

Research on the Quality Evaluation and Improvement of Carbon Emission Right Accounting Information Disclosure in the Context of Low-Carbon Economy

Zihan Yang^{#, *}, Yujia Zhai[#]

School of Economics and Management, Southwest Jiaotong University, Chengdu, Sichuan,
610031, China

* Corresponding Author Email: 2270824864@qq.com

These authors contributed equally in this manuscript.

Abstract. This paper explores the accounting treatment of carbon emission rights in the petrochemical industry in China, focusing on the challenges and opportunities presented by carbon trading mechanisms. The study analyzes existing norms in the EU's carbon trading market and evaluates SINOPEC's approach to carbon accounting and emission reduction. Through a comprehensive review of financial reports, sustainability disclosures, and industry trends, the paper offers insights into improving the accounting treatment of carbon emission rights and promoting low-carbon transformation in the petrochemical sector.

Keywords: Carbon accounting, carbon emission rights, petrochemical industry, carbon trading, SINOPEC, China, sustainability, accounting treatment, emission reduction, carbon neutrality.

1. Introduction

The petrochemical industry is a basic and pillar industry in China, but also an industry with high energy consumption and high emissions [1]. By the end of 2021, the total carbon emissions of China's petrochemical and chemical industry will be close to 1.4 billion tonnes, accounting for about 12% of the country's total carbon emissions, which is among the highest in the industrial sector [2]. Although the total carbon emissions of the petrochemical industry are lower than those of the iron and steel and cement industries, the carbon intensity of the petrochemical industry is relatively high, and the utilisation rate of energy efficiency is lower than that of the world's advanced level [3].

Carbon credit accounting is an innovation on the traditional accounting system, inheriting the original accounting structure and enriching the connotation of the traditional accounting treatment. As one of the important economic pillars in today's society, in many cases the construction of economic society is driven by carbon, so it is very important to deconstruct economic data from the perspective of carbon [3]. The accounting records and management of carbon emissions in most domestic enterprises are based on a macro-conceptual framework, with no clear responsibility for carbon emissions. This has led to a lack of clarity and deficiencies in the definition of responsibility for emissions in the internal processes of enterprises. In fact, the integration of the concept of energy efficiency and emission reduction into the internal accounting of enterprises has attracted a lot of attention internationally, leading to a series of studies based on accounting principles and inter-regional carbon transfers [4]. In China, the research on accounting principles in the concept of energy saving and emission reduction is still relatively limited, which is the significance of the thesis of this paper. This paper argues that carbon accounting is a process of accounting for and monitoring carbon assets in accordance with relevant laws and regulations. Through reasonable accounting treatment, the economic value of carbon assets in a series of economic activities is accounted for, thus assisting in the management of enterprise decision-making, which puts forward higher requirements for the business skills of traditional accountants [5]. Nowadays, in addition to profits, companies should also pay attention to environmental protection, green production methods and corporate social responsibility [6]. Companies need to accurately account for carbon credits in accordance with carbon credit accounting standards, and then comprehensively assess their environmental performance at a

given stage, and these related accounting, assessment and feedback processes are the key functions of carbon credit accounting.

The concept of carbon trading, which is derived from traditional emissions trading activities, refers to the determination of the total amount of carbon dioxide that can be used for circulation over a period of time, based on historical information and the actual situation of the enterprise. The total amount of carbon dioxide that can be used for circulation is determined over a period of time based on historical information and the actual situation of the enterprise. Under this mechanism, enterprises have more freedom: for enterprises with low emissions, they can sell their remaining carbon rights for profit; for enterprises with excessive emissions, they can buy their share in the market, which contributes to the effective control of China's carbon emissions and the achievement of the "3060" target. Dittenhofer [7] argues that carbon emission rights are similar to bank certificates of deposit of enterprises, which are held for the purpose of improving the efficiency of production and operation, and should be recognised as "inventories", and Black [8] argues that the value of carbon emission rights is more important than the form, and should be transferred to commodities eventually. Ting [9] argues that carbon emission rights should be recognised as "inventories" if they are held for trading purposes, and as "intangible assets" if they are held for personal use. Items should be recognised as "intangible assets".

