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# Effects of green finance and financial innovation on environmental quality: new empirical evidence from China

Yuyu Zhan[a], Yuan Wang[b] and Yifan Zhong[c]

[a]Economics and Management School, Wuhan University, Wuhan, China; [b]School of Music, Jiangxi Normal University, Nanchang, China; [c]School of Management and Marketing, Curtin University, Perth, Australia

**ABSTRACT**

Sustainable development pursues equilibrium between the environment, economic growth, and quality of life. Currently, in many economies, environmental pollution has become a critical issue. The financial sector development has played a crucial role in developing every sector of the economy by providing necessary funds, and the environment sector is no exception. Therefore, we aim to investigate the impact of green finance and financial innovation on the environmental status in China from 1996 to 2020. To analyze the finance-environment nexus, we have employed the ARDL model. Findings of the ARDL model confirm that the long-run estimates attached to green finance are significantly negative in both the CO2 emissions and GHGs models. Similarly, the long-run estimates of financial innovation are negative and significant in the CO2 emissions and GHGs models. These results imply that an increase in green finance and financial innovation reduces China's CO2 emissions and GHGs emissions. Thus, environmental performance improves. In the short run, only the green finance impact is significant and negative on CO2 emissions and GHGs models. The results recommend some vital policy implications.

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## 1. Introduction

Human health plays a significant role in any country's growth process, and access to human healthcare facilities is an essential right of every human being (Li et al., 2020). Healthcare financing services have become an important determinant that can improve the population's health outcomes in developed and developing economies. The World Health Organization (WHO) has launched a request for worldwide health coverage in Sustainable Development Goals (SDGs) and highlighted that everyone

**CONTACT** Yuyu Zhan yuyuzhan@whu.edu.cn

must have easy access to healthcare services. Human well-being and health are major concerns of the SDGs of the United Nations (Lee et al., 2020; Sun et al., 2021). The literature denoted a larger incidence of poor health outcomes is found in developing economies due to people's exposure to stressful incidents, detrimental living conditions, lack of access to health facilities, and lack of environmental quality (Clark & Paunovic, 2018; Su, Umar, et al., 2022). Therefore, efficiently promoting human health has become a major concern of policymakers and health specialists in recent years. Therefore, environmental quality is a key source of human health.

A bulk of studies have described the association between green finance and the environment. Green finance considers both benefits and costs of economic development (Zhang et al., 2021). The formulation of a green finance system is conducive to promoting technological development in the field of the energy sector (Li et al., 2022). So, green finance is an imperative source for solving environmental problems and promoting human well-being. Hence, environmental performance is an important issue that is faced by developing economies worldwide (Ullah et al., 2020). It is important to figure out to what extent green financial development can promote environmental outcomes. Few studies have elaborated on the concept of green finance from the macro viewpoint (Sachs et al., 2019). Conversely, some studies have correctly measured the development of green finance or adopted quantitative measures to explore green finance and environmental issues. As a vital course of the worldwide future financial progress, the development of green finance is vigorous progress in environmental quality and human well-being (Bansal & Kumar, 2021; Hafeez et al., 2022). Green finance can positively affect environmental quality, economic development, and financial issues that promote the green economy (Ahmed, 2020; Yu et al. , 2021).

Green finance illustrates that financial organizations should include environmental valuation in their financing and investment activities (Ahmad et al., 2022; Ferrat et al., 2021; Gao et al., 2021). The most conspicuous characteristic of green finance is that it highlights the living environment remunerations of society, such as well-being and health. It considers the operational usage of resources as a major criterion for determining the efficiency of its accomplishments, so it can endorse the social-economic-environmental development of the society by considering its well-being and health outcomes. The link between green finance and environmental performance proposed that environmental issues can be solved through financial instruments (D'Orazio & Popoyan, 2019; Wang et al., 2022; Zhou et al., 2020) illustrated that leading world economies should pay reasonable attention to expanding green finance to promote economic and environmental development. Most of the literature (Hu et al., 2022; Li et al., 2022; Ren et al., 2020; Su et al., 2023; Su, Li et al., 2022; Wang et al., 2021) noted that green finance promotes the environment's quality with financial funds' support.

