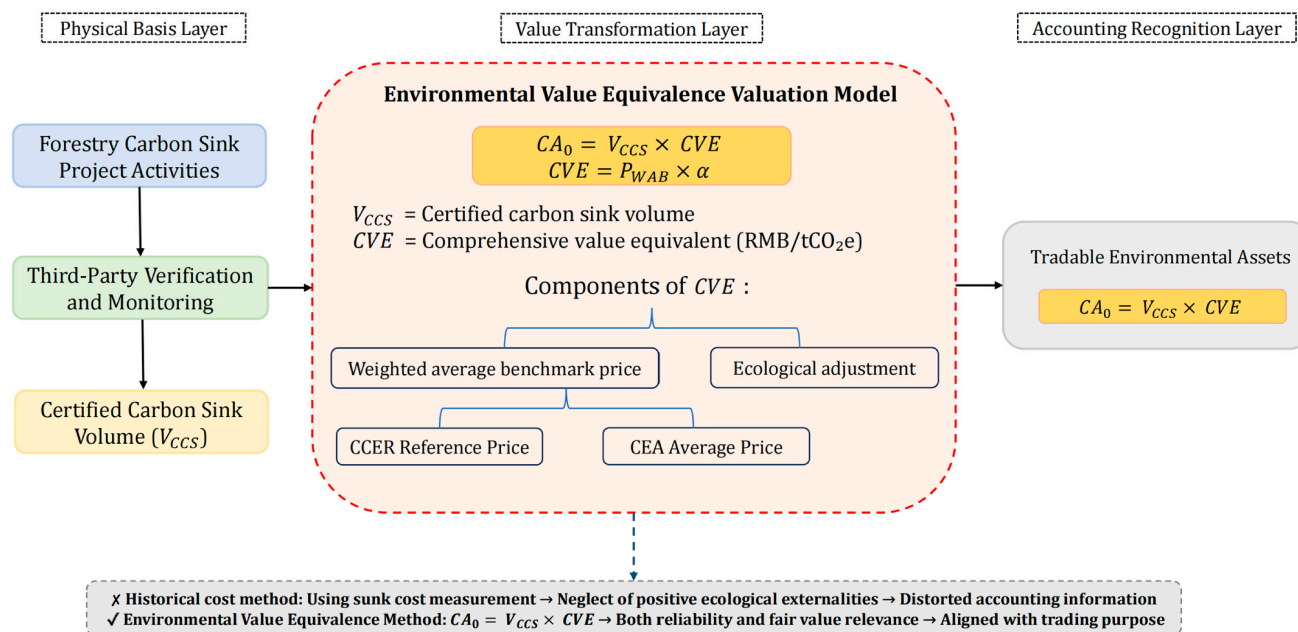


Figure 2. Environmental value equivalence method measurement framework.

This method adheres to the principle of fair value measurement but does not endorse recognizing all unrealized gains or losses on holdings in current period profit or loss. Instead, it advocates for a “deferred treatment” of value fluctuations during the holding period, with corresponding gains or losses recognized only when the value is actually realized.

Within the “Dynamic Fair Value Adjustment Method” framework, a new equity account titled “Environmental Equity Reserve” is established to serve as a buffer and risk isolation mechanism against value fluctuations. On the balance sheet date, the asset carrying amount is adjusted based on the latest fair value. The resulting change is not recorded in the “gains and losses from changes in fair value” account but is instead directly recorded in the “Environmental Equity Reserve” account.

This design effectively distinguishes between value fluctuations and current operating performance, preventing the income statement from experiencing significant volatility due to non-operating factors such as market speculation, and significantly enhancing the reliability of accounting information and its effectiveness as a basis for decision-making. The above situation is shown in Figure 3.

First, the CCER market currently only offers listed trading, and liquidity is inherently limited. Under these conditions, should the market experience extreme downward fluctuations, the credit balance of the Environmental Equity Reserve will absorb the initial impact of fair value declines. The initial source of this reserve balance is the amount credited upon the initial recognition of the asset, which is subsequently adjusted in tandem with fair value adjustments at each balance sheet date. As long as the cumulative fair value decline does not exceed the reserve balance, the income statement remains unaffected. Once the cumulative decline exceeds the reserve balance, the excess amount will be recognized in current-period profit or loss, and the income statement will inevitably be impacted. This constraint is not a design flaw of the framework but rather an inherent requirement of the accounting prudence principle. When the recoverable amount of an asset falls below its

carrying amount on a sustained basis, recognizing an impairment loss in accordance with China Accounting Standard No. 8—Impairment of Assets represents a baseline requirement that any accounting measurement method must observe.

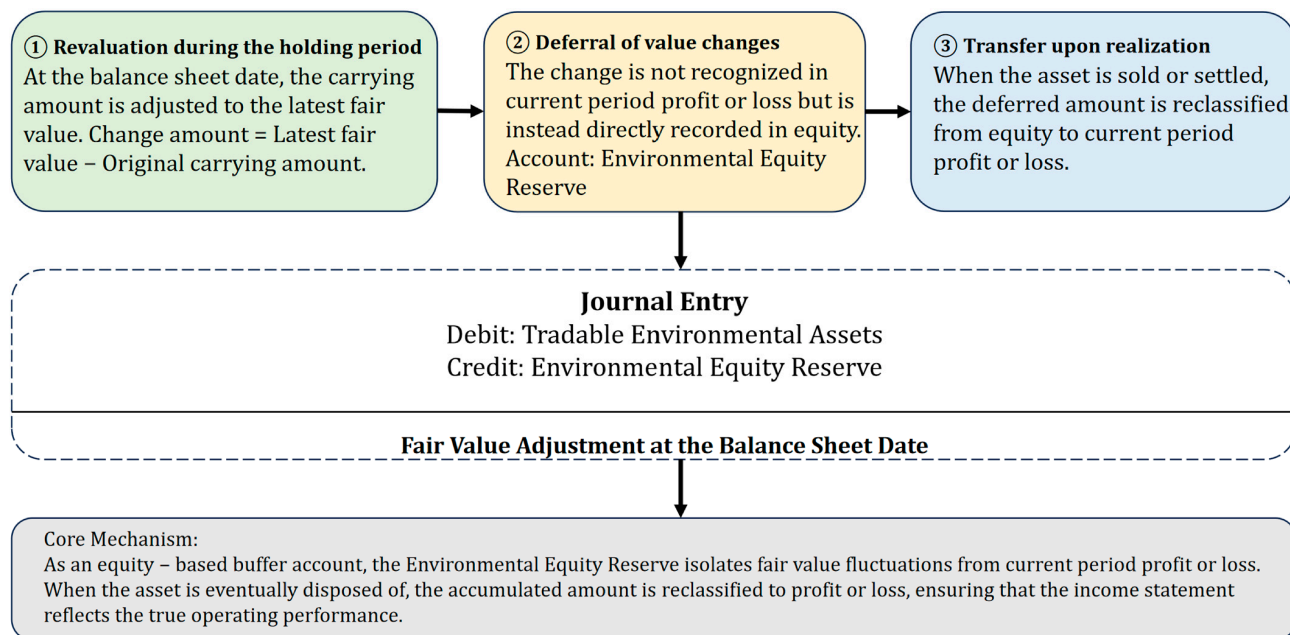


Figure 3. Dynamic Fair Value Method subsequent measurement framework.