Regarding the accounting measurement of carbon emission rights, many scholars discuss the historical cost measurement and fair value measurement, and some scholars believe that the measurement mode should be confirmed according to different situations. Ratnatunga [10] argues that the cost method can be applied to the various aspects of carbon emissions to transform these costs into the value of carbon emissions, and indicates that free carbon allowances allocated by the government can be regarded as a type of state financial subsidy, which must be initially measured at fair value around the free carbon allowances of the enterprises, and the debt needs to be based on the "deferred income". Hou Huimin [11] introduced the input-output method (IOA) and the hypothetical extraction method (HEM) to construct a set of carbon emission models that can take into account the externality factor, based on the consideration of the externality factor.

Therefore, it is important to promote the low-carbon transformation of the petrochemical industry in order to achieve the goals of peak carbon and carbon neutrality in the whole economy. Based on the current situation, this paper takes SINOPEC as a case study enterprise, and improves the company's accounting system in the context of the establishment of a unified national carbon trading market, so as to provide a reference for other emission-control enterprises and the formulation of China's relevant accounting system.

2. Analysis of the current situation and problems in the accounting treatment of carbon emission rights in China

2.1. Existing norms of accounting treatment of carbon emission rights in EU

Europe is the world's largest carbon trading market, which plays an important role in reducing global carbon dioxide emissions, and the IASB has formulated and published an "emissions control and trading" system based on market trading. The European Financial Advisory Group (EFRAG) proposed a new concept in 2013 [[12]. Firstly, carbon credits are not a factor of production, they cannot be used for operations or contractual transactions, which makes them significantly different from other assets; secondly, they arise from the process of trading carbon emissions, and are the product of a coexistence of rights and obligations. Therefore, a new accounting element should be constructed to carry out accounting recognition around carbon emissions, and in the selection of measurement attributes and disclosure of information, enterprises should use fair value to measure and disclose the trading profits generated from the use of this part of carbon emission rights. When enterprises use carbon emission rights in their operations, they can fulfil their "production" tasks under the requirements of the "government" and avoid the risk of "fines", thus reducing the "production" costs to a certain extent. "EFRAG also points out that most carbon trading in the market

is based on a certain purchase cost, and whether the allowances are received for free or purchased on the trading market, they should be measured on a fair value basis, and the disclosure of the accounting information of carbon credits needs to include the cost of emissions incurred in the process of carbon emissions by the enterprise. The accounting information disclosed for carbon emission rights should include the emission costs incurred by the enterprise in the process of carbon emission. In addition, the profit generated from the sale of free emission rights should be estimated as deferred profit in accordance with the accounting model of government subsidies.

2.2. Data related to Sinopec's carbon emission rights business

Since its establishment in 2003, carbon emissions from all trading venues in China have been increasing, and although carbon emissions decreased in 2020 and 2021 due to the epidemic, carbon emissions have been steadily increasing in the remaining years [13].

have risen steadily in the remaining years, although they have declined in 2020 and 2021 due to the epidemic [14]. Since the Chinese government has participated in carbon emissions trading, its trading system and management system have been improving. In the following, we will analyse Sinopec's carbon emissions trading in the context of Sinopec's operation report, social responsibility report and annual report.

Table 1 Sinopec's carbon emission reduction and trading situation

Years/indicators	2016	2017	2018	2019	2020	2021
total carbon dioxide emissions	—	162.66	171.52	167.69	170.94	165
Carbon trading amount (10,000 yuan)	3687	4000	3632	4857	4885	4900
Carbon dioxide capture (thousand tons)	—	—	1010	1263	1290	1310
Energy saving (10,000 tons of standard coal)	116	128	80.4	106.6	101	102
CO2 emission intensity	—	68.92	59.32	57.55	53.44	52.07
Ratio of non-operating income	0.76%	3.04%	1.75%	1.9%	2.06%	3.01%

