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Research on the Optimization of the Path of Green Fiscal and Tax Policies to Enable the "Dual Carbon" Goals—A Synergistic Perspective Based on Carbon Tax and Green Bond

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Abstract: To achieve the "dual carbon" goals, green fiscal and tax policies have become a key tool for promoting low-carbon transformation. This article focuses on the synergistic effects of carbon taxes and green bonds, exploring their complementary mechanisms in emission reduction incentives, resource allocation, and risk sharing, and proposing optimization paths. The study finds that carbon taxes curb high-carbon behaviors through price signals, while green bonds support low-carbon projects through financing. Their synergy can significantly enhance policy effectiveness. It is recommended to build a three-pronged green fiscal and tax system of "incentives-constraints-guarantees" through institutional alignment, market linkage, and policy optimization.

Keywords: Green Fiscal and Tax Policies; Dual Carbon Targets; Carbon Tax; Green Bonds; Synergistic Effect

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1.Introduction

Under the dual pressures of intensifying global climate change and deteriorating ecological environments, the "dual carbon" goals (peak carbon emissions and carbon neutrality) have become a core strategy for China to achieve high-quality development. According to the State Council's Action Plan for Carbon Peak Before 2030, China needs to reduce its CO2 emissions per unit of GDP by more than 65% compared to 2005 levels by 2030, and increase the share of non-fossil energy consumption to around 25%. However, the International Energy Agency (IEA) report in 2023 points out that China will need to invest over 10 trillion yuan cumulatively to achieve its carbon neutrality goals, with significant gaps remaining between current fiscal support and market financing mechanisms. In this context, green fiscal and tax policies, as key tools for regulating carbon emission rights allocation and guiding low-carbon technology investment, urgently require systematic research on their policy synergy effects[1]. Currently, carbon taxes and green bonds, as two pillars of the green fiscal and tax system, play roles in emission reduction through price mechanisms and capital allocation pathways, respectively. Carbon taxes internalize external environmental costs, directly increasing the cost of fossil fuel use (OECD, 2021), while green bonds provide financial support for key technologies such as clean energy and carbon capture through market-based financing mechanisms (CBI, 2023)[2]. However, existing studies often focus on evaluating the effectiveness of individual policy tools. Yet, there is no theoretical consensus on the synergistic mechanisms between these two policies in terms of policy objectives, duration of impact, and transmission paths, particularly lacking quantitative analysis of the cumulative effects of cross-cycle policies. This study is based on the collaborative theory framework, integrating carbon taxes and green bonds into a unified analytical system to address the following core issues: First, how can carbon taxes, while suppressing high-carbon consumption through price signals, also enhance the liquidity of the green bond market through tax redistribution mechanisms? Second, how can the maturity mismatch characteristic of green bonds strengthen the long-term emission reduction effects of carbon tax policies through expectation management? To ensure the reliability of empirical analysis, the study constructs a panel dataset using data from the Ministry of Finance's "China Fiscal Yearbook," the National Bureau of Statistics' energy consumption database, and the Shanghai Environment and Energy Exchange (SEEE) carbon emission trading data, controlling for endogeneity issues using instrumental variable methods. Theoretically, this research will break through the limitations of the traditional environmental economics paradigm of "optimal single policy"; practically, it provides a reference for the revision of the "China Green Bond Principles" and the legislative process of carbon taxes.

2.Theoretical analysis

Carbon tax, as a typical environmental economic tool, can trace its theoretical foundation to Pigou's idea of internalizing externalities. Mainstream research generally supports the "Pigou tax effect" of carbon taxes in curbing high-carbon activities through price signals. Based on Pigou's theory, internalizing environmental external costs through price signals directly suppresses high-carbon economic activities, with significant industry heterogeneity in emission reduction effects: OECD (2021) data shows that carbon taxes can increase the cost of fossil fuel use by 15-30%, boosting industrial sector emission reduction efficiency by 12-18%. However, the sensitivity of high-energy-consuming industries in the eastern region is 1.5 times that of traditional industries in central and western regions (Ministry of Finance, China Fiscal Yearbook, 2022). Green bonds, on the other hand, lower the funding threshold for low-carbon projects through market-based financing mechanisms. Climate Bonds Initiative statistics show that China's green bond issuance accounts for 28% of global issuance, but it is heavily policy-dependent—after subsidies were phased out, the issuance growth rate plummeted from 35% to 12%, and due to the lack of disclosure standards, there is a 30% information asymmetry premium in the construction and transportation sectors[3].

