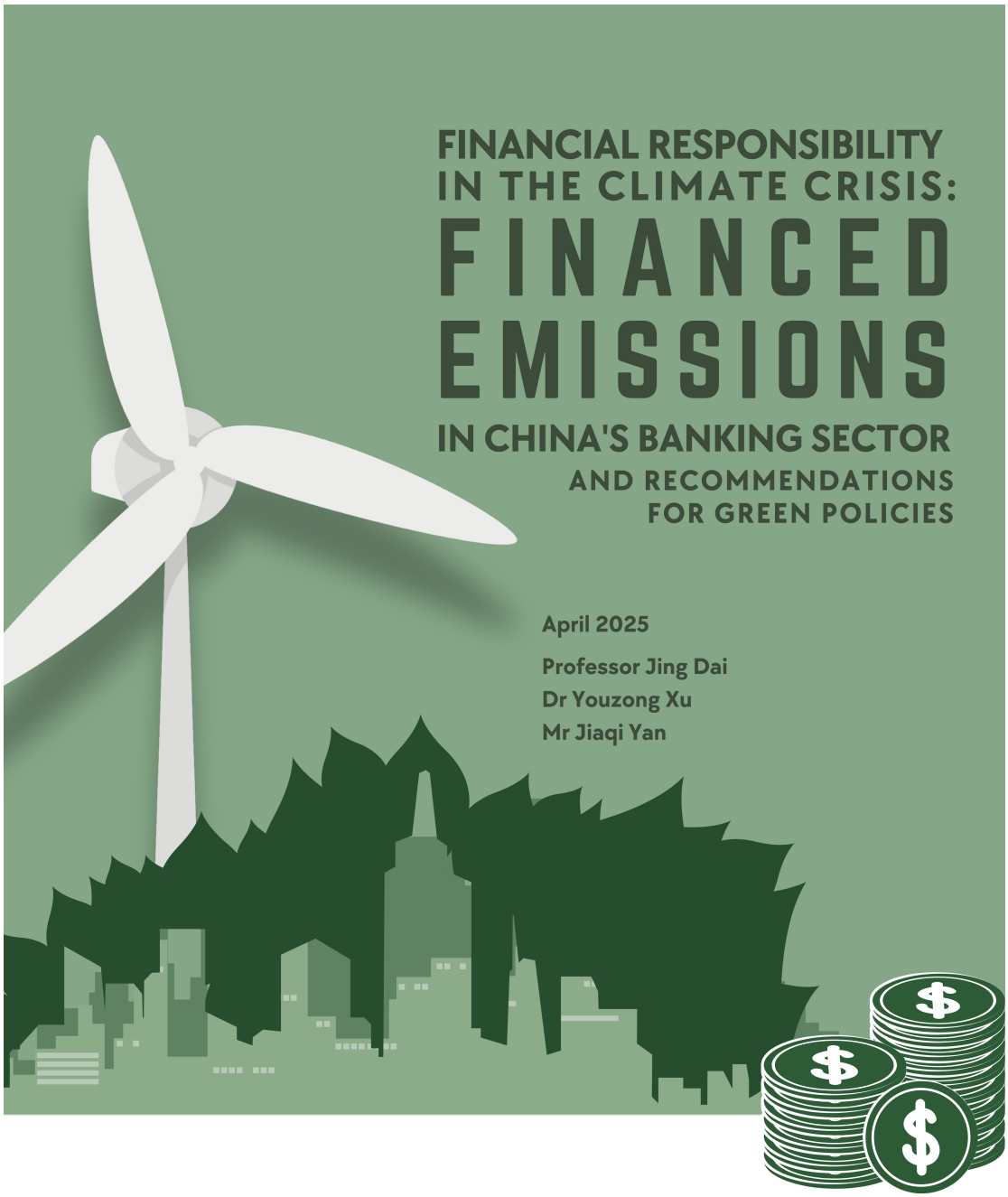

FINANCIAL RESPONSIBILITY IN THE CLIMATE CRISIS: FINANCED EMISSIONS IN CHINA'S BANKING SECTOR AND RECOMMENDATIONS FOR GREEN POLICIES

April 2025

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Centre for Responsible Business and Innovation (CRBI)

The Centre for Responsible Business and Innovation (CRBI) at the University of Nottingham Ningbo China (UNNC), established in 2023, is one of the key initiatives of the Nottingham University Business School China. Our mission is to advance research, education, and dialogue in the fields of Environmental, Social and Governance (ESG), responsible business, and sustainable innovation, thereby fostering regional sustainable development. The Centre leverages UNNC's multidisciplinary strengths in corporate social responsibility, digital technology and innovation, supply chain and operations management, circular economy, finance, engineering, and more to enhance the value of ESG and sustainable development and empower entrepreneurs to advocate ESG practices. CRBI aims to become a leading figure and educator in the realm of sustainable development, playing a proactive role in cultivating international talent and skill enhancement for sustainable development, encouraging local businesses and communities to create a sustainable culture, promoting their responsible business practices, and advocating green innovation. Currently, the Centre has initiated collaborations with stakeholders to establish ESG evaluation specifications, advance student research projects in ESG finance, facilitate sustainable scientific research and knowledge exchange, build a no-waste campus, engage in sustainable innovation and supply chain security, etc.

RCE Ningbo Acknowledged by UNU

The United Nations Regional Centres of Expertise (RCE) on Education for Sustainable Development is a global network initiated and accredited by the United Nations University, aimed at fostering collaboration among local institutions, organisations, and communities to advance education for sustainable development and share global best practices. By the end of 2024, there were over 190 RCEs worldwide, spanning across various countries and regions.

As the operation and management organisation of RCE Ningbo, CRBI will prioritize the ESD work from the following 3 key sectors, collaborative engagement, talent cultivation, and research & knowledge exchange.

Table of Contents

Financial Responsibility in the Climate Crisis: Financed Emissions in China's Banking Sector and Recommendations for Green Policies

Executive Summary

The global financial sector plays a pivotal role in determining the future trajectory of climate change, with financial institutions (FIs) contributing significantly to the emissions associated with their lending and investment activities [1]. These emissions, known as financed emissions, refer to the greenhouse gases (GHGs) produced by the entities that financial institutions lend to or invest in. As the central hub of the modern financial system, the banking sector plays an irreplaceable and crucial role in resource allocation and capital intermediation [2]. According to financial intermediation theory, commercial banks effectively allocate idle social funds to various sectors of the real economy through traditional operations such as deposit-taking and loan issuance, as well as innovative businesses including investment banking and asset management [3]. This capital allocation function not only influences the operational efficiency of the macroeconomy but also directly affects the direction of social resource allocation and environmental benefits [4].

Research indicates that banks indirectly influence the carbon emission behaviors of borrowing enterprises through their credit decisions and investment activities [5]. Specifically, financial support from banks to high-carbon industries can intensify the carbon emission intensity of these sectors, while green credit policies can effectively guide capital flows towards low-carbon and environmentally friendly industries [6]. Therefore, an in-depth study of the carbon emission effects of bank financing activities not only contributes to understanding the impact mechanisms of the financial system on climate change but also provides a significant basis for formulating sustainable financial policies [7-9]. In this study, we estimate the financed emissions associated with the investment and financing activities of 19 major banks in mainland China, specifically focusing on business loans of 12 sectors and residential mortgage loans in 2021.

The results show that the financed emissions related to business loans across 12 sectors amounted to 4,806 million tons of CO2e. The average emission intensity for these loans was 546.36 tCO2e per million USD, with a total of 8796.3 billion USD granted in business loans in 2021. In addition, the financed emissions associated with residential mortgage loans reached 156.26 million tons of CO2e, with an average emission intensity of 30.33 tons CO2e per million USD. The total value of residential mortgage loans issued by the 19 major banks in mainland China was 5152.78 billion USD.

In 2021, the top four business sectors with the highest commercial loans in mainland China were Manufacturing, Transportation, Leasing and Business Services, and Real Estate. These sectors accounted for the largest share of business financing in the country, reflecting the economic priorities and investments in infrastructure and development. Correspondingly, the sectors contributing the most to financed

emissions were Manufacturing, Production and Supply of Energy, and Transportation and Construction. These sectors also exhibit the highest emission intensities, given their energy-intensive operations and significant reliance on fossil fuels. The alignment between the highest commercial loan sectors and the sector contributing most to financed emissions underscores the crucial role of financial institutions in facilitating high-carbon activities.

Regarding residential mortgage loans, the top four banks in mainland China with the highest issuance in 2021 were China Construction Bank, Industrial and Commercial Bank of China (ICBC), Agricultural Bank of China, and Bank of China. These banks, due to their dominant position in the residential mortgage market, are also responsible for the highest financed emissions associated with these loans. The emissions resulting from the residential mortgage portfolios of these institutions highlight the significant carbon footprint embedded in housing finance, which, despite being lower in emission intensity compared to business loans, still contributes notably to the financial sector's overall climate impact. The concentration of both financial activity and emissions in these banks emphasizes the need for targeted regulatory interventions and climate strategies to address the substantial role of the banking sector in supporting both high-carbon industries and residential developments.

