

RESEARCH ARTICLE

Advancing Carbon Neutrality in China: From Green-Oriented to Climate-Driven Public Finance

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Abstract

This article presented how the existing landscape of green public finance in China works in practice with a focus on government spending, taxation, and government fund, and assessed the alignment of these financial avenues with the goals of achieving carbon neutrality. The findings suggest that while China does not have a specific plan for public climate finance, the climate goals have been systematically integrated into key public finance avenues. However, the relevance and alignment of each component to the climate goals vary. The findings yield several insights for future policymaking in financing China's net-zero goal. It is recommended that China not only establish a green or climate budget system that incorporates climate considerations into decision-making processes but also proactively explores the potential of leveraging government expenditure and fiscal revenue to expand climate financing. On the expenditure side, China can increase its fiscal spending with a specific focus on green-oriented and climate-oriented initiatives, both in terms of overall size and proportion to GDP. On the revenue side, it is necessary to assess the feasibility of aligning tax measures with climate goals and explore potential synergies with other financial mechanisms. Ultimately, this article addressed the importance of

accelerating the low-carbon transition with support from a green-oriented to a climate-driven approach in public finance.

Keywords: Green public finance, Public climate finance, Green investment, Low-carbon transition, Climate change, Carbon neutrality

I. Introduction

After a period of rapid development spanning thirty years, China has quickly risen to become the world's second-largest economy. However, this achievement has come at a great cost to the environment. The energy sector is the source of almost 90% of China's greenhouse gas emissions (IEA, 2021). It is worth noting that China has been the largest contributor to global renewables growth, leading investment in renewables capacity in 2019 with 83.4 billion USD (UNEP & BNEF, 2020). Despite China's efforts to develop renewable energy sources, China's GHG emissions have kept increasing in recent years and were only relatively flat in 2022, with growing emissions from combustion offset by declines from industrial processes (IEA, 2023).

In 2020, China committed to striving for peaking carbon emissions by 2030 and carbon neutrality by 2060 (Department of Resource Conservation and Environmental, 2021). To this end, a series of fundamental changes in energy, industry, transport, building, agriculture, and other sectors have to take place to facilitate the low-carbon transition. Meanwhile, meeting these goals will require unprecedented investments and vital support of green finance (Polzin & Sanders, 2020), which plays a critical component not only in addressing environmental challenges but also promoting sustainable economic growth (Wang et al.,

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2022; Zhou, 2022; Zhou et al., 2020). The research that attempted to project the investment under demand concluded that at least 100 thousand billion Chinese yuan would be in need (CICC Research & CICC Global Institute, 2022; He et al., 2020; Vigna et al., 2021). If considering the 211 industries included in the Green Industry Guidance Catalogue, an estimated 487 thousand billion Chinese yuan would be required, including both fixed investment and liquid assets (Ma et al., 2021).

Closing the financial gap will require massive capital from both the public and private sectors. To date, as China faces several key barriers to scaling up private green finance (Yu et al., 2021; Lee, 2020), public sources still account for at least more than half of the total green finance in China (Choi & Li, 2021). These public investments play a crucial role in advancing climate mitigation (Li & Shao, 2022; Xia et al., 2022), adaptation and resilience (Yao et al., 2022), renewable development (Li et al., 2022; Xu et al., 2022), and other environmental objectives. The mechanism of how green public finance and fiscal policies affect carbon dioxide emissions (CO₂) can be explained through several channels. First, green public finance plays an essential role in raising public revenues and leveraging private finance for green development (Peters, 2012). Second, they encourage investment in low-carbon technologies (Zhao et al., 2021) either by investing in cleaner technologies through providing subsidies or tax credits for firms that invest in research and development, production, and deployment of such technologies. Third, they correct price signals to shift consumer and business behavior toward more sustainable patterns (Cao, 2007). Fourth, they align government expenditure with sustainability goals (Petrie, 2021) by giving priority to green industries and low-carbon technological innovation projects in the

allocation of social resources (Lee & Lee, 2022). Furthermore, green public finance, particularly green investment, can also bring co-benefits in reducing pollutants and contributing to economic growth and job creation (Strand & Toman, 2010). Green fiscal policies that lead to investments resilient to climate change also have the potential to reduce financial risks (Lamperti et al., 2021).

In theory, climate finance represents a subset of green finance, specifically targeting finance for climate mitigation and adaptation (Cheng et al., 2022; Lindenberg, 2014). Green finance encompasses a broader range of environmental objectives (Cai & Guo, 2021; Zhang et al., 2019). However, in practice, green public finance in China has not only facilitated green development but also laid the groundwork necessary to address climate challenges (Bhandary et al., 2021; Cheng et al., 2022; Lee, 2020). In response to the Action Plan for Carbon Dioxide Peaking Before 2030, the Chinese government has adjusted its policy priorities in green public finance, transitioning from a primary focus on pollution control to actively addressing the synergies between pollution control and carbon dioxide emission reduction. Thus, the policies and data associated with green public finance have become invaluable tools for evaluating public climate finance efforts. While the study of green public finance has made significant progress, several research gaps still need to be addressed.