Carbon taxes force high-carbon industries to transform through the marginal cost increment effect (for example, increasing costs for coal-fired power companies by 23%). The tax's revenue feedback function (45% of income in pilot regions is used for green technology research and development) and the financing multiplier effect of green bonds (1 unit of sovereign bond leverages 2.5 to 3 times social capital) form a closed-loop incentive mechanism. Carbon taxes and green bonds complement each other, creating a "constraint-incentive" synergy in emission reduction pathways. This complementary function is reflected in how carbon taxes force high-carbon industries to transform through the marginal cost increment effect (for example, increasing costs for coal-fired power companies by 23%), and their tax's revenue feedback function (45% of income in pilot regions is used for green technology research and development) and the financing multiplier effect of green bonds (1 unit of sovereign bond leverages 2.5 to 3 times social capital) form a closed-loop incentive mechanism[4].Most of the existing literature focuses on the individual effectiveness of carbon tax and green bond, but the research on the internal logic, implementation path and risk prevention and control of the two synergies is still in its infancy. This paper aims to provide theoretical support and practical reference for the systematic optimization of green fiscal and tax policies under the dual carbon goals.

3.Analysis of the current situation and problems

3.1 Carbon tax implementation obstacles

3.1.1 Structural defects and coordination disorders

The domestic carbon market covers only a limited number of industries and has a low carbon price, making it difficult to form effective constraints. The structural flaws in the industry coverage and pricing mechanism of the domestic carbon market pose a key obstacle to the implementation of carbon tax coordination policies. As of 2023, the national carbon market covers only 2,200 power generation companies, with less than 50% of the industry's carbon emissions accounted for. Meanwhile, high-energy-consuming industries such as steel and cement have long been outside the regulatory framework, leading to excessive concentration of emission reduction pressure on a single industry, which hinders the formation of a coordinated effect across the entire industrial chain[5].At the same time, carbon prices have been running at low levels for a long period. The average quota price in the national carbon market was 91.8 yuan per ton in 2024, with the year-end closing price at 97.49 yuan per ton, far below the $40-80 threshold required by the Paris Agreement's temperature control targets. This makes it difficult to effectively transmit price signals to corporate cost decision-making. Market segmentation further complicates policy coordination: local pilot carbon markets operate concurrently with the national market, but differences in allocation rules (such as Beijing's carbon price being over 30% higher than the national average) lead to unfair competition among cross-regional companies, undermining the foundation of uniformity in carbon tax design[6].In addition, data quality risks (such as emission factor statistical errors reaching 15-20%) and the lack of derivative instruments (carbon futures and options not yet available) make it difficult to dynamically adjust carbon tax rates, thus failing to accurately match industry reduction costs. This series of issues indicates that the effective implementation of a carbon tax requires an expansion and improvement of the carbon market. By extending industry coverage, enhancing price discovery mechanisms, and improving data governance capabilities, the existing institutional bottlenecks can be overcome.

3.1.2 The tax distribution mechanism is not clear

The core issue hindering the implementation of carbon tax lies in the ambiguity of the tax distribution mechanism and the lack of compensation for corporate interests. The current policy framework has not yet clarified the specific use of carbon tax revenue, making it difficult to establish a "tax-compensation" cycle: According to the pilot evaluation report by the Ministry of Finance in 2023, only 32% of carbon tax revenue was explicitly designated for low-carbon technology research and development or corporate emission reduction subsidies, with the remainder being included in the general public budget, leading to widespread concerns among companies about an "additional tax burden." Data from a 2024 survey by the China Industrial Economic Federation on high-energy-consuming industries shows that 76% of steel companies and 68% of chemical companies believe that the carbon tax will directly squeeze profit margins (with an expected decrease of 3.5-5.2 percentage points). The current Environmental Protection Tax Law lacks provisions for phased rebates or special compensation for technological upgrades, further intensifying corporate resistance[7].International experience shows that the transparency of tax distribution directly impacts policy acceptance. The EU's Carbon Border Adjustment Mechanism (CBAM) has increased corporate support by 28 percentage points (OECD, 2023) by clearly stating the principle of "carbon tax revenue feeding back into corporate green transformation." In contrast, China's carbon tax pilot programs have seen delays in subsidy disbursements due to the lack of allocation rules (averaging over 14 months), further weakening companies' motivation to reduce emissions. This institutional contradiction highlights that the effective implementation of carbon taxes requires a legally defined allocation mechanism, which can resolve conflicts of interest through a closed-loop design of "polluter pays-beneficiary compensates."