Second, when market liquidity dries up and observable transaction prices are unavailable, the fair value source under the Dynamic Fair Value Adjustment Method can be switched to the valuation benchmark provided by the Environmental Value Equivalence Method. Specifically, this involves constructing a weighted average benchmark price based on the carbon market pricing anchor, i.e., the CEA average price, and the voluntary market benchmark, i.e., the CCER reference price, which is then multiplied by the ecological adjustment coefficient to form the Comprehensive Value Equivalent. The adjustment to the carrying amount of the asset is still completed through the Environmental Equity Reserve account, and the measurement adjustment does not rely on continuous market quote inputs. This switching mechanism ensures that the valuation framework maintains a clear logical starting point when market conditions change, preventing fair value estimates from deviating significantly from reasonable ranges due to isolated abnormal transactions or prolonged periods without trading. The stress tests presented in Section 3.3 verify that this mechanism remains effective under varying degrees of extreme price decline scenarios.

The Environmental Equity Reserve resembles Other Comprehensive Income (OCI) under the current IFRS in its function of bypassing the income statement and being recorded directly in equity. However, the two differ fundamentally in terms of recognition premise, disposal treatment, and theoretical basis. First, the applicability of OCI is premised on explicit provisions already made by accounting standards. Current standards have already permitted certain financial assets to be measured at fair value through other comprehensive income (FVOCI). In contrast, forestry carbon sinks currently lack a clearly defined asset classification and measurement model under the existing accounting standards framework, and enterprises cannot unilaterally elect to recognize fair value changes of carbon sink assets in OCI. Second, even if the standards were to incorporate carbon sinks into the FVOCI framework in the future, IFRS 9 provides that for equity instruments under FVOCI, reclassification to profit or loss upon disposal is prohibited, and the cumulative OCI amount is transferred directly to retained earnings upon disposal. This provision corresponds to the applicable object of FVOCI—that is, non-trading assets—but contradicts the economic

substance of forestry carbon sinks, which are held for trading. The Environmental Equity Reserve, while absorbing unrealized fluctuations during the holding period, preserves the channel for reclassification to profit or loss upon disposal, which is more consistent with the business model of forestry carbon sinks. Third, the theoretical basis of OCI lies in the temporary isolation of specific unrealized items under the comprehensive income framework. The theoretical basis of the Environmental Equity Reserve, by contrast, lies in the dual ecological and financial attributes of forestry carbon sinks as environmental assets. Their value both originates from ecological processes and is realized through market transactions, which determines that their fair value fluctuations should not be simplistically equated with the unrealized gains and losses of general financial assets. Under the OCI approach, the full impact of fair value changes in carbon sink assets would be permanently excluded from the income statement. The Environmental Equity Reserve, on the other hand, absorbs fluctuations during the holding period and reclassifies them to profit or loss upon disposal. The income statement is thereby shielded from short-term price volatility, while the disposal stage still reflects the actual outcomes of the business model.

2.2.3. The Innovative Establishment of the “Environmental Equity Reserve” Account

Environmental equity has been established by environmental accounting theory as one of the core elements of environmental accounting. Corresponding to “environmental assets,” this paper proposes the “Environmental Equity Reserve” account based on the development of environmental accounting theory and the practical needs of carbon credit trading. forestry carbon sinks are, in essence, a form of ecological capital. With the development of the carbon trading market, forestry carbon sinks have brought new forms of assets and sources of profit growth to forestry management organizations [34]. Traditional accounting systems struggle to accurately reflect changes in the value of such assets, and the establishment of the “Environmental Equity Reserve” account can resolve this issue.

Given the tradable nature of forestry carbon sinks, fair value is generally the most appropriate measurement attribute; however, recognizing fluctuations in their value directly in current period profit or loss can significantly impact a company’s operating performance. By aggregating these unrealized value changes under the “Environmental Equity Reserve” account and transferring them to profit or loss only upon disposal of the asset, the principle of accounting conservatism can be better upheld [35].

This study proposes that “Environmental Equity Reserve” represent the unrealized equity value accumulated by enterprises through the holding and operation of forestry carbon sink assets, which stems from the carbon sequestration services provided by forest ecosystems and is realized through the carbon trading market [35]. The establishment of this account further refines the environmental equity component within environmental accounting elements, thereby more effectively addressing the accounting implications arising from fluctuations in the fair value of forest carbon sink assets and ensuring the reliability of accounting information [34].

It should be noted that the location of the “Environmental Equity Reserve” in financial statements is a matter of presentation logic, which is conceptually distinct from its substantive nature as an independent equity-classified account. With regard to the setup of accounting accounts, in order to centrally account for changes in equity arising from forestry carbon sink assets, this paper proposes the establishment of a top-level equity account: “Environmental Equity Reserve”. Regarding financial statement presentation, given that the “Environmental Equity Reserve” stems from unrealized changes in asset value and does not represent shareholder contributions, and in accordance with the principles of equity classification in China Accounting Standard No. 30—Presentation of Financial Statements, it is recommended that the “Environmental Equity Reserve” be separately

presented under the “Other Comprehensive Income” category within the statement of changes in equity. This approach ensures the clarity and distinctiveness of accounting information while accurately reflecting the economic substance of this reserve.

The regulatory feasibility of the Environmental Equity Reserve as a newly established equity account should be examined from two perspectives: accounting standards and financial regulation. With regard to accounting standards, the authority to establish uniform accounting accounts in China rests with the Ministry of Finance, and enterprises are required to follow the China Accounting Standards as the basic framework. Any newly established primary equity-classified account that falls outside the existing framework would need to obtain formal recognition through the Ministry’s standard-setting procedures. This paper proposes this account with the aim of providing a theoretical reference for standard-setting, demonstrating that value fluctuations of forestry carbon sinks during the holding period can be isolated and buffered through an independent equity reserve rather than being directly charged against the income statement. Whether this logic will be adopted by standard-setting bodies depends on whether Tradable Environmental Assets are considered to have an independent basis for equity classification. With regard to financial regulation, the Environmental Equity Reserve relates to the presentation and disclosure of corporate financial statements, which may affect investors’ assessment of the risk exposure of carbon sink assets and thereby trigger information disclosure regulatory requirements. Should this account be formally incorporated into financial statements, financial regulators would need to clarify its position in regulatory capital measurement, risk disclosure, and information reporting.