SINOPEC has taken the initiative to reduce its carbon emissions, which has continued to improve, and has incorporated carbon emissions into its development plan, which has strengthened the company's energy management capability, as can be seen in Table 1. In addition, it has also effectively controlled the amount of greenhouse gases (GHGs) emitted from the outside world, which has led to the company's gradual clean-up and decarbonisation, and shaped its image as a leading company in the industry. The company aims at "energy efficiency improvement", energy saving in management, technology, new energy research and development and mechanisation, and further improving the level of "dual-control management" of energy, so as to realise energy saving and high efficiency and provide "green power" for the company's development. "Green Power" for the development of the company. Over the past five years, the energy saving value has increased in three years and stabilised in two years. In FY2020 and FY2021, the energy saving targets show a decreasing trend, which is mainly due to the implementation of the energy saving targets leading to an increase in the energy consumption of the company. During the 13th Five-Year Plan period, the scale of carbon trading in China has been fluctuating, but in the last three years it has been stable, and at the end of 2020, China officially announced that it would achieve "carbon peak" by 2030 and "carbon neutrality" by 2060. At the end of 2020, China officially released the solemn commitment to achieve "carbon peak" by 2030 and "carbon neutrality" by 2060, and in 2021, the nationwide carbon trading activities showed significant growth, while at the same time, the number of companies participating in carbon trading increased and the competition became

more intense, among which, the total amount of carbon trading of China's petroleum and chemical companies decreased by 5.4% compared with the same period of the previous year, and the total amount of trading decreased by 2.35% compared with the same period of the previous year. 2.35 per cent. Among the non-operating income of the company, the proportion of carbon trading income is also increasing. This fully demonstrates Sinopec's efforts in reducing energy consumption and energy consumption. In addition, under the background of "dual carbon", Sinopec will focus on building a clean energy supply system, optimising the energy industry chain, enhancing energy-saving production, and building a scientific greenhouse gas emission mechanism to effectively guarantee energy-saving and low-carbon development of the enterprise, and strive to halve methane gas emissions by 2050. It also strives to halve biogas emissions by 2050, and builds "carbon peaks" through greening and building "carbon neutral forests" to achieve "carbon peaks". Over the years, in actively responding to climate change, Sinopec has made great efforts to promote the implementation of the national carbon neutrality target through a number of carbon reduction initiatives, with the aim of achieving the full realisation of Sinopec's carbon neutrality target before the implementation of the national dual-carbon target. Since the establishment of the carbon sinks market, Sinopec's carbon sinks have been traded frequently and at a consistently high value. In the field of energy conservation, the energy consumption of the enterprise in terms of 10,000 yuan output value dropped from 496 kg in 2018 to 490 kg in 2020, a year-on-year decrease of 1.3%, and the use of crude oil, coal and natural gas decreased by 19.5%, 1.2% and 1.3% from 2018 to 2020, respectively; the content of sulphur dioxide in the tail gas of the external discharge dropped by 5.3 kilotonnes and the content of nitrogen oxides by 7.8 kilotonnes in the past three years. In the past three years, the SO In terms of technical results, China Petroleum & Chemical Corporation attaches great importance to the research and application of technology, and over the past three years, CO₂ capture has increased by 27.7% and methane recovery has increased by 165.5%. The annual report for 2021 shows that the company's operating income covers two main areas: government subsidies and others. A review of Sinopec's financial statements reveals that the Group has reclassified the benefits from the use of carbon credits and transferred them to the Other sub-section of the Non-Operating Income and Expenditure line. The trend of this income was analysed, with a significant increase in 2017 and a more moderate and stable increase in other years. According to the greenhouse gas emissions data, emissions have been declining over the past four years. Secondly, according to the data on CO₂ capture, the CO₂ capture rate has been increasing, which shows the effectiveness of the CO₂ capture technology developed by China Petroleum & Chemical Corporation in practical application. The greenhouse gas emission intensity indicator, i.e., the amount of CO₂ emitted per RMB 1 million of the company's main business income, has been reduced by 22.5% between 2017 and 2021, reflecting that Sinopec's adoption of low-carbon and energy-saving production has been particularly effective, and that it has achieved certain results in the past four years, not only in maintaining economic growth but also in lowering the amount of carbon emissions, effectively implementing the goal of low-carbon development. It has not only maintained economic growth, but also reduced carbon emissions, effectively implementing the goal of low-carbon development. According to the data of recent years, the carbon emission intensity of Sinopec has been reduced year by year.