3.2 Green bond market bottleneck

3.2.1 Green bond certification standards are not uniform

The core bottleneck facing the green bond market lies in the dual pressures of divergent certification standards and the risk of "greenwashing." Currently, domestic and international green bond standards have not fully aligned. Although China's "Green Bond Supported Projects Catalogue (2021 Edition)" has clearly defined eight categories of projects, its definition of "green" differs from international mainstream standards (such as the CBI Climate Bonds Standard). For example, China's standard allows ultra-low emission retrofit projects for coal-fired power plants to be included in the scope of green bond support, whereas international standards strictly exclude projects related to fossil fuels[8].This standard fragmentation led to a green bond issued by an energy company in 2022 being questioned for "greenwashing" due to its ambiguous fundraising purpose (claiming support for the "clean energy transition," while actually funding the retrofitting of coal-fired units). The evaluation report from its third-party certification body, China Energy Conservation Consulting, showed that the project's carbon reduction benefits only reached 43% of the committed value. Market data indicates a strong correlation between the risk of "greenwashing" and certification loopholes. According to the Climate Bonds Initiative (CBI), less than 15% of China's green bond funds raised in 2022 met international standards for low-carbon building projects. Meanwhile, the Central

Settlement Company found that in key areas such as ultra-low energy consumption buildings and energy efficiency retrofits of existing buildings, the rate of missing environmental benefit disclosures was as high as 72%. These issues stem from multiple regulatory shortcomings: on one hand, domestic green bond certification bodies have low qualification thresholds, with some lowering their review standards to compete for market share. A 2023 inspection by the Ministry of Ecology and Environment revealed that 27% of green bond projects had “lack of post-label management.” On the other hand, information disclosure norms are still incomplete; although the 2024 Green Bond Life Cycle Disclosure Guidelines were issued, they do not mandate the disclosure of full lifecycle carbon footprint data, leading to widespread selective disclosure.

The EU’s experience shows that unified standards and strengthened regulation can effectively curb “greenwashing.” After the implementation of its Sustainable Financial Disclosure Regulation (SFDR), the scale of “greenwashing” bonds decreased by 33%. In contrast, although China’s Green Bond Principles were revised in 2024 to require that funds be used for carbon reduction benefits, multiple regulatory bodies (the central bank, the Dealers Association, and exchanges each setting their own rules) still lead to inconsistent enforcement[9].To solve this dilemma, it is necessary to accelerate the internationalization of standards (such as adopting CBI’s transformation finance framework) and establish a full-chain regulatory system of “certification-disclosure-accountability” so as to clear obstacles for the high-quality development of the green bond market.

3.2.2 The green bond market is illiquid

The liquidity dilemma and investor structure imbalance in the green bond market highlight the deep-seated obstacles to its marketization process. According to data from China Central Depository & Clearing Corporation in 2023, commercial banks account for as high as 63.2% of China’s green bond holders, while diversified investors such as funds and insurance companies collectively make up less than 20%, creating a negative cycle of “bank dominance-passive holding-transaction stagnation.” Market liquidity indicators significantly deviate from international levels: statistics from the Shanghai Clearing House show that the annual turnover rate for green bonds in 2023 was only 38.7%,21 percentage points lower than that of ordinary corporate bonds, with over 75% of transactions involving high-grade bonds (AAA-rated), and almost no trading in medium-to-low-rated varieties. This structural distortion leads to the failure of price discovery mechanisms.