A more pragmatic pathway for implementation is for the Ministry of Finance to gradually incorporate such account innovations into pilots or phased adaptations during the ongoing refinement of carbon-related accounting rules—for example, through revisions to the Interim Provisions on Accounting Treatment for Carbon Emissions Trading. Prior to obtaining formal regulatory recognition, enterprises may temporarily present such reserves as separate items under existing equity categories while providing adequate disclosures in the notes to the financial statements regarding their nature, the process of changes, and the corresponding relationship with the carrying amount of carbon sink assets. This approach would ensure information transparency while seeking compliance within the current regulatory framework. Figure 4 shows the construction of this framework and clearly illustrates the main research subject and measurement methods discussed in this paper.

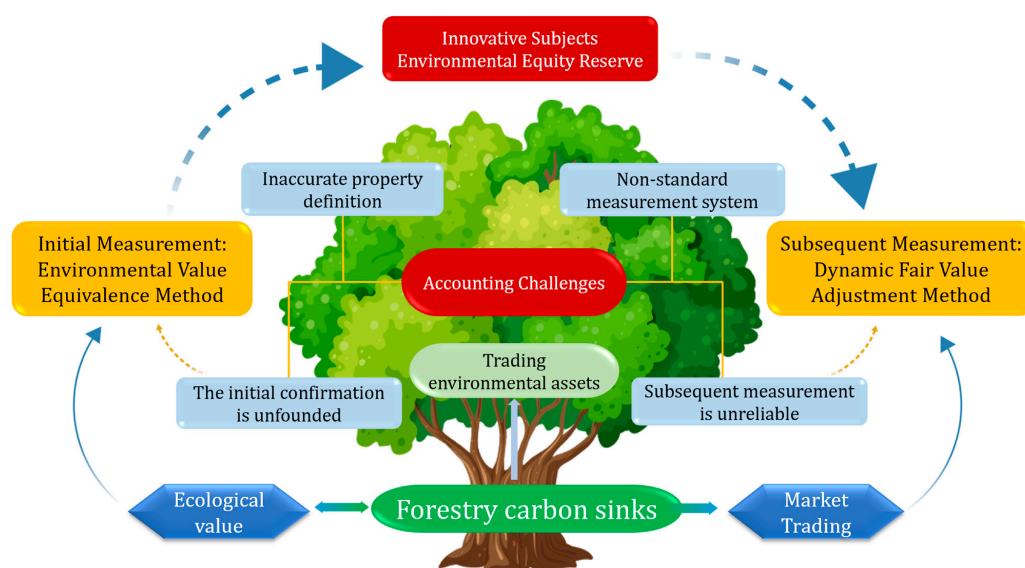


Figure 4. Forestry carbon sink accounting and measurement system.

2.3. Accounting Measurement Procedures

2.3.1. Initial Measurement

When a project has been registered with the competent authority and its environmental benefits have been independently verified and certified by a third party, the enterprise obtains tradable carbon credits, which should be recognized as “tradable environmental assets.” The initial carrying amount is determined based on the “Environmental Value Equivalence method” proposed in this paper.

For accounting purposes, the debit side is “Tradable Environmental Assets—Forestry Carbon Sink Assets,” with the amount calculated based on the fair value determined using the Environmental Value Equivalence Method; the credit side is “Environmental Equity Reserve,” with the amount matching the asset. This approach recognizes the environmental value on the balance sheet at the time of asset recognition, bypassing the income statement. It retains this unrealized appreciation in equity, directly recognizing the environmental value as equity, thereby reflecting prudence and having no impact on current-period profit.

Initial recognition is triggered upon emission reduction registration—that is, upon the completion of CCER issuance. The certified carbon sink volume Q , which serves as the starting point for measurement, has already been adjusted for permanence risk exposure during the verification process under the carbon crediting mechanism. The reason why permanence risk constitutes a core concern of the global forestry carbon crediting system is that the carbon storage of forestry carbon sinks faces uncertainties due to natural and anthropogenic disturbances such as fires, pests, and harvesting, namely, carbon reversal risk. Whether carbon credits can maintain the permanence of carbon storage throughout the crediting period directly determines their environmental integrity as an offset instrument.

Different carbon crediting mechanisms have already internalized prudent considerations of permanence risk into their institutional designs. The CDM afforestation and reforestation projects address non-permanence risk by issuing temporary carbon credits with an expiration date [36]. VCS and Gold Standard have established buffer pools, setting aside a certain percentage of emission reductions from each issuance as a risk buffer. China’s CCER adopts a deduction rate approach, directly deducting a certain percentage from emission reductions during accounting to reflect permanence risk. According to the Methodology for Afforestation Carbon Sink Projects under Voluntary Greenhouse Gas Emission Reduction (CCER-14-001-V01), the default deduction rate is 10%. The above mechanisms ensure that the certified quantity Q reflects risk-adjusted tradable environmental entitlements. At the stage of initial accounting recognition, no additional impairment provisions or risk allowances are required. If, during the subsequent holding period, the recognized carbon sink assets are subject to credit revocation or cancellation due to reversal events, the treatment shall follow asset disposal procedures: reduce the carrying amount of Tradable Environmental Assets, offset the Environmental Equity Reserve accordingly, and recognize any excess beyond the reserve balance attributable to that portion of the asset in current-period profit or loss. To address the challenges of limited liquidity and the absence of active, publicly quoted prices in the early stages of the CCER market restart, this study proposes the “Environmental Value Equivalence Method” to determine the initial carrying amount of forestry carbon sink assets. The core logic of this method is to construct an initial measurement benchmark for carbon sink assets by integrating observable market inputs with ecological adjustment factors when active market quotes are unavailable. The measurement procedures follow Equations (1) and (2) as defined above. The specific parameter values applied in this numerical case are specified in Section 2.4.

2.3.2. Subsequent Measurement

At each balance sheet date, an entity shall measure its forest carbon assets using the “Dynamic Fair Value Adjustment Method” to reflect changes in their market value. Based on the change in the assessed fair value, the carrying amount of “Tradable Environmental Assets” and the corresponding balance of “Environmental Equity Reserves” shall be adjusted simultaneously.