First, many studies focus on discussing the concept of green public finance but have yet to keep up with the latest policy progress. The concept of green public finance was introduced in China in the 1990s. Wang et al. (2006) pointed out that the Chinese green fiscal policy aimed to promote green development through revenue and expenditure. By examining the characteristics

of ecological elements in the market economy and the public finance functions, Liu et al. (2017) concluded that fiscal revenue and expenditure are effective tools to promote energy saving, emissions reduction, and green growth. Jia et al. (2017) suggested constructing China's green fiscal policy system by reforming the energy price, harmonizing the green tax system, improving fiscal spending policies, strengthening the green finance market, and other measures. These studies discussed the key theoretical concepts underlying green finance, such as externalities, and reviewed the progress of green public finance and fiscal policies before the carbon-neutral goal was proposed.

Secondly, many studies have primarily concentrated on analyzing the growth of the green capital market, such as green loans, green bonds, and green funds (Bhandary et al., 2021; Escalante et al., 2020; Jin & Han, 2018; Lee, 2020; Li et al., 2018; Zhou & Li, 2019). China has leveraged various financial instruments to channel significant capital into green industries and initiatives. As a result, China emerged as the second-largest issuer of green bonds globally in 2021 (Deng et al., 2022) and established the largest green credit market, with its green credit balance expected to reach 22.03 trillion yuan by the end of 2022 (The People's Bank Of China, 2023). The development of regulations and standards in these areas has resulted in improved data and transparency. However, despite China's systematic policy framework to address climate change, there is currently no comprehensive dataset available specifically about green finance or climate finance in the public sector. Consequently, there has been a notable lack of evaluation regarding the state of green public finance or public climate finance. Evaluating the progress and alignment of these practices with carbon-neutral goals becomes challenging.

Addressing these gaps, this article aims to provide a comprehensive review of the current state of green public finance in China with a focus on government spending, taxation, and government fund on a practical level. Furthermore, this paper assessed the relevance and alignment of these public finance avenues with the goals of achieving carbon neutrality. The primary contribution of this study lies in providing a comprehensive understanding of the landscape of green public finance and public climate finance with an analysis of the most recent policy progress and data.

Following this introduction, the remainder of this article is organized as follows. Section 2 explained the data and methodology used for this study. Section 3 outlines China's current green public finance landscape, analyzing the status quo of green spending, taxation, government fund, and the relevance of each avenue for achieving climate goals, as well as identifying untapped green public finance opportunities. Section 4 provides conclusions and actional policy recommendations drawn from the analysis to expand green public finance and improve public finance outcomes in response to achieving carbon neutrality in China.

II. Data and Methodology

In order to conduct an analysis of the current state of green public finance, the most recent policy progress with regard to green and climate public finance has been reviewed. Data relevant to green-oriented public spending, taxation, and government funds has been collected through multiple channels, as shown in Table 1, and analyzed respectively.

Data	Time	Sources
Fiscal spending	2007-2021	National Bureau of Statistics of China
Tax revenue	2007-2021	National Bureau of Statistics of China, Wind
Government bond	2021	China Electronic Local Government Bond Market Access
Government fund	2016-2020	China Statistical Yearbook

Tab. 1. Data and Sources

Source: Author

Based on the available data, a combination of methods has been applied to address different research objectives. Precisely, descriptive statistical analysis has been conducted with a comparative perspective to capture the size and trends of the conventional approaches in spending and taxation. To assess the status of green-oriented government funds, five funds have been chosen from the Chinese government fund catalog that demonstrate relevance to green development and contribute to environmental benefits to some extent. Our analysis primarily focuses on the scale and development patterns of these funds. The National Green Development Fund and Liaoning Province Green Industry Investment Fund are selected to exemplify the ways the government utilizes multiple funding sources through these funds to facilitate the low-carbon transition. Based on the findings of these analyses, this study presents policy implications and draws conclusions that contribute to a better understanding of the landscape of green public finance and public climate finance in China, as well as identifying potentials for scaling up public finance for the carbon-neutrality goals.

III. Overview of The Status Quo of Green Public Finance in Supporting Carbon Neutrality

China's green public finance development has been deeply embedded in the country's top-down governance approach. In 2021, the Chinese government launched the Action Plan for Carbon Dioxide Peaking before 2030, outlining its priorities and major economic policy instruments to support its climate goals. The plan emphasized creating a supportive tax system to drive green and low-carbon development, reforms to pricing policies such as electricity pricing, and the development of various financial instruments such as green credit, equity, bonds, insurance, and funds, to strengthen the green finance system. To translate the strategic decisions at the local level, a Climate Investment and Financing Pilot Work Plan has been carried out with 23 cities selected to facilitate climate finance.

To closely examine how these policy goals have been reflected in the major public finance avenues, this study assessed the alignment of these finance avenues with green development and climate goals, as shown in Table 2.

Components	Items	Relevant to green public finance	Relevant to public climate finance
Fiscal spending	Energy conservation and environmental protection spending	Yes	Yes
	Agriculture, forestry, water	Yes	Yes
	Natural resources,	Yes	Yes

	marine, and meteorology		
	Disaster prevention and crisis management	Yes	Yes
Taxation	Resource tax	Yes	No
	Environmental tax	Yes	No
	Pollution fee (Terminated in 2018)	Yes	No
Government funds	National Low-carbon Transition Fund	Yes	Yes
	National Green Development Fund	Yes	Yes
	Other environmental-related funds	Depending on the fund	Depending on the fund

Tab. 2. Major Public Finance Components Relevant to Green Public Finance and Public Climate Finance in China

Source: Author

Notes: Information collected and analyzed by authors

The findings highlight that while China lacks a specific plan for public climate finance, the climate goals have been systematically integrated into key public finance avenues. However, the relevance and alignment of each component in relation to the climate goals vary. For example, fiscal spending encompasses a broader range of objectives, including energy conservation, environmental protection, and forest preservation. While certain aspects of fiscal spending align closely with climate goals, others may not have a direct connection. Taxation measures primarily target pollution and resource management, which are not yet directly tied to

climate goals. The following part will investigate the status quo of each component.