2.3. Current Accounting Treatment of Carbon Emission Rights in Sinopec

From SINOPEC's annual report, it can be seen that SINOPEC does not recognise the carbon emission rights provided by the state free of charge as an asset. In addition, before the promulgation of the Interim Provisions, when SINOPEC purchased carbon emission allowances, it recorded them in the "intangible asset" account on the basis of the cost price, without considering their fair value; at the same time, because the useful life of carbon emission rights was not fixed, it did not amortise them according to the requirements of the Accounting Standards for Business Enterprises (ASBE).

Meanwhile, because the useful life of carbon emission rights is not fixed, they are not amortised as required by the Accounting Standards for Business Enterprises. Given that the carbon trading data of Sinopec is not publicly available, this paper makes a scientific assumption based on the carbon trading market in Beijing, where the headquarter of Sinopec is located, and Sinopec's carbon trading information in 2018 [15]. According to Beijing's company quota approval norms and the corresponding quota calculation formula for fixed emission CO₂ from existing installations in the petrochemical industry, $A=E \times f$, with E representing the CO₂ of the historical base year in 10,000 tonnes, and f representing the emission control factor, according to SINOPEC's sustainable development report, $f=0.8$ in 2018, from which it can be deduced that In 2018, according to SINOPEC's sustainability report, $f=0.8$, from which it can be deduced that SINOPEC issued 130,128,000 tonnes of allowances free of charge by the government, and the average carbon price was RMB 51 per tonne, as can be seen from the K-chart of carbon price in Beijing for that month.

According to the disclosure in the annual report of the company, the emission reductions made by the company's operating balance and the records obtained through emission reduction projects, after obtaining the permission from the regulatory authorities, can be counted as a kind of incentive income, used to reward the company's emission reduction work, and accounted for as "non-operating income". In addition, according to the Beijing carbon trading market trade norms, enterprises on both sides of a carbon transaction need to pay a transaction fee of 7.5 per cent each, which cannot be less than RMB 10. When the transaction is in the form of agreement transfer between the implementing agency and the executing agency, they should pay 5‰ transaction fee and the amount of each transaction should not be less than RMB 1,000. As it can be seen, the company has included these expenses in the account "Non-operating expenses", and under it there is the account "Others". Carbon emissions purchased by Sinopec from other companies are included in the accounting scope of "intangible assets". For example: (1) On 4 January 2018, the government allocated 13,028,000 tonnes of carbon allowances to Sinopec free of charge, and the trade price of carbon emission rights on that day was RMB46.15 per tonne. The Company generally did not do any accounting for the carbon quotas obtained free of charge from the government. (2) In June of the same year, China Petroleum & Chemical Corporation and an energy company in Zhejiang Province entered into a carbon emission right transaction, and the average trading price of carbon emission right in June was RMB52.8/tonne. The following are the corresponding accounting entries: Borrow: Bank Deposit 1,300,000 Credit: Non-operating Income 1,300,000 (3) Pay the transaction service fee of 5 per cent. Accounting entries are as follows: Borrow: Non-operating Expenses 6,500 Credit: Bank Deposit 6,500 (4) In August, one of its branches purchased 23,000 tonnes of carbon rights, and the price of carbon rights in that month was RMB 70.39 per tonne, and the following is the accounting situation: Borrow: Intangible Assets 1618,980 Credit: Bank Deposit 1618,980 According to the 2018 SINOPEC Annual Report, it can be learnt that the company obtained carbon rights by other means than the government. According to Sinopec's annual report for 2018, it can be learnt that the carbon emission allowances acquired by the company by means other than the government are measured at market price. However, at the end of the accounting period, the "gain or loss on fair value change" would not affect the trading value of the enterprise in the market, and the Company did not disclose it in the balance sheet.