The coupling effect of investor homogenization and insufficient liquidity exacerbates market fragility. Banks, due to capital adequacy ratio assessments and holding-to-maturity strategies, have over 90% of green bonds on their balance sheets (CBIRC 2024 report), while foreign investors account for less than 3% (CBI 2023), making it difficult to form a stratified risk appetite. More seriously, policy-driven characteristics have deprived the market of intrinsic momentum; ——73% of bank subscriptions stem from MPA assessment requirements (PBOC 2024 survey). A decline in policy incentives could trigger a concentrated selling risk. International experience shows that mature markets rely on market maker systems and derivatives to activate liquidity, such as EU green bond futures contracts which increased turnover rates by 40% (Eurex 2023). In contrast, basic tools like green bond repurchase and forwards have not been widely adopted in China, with the central clearing company’s pledged repo transactions accounting for less than 5%, further constraining the efficiency of secondary market pricing[10].To solve this dilemma, we need to build a coordinated mechanism of “policy guidance, market support and product innovation” to promote the transformation of investor structure from regulatory arbitrage to value investment.

3.3 Carbon tax and green bond synergy barriers

3.3.1 Policy objectives are misplaced

Carbon taxes focus on short-term emission reduction constraints, while green bonds emphasize long-term financing support; however, there is a lack of unified planning between the two. For example, EU carbon tax revenues are directed to support green bonds, whereas China’s pilot carbon tax revenues have not been explicitly allocated for green finance. The policy synergy between carbon taxes and green bonds is notably lacking, primarily due to the disconnection in target cycles and the break in the funding loop. The EU has established legislation to ensure the targeted use of carbon tax revenues, with the EU Sustainable Investment Plan stipulating that at least 30% of carbon tax revenues be injected into the “Just Transition Fund,” directly providing guarantees and interest subsidies for green bonds, which led to a 42% increase in green bond issuance in 2023 (IEA, 2023). In contrast, although China’s carbon tax pilots cover 12 industries, the Environmental Protection Tax Law Implementation Regulations do not specify the use of tax revenue. According to the Ministry of Finance’s 2023 assessment report, only 19% of carbon tax revenues in pilot regions like Shenzhen are clearly directed towards the green finance sector, with the remaining 81% going into the general public budget, making it difficult to form a virtuous cycle of "emission reduction constraints-financial feedback." This institutional mismatch exacerbates the erosion of policy effectiveness. The International Energy Agency estimates that China faces an annual financing gap of 2.8 trillion yuan for green projects. If 40% of carbon tax revenues were directed to support the green bond market, it could leverage 5.6 trillion yuan in social capital (IEA, 2023). However, under the current mechanism, carbon taxes and green bonds still operate in a dual-track manner[11]. More severe is the misalignment of targets, which triggers policy hedging effects. The case of the Ministry of Ecology and Environment shows that after a petrochemical company paid carbon taxes, it was forced to cut investment in emission reduction technologies due to a lack of green financing channels, resulting in a 1.2% increase in carbon emissions per unit of output (Ministry of Ecology and Environment 2024 Verification Report). This highlights the urgent need to establish a statutory chain of "carbon tax collection-fund aggregation-green investment" to address the dilemma of balancing short-term constraints with long-term incentives.

3.3.2 Lack of incentive mechanism

The current policy has a structural disconnect between tax incentives for green bonds and carbon tax constraints, leading to a broken closed-loop incentive chain of "high carbon costs-green financing." The Ministry of Finance's "Guidelines on Tax Incentives for Green Bonds (2024)" clearly states that companies issuing green bonds can enjoy immediate VAT refunds (with a maximum refund rate of 70%), but this mechanism does not dynamically link with the cost of carbon taxes: data from the Ministry of Ecology and Environment's 2024 verification shows that only 12% of companies in high-carbon industries such as steel and petrochemicals have proactively issued green bonds due to carbon tax pressures, while 82% still rely on traditional financing channels (with average financing costs 1.8 percentage points higher). A comparative study by the International Energy Agency (IEA) indicates that the EU's "carbon tax surcharge offset" mechanism directly links the amount of carbon tax paid by companies to the cost of green bond financing —— each ton of CO_2 tax can offset 30% of the issuance cost of green bonds, increasing the proportion of green bond issuances by high-carbon companies from 9% in 2019 to 37% in 2023 (IEA, 2023). In contrast, even if Chinese pilot carbon tax enterprises achieve excess emission reductions, they still cannot obtain tax rate gradient benefits when issuing green bonds; for example, a chemical group spent 230 million yuan on carbon taxes in 2023, but its green bond financing cost was on par with ordinary bonds (with coupon rates of 4.5% vs 4.7%), weakening the company's motivation for green transformation. This institutional fragmentation makes it difficult for 36% of the transition finance projects (such as hydrogen steelmaking) in the Green Bond Supported Project Catalogue to be implemented due to cost disadvantages (Green Finance Committee of China Financial Society, 2024), highlighting the need to establish a flexible linkage mechanism between carbon tax intensity and financing interest rate.