These findings underscore the substantial impact that the financial sector has on global emissions. Despite international efforts, including the Task Force on Climate-related Financial Disclosures (TCFD) and the Partnership for Carbon Accounting Financials (PCAF), progress in the accurate estimation and reporting of financed emissions remains limited. The data gaps and challenges in emissions accounting persist, particularly in the Chinese financial sector, where emissions reporting is still in its nascent stages.

Policymakers and regulators must strengthen regulations surrounding climate disclosures and incentivize financial institutions to integrate climate risk management into their decision-making processes. The results of this study highlight the need for a comprehensive approach to decarbonization in the financial sector, including improved reporting frameworks and enhanced climate-related investment strategies to meet global climate goals.

Highlights of The Key Points:

- We covered two types of investment and financing activities of 19 major banks in mainland China and estimated financed emissions for business loans in 12 sectors and residential mortgage loans in 2021.

- Emissions associated with business loans. The financed emissions associated with business loans of 12 sectors was 4806 Mt CO2e. The average emission intensity was 546.36 t CO2e/million USD. The total granted business loans in 12 sectors were 8796.3 billion USD in 2021.

- Emissions associated with residential mortgage loans. In 2021, the financed

emissions associated with residential mortgage loans were 156.26 Mt CO2e. The average emission intensity was 30.33 t CO2e/million USD. The total value of residential mortgage loans issued by 19 major banks in mainland China was 5152.78 billion.

Based on the analysis, this study proposes several policy recommendations aimed at promoting the improvement and development of the green financial system in mainland China, thereby providing substantial support for achieving the "Dual Carbon" strategic goals：

1. Strengthening Climate Information Disclosure for Financial Institutions

- Develop a mandatory climate disclosure framework, requiring financial institutions to report financed emissions, particularly in high-carbon sectors.
- Introduce third-party audits for data accuracy and comparability. And Implement guidelines for climate-related financial disclosures in annual reports, with standardized templates and methodologies.

2. Promoting Green Finance Transformation

- Integrate climate risk management into decision-making and prioritize low-carbon projects. Use monetary tools (e.g., reserve requirement cuts) and tax incentives to support green finance.
- Develop innovative green financial products (e.g., green funds, insurance) and establish a performance evaluation system.

3. Optimizing Financing for High-Carbon Industries

- Set industry-specific carbon intensity standards and prioritize loans for low-carbon projects.
- Establish "carbon performance-linked" financing mechanisms and dedicated green credit departments. Monitor financing structures and carbon performance regularly.

4. Enhancing Carbon Emission Accounting and Transparency

- Create a unified carbon accounting methodology and national data platform.
- Encourage third-party verification of emissions data and establish public disclosure mechanisms. Promote collaboration between financial institutions and third-party organizations for data accuracy.

Introduction

As the world is facing the urgent challenge of climate change, the financial sector has emerged as a key player in determining the pace of global decarbonization. Financial institutions, through their investment and lending activities, significantly influence the direction of various industries, either supporting or hindering the transition to a low-carbon economy [10]. This report focuses on the financed emissions, which are the greenhouse gas (GHG) emissions resulting from investment and financing activities of 19 major banks in mainland China, business loans in 12 sectors, and residential mortgage loans in 2021. Financed emissions represent a crucial, yet often overlooked, component of the overall emissions footprint of the financial sector.

Despite the growing recognition of the financial sector's role in climate change, the estimation and disclosure of financed emissions have faced several challenges, including data limitations and the lack of standardized methodologies [11]. This report utilizes the Partnership for Carbon Accounting Financials (PCAF) Global GHG Accounting and Reporting Standard, a leading framework for measuring financed emissions across different asset classes.

The study covers the financed emissions resulting from business loans and residential mortgage loans issued by 19 major banks in mainland China in 2021. The results show that the financed emissions associated with business loans across 12 sectors amounted to 4,806 million tons of CO2e, with an average emission intensity of 546.36 t CO2e per million USD. In contrast, the financed emissions from residential mortgages were 156.26 million tons of CO2e, with an average emission intensity of 30.33 t CO2e per million USD.

These findings demonstrate the significant contribution of the financial sector to global emissions, particularly in emerging markets like China. They highlight the urgent need for robust climate-related financial disclosures and the development of more comprehensive strategies to align financial activities with the goals of the Paris Agreement. Regulators and financial institutions must work together to address the gaps in emissions reporting and to create a more sustainable financial ecosystem that supports the transition to a low-carbon future.

SCOPE AND APPROACH

Scope of emissions

GHG emissions accounting is the process of systematically measuring, tracking, and reporting greenhouse gas (GHG) emissions generated, avoided, or removed by an entity [12]. This ensures consistency over time. The gases accounted for include the seven regulated under the Kyoto Protocol and required in national inventories under the United Nations Framework Convention on Climate Change (UNFCCC): carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). To

facilitate comparison, these gases are typically expressed in carbon dioxide equivalents (CO_2e).

Governments, businesses, and organizations commonly use GHG accounting to quantify both direct and indirect emissions linked to their operations and broader value chain activities. According to the GHG Protocol Corporate Accounting and Reporting Standard, direct emissions come from sources under the organization's ownership or control, while indirect emissions result from the company's activities but originate from assets owned or controlled by another entity.

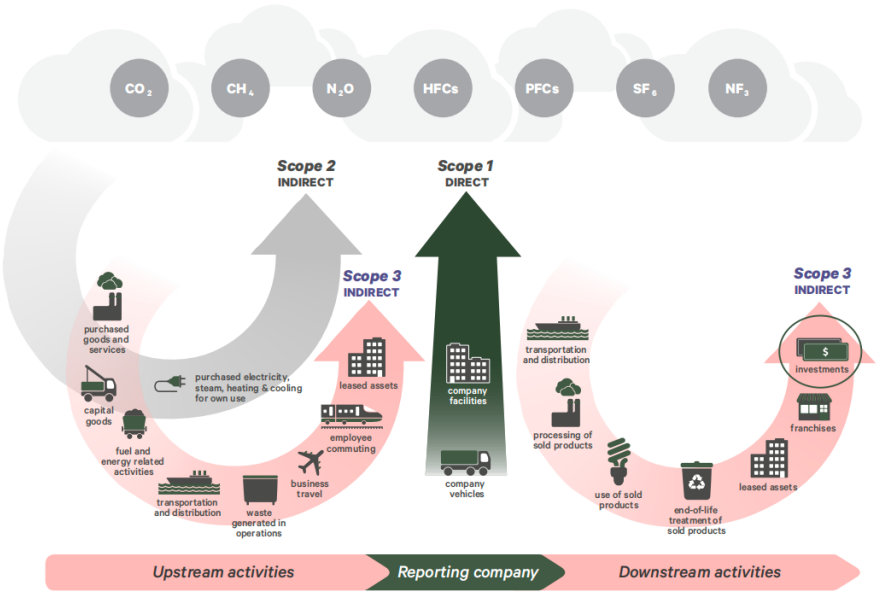
GHG emissions are categorized into three scopes, depending on their origin and where they occur in the value chain:

- Scope 1: Direct emissions from assets the organization owns or controls, such as company-operated boilers, furnaces, and vehicles.
- Scope 2: Indirect emissions from electricity, steam, heating, or cooling purchased and consumed by the company. These emissions occur at the facility where the energy is generated.
- Scope 3: All other indirect emissions beyond Scope 2 that arise throughout the organization's value chain. This includes upstream emissions, such as those from raw material extraction and production, and downstream emissions from the use of the company's products or services.

The GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard further divides Scope 3 emissions into 15 categories (illustrated in Figure 2-1). Emissions from an organization's loans and investments fall under Scope 3 downstream emissions, specifically category 15 (investments).

For financial institutions, GHG accounting involves the yearly measurement and disclosure of Scope 3, category 15 emissions, recorded at a set point in time in alignment with financial reporting cycles [13-16].

Figure 1 Overview of GHG Protocol scopes and emissions across the value chain



Source: (WRI and WBCSD, 2011)

Approach

In this study, we conducted a comprehensive assessment of residential mortgage loans and commercial loans issued by banks in mainland China up to the year 2021. However, due to the lack of mandatory disclosure requirements for asset management companies to reveal their investment portfolios in mainland China, we were unable to obtain sufficient data for precise estimations.

The accounting of financed emissions is typically based on financial activities across different sectors and emission factors. Financial activities are defined as the monetary volume of specific financial transactions, whereas emission factors are determined by the detailed energy consumption associated with such activities. According to the guidelines provided by PCAF (Partnership for Carbon Accounting Financials), financed carbon emissions can be calculated using two approaches depending on data availability — a top-down or a bottom-up approach. This study refers to the research method from Hong Kong, employing a top-down methodology for estimation [17], with data sourced from the National Financial Regulatory Administration of China and the official annual reports of major banks in mainland China.