The Social Responsibility Report and the Sustainability Report are two public reports used by SINOPEC to disclose data on carbon emissions trading. The company disclosed its carbon emissions in the Social Responsibility Report and the Sustainability Report in accordance with the Sustainable Development Goals (SDGS) for the period from 2007 to 2021 in a precise and detailed manner. Actions taken by the company to address climate change, ranging from strategic management to production development, as well as achievements, including environmental performance, are also disclosed. In particular, the Sustainability Report mentions emission reduction initiatives to address climate change, such as technological innovation, policy development and management enhancement, and increased sales of low-carbon products. However, enterprises do not provide detailed records in the quantitative information sheet on carbon emissions and carbon trading and other related data. In addition to disclosure in the table, the disclosure of carbon emission rights should also be taken into

account outside the table, so that the information users can be more comprehensively informed of the energy saving and emission reduction strategies adopted by the enterprise, the level of management of the enterprise's carbon assets, and the amount of carbon trading. Based on Sinopec's social responsibility report and sustainable development report, it can be learnt that Sinopec provides more comprehensive information than other industries.

According to the relevant information, it can be found that in 2021, the carbon emission management of the case group focuses on the authenticity of carbon accounting. In order to achieve this goal, the enterprise has set up a special carbon accounting information audit department and carried out comprehensive and effective carbon emission verification activities, covering the entire production process of the enterprise headquarters and its subsidiaries and branches, and then carried out comprehensive management. Taking SINOPEC, represented by East China and South China, as an example, it has carried out a demonstration project of CCUS for the whole industrial chain in Jiangsu region and conducted in-depth research on it, exploring the recovery of CO₂ exhaust gas and applying it to the recovery rate and recovery rate of oilfields, so as to realise the comprehensive utilisation of CO₂ resources in the company. According to the CO₂ emission of Jiangsu refining and chemical industry and the oil drive needs of major oil companies, two CO₂ capture and recovery systems have been built to process CO₂ waste gas annually, and the capacity of processing CO₂ reaches 100,000 tonnes per year.

3. Suggestions for Improving the Accounting Treatment of Carbon Emission Rights

In order to do a good job of "double carbon", the first step is to identify and discover carbon assets accurately and timely, to find and calculate the carbon assets owned by enterprises, and to disclose and react to them in real time. However, in practice, there is still a lot of work to be explored, and there is still a long way to go to realise real-time and accurate carbon measurement at this stage. Therefore, it is important for accountants to identify carbon assets and categorise the carbon emissions of assets within a company. According to the current regulation of China's carbon market, the allocation of carbon allowances to enterprises is based on their historical emissions, and the government allocates carbon allowances to enterprises free of charge. After that, the government auctions and coordinates the trading, and enterprises actively carry out emission reduction work, such as CDM, CCER and other emission reduction projects, and need to pay the corresponding consideration. In terms of relative share, the largest proportion of carbon allowances is obtained through the government's free distribution channel. In addition, if an enterprise obtains a surplus of carbon allowances through emission reduction measures, it can sell them for a profit.

Since the purpose of carbon accounting is to accurately measure carbon emissions, a very important part of accounting is the carbon emissions resulting from production and operations during the compliance phase of carbon trading after an enterprise has acquired carbon allowances at the beginning of the period. According to the requirement of "Double Carbon", if the actual amount of external emissions is larger than the amount of carbon emissions held by the enterprise, the enterprise needs to purchase carbon emission rights through carbon emission trading. If the amount of quota paid is much smaller than the actual amount of external emissions, the management department will take corresponding punitive measures, and the purchasing or punitive measures will greatly impede the development of the enterprise's production and operation. Therefore, the company needs to account for it as a liability. Currently, the company is exploring an internal carbon pricing mechanism, conducting a comprehensive carbon emission assessment of fixed asset investment projects, and incorporating carbon emission costs into the accounting of investment income, integrating carbon emission management with the company's production and operation, and promoting interaction and synergy of carbon emission management among multiple departments within the company, so as to promote the management of carbon emission and the implementation of the responsibility of carbon emission reduction of the enterprise. At the same time, it is determined that excess emissions will be

treated as debt when they occur. Since the emissions of key emitters will be under great scrutiny when they can be traded in the carbon market, these companies must actively develop carbon emission reduction technologies and fulfil their emission reduction obligations by capturing and recycling carbon dioxide. At the end of the compliance period, the carbon accounting department compares the amount of carbon dioxide actually emitted with the amount of carbon allowances allocated to the company at the beginning of the period, so that the current obligation to reduce carbon emissions arising from previous production and operations can be clearly identified.