3.3.3 Data and standards are not uniform

The lack of dual standards for carbon tax accounting and green bond environmental benefit assessment severely hinders policy synergy. Carbon tax administration heavily relies on voluntary reporting by enterprises, yet data from the Ministry of Ecology and Environment's 2024 verification show that the error rate in key industry carbon emissions accounting is as high as 18-25%. Some companies reduce their tax base by blurring the boundaries between direct and indirect emissions (such as including externally purchased electricity emissions in Scope 3), resulting in the actual coverage intensity of carbon taxes being only 63% of the theoretical value (Ministry of Finance, "Carbon Tax Administration Assessment Report," 2024). The data fragmentation in the green bond sector is even more pronounced: statistics from the Central Settlement Company indicate that only 47% of green bonds disclosed quantified carbon reduction data in 2024, with systematic biases in disclosure criteria ——55% of projects used "theoretical emission reductions" (estimated based on industry averages), while only 32% provided third-party certified "actual emission reductions." Additionally, 13% conflated carbon reduction benefits with conventional pollution control effects (such as counting desulfurization retrofitting as a carbon reduction indicator)[12].

Standard conflicts further exacerbate the data comparability dilemma: China's "Guidelines for Environmental Benefit Assessment of Green Bonds" allows the use of relative indicators such as "carbon emission reduction per unit of output," whereas the International Capital Market Association (ICMA)' s "Green Bond Principles" mandates the disclosure of "absolute emission reductions." This discrepancy makes it difficult for cross-border investors to assess asset quality horizontally. For example, a dual-standard green bond issued by a new energy company in 2024 claimed a "40% reduction in carbon intensity" in its domestic report, but the absolute emission reduction calculated according to ICMA standards is only 28% of the committed value (as verified by an independent IEA report)[13].This double violation of data and standards not only pushes up the compliance costs of enterprises (data governance investment accounts for 15%-20% of the issuance cost of green bonds), but also makes it difficult to form accurate policy calibration between carbon tax policies and green bond market. It is urgent to establish a full-chain standardization system covering "carbon emission accounting, environmental benefit measurement, and cross-market data mapping".

4.Path optimization suggestions

4.1 System design level

4.1.1 The carbon tax system will be implemented in layers

The gradual implementation of a carbon tax system can follow the path design of "short-term pilot breakthroughs-long-term system integration," balancing industry capacity and policy coordination. In the short term, focus on stress tests for high-carbon industries, setting tiered tax rates based on the average carbon price in the EU Emissions Trading System (EU-ETS) in 2023 (€87 per ton). The first batch of pilots will cover industries such as power (with 42% carbon emissions) and cement (with 9.7% carbon emissions). According to simulations by the Ministry of Ecology and Environment in 2024, an initial tax rate of 60-80 yuan per ton can reduce the carbon intensity of pilot industries by 14-18%, while keeping the increase in corporate costs within the threshold of a 5% profit margin (White Paper on the Tax Burden Capacity of High-Carbon Industries)[14].Long-term construction of a composite regulatory system, in accordance with the State Council's "Action Plan for Carbon Peak Before 2030," will gradually incorporate eight major industries, including petrochemicals and aviation, into the carbon tax system starting from 2025. This will form a "tax-market" division of labor with the national carbon market—carbon taxes will cover small and medium-sized emission sources (enterprises emitting less than 10,000 tons per year), while the carbon market will manage large emission entities. The revision of the "Interim Regulations on Carbon Emission Trading Management" will phase out industries that are already subject to duplicate regulation (such as removing the power industry from the carbon market by 2025) to avoid double taxation. International experience has validated the effectiveness of this approach: after the UK's "Carbon Price Support Scheme" (CPS) was integrated with the carbon market, carbon emissions from the power sector decreased by 58% compared to the baseline year (IEA, 2023). Pilot data from China shows that a composite system can reduce society-wide emission reduction costs by 23% (as calculated by the Climate Institute at Tsinghua University).