Our methodological approach differs substantially from prior studies conducted on the UK and US [18,19]. Research in these two countries utilized a bottom-up approach, which relied on samples of selected financial institutions. Such studies only covered scope 1 and scope 2 emissions generated by borrowers and investees and excluded scope 3 emissions resulting from loans or investments made by financial institutions [20]. In contrast, our study's estimation framework is more expansive, encompassing not only the overall scale of the financial sector (industry-wide information) but also the full scope of financed emissions from loans and financial activities by financial institutions (i.e., all financed emissions related to target financial activities).

Financed Emissions Estimation Methods

According to the Guidance on Estimating Greenhouse Gas Emissions of Financial Institutions published by the Partnership for Carbon Accounting Financials (PCAF) in 2022, the carbon emissions of financial institutions are estimated using economic activity data and corresponding carbon emission factors. Economic activity data is a quantitative indicator of the scale of investment and financing activities. Relevant data can be collected from public sources, such as government publications and company annual reports. Industry emission factor, the amount of greenhouse gas emitted per unit of consumption in the industry, is used to convert economic activity data into greenhouse gas emissions. Emission factors can be obtained from government statistical yearbooks and databases or can be calculated using macro data. On this basis, following the guidance of PCAF, our method for estimating emissions from bank financing in mainland China mainly involves two parts: (1) determining the financial activities of banks and their quantity; and (2) distinguishing the industries to which the financial activities belong to determine the corresponding emission factors.

For business loans and residential mortgages, the formula for estimating GHG emission is:

$$\sum_{c} \boldsymbol{Outstanding\ amount_c} * \boldsymbol{Asset\ turnover_s} * \frac{\boldsymbol{GHG\ emission_s}}{\boldsymbol{Revenue_s}}$$

The outstanding loan amount represents the value of issued loans, while the asset turnover rate refers to the operational cycle of different asset categories (typically on an annual basis). Based on this, the average annual transaction volume of loans and other financial activities can be estimated. The greenhouse gas emissions per unit of revenue reflect the annual emission factor of the industries associated with the loans.

Emission factors for different industries are obtained from the China Statistical Yearbook or corresponding databases (e.g., EXIOBASE) [21-23]. The annual asset turnover rates of various industries are derived either from publicly available statistical data (if available) or through estimations (details and formulas are provided in the Appendix).

Data on the total residential mortgages and commercial loans issued by banking institutions in 2021 were collected from the annual reports of commercial banks (Table 1, Column 1).

Table 1 Estimation Parameters for Carbon Emissions by Sector from Business Loans and Residential Mortgage in Mainland China

	Column 1	Column 2	Column 3
	Outstanding loans (million USD)	Carbon emission factor by sector (tCO2e/million USD)	Asset turnover ratio
Residential mortgage loans	5152781	918.9	0.03
Business Loans			
Manu.	1673234	1488.9	1.05
Constr.	424201	918.9	0.86
RE	1005686	80.00	0.12
Logistics/Transport	1702022	1459.3	0.27
Utilities/Energy	785211	2556.3	0.40
Mining	221605	1033.5	0.48
Environmental Mgmt./Infrastructure	814947	74.0	0.06
Trade/Retail	635407	186.9	1.88
Agri./AFHF	37884	178.6	0.64
IT/ICT	49129	74.0	0.52
Leasing/Services	1437562	141.8	0.13

In Table 1, column 2, shows the emission factor information for each industry. Since there are no official emission factors or authoritative data for each industry in mainland China, we refer to the EXIOBASE data compiled by the European Union

and the carbon emissions of energy consumption in various industries in mainland China for estimation. The asset turnover rate in column 3 is calculated based on industry statistical data.

Summary of Results

The estimates indicate that the total GHG emissions (financed emissions) generated by 19 major banks on business loans and residential mortgages were 4224.26 Mt CO2e in 2021. These emissions were from business loans (4806 Mt CO2e) and residential mortgage loans (156.26 Mt CO2e), (Table 2).

Table 2.

Financial activities	Financial volume million USD	Emission intensity tCO2e/million USD	Financed emission Mt CO2e
Business loans	8796.3	546.36	4806
Residential mortgages	5152.78	30.33	156.26

These data fully reveal the substantial scale of financed carbon emissions in the banking sector of mainland China. Comparative research shows that this phenomenon is highly consistent with the findings reported in current studies on financed carbon emissions in major international financial centers. For instance, as highlighted in the report *The Big Smoke*, a case study of the City of London involving 15 commercial banks and 10 asset management companies demonstrated that the total financed carbon emissions reached 1.8 times the direct emissions of the UK itself. This study employed internationally recognized accounting methodologies to comprehensively measure the financed carbon emissions of the sampled financial institutions, covering Scope 1 (direct emissions) and Scope 2 (indirect emissions) emissions from borrowers and investees across multiple economic sectors.

Similarly, the report *Wall Street's Carbon Bubble: The Global Emissions of the US Financial Sector* presented findings from two independent studies on New York's financial sector, which yielded comparable conclusions. The results indicated that the greenhouse gas emissions generated by New York financial institutions through cash deposits and investment activities were not only twice the emissions of the local transportation sector but also exceeded the total annual emissions of Japan, the world's fifth-largest carbon emitter in 2020 (1.06 billion tons of CO2 equivalent). Notably, related studies in the Hong Kong Special Administrative Region of China also confirmed the significant scale of financed carbon emissions, further corroborating the common challenges faced by major global financial centers in addressing financed carbon emissions. These cross-national and cross-regional studies

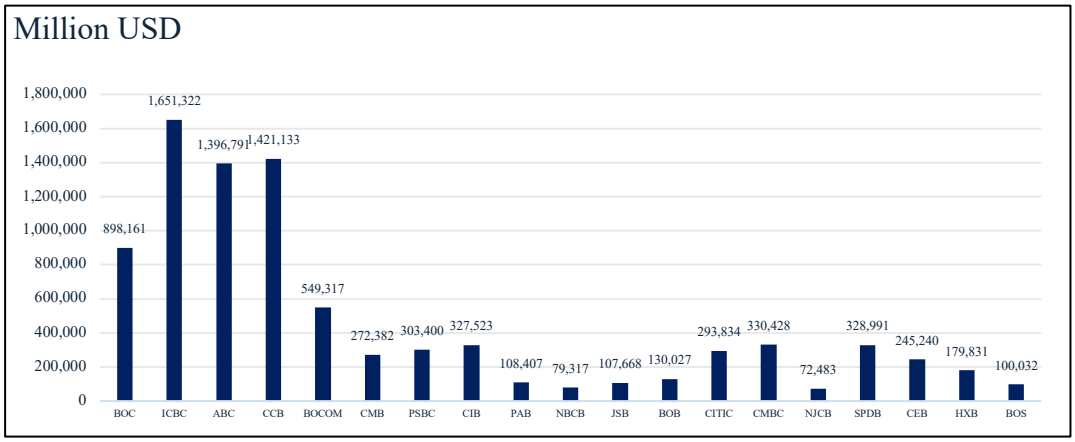
provide critical data support and theoretical foundations for understanding the role of financial institutions in climate change.

Results by Financial Activities:

Business Loans in Mainland China, 2021

In this study, we selected 19 banks in mainland China, including six national commercial banks and 13 major joint-stock banks, covering 12 industries, including manufacturing, construction, transport, mining, real estate, etc. The total business loans in 12 sectors granted by 19 banks were 8.796 trillion USD in 2021. The top 4 banks achieved 67.3% of the total loans.

Figure 2 Business loans for 19 Banks, 2021

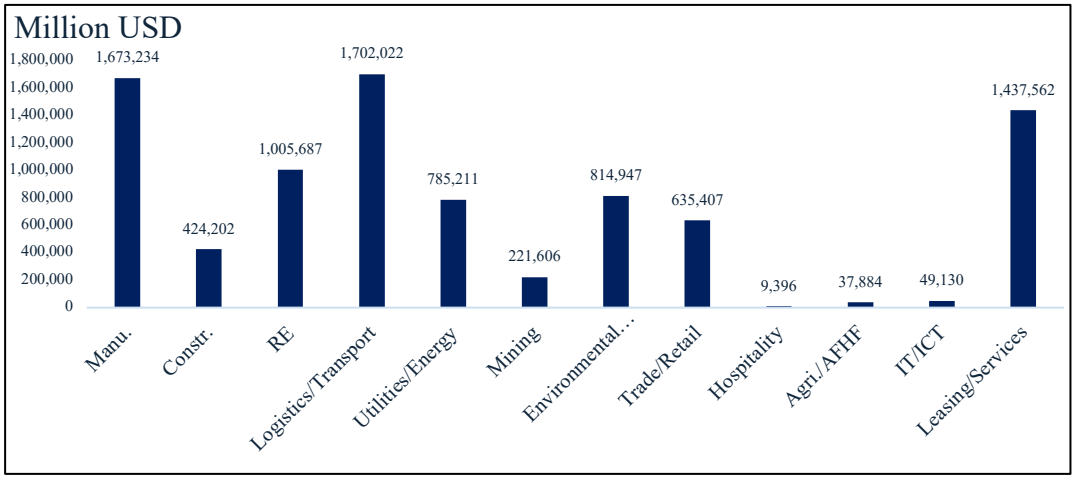


Source: Banks' annual report 2021

Business Loans of Each Sector, 2021

The industries of manufacture, transportation, warehousing and postal services, leasing and commercial services show the major portion of the business loan.