3.1. Green-oriented Spending

Green fiscal spending refers to government expenditures aimed at promoting environmental conservation and sustainable development (O’Callaghan et al., 2022). We noted that this spending can be understood in two ways. In a narrow sense, green fiscal spending encompasses only those expenditures that directly contribute to environmental protection. In a broad sense, green fiscal spending also includes expenditures promoting green production and consumption activities, which contribute to a green and sustainable economy. Within the Chinese policy context, certain spending categories can be broadly considered green-oriented spending. These categories include energy conservation and environmental protection, agriculture, forestry, water, natural resources, marine, meteorology, disaster prevention and crisis management (see Table 3). However, it is important to note that the relevance of these spending items to green development and climate policy goals varies as some exhibit a higher degree of alignment with climate goals such as energy conservation and environmental protection spending, while others demonstrate a lower level of relevance based on the spending items.

Spending category	Spending items
Energy conservation and environmental protection	Pollution control, return farmland to forest, ecology conservation, energy conservation, renewable energy, etc.
Agriculture, forestry, water	Agriculture development, rural area development, water projects, poverty alleviation, etc.

Natural resources, marine, and meteorology	Natural resources management, mineral resources investigation, sea area management, meteorological infrastructure construction, operation, etc.
Disaster prevention and crisis management	Forest fire prevention, earthquake prevention, rescue, etc.

Tab.3. Classification of Green-oriented Fiscal Spending in China

Source: Author

Notes: Based on government revenue and expenditure classification in 2021

As energy conservation and environmental protection spending directly align with environmental policy goals, we conducted a comprehensive analysis to examine its size and trend to gain insights into the priorities of environmental and climate policies within the budgeting process. Our findings reveal that from 2007 to 2021, this type of spending has quadrupled in size. However, its proportion relative to total fiscal spending and GDP has remained relatively stable, ranging from 2-3% of total fiscal spending and 0.3-0.7% of GDP, respectively (see Figure 1).

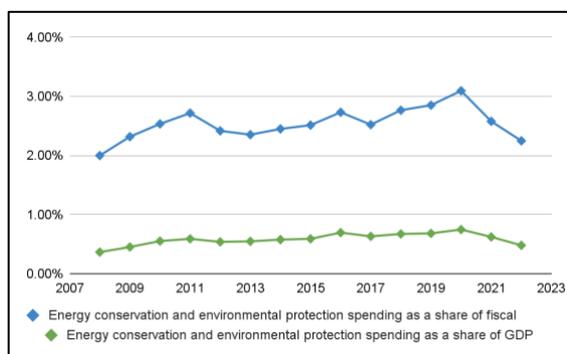


Fig. 1. Energy conservation and environmental protection spending accounted for total fiscal spending and GDP in China from 2007-2022.

Source: Drawn based on data from the National Bureau of Statistics of China.

When comparing to other expenditure categories, such as education (15%), social security and employment (14%), and general

public service (8%), it becomes apparent that energy conservation and environmental protection spending accounts for a lower share of the total fiscal spending (refer to Figure 2). Moreover, in comparison to the European Union (EU), where environmental protection expenditure amounts to approximately 0.8% of GDP (Eurostat, 2020), the share of such spending in China's GDP is likewise lower. These comparisons indicate that China has room for improvement in terms of both the level and share of GDP. By increasing the allocation of funds towards green-oriented spending, China can strengthen its commitment to sustainability, environmental preservation, and climate change mitigation.

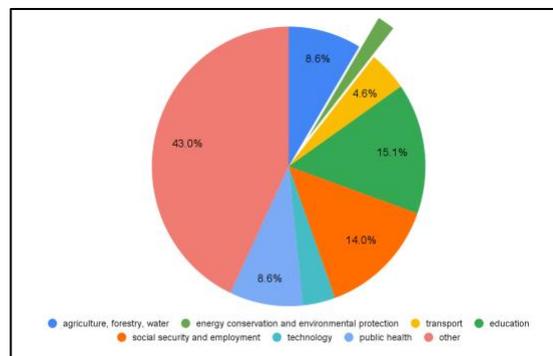


Fig. 2. Comparison of public spending by ratio in 2022.

Source: Drawn based on data from the National Bureau of Statistics of China.

3.2. Green-oriented Tax

Green tax is considered as either a form of investment relief for taxpayers who invest in pollution prevention or environmental protection or taxes imposed on industries that pollute or use pollutants (Eurostat, n.d.; Nellor & McMorran, 1994; Norregaard & Reppelin-Hill, 2000). In China, the green-oriented tax primarily consists of resource taxes and environmental taxes, which are directly levied for environmental protection purposes, as well as supplementary

taxes such as consumption taxes and corporate income taxes that play an indirect role in promoting green development.

Resource tax in China was first introduced in 1984, with the current framework established in 1994. The tax targets entities and individuals engaged in resource development, such as the crude, natural gas, and coal industries. Since 2007, the amount of resource tax collected in China has grown significantly, increasing from 26 billion to 228 billion Chinese Yuan, accounting for 1.1% of the government's total revenue in 2021. However, since the tax is levied primarily based on resource price or quantity and is not directly aligned with climate goals, its impact on reducing energy consumption or greenhouse gas (GHG) emissions is limited.