When fair value increases, the carrying amount of the asset and the equity reserve are adjusted upward. When fair value decreases, the carrying amount of the asset and the equity reserve are decreased. This structure ensures that the market value of assets is dynamically updated on the balance sheet while isolating unrealized holding gains and losses within the “Environmental Equity Reserve” equity item. This reduces the impact of market price fluctuations on the income statement and maintains the stability of financial reporting.

When reversal events—such as fires, pests, droughts, storms, or illegal logging—result in forest damage and are formally recognized by the carbon crediting mechanism’s administrative body, which then initiates carbon credit revocation or cancellation procedures, an impairment assessment should be triggered immediately. The trigger signal is the notice of revocation or cancellation at the carbon crediting mechanism level, such as a compliance review conclusion or a carbon credit cancellation decision issued by the CCER administrative body, rather than a decline in market prices. The recoverable amount after impairment should be determined based on observable market quotes if available; if no observable market quotes are available, it should be determined based on the valuation benchmark established by the Environmental Value Equivalence Method. When carbon credits are fully cancelled, the recoverable amount is zero. In the case of partial cancellation, the measurement is based on the remaining carbon credit volume after revocation.

Physical risk-induced losses in carbon stock constitute a direct reduction of the certified carbon sink volume Q , which is distinct from fair value changes caused by market fluctuations. Therefore, such impairment losses should be recognized in current-period profit or loss, with a debit to impairment loss on assets and a corresponding reduction in the carrying amount of Tradable Environmental Assets, while the portion of the Environmental Equity Reserve balance corresponding to the extinguished portion is offset simultaneously. The correspondence between assets and equity is thereby maintained, and the loss is reflected in the income statement.

Under the CCER framework, once carbon credits are cancelled, the reduction is permanent, and there is no operational pathway in the registration system to reinstate cancelled carbon credits. Even if the ecosystem recovers in subsequent years, a new application for emission reduction registration and issuance is required, which is unrelated to the cancelled credits. Therefore, this framework does not distinguish between temporary and permanent carbon reversal; the two scenarios are treated identically for accounting purposes, and both follow the impairment procedures described above.

2.4. General Assumptions and Parameter Selection

Since the national CCER market resumed operation in January 2024, comprehensive data covering the full accounting cycle from initial measurement to the trading of forestry carbon sink projects have not yet been sufficiently disclosed or made publicly available as of this writing. Through public channels such as the National Greenhouse Gas Voluntary Emission Reduction Trading System and the Beijing Green Exchange, market transaction data—including trading volume, transaction prices, and price trends—are accessible. This paper conducts a case analysis based on actual CCER market transaction data to demonstrate the operational procedures and underlying logic of the Environmental Value Equivalence Method and the Dynamic Fair Value Adjustment Method. All input

parameters are derived from publicly available market transaction data and current policy documents, ensuring the traceability and verifiability of the calculation process. The relevant case scenarios and measurement results are presented in Section 3.

2.4.1. Ecological Adjustment Coefficient

The ecological adjustment coefficient is designed to reflect the synergistic ecological benefits that distinguish forestry carbon sinks from ordinary carbon emission allowances. While forest ecosystems perform carbon sequestration functions, they simultaneously generate synergistic services such as soil conservation, water retention, and biodiversity protection. These supporting services directly affect the persistence and stability of carbon sinks.

The ecological adjustment coefficient is set at 1.15. This modest premium reflects the additional ecological benefits that forestry carbon sinks deliver—soil conservation, water retention, and the like—which ordinary carbon allowances do not provide but are essential for the long-term persistence of the carbon sink itself.

Valuing these non-market benefits is not straightforward, but the literature offers some guidance. Costanza et al. (2014) [37] established that putting a monetary figure on ecosystem services, while imprecise, is better than implicitly valuing them at zero. In the forestry context, Jiang and Yang (2023) [38] showed that adjustment factors tied to biomass and local socioeconomic conditions can meaningfully correct valuation biases. Following that same logic, an adjustment factor for the ecological side benefits of carbon sinks seems reasonable.

Regarding the determination of the coefficient value, the existing literature indicates that forest carbon sinks are accompanied by significant synergistic ecological benefits. Although the specific magnitude varies across regions and assessment methods, the qualitative importance of these benefits is widely recognized. In the absence of project-level data for precise calibration, this paper adopts a conservative estimate in accordance with the prudence principle of the Basic Standard for Enterprise Accounting, quantifying the synergistic ecological benefit as 15% of the baseline carbon sequestration value, resulting in an ecological coefficient of 1.15. The robustness of this coefficient is verified through multi-scenario analysis, which is presented in Section 3.1.2.

The distinctiveness of forestry carbon sinks relative to ordinary carbon allowances lies not only in the synergistic ecological benefits discussed above but also in the dimension of the HWP carbon pool. The IPCC Guidelines list HWPs as an independent carbon pool alongside forest biomass, dead organic matter, and soil [39]. Zhang et al. (2025) estimated that China's HWP carbon pool had accumulated to 3376 MtCO₂e by 2020 [19]. However, HWP carbon storage occurs after timber harvesting and represents a carbon transfer pathway rather than a synergistic benefit generated during the carbon sink formation process. Moreover, HWP accounting is primarily applicable at the national greenhouse gas inventory level, which belongs to a different accounting hierarchy from the initial measurement of carbon credits at the enterprise level in this paper. Therefore, the ecological adjustment coefficient in this paper focuses on the synergistic ecological benefits generated during the carbon sink formation process, such as soil conservation and water retention, and does not incorporate HWP carbon storage. Future research could further explore the incorporation of HWP carbon storage into valuation models for corporate carbon sink assets.

2.4.2. Weighted Average Benchmark Price

The weighted average benchmark price is constructed as a weighted composite of two types of price signals from the carbon market. The weight allocation follows the “information quality orientation” principle: the higher the transparency and data verifiability of a price signal, the greater the weight assigned.

The CEA price is selected as the pricing anchor for forestry CCER valuation due to the institutional linkage between the two markets. China's carbon market adopts a dual-track mechanism consisting of CEA and CCER, which are connected through a 5% offset mechanism: compliance entities may use CCER credits to offset up to 5% of their CEA compliance obligations. This institutional design establishes an intrinsic economic linkage between the two types of prices.

Empirical studies have confirmed this price linkage. When CCER prices fall below CEA prices, manufacturers' emission reduction decisions adjust accordingly, demonstrating that CEA prices can serve as an effective benchmark for CCER pricing [40]. A profit-based game-theoretic model further reveals a verifiable economic linkage between the two types of price signals in the technology adoption and supply chain decisions of power plants under the dual CEA and CCER mechanisms [41].