Figure 3 Business Loans for 12 Sectors, 2021



Source: Banks' annual report 2021

Figures 2 and 3 shows the estimated financing emissions for each bank and the industry level based on statistics on total commercial loans by industry in mainland China, as well as emission factors and turnover rates by industry (Figure A-1 and Figure A-2 in the Appendix).

Finance Emission from Business Loans in Mainland China, 2021

From the perspective of the banking sector, figure 2 shows that the Industrial and Commercial Bank of China (ICBC), Agricultural Bank of China (ABC), China Construction Bank (CCB), and Bank of China (BOC) demonstrate a significant leading position in terms of business loans scale. Research data indicate that the total business loans volume of these four major commercial banks accounts for 61% of the total volume among the 19 sampled banks, while their corresponding financed emissions represent 64.9% of the total emissions, figure 4. This phenomenon highlights the dominant role of large commercial banks in China's credit market and their associated environmental responsibilities.

Notably, when examining the key metric of carbon emission intensity (i.e., carbon emissions per unit of loan), the Bank of China (BOC), Postal Savings Bank of China (PSBC), Bank of Ningbo (NBCB), and Agricultural Bank of China (ABC) exhibit relatively high carbon emission density characteristics, figure 5. This empirical finding suggests that the carbon emission performance of commercial banks is influenced not only by their loan scale but also by the industry distribution characteristics of their credit asset portfolios. Specifically, some regional and specialized banks, despite their relatively limited loan volumes, demonstrate significantly elevated carbon emission intensity metrics due to their higher proportion of credit allocation to carbon-intensive industries.

Further analysis reveals that the Bank of China (BOC) and Agricultural Bank of China (ABC) rank high in both loan volume and carbon emission intensity, due to their concentrated credit exposure to carbon-intensive sectors such as energy, heavy industry, and transportation. In contrast, the cases of Postal Savings Bank of China (PSBC) and Bank of Ningbo (NBCB) are more illustrative: despite their relatively smaller asset sizes, their high carbon emission intensity metrics fully reveal the structural challenges faced by small and medium-sized banks in the process of green financial transformation. These empirical findings not only confirm the intrinsic relationship between the credit structure of commercial banks and their carbon emission performance but also provide important decision-making references for the banking sector to optimize credit resource allocation under the constraints of the "dual carbon" goals.

From the perspective of the industry sector, financing emissions totaled 4805.86 million tons of CO2e, of which 54.5% came from the manufacturing industry (2617.92 million tons of CO2e), although the industry's loan amount accounted for only 19% of different types of commercial loans in 2021, as shown in Figures 6 and 7. Figure 8 shows that the manufacturing industry has the highest emission intensity among all industries (1564.6 tons of CO2e/million US dollars) and is significantly

higher than the average emission intensity of all commercial loans (546.36 tons of CO2e/million US dollars).

The top four finance emission business sectors are manufacturing, production and supply / energy industry, transportation, and Construction.