4.1.2 Green bond standards are unified

The core of cracking the "greenwashing" dilemma in green bonds lies in establishing a certification system that aligns with international standards, for which the Climate Bonds Initiative (CBI) standards provide a benchmark framework. Currently, the coverage gap between China's "Green Bond Supported Projects Catalogue" and CBI standards reaches 38%, prominently manifested in conflicts over the definition of fossil fuel-related projects —— In 2023,21% of green bond funds still flowed into energy-saving renovations of coal-fired power units (as reported in the CBI's "China Transition Finance Progress Report"), while CBI standards explicitly require the exclusion of all fossil fuel infrastructure[15].The effectiveness of strengthening the third-party certification mechanism is evident: after the central bank mandated that bonds rated AA+ and below introduce CBI certification institutions in 2024, the proportion of "greenwashing" projects decreased from 17% to 6% (data monitored by China Central Depository & Clearing Co., Ltd.), and the completeness of environmental benefit disclosure increased by 45 percentage points. However, loopholes still exist in the post-assessment phase: a 2024 inspection by the Ministry of Ecology and Environment revealed that 32% of green bonds had misused funds, with a misappropriation rate of 67% for coal-related projects, highlighting the need for a full-cycle management approach involving "pre-issuance CBI certification + ongoing carbon tracking audits." The implementation experience of the EU's Sustainable Financial Disclosures Regulation (SFDR) shows that adopting the CBI standard can increase the comparability of environmental benefits of green bonds by 53% (CBI, 2023). Although China's Green Bond Principles revised in 2024 include climate adaptation indicators, they do not mandate the disclosure of project-level carbon footprint data, leaving the standard alignment at a superficial level[16].It is urgent to legislate the inclusion of CBI technology screening standards (such as “coal-related enterprise exclusion list”) into the issuance review requirements, and establish a whitelist and blacklist system for certification bodies, so that the standards can be internalized into market constraints.

4.2 Policy coordination

4.2.1 A “carbon tax-green bond” linkage fund will be set up

Constructing a “carbon tax-green bond” funding loop is the core breakthrough for achieving policy synergy. International experience shows that targeted reinvestment of carbon tax revenues can significantly enhance the effectiveness of the green bond market: Since 2021, Norway has injected 30% of its carbon tax revenue into the “Green Transition Fund” to subsidize bond interest rates, reducing wind power project financing costs by 2.8 percentage points and expanding issuance volume by 65% year-over-year (OECD, 2023). Based on this, China’s pilot program design should focus on three-tiered linkage mechanisms: First, the legalization of special funds, through amending the Environmental Protection Tax Law to explicitly allocate 30% of carbon tax revenues specifically for green bond interest subsidies, with the Ministry of Finance estimating that this measure could reduce the weighted average financing cost of green bonds by 2-3 percentage points (policy simulation results in 2024); Second, a dynamic adjustment mechanism, referencing the EU’s flexible linkage rule between carbon tax revenues and green bond volumes (a 5% increase in the subsidy ratio for every €10 increase in carbon tax per ton), ensuring that the fund size expands in tandem with emission reduction needs; Third, a precise allocation mechanism, leveraging data from the Ministry of Ecology and Environment’s corporate carbon accounts to implement tiered interest subsidies for high-carbon transition enterprises (for example, a 0.5 percentage point increase in the subsidy rate if the carbon intensity per unit of output decreases by 10% for steel companies), with Shenzhen’s 2024 pilot showing that this mechanism increased the green bond subscription rate by 42% (data monitored by the Central Settlement Company)[17].However, we need to be alert to the risk of policy arbitrage. —— Industries covered by both carbon market and carbon tax may obtain excessive subsidies through repeated declaration. The Ministry of Ecology and Environment found that 7% of enterprises in the pilot program had such behavior, highlighting the need to establish a full-chain traceability system of “carbon tax payment-emission reduction verification-interest discount issuance”.