Since its launch in 2021, the CEA market has developed continuous and active daily trading. In 2025, the national carbon market recorded a cumulative trading volume of 235 million tonnes, with a total transaction value of RMB 14.63 billion and an annual average trading price of RMB 62.36/tonne. The market exhibits high price transparency, trading frequency, and data verifiability and is capable of reflecting the marginal cost of carbon emission reductions.

Given the advantages of the CEA market in terms of trading continuity, market depth, and price discovery function, and considering that the China Carbon Emission Registration Center's national carbon market compliance benchmark price index is based on a rolling weighted average of CEA and CCER prices, this study assigns a weight of 55% to the CEA price.

The CCER reference price is derived from actual CCER market transaction data. The CCER market was relaunched in January 2024, and the first batch of CCERs began trading on 7 March 2025. From 7 March to 31 December 2025, the National Voluntary Greenhouse Gas Emission Reduction Trading Market operated for 203 trading days, with a total trading volume of 8,844,100 tonnes, a total transaction value of RMB 626 million, and a cumulative average transaction price of RMB 70.76/tonne.

In the early stage of the CCER market restart, trading was discontinuous and the trading volume was highly concentrated, with approximately 68.2% of the annual trading volume in the fourth quarter. The price discovery function remains underdeveloped, and the information reliability is relatively low compared to the CEA market. Previous studies have noted that CCER, as a distinct category of carbon assets, requires a dedicated valuation model rather than simple reference to CEA prices, and the comprehensive value assessment model proposed therein provides a methodological reference for CCER valuation [42].

Based on the above market characteristics, this study assigns a weight of 45% to the CCER reference price to reflect its relatively lower information quality.

The above weight allocation of 55% and 45% quantifies the differences between the two markets in terms of market size, trading continuity, and price discovery function. The robustness of the weight allocation is verified through sensitivity analysis, with the results presented in Section 3.1.2.

Under the CCER framework, issued carbon credits have no expiration or maturity date. The Measures for the Administration of Voluntary Greenhouse Gas Emission Reduction Trading (Trial) do not specify a validity period for CCERs, and registered CCERs may be held indefinitely. The records in the registration system serve as the ultimate basis for determining the ownership and status of certified voluntary emission reductions. Except in specific circumstances such as voluntary cancellation by the project owner or credit revocation due to carbon reversal events, registered CCERs do not automatically expire over time.

The project crediting period is generally 20 to 40 years, but this constrains the project's ability to generate new emission reductions rather than the holding status of already issued

CCERs. The timing constraint for emission reduction registration requires that reductions be registered within five years of generation, which constrains whether reductions can be registered as CCERs and similarly has no bearing on the validity of already registered CCERs. None of the above time constraints affect the fair value measurement of CCERs already held, and this framework does not require consideration of a remaining maturity discount. Should future CCER rules introduce a validity period or a surrender requirement upon maturity, the Dynamic Fair Value Adjustment Method would need to be modified accordingly to incorporate a remaining maturity factor.

The weighted average benchmark price is calculated as follows:

$$P_{WAB} = \omega_1 P_{CEA} + \omega_2 P_{CCER} \quad (3)$$

where P_{WAB} is the weighted average benchmark price, ω_1 and ω_2 are the weights assigned to the CEA and CCER price anchors respectively ($\omega_1 + \omega_2 = 1$), P_{CEA} is the carbon market pricing anchor, and P_{CCER} is the voluntary market pricing anchor.

2.5. Disclosure Considerations

Under the disclosure requirements of the China Accounting Standards, IFRS 13, IFRS S2, and other relevant standards, an enterprise should at a minimum disclose the following information in the notes to financial statements: the type and geographic location of forestry carbon sink projects; the methodology applied and its applicable conditions; the crediting period and remaining duration; mitigation measures for carbon reversal risk, such as insurance arrangements or buffer pool mechanisms; the valuation technique used for fair value measurement, namely the Environmental Value Equivalence Method; and the key inputs, including the weighted average price of CEA and CCER, the ecological adjustment coefficient, and other relevant parameters. In addition, the method of acquisition, the year of acquisition, the purpose of holding, and changes in holdings during the period should be disclosed. The above information helps financial statement users assess the credit quality, price volatility risk, and permanence risk associated with this category of assets.

3. Accounting Measurement Procedures: A Case Demonstration

3.1. Subsection

3.1.1. Basic Information of the Case

The afforestation CCER project developed by Honghe Prefecture Hongchan Forestry Development Co., Ltd. (Mengzi City, China) is one of the first batch of forestry carbon sink projects in Yunnan Province following the CCER market restart. The project covers the areas of Luxi County, Kaiyuan City, and Zhicun Forest Farm in Honghe Prefecture and was announced on the National Greenhouse Gas Voluntary Emission Reduction Registration System on 26 September 2025.

According to the information provided, the estimated initial issuance of emission reductions is approximately 100,000 tonnes of carbon dioxide equivalent. On 28 September 2025, Hongchan Forestry signed a pre-purchase agreement with Sichuan Ruidian New Energy Technology Development Co., Ltd. Based on an estimated price of RMB 100/tonne, the initial payment accounted for 20% of the total consideration, amounting to RMB 2 million. This pre-purchase price serves as the price reference benchmark for initial measurement in this case.

Since the CCER market restart, no complete accounting cycle case—from project announcement and emission reduction registration to carbon credit issuance and eventual trading and disposal—has been available for direct reference in the forestry carbon sink sector. To demonstrate the complete operational procedures of the Environmental Value

Equivalence Method and the Dynamic Fair Value Adjustment Method, this case, based on accounting measurement needs, takes 31 December 2025, i.e., the year-end balance sheet date, as the initial recognition date, and 30 June 2026, i.e., the semi-annual balance sheet date, as the disposal date. All market prices used are derived from actual transaction data published by the National Greenhouse Gas Voluntary Emission Reduction Trading System.

3.1.2. Basis for Determining the Initial Measurement and Disposal Price

(1) Determination of the Initial Measurement Price

This case takes 31 December 2025 as the initial recognition date. The selection of the initial measurement price involves the following three alternative references.

First, the CCER transaction price on 31 December 2025 was RMB 85.00/tonne, but the daily trading volume was only 1 tonne. An extremely low single-day trading volume price is susceptible to transaction-specific factors of individual counterparties and is therefore not suitable as a direct input for fair value measurement.

Second, the pre-purchase agreement price signed for the Honghe Prefecture project on 28 September 2025 was RMB 100/tonne. This price represents a primary market pre-purchase price, reflecting both parties' expectations for future carbon prices and the risk premium compensation for project development risks prior to CCER issuance, which differs from the fair value of already issued carbon credits in the secondary market.