Figure 4 Financed Emission by Bank, 2021

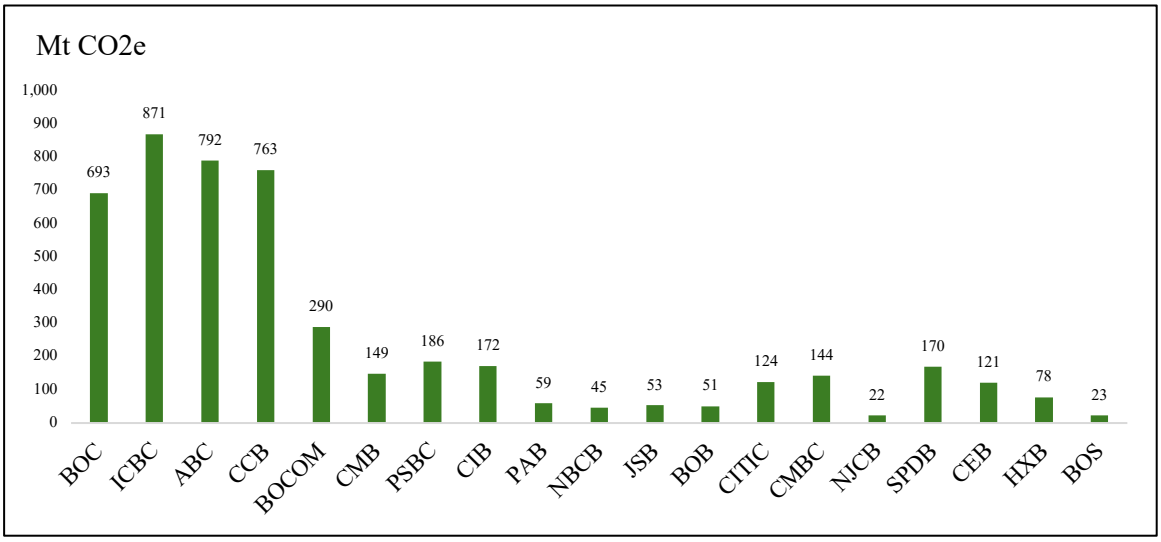


Figure 5 Emission Intensity of Business Loans by Bank, 2021

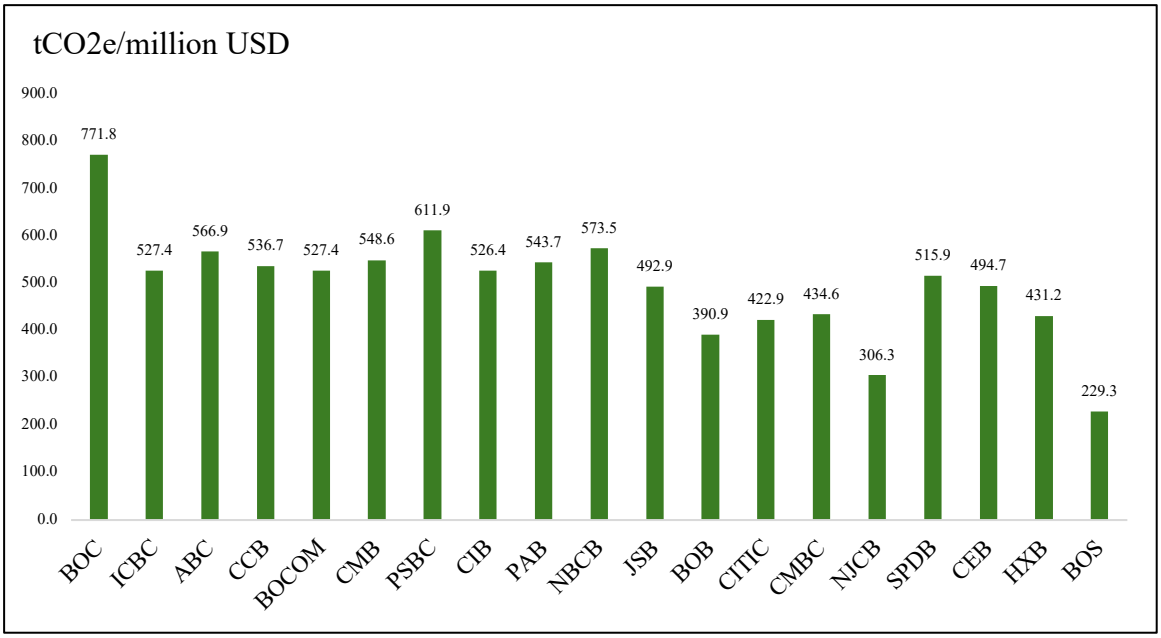


Figure 6 Financed Emission from Business loans by Sector, 2021

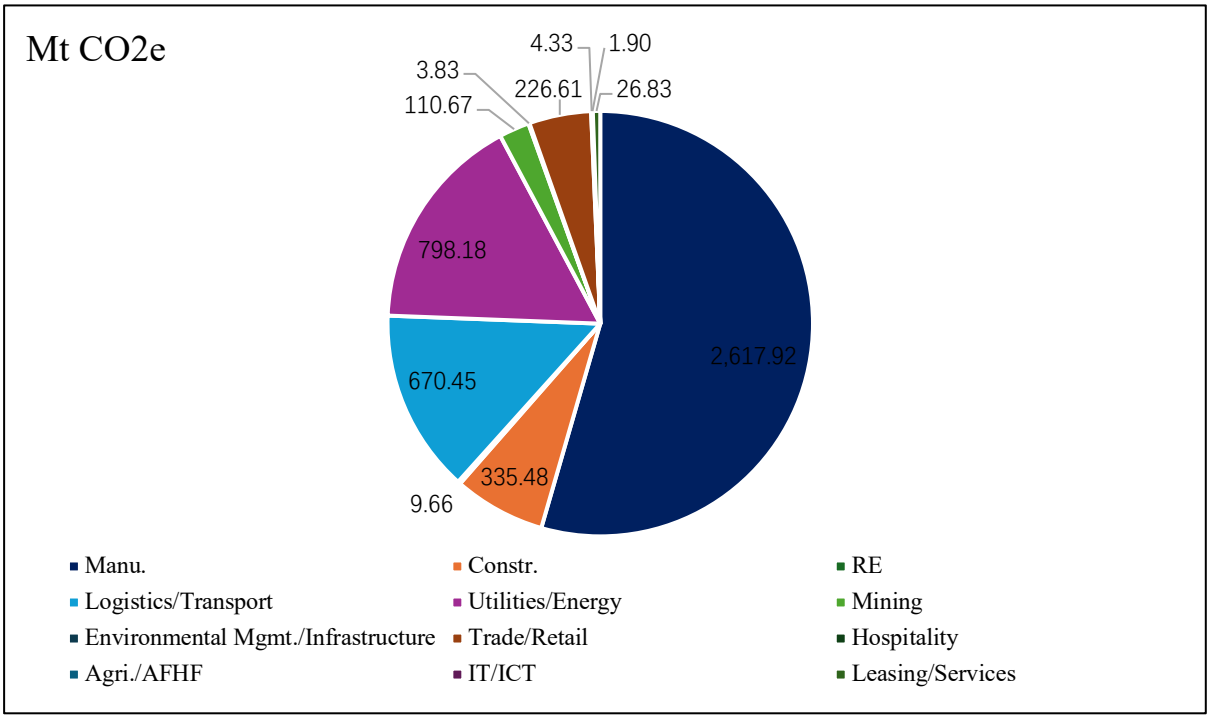


Figure 7 Financed Emission from Business Loans by Sector, 2021

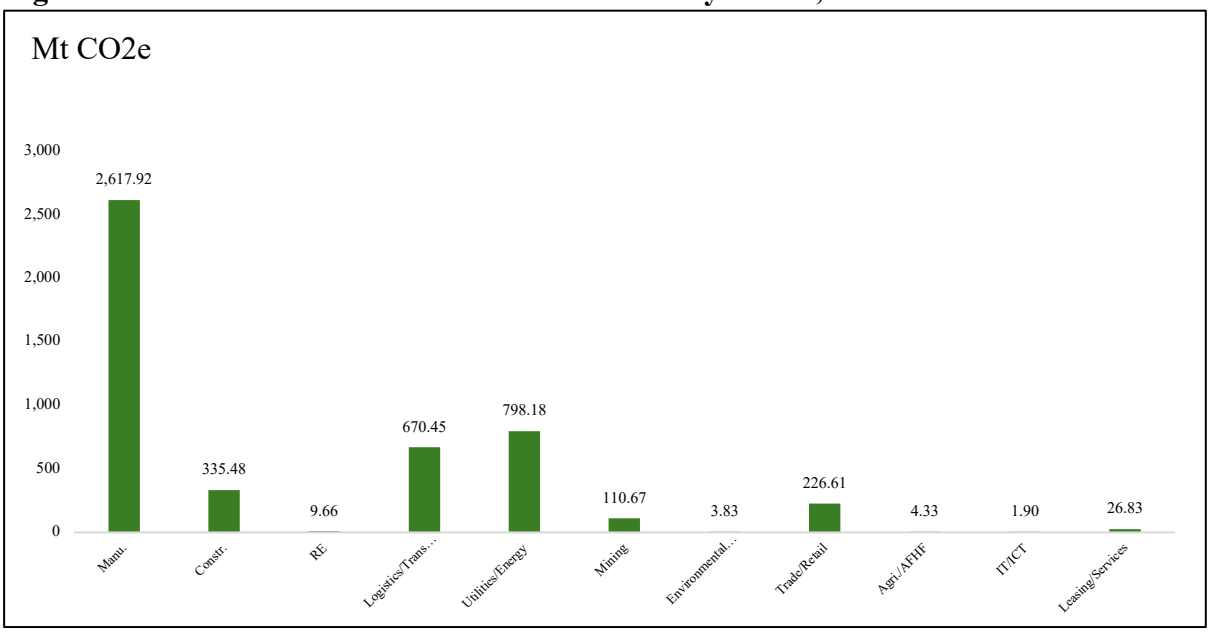


Figure 8 Emission Intensity by Sector, 2021

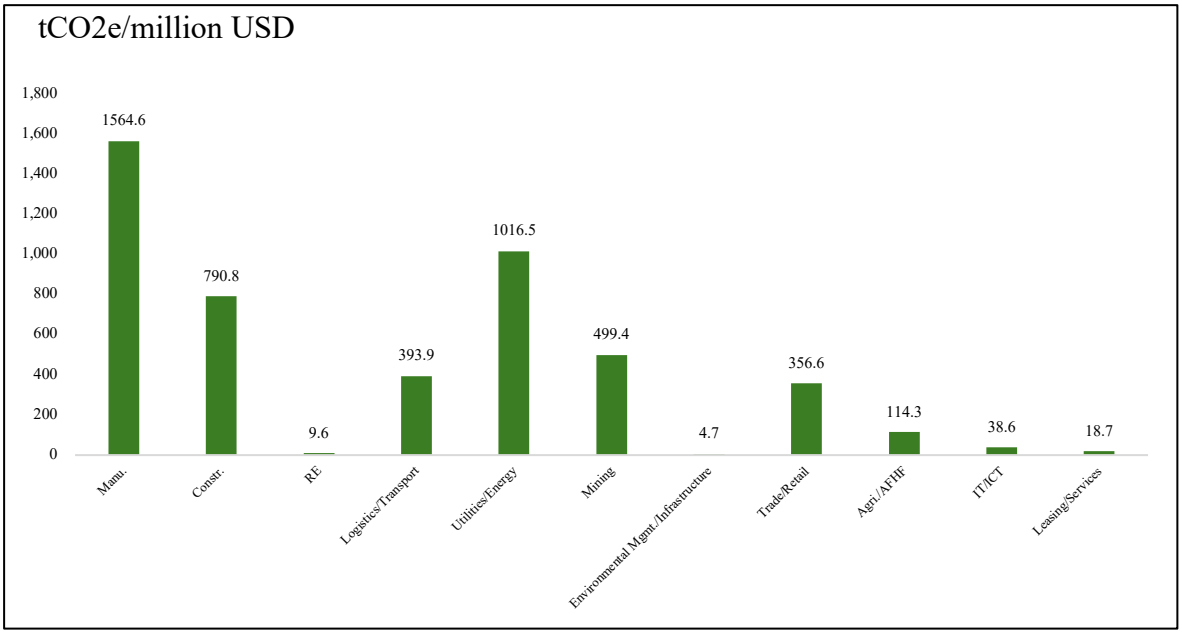
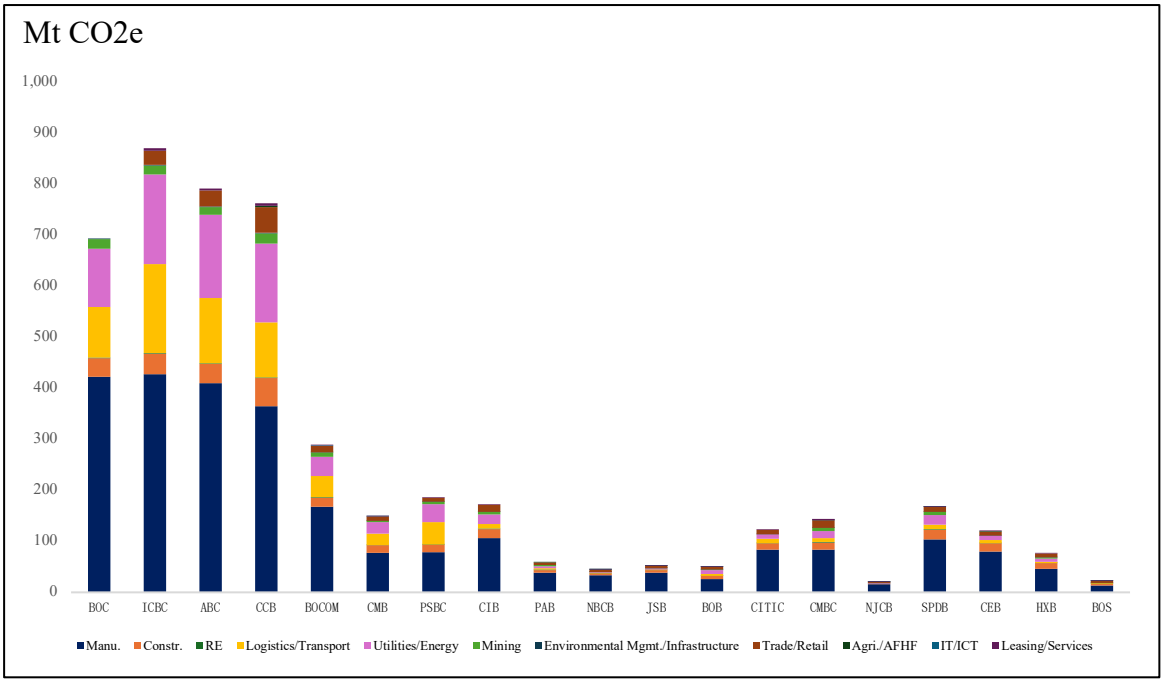