Category	Item	Tax rate
Energy minerals	Crude (6%), natural gas (6%), coal (2%-10%), etc.	1%-20%
Metal minerals	Black metal(1%-9%), non-ferrous metals (1%-20%), etc.	1%-20%
Non-metallic minerals	Minerals (1%-12%), rocks (1%-20%), etc.	1%-20%
Water vapor minerals	Carbon dioxide gas (2%-5%), mineral water (1%-20%)	1%-20%
Salt	Sodium salt, potassium salt, sea salt	2%-15%

Tab. 4. The Resource Tax Rate in China Since 2020

Source: State Taxation Administration

In addition to resource tax, China also had pollution fees levied on polluting industries, such as waste discharge and air pollution control fees before 2018. These fees aim to reduce pollution by making it more

expensive to engage in polluting activities, thereby incentivizing companies to invest in cleaner technologies and processes. Companies and individuals responsible for generating wastewater, air pollutants, solid waste, hazardous waste, and noise pollution were required to pay fees based on the total amount of pollutants they generated. The collected fees were then utilized to provide subsidies or discounts on loan interests for pollution prevention and control technologies (Sun, 2007). However, the effectiveness of these pollution fees has been proved limited, as the fee standards were too low to compensate for the cost of pollution and were difficult to collect in practice (Wang, 2000). Therefore, in 2018, China replaced the pollution fee with the environmental protection tax. This tax was levied on companies based on the actual volume of pollutants they generated, and enforcement of the tax law was strengthened to ensure compliance. The environment protection tax has maintained a relatively stable trend, with an annual range of 17-20 billion Chinese Yuan (see Figure 3). The proportion of the environmental protection tax in total government revenue has decreased to 0.1%, considerably smaller than the resource tax (see Figure 4). It is also much lower than the EU, where environmental tax revenue accounted for 5.4% of the EU's total government revenue in 2020 (Eustat, 2022). Even though the environmental protection tax is not directly aligned with climate goals, its impact on reducing pollution contamination can indirectly contribute to carbon dioxide emission reduction to some extent.

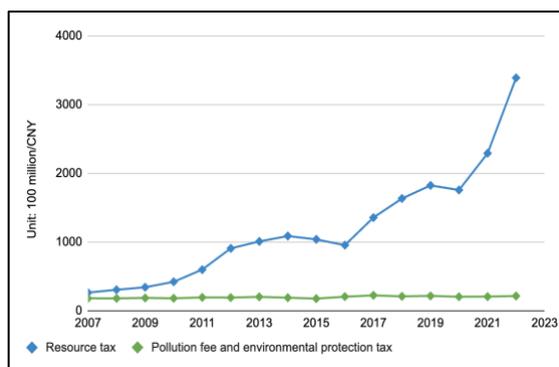


Fig. 3. Green-oriented Tax Values in China from 2007-2022.

Source: Drawn based on data from the National Bureau of Statistics of China

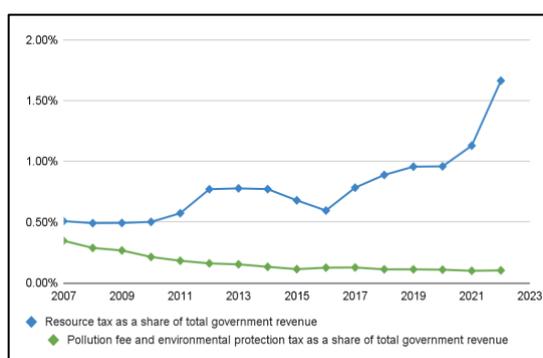


Fig. 4. Green-oriented Tax Percentage in China From 2007-2021.

Source: Drawn based on data from the National Bureau of Statistics of China

The current green-oriented tax has not directly aligned with the climate goals, thus, they provided limited economic incentives for industries to adopt cleaner technologies, reduce greenhouse gas emissions, and encourage energy efficiency. While China has not yet implemented a nationwide carbon tax, it has been exploring market-based mechanisms such as emissions trading systems (ETS) to curb greenhouse gas emissions. To generate revenues that can be used to fund investments in climate mitigation and adaptation measures, there is a need to assess the feasibility of aligning tax measures with climate goals and explore potential synergies with existing market-based mechanisms.

3.3. Green-oriented Government Fund

Government funds refer to the funds collected for specific objects within a certain period and used for public utilities (Chen, 2017). The green-oriented government funds listed in the Chinese government fund catalog have been thoroughly examined to assess their alignment with green development and climate goals. Among the funds analyzed, five specific funds as shown in Figure 5 have been selected as examples to evaluate their size and trend, considering their potential to contribute to environmental benefits.

Of these five funds, the renewable energy development fund and the sewage treatment fee have seen steady growth, with larger volumes from 2016 to 2020. The renewable energy development fund is directly aligned with climate policy goals, as it is primarily utilized to subsidize the development of the renewable energy industry. This funding source plays a crucial role in supporting the expansion and advancement of renewable energy projects, which contribute significantly to reducing greenhouse gas emissions and mitigating climate change. While other funds may focus on broader environmental conservation and sustainability initiatives, they may not be specifically targeted for climate-related purposes.