Third, data from the National Greenhouse Gas Voluntary Emission Reduction Trading System show that from 7 March to 31 December 2025, the CCER market operated for 203 trading days, with a cumulative trading volume of 8,844,100 tonnes and a cumulative average transaction price of RMB 70.76/tonne. This average price is calculated as a weighted average based on 203 trading days and 8,844,100 tonnes of trading volume, with a sufficient sample size to effectively smooth out single-day abnormal fluctuations.

Based on the above analysis, this case adopts the cumulative average CCER transaction price of RMB 70.76/tonne for the full year 2025 as the CCER reference price, and the annual average CEA transaction price of RMB 62.36/tonne published by the Ministry of Ecology and Environment as the CEA benchmark price, with the two prices sharing the same time frame. The weighted average benchmark price is calculated according to Equations (1)–(3), with the results presented in Table 1.

Table 1. Parameter composition of the weighted average benchmark price.

Parameter	① P_{CEA} (RMB/Tonne)	② P_{CCER} (RMB/Tonne)	③ P_{WAB} (RMB/Tonne)	④ α	⑤ CVE (RMB/Tonne)
Value	62.36	70.76	66.14	1.15	76.06
Weight	55%	45%	① $\times$ 55% + ② $\times$ 45%	—	③ $\times$ ④

To verify the robustness of the ecological adjustment coefficient $\alpha = 1.15$, this study conducts a multi-scenario analysis around this conservative estimate. Based on the weighted average benchmark price of RMB 66.14/tonne, the initial carrying amounts and deviations corresponding to each scenario are presented in Table 2.

The sensitivity analysis shows that when the ecological adjustment coefficient varies within a reasonable range, the maximum deviation in the initial carrying amount is approximately $\pm 8.70\%$. Considering the daily fluctuation range of the carbon market and the inherent uncertainty in ecosystem service valuation, this deviation range remains within an acceptable tolerance. This suggests that the valuation results are not highly sensitive to the selected coefficient value of $\alpha = 1.15$, and the robustness of the coefficient is confirmed.

Table 2. Multi-scenario analysis of the ecological adjustment coefficient.

Scenario	α	CVE (RMB/Tonne)	Initial Carrying Amount (RMB)	Deviation From Baseline
Baseline	1.15	76.06	7,606,000	—
Lower bound	1.10	72.75	7,275,000	−4.35%
Moderate–low	1.125	74.41	7,441,000	−2.17%
Moderate–high	1.20	79.37	7,937,000	+4.35%
Optimistic	1.25	82.68	8,268,000	+8.70%

Regarding the robustness verification of the weight allocation, as shown in Table 3, this case varies the CEA weight within the range of 45% to 65% in increments of 5 percentage points to observe the resulting changes in the initial carrying amount. The results show that the maximum deviation in the initial carrying amount is only $\pm 1.3\%$, indicating that the weight setting has a very limited impact on the valuation outcomes. The weight allocation of 55% and 45% thus exhibits satisfactory robustness.

Table 3. Sensitivity analysis of weight allocation on initial carrying amount.

Scenario	CEA Weight	CCER Weight	P_{WAB} (RMB/Tonne)	CVE (RMB/Tonne)	Initial Carrying Amount (RMB)	Deviation From Baseline
Baseline	55%	45%	66.14	76.06	7,606,000	—
Lower bound	45%	55%	66.98	77.03	7,703,000	+1.28%
Conservative	50%	50%	66.56	76.54	7,654,000	+0.63%
Aggressive	60%	40%	65.72	75.58	7,558,000	−0.63%
Upper bound	65%	35%	65.30	75.10	7,510,000	−1.26%

(2) Determination of the Disposal Price

This case is set to dispose of 10,000 tonnes of CCER on 30 June 2026. The disposal price is determined based on the listed trading data for June 2026 published by the National Greenhouse Gas Voluntary Emission Reduction Trading System. During that month, the CCER market operated for 20 trading days, with a total monthly trading volume of 2,483,817 tonnes and a total transaction value of RMB 205,743,399.40. The complete daily trading data are provided in Appendix A.1. Using trading volume as the weight, the weighted average price is calculated as follows:

$$P_W = \frac{\sum_{i=1}^n V_i P_i}{\sum_{i=1}^n V_i} \quad (4)$$

where P_w is the weighted average price, V_i is the trading volume on day i , P_i is the average transaction price on day i , and n is the number of trading days in the sample period. It yields a weighted average price of RMB 82.77/tonne.

Based on the above calculations, on 30 June 2026, Hongchan Forestry publicly transferred 10,000 tonnes of CCER through the National Greenhouse Gas Voluntary Emission Reduction Trading System at a weighted average price of RMB 82.77/tonne, recognizing disposal income of RMB 827,700.

3.2. Initial Measurement Results

Based on the initial measurement price of RMB 76.06/tonne calculated in Section 3.1.2, the initial carrying amount of 100,000 tonnes of CCER is RMB 7,606,000 ($76.06 \times 100,000 = 7,606,000$). When Hongchan Forestry obtained the CCER issuance on December 31, 2025, the following journal entry would have been recorded:

Debit: Tradable Environmental Assets—Forestry Carbon Sinks (CCER), RMB 7,606,000.
Credit: Environmental Equity Reserve, RMB 7,606,000.

3.3. Subsequent Measurement Results

Following the design logic of the “Dynamic Fair Value Adjustment Method,” an enterprise should reassess the fair value of its forestry carbon sink assets at each balance sheet date and record the change amount in the “Environmental Equity Reserve” account to avoid impacting the current period income statement. Based on actual CCER market transaction data, the fair values at key time points are set as shown in Table 4.

Table 4. Basis for setting fair values of forestry carbon sink assets.

Time Point	Fair Value (RMB/Tonne)	Basis and Data Source
31 December 2025 (Initial measurement)	76.06	Calculated using the Environmental Value Equivalence Method (Table 1)
31 March 2026	87.29	Monthly weighted average CCER transaction price for March 2026 (National Greenhouse Gas Voluntary Emission Reduction Trading System)
30 June 2026 (Disposal date)	82.77	Monthly weighted average CCER transaction price for June 2026 (National Greenhouse Gas Voluntary Emission Reduction Trading System)

Note: All fair values are determined based on publicly available market data. The initial fair value on 31 December 2025 is calculated using the Environmental Value Equivalence Method. The fair values on 31 March 2026 and 30 June 2026 adopt monthly weighted average transaction prices published by the National Greenhouse Gas Voluntary Emission Reduction Trading System, representing Level 2 inputs in the fair value hierarchy.