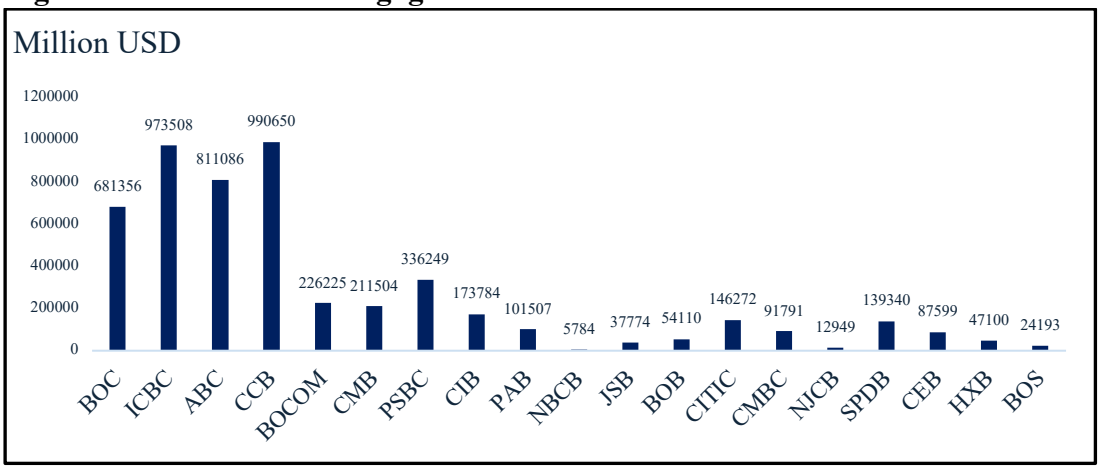
Figure 9 Financed Emission in Bank By-sector, 2021



Residential Mortgage Loans in Mainland China, 2021

In 2021, the residential mortgage loans granted by the top 12 banks of mainland China totaled 5,152.8 million USD. From the perspective of market share distribution in the residential mortgage loans, the Bank of China (BOC), Industrial and Commercial Bank of China (ICBC), Agricultural Bank of China (ABC), and China Construction Bank (CCB) dominate in terms of residential mortgage loan issuance volume. As shown in Figure 10, the total residential mortgage loan issuance of these four major commercial banks accounts for 67.1% of the total issuance among the 19 sampled banks. This significant market concentration reflects the dominant position of large state-owned commercial banks in the housing finance sector.

Figure 10 Residential Mortgage Loans

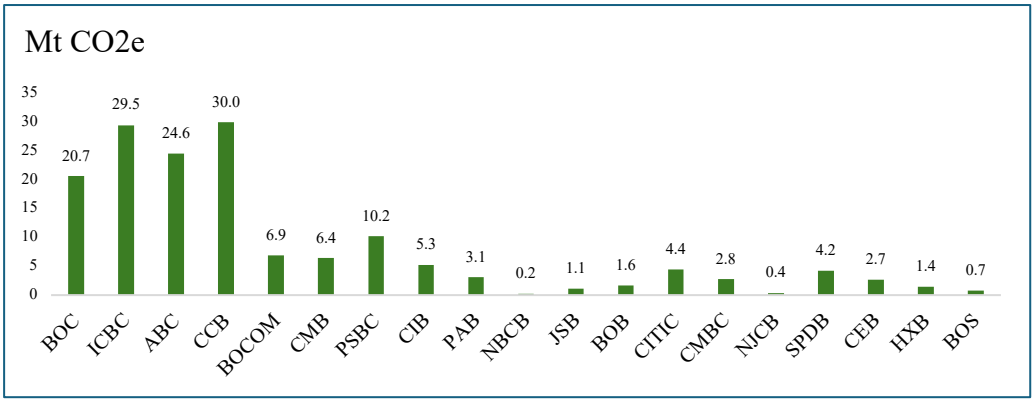


Source: Banks' annual report 2021

Finance Emissions from Residential Mortgages in Mainland China, 2021

The estimation of financed emissions associated with residential mortgage loans is based on the volume of granted residential mortgages. In 2021, the financed emissions associated with residential mortgage loans were 156.26 Mt CO2e. The average emission intensity was 30.33 t CO2e/million USD. (The estimated emissions excluded the embodied carbon emissions from buildings). Figure 11 illustrates the financed emissions from residential mortgages of the selected banks.

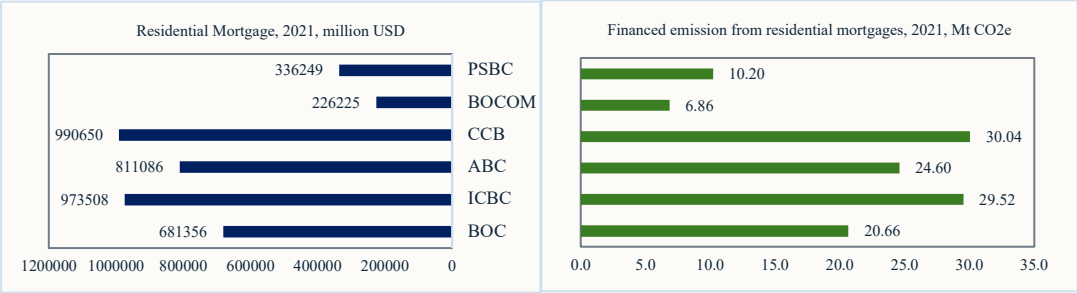
Figure 11 Finance Emissions from Residential Mortgages



Financed Emissions from Residential Mortgages of Top Six Banks, 2021

Most residential mortgage loans in Mainland China were from the Bank of China (BOC), Industrial and Commercial Bank of China (ICBC), Agricultural Bank of China (ABC), China Construction Bank (CCB), Bank of Communications (BOCOM), and Postal Savings Bank of China (PSBC). The six top banks achieved 3,456.6 billion USD in residential mortgages, which is 67% in total. Accordingly, the estimated financed emissions from residential mortgages of PSBC, BOCOM, CCB, ABC, ICBC, and BOC were 10.2, 6.86, 30.04, 24.6, 29.52, and 20.66 Mt CO2e, respectively (Figure 14).

Figure 12 Residential Mortgage Loans and Financed Emissions: 6 Major Banks



Financed Emissions from Bank Loans in Mainland China, 2021

According to the above estimation and analysis, the total financed emissions from business and residential mortgage loans were 4224.26 Mt CO_2e in 2021.
The comparison of by-sector emissions reveals that the industries engaged in the loans affect the emissions. The major banks of Mainland China currently provide more loans to high carbon-intensity sectors like manufacturing than low-carbon-intensity sectors. In the future, redirection of loans to low-carbon-intensity sectors, such as the high-tech and green-tech sectors, will be helpful to support the decarbonization of the economy and achieving the carbon neutrality target.

Conclusions

Overall, this study systematically estimated the financed emissions of 19 major banks in mainland China for the year 2021. The results indicate that the total financed emissions amounted to 4962.2 million tons of carbon dioxide equivalent (Mt CO_2e), with residential mortgage loans contributing 156.26 Mt CO_2e and business loans contributing 4806 Mt CO_2e. This estimation provides a crucial quantitative basis for understanding the role of China's financial sector in climate change.

However, the estimation process faced multiple challenges and limitations. Firstly, the incompleteness of foundational data was one of the most significant obstacles. In particular, the asset management industry (AUM), as a major component of the financial sector, has a substantial carbon footprint that cannot be overlooked. Yet, due to the lack of regulatory requirements for asset management companies to disclose historical asset allocation data, this study was unable to include their financed emissions in the estimation. This data gap limits a comprehensive assessment of the overall carbon emission impact of the financial sector.