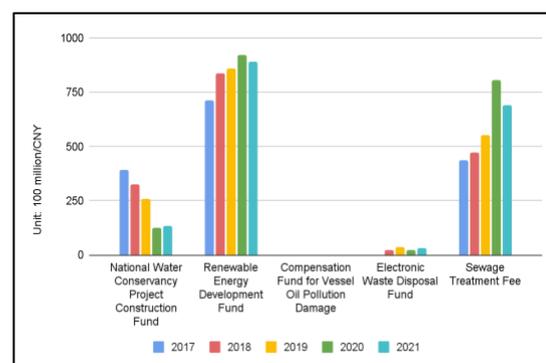


Fig. 5. Green Government Fund in China

Source: Drawn based on data from the National Bureau of Statistics of China.

The existing green-oriented government funds, primarily relying on public fund sources, have offered limited support for the goal of achieving carbon neutrality. Their relatively small sizes and dependency on public funds hinder their potential impact. To address this limitation, it is crucial to involve more private financial resources by establishing government-led funds that engage multiple stakeholders, including banks and companies.

In recent years, there has been a notable growth in green industry investment funds, encompassing a range of funds such as international cooperation funds, national green development funds, and local green development funds. These funds operate with the support and backing of the government, and their investments are primarily directed toward projects outlined in the Green Industry Guidance Catalog. Due to the government's endorsement and credibility, these funds often enjoy the trust of financial institutions and other investors. This enables them to effectively meet the financing requirements of the green industry. The alignment between the funds' objectives and the financing needs of green projects contributes to their success in attracting investment and promoting sustainable and environmentally friendly initiatives.

The development of green industry funds presents an opportunity to harness the power of capital and effectively mobilize social capital at both the national and local levels. For instance, at the national level, the establishment of the National Green Development Fund in July 2020, led by the Ministry of Finance, the Ministry of Ecology and Environment, and Shanghai Municipality, with an initial scale of 88.5 billion yuan, aims to primarily invest in 11 provinces and cities along the Yangtze River Economic Belt. With a

leverage ratio of 1:5, it is anticipated to mobilize nearly 400 billion yuan of social capital for investments in ecological and environmental protection (Dong, 2021). On the provincial level, as an example, Liaoning Province set up a 3 billion yuan green industry investment fund in 2020, initiated by the Liaoning Provincial Environmental Protection Industry Association, to invest in the equity of exemplary environmental protection companies and key projects in the industry.

While policies encourage and support green industry investment funds, there is a need to establish incentives for investment. Currently, only a few provinces and cities have implemented measures to support green funds, as green investments may involve certain externalities that do not align with the investment objectives of private capital in terms of investment cycles, returns, and risks. Therefore, incentives such as tax reductions are crucial to attract private investment.

IV. Conclusions and Policy Implications

The landscape of green public finance is dynamic and constantly changing in China, along with the adjustment of the financial demand and policy objectives. This paper provides a review of the current status of the major public green finance aspects, including fiscal spending, taxation, and government funds, and seeks to understand the existing landscape of green or climate public finance on a practical level. Furthermore, this paper assessed the alignment of these financial mechanisms with the goals of achieving carbon neutrality by examining the trends and relevant practices. Moreover, the analysis identified untapped opportunities for green public finance that go beyond conventional approaches.

This study concludes that while China does not have a specific public climate finance plan, the climate goals have been systematically integrated into key public finance avenues and development strategies (Gonguet et al., 2021). However, the relevance and alignment of each component to the climate goals vary. Moreover, there is still potential to leverage more public financial resources. Firstly, China has room for improvement in energy conservation and environmental protection spending in terms of both the level and share of GDP. Secondly, while China has established resource tax and environmental protection tax, they account for a low government revenue ratio and have not directly aligned with the climate goals. Thus, they provided limited economic incentives for industries to adopt cleaner technologies, reduce greenhouse gas emissions, and encourage energy efficiency, which has also been addressed by Xue et al. (2020). Thirdly, among current major government funds, the renewable energy development fund is directly aligned with carbon neutrality goals while other funds focus on broader environmental goals. The findings yield several insights for future policymaking in financing China's net-zero goal.

Firstly, it is crucial for China to establish a green or climate budget system that incorporates climate considerations into decision-making processes. This entails prioritizing climate actions in budget allocations and adopting a 'whole of government' approach to effectively utilize spending, taxation, and market-oriented mechanisms (C40, 2021). It is necessary to set science-based emission reduction targets at the national, subnational, and sectoral levels, aligning them with public finance and fiscal plans. To enhance implementation, a monitoring system should be in place to track budget plans and evaluate financial progress

toward achieving carbon neutrality goals. Additionally, the budget system should track and differentiate financial flows based on objectives related to pollution control, nature conservation, and carbon neutrality (Liu, 2022), which are the three major works that green public finance attributes to. As such, the financial resources can be coordinated and monitored in a systematic approach.

Secondly, China should proactively explore the potential of leveraging government expenditure and fiscal revenue to expand climate financing. On the expenditure side, China can increase its fiscal spending with a specific focus on green-oriented and climate-oriented initiatives, both in terms of overall size and proportion to GDP (Gao, 2018; Liu, 2022; Zhang, 2017). To maximize the effectiveness of these expenditures, it is crucial to align them with the green industry catalog or green finance taxonomy, directing funds towards activities and projects that promote renewable energy, low-carbon transportation, decarbonization in manufacturing, and more (Shi & Liu, 2022). Increasing government spending on technology and education is also important, as these areas indirectly contribute to carbon neutrality and green development (Sun, 2007). On the revenue side, it is necessary to assess the feasibility of aligning tax measures with climate goals and explore potential synergies with existing market-based mechanisms to mobilize more green public finance. This includes incorporating a 'carbon constraint' into current tax measures and establishing an effective carbon pricing mechanism (Li & Jia, 2017), such as improving the emissions trading system (ETS) or implementing a new carbon tax (Zhang, 2017). This ensures that the true cost of carbon emissions is reflected in economic activities.