It is obvious how important financial development is to a nation's economy (Yang, 2020). In addition, it is impossible to disregard the importance of financial inclusion as a component of financial growth. At the beginning of the millennium, research that identified financial exclusion as the main cause of poverty and poor living conditions brought the concept of financial inclusion to light (Chibba, 2009; Mirza et al., 2022). Financial inclusion implies that everyone in the nation, including people and businesses, should have simple access to a broad range of financial goods and services in a suitable, affordable, and acceptable manner (World Bank, 2018; Xu et al., 2022).

Although various studies have shown a correlation between economic development and improved environmental quality (Li et al., 2022; Liu et al., 2022; Yang et al., 2020), research into the effect of financial inclusion on carbon dioxide emissions is only getting started. CO2 emissions may be affected by financial inclusion in either a good or negative manner. As was previously said, clean technology investment is made more feasible via increased access to and use of financial services. The positive effects of a more inclusive financial system on the climate may be realized via the sector's increased accessibility, affordability, and adoption of high-quality pollution regulations (Le et al., 2021). Increased financial inclusion is most helpful for the economically disadvantaged, who often lack the resources to invest in clean energy technologies and hence generate significantly lower carbon dioxide emissions (Renzhi & Baek, 2020). Financial restrictions were also noted as the primary challenge to constructing solar networks in Vietnam by (Baulch et al., 2018). This evidence suggests that increased access to financial services may help green technologies get off the ground by making raising money for vital environmental initiatives easier. On the other hand, a positive change in financial inclusivity may boost manufacturing and industrial activity, leading to increased CO2 emissions and other forms of environmental degradation (Qin et al., 2021; Su, Li et al., 2022). Likewise, buyers may purchase more energy-intensive items owing to the cheap accessibility of finances and credits, which significantly increases atmospheric carbon pollution.

Financial innovation has been envisioned as an instrument to fund environmental initiatives. In this regard, (Allen, 2012) confirmed the positive role of financial innovation in implementing the Clean Water Act in the USA. (Huo et al., 2022) found that financial innovation encourages green innovation in the context of more stringent environmental laws and relatively low levels of banking competition. According to (Qin et al., 2022), pollution finance is a significant component of China's innovative financial macroenvironment and is believed to be the primary reason behind the country's declining carbon intensity. According to (Chien et al., 2021), financial innovation has been successful in halting ecological damage in Asian economies. Given the above-mentioned discussion, it is evident that the literature on the impact of green finance and financial innovation on environmental quality is very scarce. Moreover, the existing literature provides mixed evidence on the quality of the environment. Thus, there is a need to explore the nexus between financial innovation, green finance, and the environment to get clarification. The existing studies have used outdated techniques, another drawback of the available literature.

The above discussion confirms the significant role of green finance and financial innovation in improving environmental quality. There is a lack of empirical evidence exploring the impact of financial innovation and green finance on carbon emissions in the case of China. Thus, to fulfil this existing gap, our study aims to empirically examine the impact of green finance and financial inclusion on the environmental outcomes of the Chinese nations. This analysis is important because maintaining the financial innovation trajectory is crucial in the context of the development of environment-related regulation so that the problem of environmental damage may be addressed consistently. Moreover, for a country like China which ranks second in the world in terms of total GDP and rank first in emitting carbon, and where the financial sector is growing, the findings of this analysis can provide essential guidelines for concerned stakeholders. The study uses China data for the empirical task from 1996 to 2020.