Additionally, inconsistencies in the statistical scope of certain industries further complicate the estimation process. Despite these limitations, the estimation of financed emissions in this study provides important preliminary data to understand the current state of financed emissions in mainland China. This achievement lays the groundwork for future research to develop more robust accounting standards and methodologies.

We hope that this report will raise awareness among all sectors of society regarding the issue of financed emissions. The preliminary findings of this study not only highlight the shortcomings of the current data system but also point out priority directions for the formulation of future emission reduction policies. To achieve more accurate estimations of financed emissions, governments, regulatory agencies, and society must work together to promote the establishment of a more comprehensive emission estimation mechanism. Specifically, rules should be formulated to require financial institutions to fully disclose their financial activity data, and an emission factor database tailored to China's context should be developed. Furthermore, to incentivize financial institutions to drive emission reductions in other economic sectors through their investment and financing activities, the carbon emission data of their investment and financing portfolios should be made transparent, and a clear accounting framework should be established.

Based on these data, the estimation and disclosure of financed emissions will serve as a critical benchmark for financial institutions to develop strategies for transitioning to net-zero targets. As one of the largest carbon-emitting countries globally, China plays a central role in the global climate agenda. Therefore, improving the disclosure and data quality of financed emissions from financial institutions is essential for achieving China's goals of peaking carbon emissions by 2030 and achieving carbon neutrality by 2060. In the future, it is imperative to strengthen policy guidance and international cooperation to encourage the financial sector to play a more active role in climate governance.

Policy Recommendations

The Chinese government explicitly proposed the "Dual Carbon" strategic goals in 2020, aiming to peak carbon dioxide emissions by 2030 and achieve carbon neutrality by 2060. To systematically advance this significant strategic initiative, the Central Committee of the Communist Party of China and the State Council recently issued the "Guidelines on Fully and Accurately Implementing the New Development Philosophy to Achieve Carbon Peak and Carbon Neutrality." This document provides comprehensive and systematic policy guidance and implementation pathways for achieving the "Dual Carbon" goals from a top-level design perspective [24,25]. Against this backdrop, this research aims to explore the key pathways and innovative mechanisms for achieving the "Dual Carbon" goals, offering theoretical support and practical references for the ongoing carbon peak and carbon neutrality initiatives, thereby facilitating China's green and low-carbon transition and high-quality development.

I. Strengthening Climate Information Disclosure Requirements for Financial Institutions

• Policy Recommendations:

Chinese regulatory authorities should learn from international experiences (such as TCFD and PCAF) to develop and implement a mandatory climate information disclosure framework requiring financial institutions to regularly report their financed emissions data. Financial institutions should disclose the carbon emission intensity and total emissions associated with loans and investments in high-carbon industries (e.g., manufacturing, energy production and supply, transportation, etc.). Asset management companies should be required to publish historical portfolio data to assess the carbon emission trends and climate risk exposure of their investment activities. Introduce third-party audit mechanisms to ensure the accuracy and comparability of disclosed data.

• Implementation Pathways:

The National Financial Regulatory Administration can issue guidelines requiring major banks and financial institutions to include climate-related financial information in their annual reports, gradually extending this requirement to all financial institutions. Develop detailed climate information disclosure templates, including methodologies for calculating financed emissions, data sources, and industry classifications, to ensure consistency and transparency in disclosures. Establish regular communication mechanisms between regulators and financial institutions to promptly address technical issues in information disclosure. Encourage financial institutions to adopt internationally recognized carbon accounting standards (e.g., PCAF) and enhance their data collection and reporting capabilities. Require asset management companies to publish historical portfolio data and conduct annual assessments and disclosures of their portfolios' carbon emissions.

II. Promoting Green Finance Transformation in Financial Institutions

• Policy Recommendations:

Encourage financial institutions to integrate climate risk management into their decision-making processes and prioritize support for low-carbon and green projects. Measures such as setting green credit quotas and providing incentives for green bond issuance can guide funds toward renewable energy, energy efficiency, green building, and other sustainable sectors. Promote the development of innovative green financial products by financial institutions, such as green funds, green insurance, and green trusts, to meet the diverse needs of investors. Establish a green finance performance evaluation system to regularly assess and rank the green finance activities of financial institutions.

• Implementation Pathways:

The People's Bank of China can use monetary policy tools like targeted reserve requirement ratio cuts and relending to provide low-cost funding for green finance projects. Set annual lending limits for high-carbon industries and gradually reduce lending volumes by a certain percentage each year. The Ministry of Finance can offer tax incentives for green bond issuance and establish a green finance special fund to support the development and promotion of green projects. The National Financial Regulatory Administration can formulate green finance business guidelines, clarifying the standards and evaluation methods for green projects. Encourage financial institutions to collaborate with research institutions to develop innovative green finance products and to promote best practices. Establish an evaluation system to regularly assess and rank the green finance activities of financial institutions.

III. Optimizing Financing Structures for High-Carbon Industries

• Policy Recommendations:

For high-carbon industries such as manufacturing, energy production and supply, and transportation, regulators should set industry-specific carbon emission intensity standards and require financial institutions to prioritize loans for low-carbon technology applications and energy efficiency improvement projects. For projects with high emission intensity, financial institutions should raise financing thresholds or require additional climate risk compensation. Encourage financial institutions to establish dedicated green credit departments responsible for financing the low-carbon transition of high-carbon industries. Promote collaboration between financial institutions and high-carbon enterprises to develop low-carbon transition roadmaps and provide corresponding financing support.

• Implementation Pathways:

The National Development and Reform Commission and the Ministry of Ecology and Environment can jointly develop industry-specific carbon emission intensity benchmarks and collaborate with financial institutions to establish a "carbon performance-linked" financing mechanism. The National Financial Regulatory Administration can issue financing guidelines for high-carbon industries, clarifying

the priority order and risk assessment methods for financing low-carbon projects. Encourage financial institutions to establish dedicated green credit departments responsible for financing the low-carbon transition of high-carbon industries. Promote collaboration between financial institutions and high-carbon enterprises to develop low-carbon transition roadmaps and provide corresponding financing support. Establish a financing monitoring mechanism for high-carbon industries to regularly evaluate the financing structures and carbon emission performance of financial institutions.

IV. Enhancing Carbon Emission Accounting and Data Transparency

• Policy Recommendations:

Establish a unified carbon emission accounting methodology and data platform to help financial institutions more accurately assess their financed emissions. Encourage financial institutions to adopt internationally recognized carbon accounting standards (e.g. PCAF) and strengthen their data collection and reporting capabilities. Promote collaboration between financial institutions and third-party organizations to verify and validate carbon emission data, ensuring its accuracy and reliability. Establish a public disclosure mechanism for carbon emission data to improve transparency and public participation.

• Implementation Pathways:

The Ministry of Ecology and Environment can lead in establishing a national carbon emission data platform and share industry carbon emission data with financial institutions. Develop a unified carbon emission accounting methodology, clarifying standards and procedures for data collection, calculation, and reporting. Encourage third-party organizations to provide carbon emission accounting and verification services and establish a certification and regulatory mechanism for these organizations. Promote collaboration between financial institutions and third-party organizations to verify and validate carbon emission data, ensuring its accuracy and reliability. Establish a public disclosure mechanism for carbon emission data to enhance transparency and public participation and regularly publish carbon emission reports.

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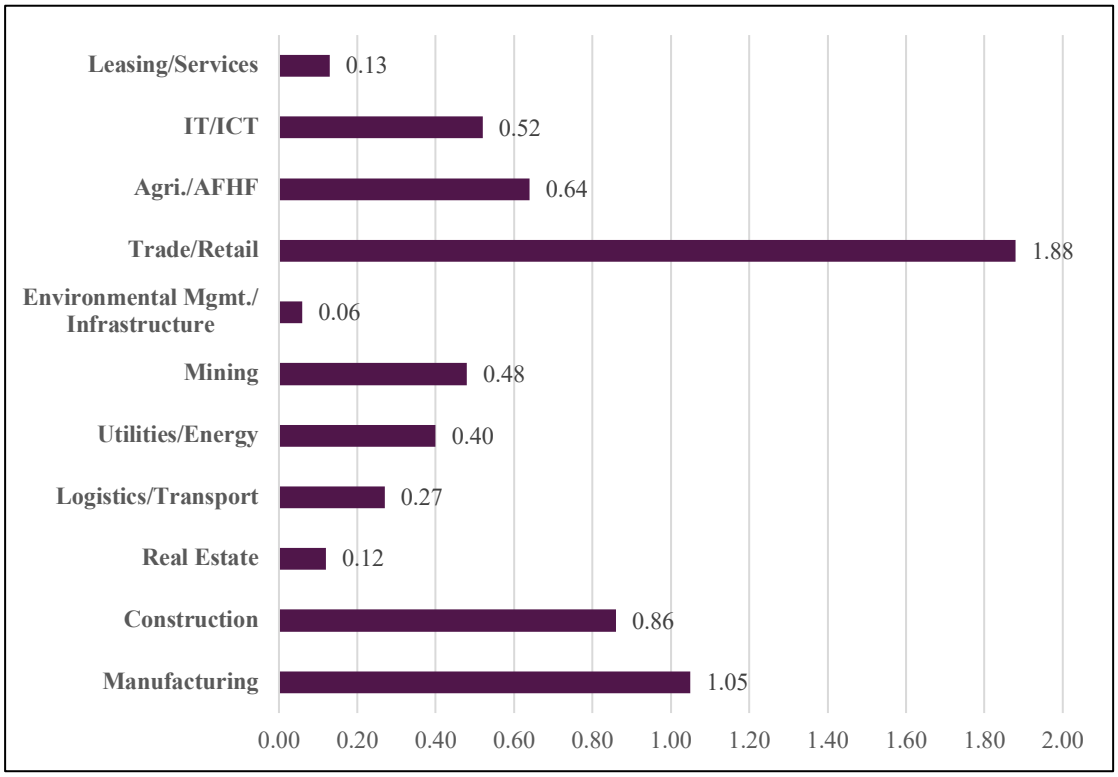
Appendix