Thirdly, multiple financial sources can be leveraged through government-led funds

that engage various stakeholders, including banks and companies, both on the national and local levels. The central government needs to create platforms that bring together stakeholders from the public and private sectors to identify potential green projects and investment opportunities. Offering incentives, such as tax breaks, grants, or subsidies, can encourage companies and investors to allocate funds toward climate-friendly projects (Dong, 2021). Meanwhile, regulatory bodies should establish green fund standards and investment guidelines, clarifying the concept, scope, and investment areas of green industry funds to provide clear definitions and recognition criteria for green or climate-oriented funds to avoid greenwashing (Shenzhen Green Finance Committee & CEEX, 2019).

We have identified three areas for future research to address these gaps. Firstly, given China's lack of a climate budget system, further research is needed to explore how to establish such a system based on current policy and financial progress. Secondly, as multiple policy measures are implemented concurrently, it is important to analyze the trade-offs and co-benefits between green public finance and other forms of finance. This analysis will help policymakers harmonize different goals and establish an integrated finance system. Lastly, it is crucial to explore effective ways of engaging private capital and mobilizing additional financial resources through innovative policy measures and financial instruments.

Works Cited

Bhandary, R. R., Gallagher, K. S., & Zhang, F. (2021). Climate finance policy in practice: A review of the evidence. *Climate Policy*, 21(4), 529–545. <https://doi.org/10.1080/14693062.2020.1871313>

- C40, C. C. L. G. (2021). *Climate budgets: Why your city needs one*. https://www.c40knowledgehub.org/s/article/Climate-budgets-why-your-city-needs-one?language=en_US
- Cai, R., & Guo, J. (2021). Finance for the Environment: A Scientometrics Analysis of Green Finance. *Mathematics*, 9(13), 1537. <https://doi.org/10.3390/math9131537>
- Cao, J. (2007). *Essays on Environmental Tax Policy Analysis: Dynamic Computable General Equilibrium Approaches Applied to China*. Harvard University. <https://www.proquest.com/openview/368002e02da63ce72c58c98b168f28e4/1?pq-origsite=gscholar&cbl=18750>
- Chen, G. (2017). *Public Finance* (9th ed.). China Renmin University Press.
- Cheng, S. L., Lucey, B., Kumar, S., Zhang, D., & Zhang, Z. (2022). Climate finance: What we know and what we should know? *Journal of Climate Finance*, 1, 100005. <https://doi.org/10.1016/j.jclimf.2023.100005>
- Choi, J., & Li, W. (2021). *The Potential for Scaling Climate Finance in China*. <https://www.climatepolicyinitiative.org/wp-content/uploads/2021/02/The-Potential-for-Scaling-Climate-Finance-in-China.pdf>
- CICC Research, & CICC Global Institute. (2022). *Guidebook to Carbon Neutrality in China: Macro and Industry Trends under New Constraints*. Springer Singapore. <https://doi.org/10.1007/978-981-16-9024-2>
- Deng, M., Xie, W., & Shang, J. (2022). *China Green Bond Market Report 2021*. Climate Bonds Initiative. https://www.climatebonds.net/files/reports/cbi_china_sotm_2021_0.pdf
- Department of Resource Conservation and Environmental. (2021). *Action Plan for Carbon Dioxide Peaking Before 2030*. https://en.ndrc.gov.cn/policies/202110/t20211027_1301020.html
- Department of Resource Conservation and