Using fair value as a measurement method in the accounting process not only allows the government to have a reference for the initial measurement of free allowances, but also allows the company to have a clear understanding of changes in the fair value and the impact of those changes on the carrying value. The treatment of carbon offsets is the accounting treatment related to the carbon emissions retained by the company in the final phase. The Temporary Provisions promulgated in 2019 clearly state that after the expiry of the implementation period, the company's remaining allowances can be used for sale and included in "non-operating income" as an incentive for the company to proactively fulfil its responsibility for energy conservation and emission reduction. "Sinopec has adopted a similar practice, which is widely accepted by many companies. The reason why profits from trading of surplus carbon allowances are included in non-operating profits is that if a company in the pilot region that is included in the carbon emission accounting process exceeds the amount of emissions, it needs to purchase the surplus carbon allowances of other enterprises, or else it will be penalised by the management, which is the core concept for the development of enterprises to develop a low-carbon economy, and the penalty for exceeding the amount of carbon emissions will greatly affect the reputation of the enterprise, so this practice can enhance the energy saving and emission reduction of enterprises. Therefore, such a practice can enhance enterprises' awareness of energy saving and emission reduction, and promote the implementation of national energy saving, emission reduction and carbon neutrality targets.

In a dual-carbon context, enterprises should plan and forecast their carbon emissions activities and related operations, and include them in the preparation of their statements. Carbon budget statements include: carbon trading budget, carbon responsibility centre budget, carbon emission reduction budget, carbon assets and carbon liabilities. The carbon budget statement also includes the projected trading volume and price of carbon rights, so that the company can buy and sell carbon rights in carbon trading, thus realising the most effective use of carbon rights. Non-operating Income - Carbon Emission Right Trading Income" is set up to calculate the income from carbon allowances generated from reduction measures and projects undertaken by Sinopec; "Administrative Expenses" is set up to calculate the income from carbon allowances generated from reduction measures and projects undertaken by Sinopec; "Administrative Expenses" is set up to calculate the income from carbon allowances generated from carbon allowances generated from reduction measures and projects undertaken by Sinopec. Administrative expenses" is the amount used to calculate the depreciation of assets that are owned and considered intangible assets; "Non-operating expenses" refers to the costs incurred by Sinopec to calculate its emissions in excess of the required level. By charging the cost of carbon emissions to "administrative expenses" and creating "environmental expenses" as a sub-account separate from other administrative expenses, the financial statements can be more detailed and efficient.

In order to fulfil the "dual carbon" requirement, it is necessary to provide detailed explanations of the "dual carbon" information in the statements in addition to the "on-balance sheet" information. In the disclosure process of the statement, items related to carbon emissions trading and detailed items have been added, and Sinopec should give more explanations about them to avoid inconvenience to the users of the report. Firstly, in the accounting, the source of intangible assets calculated at a certain percentage should be indicated in the notes, i.e. carbon emission allowances provided by the state without compensation and carbon emission allowances obtained from carbon emission agreements approved by the state. At the same time, it is also necessary to present in the notes the proportion and basis of the allocation of carbon allowances in detail, and provide additional explanations on the

secondary accounts set up, and describe in detail the measurement specifications and amortisation methods of the intangible assets. Secondly, in the description of key entries and matters in the financial report, add a detailed category to describe the company's energy-saving and emission reduction measures and achievements, as well as the amount of the company's purchases for the current period, the balance at the end of the period, and the amount of the company's sales for the current period. Finally, in the process of dealing with the remaining part of carbon emission rights, carbon allowances obtained for free through the government and carbon allowances obtained through certified emission reduction projects should be classified. At the same time, it is necessary to set up a new category in liabilities - "Carbon Emission Rights Payable", and analyse its disclosure in detail, explaining the accounting value of the account, the measurement norms and the corresponding accounting standards.