Turnover Rations by Sector

To determine of industry turnover rates, we have adopted a differentiated approach to data acquisition and processing. For industries where turnover rate data have been officially published by authoritative institutions (such as the National Bureau of Statistics and industry associations), we directly utilize their official statistical results.

For industries lacking direct turnover rate statistics, we calculated based on annual industry economic indicators released by the National Bureau of Statistics.

Figure A-1 Turnover Ratio by Sector Applied in This Report



Source:
https://data.stats.gov.cn/easyquery.htm?cn=C01
https://www.stats.gov.cn/sj/ndsj/2021/indexch.htm

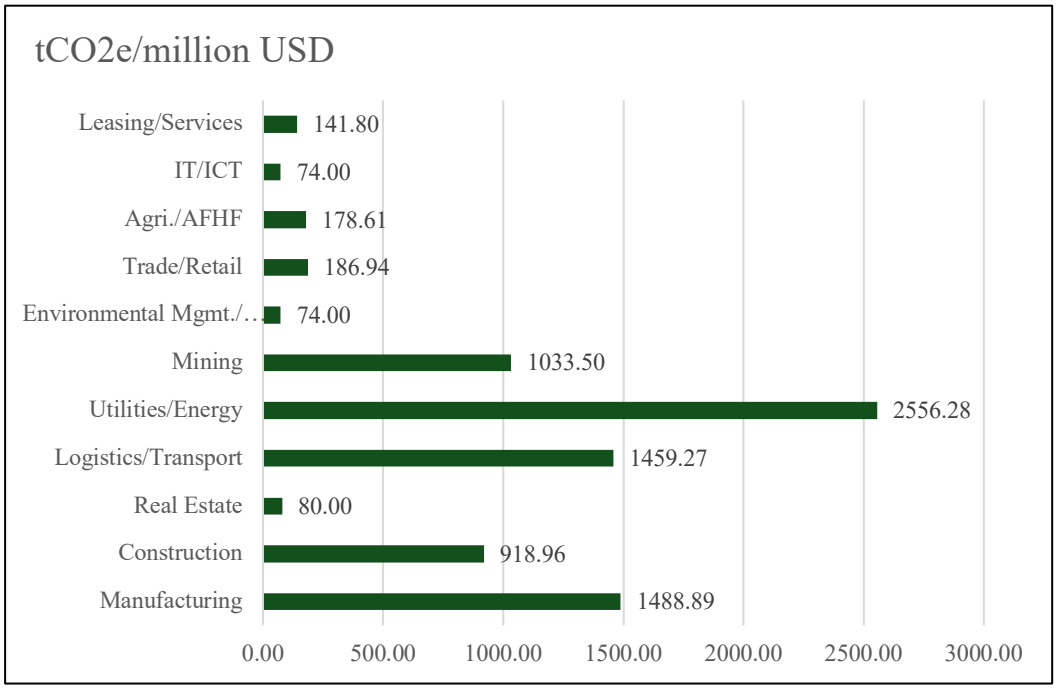
Emission factors by sector

To determine and calibrate industry carbon emission factors, we have adopted a systematic research methodology. For industries already included in the greenhouse gas emission statistical system, we have established benchmark emission factors at the industry level by integrating authoritative emission data from the National Bureau of Statistics and the Ministry of Ecology and Environment of China with economic indicators such as annual industry output value and added value, using a "top-down" accounting approach. To ensure the representativeness and accuracy of the data, we

have paid special attention to the data quality of key emission industries and implemented strict screening and correction procedures for outliers.

For industries without a comprehensive emission statistical system, we have developed an estimation method based on multi-source data fusion. We selected the internationally recognized environmental input-output database EXIOBASE as the primary data source, incorporating the China Carbon Accounting Database and relevant research findings published in authoritative domestic and international journals. Furthermore, we introduced an industry energy consumption structure analysis method. By analyzing the typical energy consumption patterns of various industries and combining data from China's Energy Statistical Yearbook, we established an energy consumption-emission equivalent conversion model.

Figure A-2 Emission Factors by Sector Applied in This Report



Source：
https://www.ceads.net.cn/data/emission_factors/
https://www.stats.gov.cn/sj/ndsj/2021/indexch.htm
https://lca.cityghg.com/
http://meicmodel.org.cn/?p=1238
https://www.cabee.org/

Residential Mortgage Loans Emission Factor and Intensity

In this study, we assume a 30-year payback time for the residential mortgage, 1/30=0.033. We applied the emission factor 918.96 tCO2e/million USD for the residential mortgage, based on the estimation of the carbon emission during the building process by the China Association of Building Energy Efficiency.

ACRONYMS AND ABBREVIATIONS

Industry abbreviation

Manu.	Manufacturing
Constr.	Construction
RE	Real Estate
Logistics/Transport	Transportation, Storage, and Postal Services
Utilities/Energy	Electricity/Heat/Gas and Water Production and Supply/Energy
Mining	Mining
Environmental Mgmt./Infrastructure	Water Conservancy, Environment, and Public Facilities Management/Investment
Trade/Retail	Wholesale and Retail/Commercial Trade
Agri./AFHF	Agriculture, Forestry, Animal Husbandry, and Fishery
IT/ICT	Information Transmission, Software, and Information Technology Services
Leasing/Services	Leasing and Business Services

Bank Name Abbreviation

BOC	Bank of China
ICBC	Industrial and Commercial Bank of China
ABC	Agricultural Bank of China
CCB	China Construction Bank
BOCOM	Bank of Communications
CMB	China Merchants Bank
PSBC	Postal Savings Bank of China
CIB	Industrial Bank
PAB	Ping An Bank
NBCB	Bank of Ningbo
JSB	Bank of Jiangsu
BOB	Bank of Beijing
CITIC	China CITIC Bank
CMBC	China Minsheng Bank
NJCB	Bank of Nanjing
SPDB	Shanghai Pudong Development Bank
CEB	China Everbright Bank
HXB	Hua Xia Bank
BOS	Bank of Shanghai

Student Assistants List

Table A-1 List of student assistants participating in this research project

Year Enrolled	Name	Major	Faculty
2021	Binru YE	Finance, Accounting and Management	Nottingham University Business School China
2021	Xinchen LYU	Finance, Accounting and Management	Nottingham University Business School China
2021	Zihan ZHOU	Finance, Accounting and Management	Nottingham University Business School China
2021	Jiaye XIE	Finance, Accounting and Management	Nottingham University Business School China
2022	Zhijing LIANG	Finance, Accounting and Management	Nottingham University Business School China
2022	Jingxiang LYU	Finance, Accounting and Management	Nottingham University Business School China
2020	Jiyao DONG	International Business and Management	Nottingham University Business School China
2022	Hanbing JIANG	Economics	Faculty of Humanities and Social Science
2022	Guoxi XIANG	Economics	Faculty of Humanities and Social Science
2022	Jing WANG	Economics	Faculty of Humanities and Social Science
2022	Xuye YANG	Economics	Faculty of Humanities and Social Science
2022	Jiayi ZHAO	Economics	Faculty of Humanities and Social Science
2021	Aoyu DONG	Economics	Faculty of Humanities and Social Science
2021	Haoran ZHAO	International Economics and Trade	Faculty of Humanities and Social Science
2020	Linger HUANG	Economics	Faculty of Humanities and Social Science
2020	Jinghan WEN	Mathematics with Applied Mathematics	Faculty of Science and Engineering

Centre for
Responsible Business and Innovation

April 2025

Professor Jing Dai | Dr Youzong Xu | Mr Jiaqi Yan

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