- Environmental Protection. (2022). *Continuous promotion of energy transformation with significant results in energy conservation and consumption reduction*. https://www.ndrc.gov.cn/fggz/hjzy/jnhnx/202210/t20221011_1338503.html
- Dong, R. (2021). *Analysis of the Development Status of China's Green Industry Fund*. https://www.sohu.com/a/480212997_828724
- Escalante, D., Choi, J., Cui, Y., & Larsen, M. L. (2020). *The State and Effectiveness of the Green Bond Market in China*. International Institute of Green Finance. <https://www.climatepolicyinitiative.org/wp-content/uploads/2020/06/The-State-and-Effectiveness-of-the-Green-Bond-Market-in-China-Mandarin-Version.pdf>
- Eurostat. (2020). *How much do governments spend on environmental protection?* <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20200227-2>
- Eurostat. (n.d.). *Glossary:Environmental tax*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Environmental_tax
- Eustat. (2022). *Environmental tax statistics*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Environmental_tax_statistics
- Gao, W. (2018). *Research on Fiscal Expenditure Policy to Promote Green Development*. Chinese Academy of Fiscal Science.
- Gonguet, F., Wendling, C., Aydin, O., & Battersby, B. (2021). *Climate-Sensitive Management of Public Finances "Green PFM."* International Monetary Fund.
- Green Finance Committee of China Society for Finance and Banking. (2021). *Roadmap for financing China's Carbon Neutrality*. http://www.greenfinance.org.cn/upfile/file/20211204222634_82821_73556.pdf
- He, J., Li, Z., & Zhang, X. (2020). China's low carbon development strategy and transition pathway in the long term. *China Population, Resources and Environment*, 30(11), 1–25.
- IEA. (2021). *An energy sector roadmap to carbon neutrality in China*. <https://www.iea.org/reports/an-energy-sector-roadmap-to-carbon-neutrality-in-china>
- IEA. (2023). *CO2 Emissions in 2022*. <https://www.iea.org/reports/co2-emissions-in-2022>
- Jia, kang, Liang, J., Liu, W., Su, J., Li, J., Ding, W., & Shen, Y. (2017). *Research on the construction of China's green fiscal and taxation system in the context of development and reform*. Energy Foundation China. <https://www.efchina.org/Attachments/Report/report-lceg-20170812/%E5%8F%91%E5%B1%95%E6%94%B9%E9%9D%A9%E4%B8%AD%E7%9A%84%E4%B8%AD%E5%9B%BD%E7%BB%BF%E8%89%B2%E8%B4%A2%E7%A8%8E%E5%88%B6%E5%BA%A6%E4%BD%93%E7%B3%BB%E6%9E%84%E5%BB%BA%E7%A0%94%E7%A9%B6-%E7%BB%9F%E7%A8%BF.pdf>
- Jin, J., & Han, L. (2018). Assessment of Chinese green funds: Performance and industry allocation. *Journal of Cleaner Production*, 171, 1084–1093. <https://doi.org/10.1016/j.jclepro.2017.09.211>
- Lamperti, F., Bosetti, V., Roventini, A., Tavoni, M., & Treibich, T. (2021). Three green financial policies to address climate risks. *Journal of Financial Stability*, 54, 100875. <https://doi.org/10.1016/j.jfs.2021.100875>
- Lee, C.-C., & Lee, C.-C. (2022). How does green finance affect green total factor productivity? Evidence from China. *Energy Economics*, 107, 105863. <https://doi.org/10.1016/j.eneco.2022.105863>
- Lee, J. W. (2020). Green Finance and Sustainable Development Goals: The

- Case of China. *The Journal of Asian Finance, Economics and Business*, 7(7), 577–586.
<https://doi.org/10.13106/JAFEB.2020.VOL7.NO7.577>
- Li, S., & Shao, Q. (2022). Greening the finance for climate mitigation: An ARDL–ECM approach. *Renewable Energy*, 199, 1469–1481.
<https://doi.org/10.1016/j.renene.2022.09.071>
- Li, W., & Jia, Z. (2017). Carbon tax, emission trading, or the mixed policy: Which is the most effective strategy for climate change mitigation in China? *Mitigation and Adaptation Strategies for Global Change*, 22(6), 973–992.
<https://doi.org/10.1007/s11027-016-9710-3>
- Li, Z., Kuo, T.-H., Siao-Yun, W., & The Vinh, L. (2022). Role of green finance, volatility and risk in promoting the investments in Renewable Energy Resources in the post-covid-19. *Resources Policy*, 76, 102563.
<https://doi.org/10.1016/j.resourpol.2022.102563>
- Li, Z., Liao, G., Wang, Z., & Huang, Z. (2018). Green loan and subsidy for promoting clean production innovation. *Journal of Cleaner Production*, 187, 421–431.
<https://doi.org/10.1016/j.jclepro.2018.03.066>
- Lindenberg, N. (2014). *Definition of Green Finance*.
https://web.archive.org/web/20180721183829id_/https://www.die-gdi.de/uploads/media/Lindenberg_Definition_green_finance.pdf
- Liu, S., Shi, Y., Pan, L., & Luo, H. (2017). *Analysis and evaluation of China's climate public expenditures—A study based on Hebei Province*.
https://www.undp.org/sites/g/files/zskgke326/files/migration/cn/UNDP_SS_C_CPEIR-2017-report-CH.pdf
- Liu, T. (2022). *Study on the Optimization of Fiscal Environmental Protection Expenditure Policy in China*. Chinese Academy of Fiscal Science.
- Nellor, D. C., & McMorran, R. T. (1994). *Tax Policy and the Environment*. International Monetary Fund.
<https://www.elibrary.imf.org/view/journals/001/1994/106/article-A001-en.xml>
- Norregaard, J., & Reppelin-Hill, V. (2000). *Controlling Pollution Using Taxes and Tradable Permits*. International Monetary Fund.
<https://www.imf.org/external/pubs/ft/issues/issues25/index.htm>
- O'Callaghan, B., Yau, N., & Hepburn, C. (2022). How Stimulating Is a Green Stimulus? The Economic Attributes of Green Fiscal Spending. *Annual Review of Environment and Resources*, 47(1), 697–723.
<https://doi.org/10.1146/annurev-environ-112420-020640>
- Peters, S. (2012). *The Role of Green Fiscal Mechanisms in Developing Countries: Lessons Learned*.
https://www.greenfinancelac.org/wp-content/uploads/2020/11/Events_management_system__Fiscal_Mechanisms_Case_Study.pdf
- Petrie, M. (2021). Environmental Governance and the Greening of Fiscal Policy. In *Environmental Governance and Greening Fiscal Policy* (pp. 109–142). Springer International Publishing.
https://doi.org/10.1007/978-3-030-83796-9_5
- Polzin, F., & Sanders, M. (2020). How to finance the transition to low-carbon energy in Europe? *Energy Policy*, 147, 111863.
<https://doi.org/10.1016/j.enpol.2020.111863>
- Shenzhen Green Finance Committee, & CEEEX. (2019). *Research on China Green Fund Standard*.
<https://www.efchina.org/Attachments/Report/report-lceg-20200731-2/%E4%B8%AD%E5%9B%BD%E7%BB%BF%E8%89%B2%E5%9F%BA%E9%87%91%E6%A0%87%E5%87%86%E7%A0%94%E7%A9%B6.pdf>
- Shi, Y., & Liu, S. (2022). Practice, Issues, and Suggestions of Green Investment Policies under the “Dual Carbon” Goal. *Sub National Fiscal Research*, 10.