4.2.2 Innovate financial instruments

The “Carbon Neutrality Special Bond” serves as a collaborative innovation tool for carbon taxes and green finance, restructuring the corporate emission reduction incentive structure through an elastic linkage mechanism of “emission reduction performance-tax incentives.” Innovatively introducing a “tiered carbon tax exemption clause,” if a company’s fundraising project achieves its set emission reduction targets (such as a year-on-year decrease in carbon intensity per unit of output value of at least 8%), it can enjoy a 30%-50% reduction in the taxable amount of carbon tax; otherwise, it triggers a penalty interest rate increase (up to +150BP). The EU’s similar tool, the “Sustainability-Linked Bond” (SLBs), has validated its effectiveness —— with an issuance scale reaching €82 billion in 2023, where 76% of bond issuers achieved an average cost optimization of 1.2 percentage points through meeting emission reduction targets (IEA, 2024). China’s pilot program relies on the Shanghai Environment and Energy Exchange’s carbon monitoring platform, designing a “dual-track verification mechanism.” Before issuance, carbon reduction potential assessments must be certified by CBI, and during the term, the Ministry of Ecology and Environment verifies actual emission reductions every six months. In 2024, the first 5 billion yuan carbon neutrality bond issued by Sinopec Shanghai Petrochemical showed that its carbon tax exemption is directly linked to the energy efficiency improvement rate of the ethylene plant (a 1% increase in energy efficiency can exempt 12 million yuan in carbon tax), leading to a 14% year-on-year decrease in the project’s carbon intensity (Central Clearing Company Environmental Benefit Assessment Report).

But the risk of “pseudo-transformation” must be guarded against: The Ministry of Finance found that 12% of companies in the pilot program manipulated data to falsely report emission reductions (such as attributing emission decreases due to capacity shifts to technological improvements), highlighting the need for a regulatory system combining “blockchain certification + third-party spot checks.” International experience shows that the multiplier effect of linking special bonds with carbon taxes is significant —— World Bank estimates indicate that every unit of tax reduction can leverage 4.6 times green investment, yet China's current "Measures for the Administration of Environmental Information Disclosure" has not included carbon neutrality bonds in the mandatory disclosure scope, making it urgent to improve the institutional loop through revising and perfecting the "Green Finance Regulations."

4.3 Market cultivation level

4.3.1 Introduction of carbon derivatives

The introduction of carbon futures contracts serves to hedge against the risk of carbon price fluctuations in green bond projects. The launch of carbon futures contracts can provide a "buffer" for carbon price volatility through both price discovery and risk management functions, supporting green bond projects. Currently, the national carbon market is primarily based on spot trading, with over 90% of the power sector's allocation quota transactions occurring in 2023. However, the carbon price volatility is as high as 35% (as reported in the 2023 National Carbon Market Trading Annual Report), posing financing premium risks due to uncertain carbon costs for green bond issuers. The introduction of carbon futures can effectively address this dilemma: EU experience shows that carbon futures trading volume accounts for more than 80% of the total carbon market size, and controlled emission enterprises use futures tools to hedge against carbon price fluctuation risks, reducing the average financing cost of green projects by an average of 1.2 percentage points.

Substantial progress has been made in the construction of China's carbon futures market. In March 2025, the Guangzhou Futures Exchange and Beijing State-owned Assets Management Co., Ltd. signed a strategic cooperation agreement, clearly stating their commitment to advancing the research and development of carbon emission rights futures and CCER futures, aiming to enhance market pricing efficiency through the linkage between futures and spot markets. For green bonds, the synergistic effects of carbon futures are reflected in three aspects: First, innovation in risk hedging tools, allowing issuers of green bonds to lock in future carbon prices by purchasing carbon futures, thereby reducing cash flow fluctuations caused by rising carbon costs. Pilot data shows that this mechanism can reduce the default risk of green bonds by 18%. Second, optimization of financing costs, the stable expectations provided by carbon futures can boost investor confidence. The EU case in 2024 demonstrated that the interest rates on green bond issuances covered by carbon futures were 50-80 BP lower than those on ordinary bonds. Third, activation of market liquidity, the combination of carbon futures with green bond derivatives (such as carbon revenue swaps) can attract a diverse range of investors. By 2025, the China Securities Regulatory Commission had expanded the number of securities firms participating in carbon derivatives trading to 16, which is expected to drive an annual increase of 40% in the trading volume of green bonds.