The full-cycle accounting treatment of forestry carbon sink assets—from initial measurement through subsequent adjustment to disposal—is summarized in Table 5.

Table 5. Summary of accounting treatments for forestry carbon sink assets (CCER).

Date	Description	Account	Quantity (Tonnes)	Unit Price (RMB/Tonne)	Debit (RMB)	Credit (RMB)
31 December 2025	Initial recognition	Tradable Environmental Assets—Forestry Carbon Sinks (CCER)	100,000	76.06	7,606,000	
		Environmental Equity Reserve	—	—		7,606,000
31 March 2026	Fair value adjustment	Tradable Environmental Assets—Forestry Carbon Sinks (CCER)	100,000	+11.23	1,123,000	
		Environmental Equity Reserve	—	—		1,123,000
30 June 2026	Fair value adjustment	Environmental Equity Reserve	100,000	−4.52	452,000	
		Tradable Environmental Assets—Forestry Carbon Sinks (CCER)	100,000			452,000
	Disposal of 10,000 tonnes	Bank Deposit	10,000	82.77	827,700	
		Environmental Equity Reserve	10,000	82.77	827,700	
		Tradable Environmental Assets—Forestry Carbon Sinks (CCER)	—	82.77		827,700
		Investment Income	—	82.77		827,700

As shown in Table 5, during the holding period, the fair value increased by RMB 1,123,000, from RMB 76.06/tonne to RMB 87.29/tonne, and this increase was recorded in the Environmental Equity Reserve, with no impact on the income statement. Subsequently, the fair value decreased by RMB 452,000, from RMB 87.29/tonne to RMB 82.77/tonne, and this decrease was also absorbed by the same reserve account. Upon disposal of 10,000 tonnes, the accumulated reserve of RMB 827,700 corresponding to the disposed portion was transferred to current-period profit or loss and recognized as investment income. The remaining 90,000 tonnes of CCER had a carrying amount of RMB 7,449,300 at the end of the period, with a corresponding reserve balance of RMB 7,449,300, which can continue to absorb future fair value fluctuations.

Upon completion of the above disposal entries, the debit balance of Tradable Environmental Assets—Forestry Carbon Sinks (CCER) was RMB 7,449,300, representing the carrying amount of the remaining 90,000 tonnes of CCER still held by the enterprise

(90,000 × 82.77 = 7,449,300). The credit balance of the Environmental Equity Reserve was RMB 7,449,300, representing the cumulative unrealized environmental equity corresponding to the remaining assets.

As of 30 June 2026, after the completion of the disposal, Hongchan Forestry held 90,000 tonnes of CCER, with a corresponding reserve balance of RMB 7,449,300 (the pre-disposal reserve of RMB 8,277,000 minus the transferred amount of RMB 827,700). Assuming that in subsequent reporting periods, the CCER market price declines from RMB 82.77/tonne to RMB 70/tonne, RMB 60/tonne, and RMB 50/tonne, the absorption capacity of the reserve against the decline in fair value of the remaining assets is simulated in Table 6.

Table 6. Stress test results for the absorption capacity of the Environmental Equity Reserve.

Scenario	Assumed Price (RMB/Tonne)	Decline Per Tonne (RMB)	Fair Value Loss (RMB)	Reserve Balance (RMB)	Income Statement Impact
Baseline	82.77	—	—	7,449,300	0
Mild stress	70.00	12.77	1,149,300	6,300,000	0
Moderate stress	60.00	22.77	2,049,300	5,400,000	0
Severe stress	50.00	32.77	2,949,300	4,500,000	0

Under the stress scenario, even if the price falls to RMB 50/tonne, representing a 39.6% decline from RMB 82.77/tonne, the reserve balance would still amount to RMB 4,500,000, and the income statement would remain unaffected. The reserve balance would only be exhausted if the price fell to zero, whereas the historical lowest daily average transaction price in the CCER market is RMB 50.84/tonne, far above zero. This indicates that the Environmental Equity Reserve has sufficient absorption capacity to protect against extreme market fluctuations, and the income statement is not directly impacted under downward price pressure.

3.4. Prospects for Standardized Trading and Derivatives Markets for Forestry Carbon Sinks

The CCER transaction data used in this case were sourced from listed trading on the National Greenhouse Gas Voluntary Emission Reduction Trading System. According to the Rules for Voluntary Greenhouse Gas Emission Reduction Trading and Settlement (Trial), listed trading adopts an open bidding mechanism based on price priority and time priority. The standardized measurement unit, the well-established bidding mechanism, and the traceable transaction records indicate that CCER carbon credits have possessed the basic institutional conditions for standardized trading since the early stage of the market restart.

In terms of the current market landscape, CCER spot trading has formed a basic exchange-trading framework. However, the issuance of Forestry CCER credits has lagged behind that of energy-based projects, and trading activity remains relatively low. As more afforestation carbon sink projects complete registration, the supply scale of forestry carbon sinks and the number of market participants are expected to grow gradually. Should the level of standardization and liquidity improve further, carbon financial derivatives—such as futures and options with forestry CCER credits as the underlying assets—are likely to enter the market. The Chicago Mercantile Exchange has already launched Nature-Based Global Emission Offset (N-GEO) futures contracts, providing a reference development model for carbon credit derivatives. At the domestic level, the China Securities Regulatory Commission and the Ministry of Ecology and Environment have successively signaled policy directions toward advancing the development of a carbon futures market. The institutional foundation for extending the carbon market from spot to derivatives is steadily taking shape.

With respect to the framework of this paper, the above developments do not alter the fundamental logic of the accounting measurement framework. However, the price discovery function of the derivatives market could provide more continuous price signal references for fair value measurement, and hedging instruments could assist carbon asset holders in managing carbon price volatility risks. Should forestry CCER credits achieve a higher degree of standardization and derivative instruments be introduced in the future, the applicability of this framework would be enhanced, and the acquisition of various measurement parameters would benefit from a richer set of market data sources.

4. Conclusions and Perspectives

4.1. Conclusions

This study aims to address the issue of measurement inaccuracies in forestry carbon sink assets resulting from ambiguous accounting classifications and the absence of measurement rules, particularly in the context of the resumption of the CCER program. The study demonstrates that simply classifying forestry carbon sinks as “intangible assets,” “financial assets,” or the broad category of “environmental assets” fails to accurately capture their core business model of being held for trading and their environmental equity value essence. Therefore, this study argues for the theoretical validity of defining them as “Tradable Environmental Assets,” thereby providing a significant supplement and refinement to existing asset classification paradigms.