- <http://www.dfczyj.com/upload/202212/12/202212121528013197.pdf>
- Strand, J., & Toman, M. (2010). "Green Stimulus," *Economic Recovery, And Long-Term Sustainable Development*. The World Bank. <https://doi.org/10.1596/1813-9450-5163>
- Sun, Y. (2007). *Research on Fiscal Policies to Promote Green Growth*. CNKI. <https://cdmd.cnki.com.cn/Article/CDMD-80000-2007083327.htm>
- The People's Bank Of China. (2023, February 13). *Green loans in China maintained a high-speed growth in 2022*. https://www.gov.cn/xinwen/2023-02/03/content_5739953.htm
- UNEP. (n.d.). *Climate Action Note*. https://www.unep.org/explore-topics/climate-action/what-we-do/climate-action-note/state-of-climate.html?gclid=CjwKCAjwo7iiBhAEEiwAslxQEQRiRh9aC6eh98p3MypDXOjEydwwFkirw87K02KZPfjhRXmz76SV DhoCYaoQAvD_BwE
- UNEP, & BNEF. (2020). *Global Trends in Renewable Energy Investment 2020*. https://www.fs-unep-centre.org/wp-content/uploads/2020/06/GTR_2020.pdf
- Vigna, M. D., Stavrinou, Z., & Ji, C. (2021). *China net zero: The clean tech revolution*. The Goldman Sachs Group. <https://www.goldmansachs.com/insights/pages/gs-research/carbonomics-china-netzero/report.pdf>
- Wang, B. (2000). Policy Recommendations for Achieving the Greening of China's Tax System. *China Taxation News*. <http://rdbk1.yilib.cn:6251/qw/Paper/138167>
- Wang, G., Li, S., & Yang, L. (2022). Research on the Pathway of Green Financial System to Implement the Realization of China's Carbon Neutrality Target. *International Journal of Environmental Research and Public Health*, 19(4), 2451. <https://doi.org/10.3390/ijerph19042451>
- Wang, J., Wu, S., & Lu, Y. (2006). *Excellent Proceedings of the Annual Conference of the Chinese Society for Environmental Sciences*. 13–25.
- Xia, L., Liu, Y., & Tian, Y. (2022). Green finance strategies for mitigating GHG emissions in China: Public spending as a new determinant of green economic development. *Frontiers in Environmental Science*, 10, 991298. <https://doi.org/10.3389/fenvs.2022.991298>
- Xu, N., Kasimov, I., & Wang, Y. (2022). Unlocking private investment as a new determinant of green finance for renewable development in China. *Renewable Energy*, 198, 1121–1130. <https://doi.org/10.1016/j.renene.2022.07.037>
- Xue, G., Ming, H., & Liu, Y. (2020). Inverted U-shaped Effect of Environmental Protection Tax on Emission Reduction and Pollution Control-based on measurement of the intensity of regional collection. *Tax and Economic Research*, 3, 25–34.
- Yao, Y., Fan, M., Heckmann, A., & Posadas, C. (2022). *Transformative Solutions and Green Finance in the People's Republic of China and Mongolia*. Asian Development Bank Institute. <https://doi.org/10.56506/XFVH2542>
- Yu, C.-H., Wu, X., Zhang, D., Chen, S., & Zhao, J. (2021). Demand for green finance: Resolving financing constraints on green innovation in China. *Energy Policy*, 153, 112255. <https://doi.org/10.1016/j.enpol.2021.112255>
- Zhang, C. (2017). *Research on the Impact of Green Finance on Local Environmental Pollution under China's Fiscal Decentralization*. Hunan University.
- Zhang, D., Zhang, Z., & Managi, S. (2019). A bibliometric analysis on green finance: Current status, development, and future directions. *Finance Research Letters*, 29, 425–430. <https://doi.org/10.1016/j.frl.2019.02.003>
- Zhao, L., Zhang, Y., Sadiq, M., Hieu, V. M., & Ngo, T. Q. (2021). Testing green fiscal

- policies for green investment, innovation and green productivity amid the COVID-19 era. *Economic Change and Restructuring*. <https://doi.org/10.1007/s10644-021-09367-z>
- Zhou, J. (2022). Analysis and Countermeasures of Green Finance Development under Carbon Peaking and Carbon Neutrality Goals. *Open Journal of Social Sciences*, 10(02), 147–154. <https://doi.org/10.4236/jss.2022.102009>
- Zhou, K., & Li, Y. (2019). Carbon finance and carbon market in China: Progress and challenges. *Journal of Cleaner Production*, 214, 536–549. <https://doi.org/10.1016/j.jclepro.2018.12.298>
- Zhou, X., Tang, X., & Zhang, R. (2020). Impact of green finance on economic development and environmental quality: A study based on provincial panel data from China. *Environmental Science and Pollution Research*, 27(16), 19915–19932. <https://doi.org/10.1007/s11356-020-08383-2>