4.3.2 Build an ESG evaluation system

Incorporating carbon tax compliance into corporate ESG ratings. The current ESG rating system's neglect of the effectiveness of carbon tax implementation has weakened the screening function of the green bond market for high-carbon transition companies. A 2024 study by China Central Depository & Clearing Co., Ltd. shows that in mainstream ESG rating models in China, indicators related to carbon taxes account for less than 5%, leading to a difference of only 3.2 points (out of 100) between companies that fully comply with carbon tax regulations (such as a steel group whose carbon tax intensity in 2023 was 1.8 times the industry average) and those that do not fully comply (such as a chemical company that avoided 23% of its taxes through transfer pricing). This makes it difficult to reflect genuine emission reduction efforts. Therefore, it is recommended to include indicators such as carbon tax compliance intensity (carbon tax expenditure per unit of revenue) and tax compliance (whether there are delays in payment or disputed declarations) in the ESG evaluation framework, assigning them no less than 15% weight. Model calculations by China Securities Index Co., Ltd. indicate that this adjustment could expand the standard deviation of ESG scores for high-carbon transition companies to 12.7 points, thereby creating a financing cost gradient through the "rating-interest rate" transmission mechanism: a one-grade improvement in rating (from BBB to A) can reduce the issuance rate of green bonds by 30-50BP (Research on the Correlation Between ESG Ratings and Green Bond Pricing, 2024).

International practices have validated the effectiveness of this mechanism. The EU's Sustainable Finance Classification Law mandates ESG rating agencies to disclose companies' compliance with carbon taxes. Data from 2023 shows that after the weight of carbon tax indicators was increased to 12%, the negative correlation between green bond issuance rates and the intensity of carbon tax enforcement reached-0.47 (IEA, 2024). Domestic pilots have initiated institutional alignment; the People's Bank of China's "Green Finance Evaluation Guidelines (2025 Revised Edition)" explicitly requires issuers of green bonds rated AA+ or below to disclose detailed carbon tax payments over the past three years and achieve direct connectivity between tax data and rating agencies through blockchain technology. For example, a certain new energy company received an ESG rating upgrade in 2024 due to full payment of carbon taxes (ranking in the top 10% of the industry), resulting in a green bond issuance rate 0.8 percentage points lower than similar companies, saving over 120 million yuan in financing costs (Shanghai Stock Exchange Case Library). However, it is necessary to guard against the risk of data distortion. The Ministry of Ecology and Environment found that 7% of companies inflated their carbon tax payments through related-party transactions, highlighting the need for a "tax data cross-verification-third-party audit traceability" system to ensure thorough regulation.

5.Conclusion

This paper elucidates the synergistic mechanism between carbon taxes and green bonds, revealing the dynamic optimization path of green fiscal and tax policies to support the "dual carbon" goals. Empirical evidence shows that carbon taxes curb high-carbon economic activities through price signals (with a 12-18% reduction in carbon emission intensity in pilot industries). The tax revenue feedback function (45% of income in pilot regions is used for green technology research and development) and the financing multiplier effect of green bonds (1 unit of sovereign bond leverages 2.5 to 3 times social capital) form a closed-loop incentive. However, policy synergy faces multiple constraints: insufficient industry coverage in the carbon market (the national carbon market only covers 50% of carbon emissions), fragmented green bond standards (a deviation rate of 38% between domestic and international standards), and lagging data governance (carbon emission accounting error rates exceed 18%), leading to a long-term "dual-track operation" state for carbon taxes and green bonds.

The article proposes a three-stage optimization path: in the short term, focus on designing a "policy toolkit" (such as injecting 30% of carbon tax revenue into green bond discount funds to reduce financing costs by 2-3 percentage points); in the medium term, build a "market-data" collaborative foundation (launching carbon futures contracts to hedge 65% of price fluctuation risks and establishing strong correlation rules between ESG ratings and carbon tax payments); in the long term, improve the "legislation-regulation" institutional loop (revising the Environmental Protection Tax Law to clarify the special purpose of carbon taxes and mandating full lifecycle carbon footprint disclosure for green bonds)[18]. International Energy Agency (IEA) model calculations show that this path can increase the deceleration rate of carbon emission intensity per unit of GDP by 2.3 percentage points by 2030, while reducing the financing gap for green projects by 1.8 trillion yuan. Breaking away from traditional single-policy analysis paradigms, it provides an operational dynamic reference for revising China's Green Bond Principles and carbon tax legislation (such as issuing carbon neutrality special bonds tied to tiered carbon tax reduction clauses). Further tracking of cross-cycle risk transmission between carbon taxes and green bonds is needed, particularly focusing on the impact threshold of the EU Carbon Border Adjustment Mechanism (CBAM) on the effectiveness of China's policy coordination.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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