At the same time, this study proposes the “Environmental Value Equivalence Method,” which provides a scientific anchor for reliable initial measurement in the early stages of a market, thereby overcoming the dilemma of relying solely on unstable market prices or historical cost. In the subsequent measurement phase, the “Dynamic Fair Value Adjustment Method” is adopted, and the “Environmental Equity Reserve” account is introduced. This successfully isolates the impact of value fluctuations on the income statement, safeguarding the robustness of the income statement while ensuring consistency with the balance sheet. Following the theoretical exposition, this study presents a comprehensive overview of the initial and subsequent measurement of forestry carbon sinks after the restart of the CCER program through practical application.

The generalizability of this study’s conclusions and their practical impact on corporate financing costs and market value require further empirical testing using large samples once sufficient CCER market data become available. Regarding asset impairment triggered by extreme events such as fires and pest infestations, this paper has already established the treatment logic at the institutional design level. When a carbon reversal event is formally recognized by the administrative body of the carbon crediting mechanism, and carbon credit revocation or cancellation procedures are initiated, an impairment assessment is triggered. The recoverable amount is determined by multiplying the remaining carbon credit volume by its fair value, and the impairment loss is recognized in the current-period profit or loss, strictly distinguished from fair value changes caused by market fluctuations. Since no carbon reversal event occurred in this case study, this treatment logic was not demonstrated in the case analysis section. Future research could further test its applicability under specific reversal scenarios.

Regarding disclosure, this paper has proposed the basic elements of a disclosure framework, including project type and geographic location, the type of methodology applied and its applicable conditions, the crediting period and remaining duration, mitigation measures for carbon reversal risk, valuation techniques, and key inputs, as well as the method of acquisition and changes in holdings of CCERs. The specific disclosure format and quantitative standards for each element have not yet been designed in detail and could be further refined in future research in light of regulatory practices.

In addition, although this paper identified the Harvested Wood Product (HWP) carbon pool as a distinctive dimension of forestry carbon sinks relative to ordinary carbon allowances, it has not yet incorporated it into the core measurement framework. Future research could further explore the accounting recognition and measurement of HWP carbon stocks, and integrate the pathways of carbon transfer and delayed release into the valuation system for forestry carbon sink assets, so as to enhance the completeness of the framework at the physical measurement level.

4.2. Perspectives

Given the limitations of the present study, future research could be deepened along the following three closely interrelated directions against the backdrop of the CCER market's growing data and evolving practices.

First, at the empirical testing level, since the practical effectiveness of the current framework has yet to be validated by the market, future research could utilize transaction data accumulated after the CCER market reopens. Through large-sample empirical analysis, it could examine whether enterprises adopting this framework demonstrate higher accounting information value relevance or lower financing costs due to the robust and transparent value information provided by "Environmental Equity Reserve." This would better demonstrate the advantages of this measurement system over traditional methods and address questions regarding its universality.

Second, regarding impairment testing, a model tailored to environmental risk-oriented forestry carbon sink impairment testing could be developed. This would expand the "Dynamic Fair Value Adjustment Method" from addressing market risks alone to also addressing environmental risks. When non-market events occur in a specific region—such as major forest fires or official pest and disease warnings—research should focus on how to identify impairment indicators for carbon sink assets. Once impairment indicators emerge, it is crucial to study how to measure "recoverable amounts." In particular, there is a need for in-depth discussion on whether such impairment losses should be recognized in current profit or loss or whether the methodology of this study should continue to be used to offset "Environmental Equity Reserve." This model would help elevate accounting measurement from merely reflecting market fluctuations to a comprehensive tool for managing environmental risks.

Third, regarding information disclosure, to address the current lack of disclosure guidelines, a tiered reporting framework for this account could be established in the future. This would include specifying its presentation in the statement of changes in equity and breaking down the changes in the notes to the financial statements into detailed items such as "initial recognition," "fair value revaluation," and "impairment provisions," thereby ensuring transparent traceability of value changes. Furthermore, blockchain technology could be explored as an underlying infrastructure to provide tamper-proof evidence and verification access points for each carbon sink project and its key parameters listed in the notes, thereby comprehensively enhancing the reliability of accounting information [43].

Fourth, at the institutional governance level, the international applicability of this framework warrants further investigation. In November 2025, Brazil, China, and the European Union jointly launched the Open and Compliant Carbon Markets Alliance, signaling a clearer trend toward the interconnection of carbon pricing systems. Beljan et al. (2025), in their review of forest and climate change economics, pointed out that the integration of forest carbon accounting with the broader climate governance framework—particularly the coordination among compliance markets, voluntary carbon markets, and emerging international mechanisms—remains a critical yet underdeveloped area [26]. As carbon markets become increasingly interconnected, accounting methods developed under China's

CCER framework, especially the Environmental Value Equivalence Method and the Environmental Equity Reserve, may gradually interact with broader international compliance markets. Future research could explore how this framework could adapt to cross-border contexts and address key issues such as accounting comparability, transparency, offset integrity, and cross-border recognition of forestry carbon assets, which would help enhance the international relevance of this framework.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Appendix A.1

Table A1. Transaction Prices in the National CCER Market, June 2026.

Date	Trading Volume (Tonnes)	Average Price (RMB/Tonne)
1 June	145,554	83.07
2 June	81,000	80.85
3 June	50,000	83.00
4 June	10,000	83.00
5 June	341,027	82.91
8 June	224,348	82.81
9 June	40,033	82.70
10 June	51,992	82.71
11 June	259,241	82.57
12 June	5818	82.53
15 June	326,022	82.92
16 June	458,515	82.50
17 June	40,010	83.00
18 June	10,200	89.38
23 June	60,000	82.90
24 June	49,000	83.21
25 June	10,810	83.67
26 June	21,212	83.30
29 June	20,500	83.30
30 June	70,000	83.36
Total	2,275,282	82.77

Appendix A.2

Table A2. Transaction Prices in the National CCER Market, March 2026.

Date	Trading Volume (Tonnes)	Average Price (RMB/Tonne)
2 March	2002	86.00
3 March	109	86.09
4 March	20	87.00
5 March	10,000	86.00
6 March	201	88.00
9 March	13	88.49
10 March	1722	95.80
11 March	51,285	85.58
12 March	12,400	86.96
13 March	80,010	86.50
16 March	10	84.00
17 March	90	86.78
18 March	100	86.36
19 March	95	87.02
20 March	100,983	85.05
23 March	30,000	95.00
24 March	237,487	88.72
25 March	20,111	84.50
26 March	310	88.72
27 March	80,100	90.13
30 March	31,010	84.39
Total	758,058	87.29

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