4. Conclusions

The analysis highlights the importance of accurate carbon accounting and transparent disclosure in the petrochemical industry. Recommendations for improving accounting practices include integrating carbon emission assets and liabilities into financial statements, adopting fair value measurement for carbon allowances, and enhancing disclosure of carbon trading activities. These measures can contribute to achieving national carbon reduction goals, promoting environmental responsibility, and facilitating the transition to a low-carbon economy in China's petrochemical sector.

References

- [1] hao, S., Zhao, D., & Song, Q. (2022). Comparative lifecycle greenhouse gas emissions and their reduction potential for typical petrochemical enterprises in China. *Journal of Environmental Sciences*, 116, 125-138.
- [2] Jiang, B., & Xia, D. (2023). Toward carbon neutrality in China: A national wide carbon flow tracing and the CO₂ emission control strategies for CO₂-intensive industries. *Science of The Total Environment*, 879, 163009.
- [3] Keivani, E., Abbaspour, M., Abedi, Z., & Ahmadian, M. (2021). Promotion of low-carbon economy through efficiency analysis: a case study of a petrochemical plant. *International Journal of Environmental Research*, 15, 45-55.
- [4] Chen, Z., Zhang, X., & Chen, F. (2021). Do carbon emission trading schemes stimulate green innovation in enterprises? Evidence from China. *Technological Forecasting and Social Change*, 168, 120744.
- [5] Trotman, A. J., & Trotman, K. T. (2015). Internal audit's role in GHG emissions and energy reporting: Evidence from audit committees, senior accountants, and internal auditors. *Auditing: A Journal of Practice & Theory*, 34(1), 199-230.
- [6] Lohmann, L. (2009). Toward a different debate in environmental accounting: The cases of carbon and cost-benefit. *Accounting, organizations and society*, 34(3-4), 499-534.
- [7] Barauskaite, G., & Streimikiene, D. (2021). Corporate social responsibility and financial performance of companies: The puzzle of concepts, definitions and assessment methods. *Corporate Social Responsibility and Environmental Management*, 28(1), 278-287.
- [8] Kapiszczwska, K. B. M., Maciąg, Z., Majchrowski, J., Milovanovic, V., Nicstrój, R., Pomianck, T., ... & Pomorski, J. M. scientific editor Zbigniew Paszek Kraków 2010 Editorial Council.
- [9] Black, C. M. (2013). Accounting for carbon emission allowances in the European Union: In search of consistency. *Accounting in Europe*, 10(2), 223-239.
- [10] Ting, L. (2021). Research on confirmation and measurement of Carbon Emission Rights. *Academic Journal of Engineering and Technology Science*, 4(6), 1-8.
- [11] Ratnatunga, J., & Balachandran, K. R. (2013). Carbon emissions management and the financial implications of sustainability. In *Corporate Sustainability* (pp. 59-87). Berlin, Heidelberg: Springer Berlin Heidelberg.

- [12] Hou, H., Wang, J., Yuan, M., Liang, S., Liu, T., Wang, H., ... & Xu, H. (2021). Estimating the mitigation potential of the Chinese service sector using embodied carbon emissions accounting. *Environmental Impact Assessment Review*, 86, 106510.
- [13] Abela, M., Barker, R., Sommer, R., Teixeira, A., & André, P. (2014). Towards a new conceptual framework: presentations at the accounting in europe and european accounting association financial reporting standards committee symposium. *Accounting in Europe*, 11(2), 259-271.
- [14] Ray, R. L., Singh, V. P., Singh, S. K., Acharya, B. S., & He, Y. (2022). What is the impact of COVID-19 pandemic on global carbon emissions?. *Science of The Total Environment*, 816, 151503.
- [15] Lu, J., Chen, H., & Cai, X. (2022). From global to national scenarios: Exploring carbon emissions to 2050. *Energy Strategy Reviews*, 41, 100860.
- [16] Wu, X., Tian, Z., & Guo, J. (2022). A review of the theoretical research and practical progress of carbon neutrality. *Sustainable Operations and Computers*, 3, 54-66.