The novelty of this paper lies in the following aspects. The basic intention of green finance is to ensure environmental sustainability with the help of financial innovation. However, there is a shortage of literature to confirm whether green financial and financial innovation has attained this basic intention. Thus, the prominent contribution of this research is to integrate financial innovation, green finance, and environmental performance into a cohesive system to represent the direct effect of green finance and financial innovation on environmental quality. Most existing studies use the green finance index in analysis. However, our study has used green finance allocated for renewable energy projects, another contribution to the literature on green finance. To explore the dynamics of financial innovation and green finance on pollution emissions, the study employs the ARDL approach. The best feature of the ARDL approach is that it provides an empirical relationship among variables.

## 2. Model and methods

Green finance significantly improves environmental quality and promotes economic development (Hmaittane et al., 2019; Naqvi et al., 2021; Umar et al., 2021). Green finance instruments are green credit and green bonds (Chen et al., 2022; Rizvi et al., 2022). Green finance transfers funds from surplus segments to shortfall segments and alleviates difficulties in channeling funds (Ielasi et al., 2018; Yarovaya & Mirza, 2022). The climate finance theory noted that green finance plays a key role in carbon neutrality (Markandya et al., 2017; Su et al., 2023). Similarly, financial innovation is another important determinant that stimulates economic activities that help curb $CO_2$ emissions (Chishti & Sinha, 2022; Tao et al., 2022). Financial innovation improves the innovation process and minimizes financial risks and constraints that help improve green investment for environmental sustainability (Su et al., 2022). Theoretical research reasons that green finance and financial innovation may also play a forceful role in environmental quality through several social and economic channels. (Meo & Abd Karim, 2022) noted that green finance, directly and indirectly, influences carbon emissions in the long run. While financial innovation also plays a long-lasting role in improving health, well-being, and the environment (Su & Gao, 2022). Therefore, in line with (Ozturk & Ullah, 2022) and (Su & Gao, 2022), we embrace the following econometric model:

$$EP_t = \lambda_0 + \lambda_1 GF_t + \lambda_2 FI_t + \lambda_3 GDP_t + \lambda_4 EC_t + \lambda_5 Internet_t + \varepsilon_t$$

Where green finance (GF), financial innovation (FI), GDP per capita (GDP), energy consumption (EC), and internet development (Internet) are used as a determinant of the environment in China. Environmental pollution is captured through carbon emissions and greenhouse gas emissions. Therefore, if green finance role plays in the functioning of environmental development, thus $\lambda_1$ will be negative for environmental concern models. Emerging literature noted that financial innovation could negatively impact environmental concern models. The basic equation yields only long-term estimates. Therefore, we can get a short-term effect using the error-correction model, formally announced by (Pesaran et al., 2001). The error-correction model can be written as follows:

$$\Delta EP_t = \varphi_0 + \sum_{k=1}^{n} \alpha_{1k}\Delta EP_{t-k} + \sum_{k=0}^{n} \alpha_{2k}\Delta GF_{t-k} + \sum_{k=1}^{n} \alpha_{3k}\Delta FI_{t-k} + \sum_{k=0}^{n} \alpha_{4k}\Delta GDP_{t-k} + \sum_{k=1}^{n} \alpha_{5k}\Delta EC_{t-k} + \sum_{k=0}^{n} \alpha_{6k}\Delta Internet_{t-k} + \lambda_1 EP_{t-1} + \lambda_2 GF_{t-1} + \lambda_3 FI_{t-1} + \lambda_4 GDP_{t-1} + \lambda_5 EC_{t-1} + \lambda_6 Internet_{t-1} + \delta.ECM_{t-1} + \varepsilon_t$$

From the above specification (2), we can separate the short-term estimates ($\alpha_{1k}$, $\alpha_{2k}$, $\alpha_{3k}$, $\alpha_{4k}$, $\alpha_{5k}$, and $\alpha_{6k}$) from the long-term estimates ($\pi_2 - \pi_6$ normalized on $\pi_1$). While $\delta$ shows the speed of convergence. For the validity of the long-term estimates, we have relied on the F-test and $ECM_{t-1}$or t-test. The ARDL approach has some advantages over the conventional time series method. The ARDL model can apply with a mixture of I(0) and I(1) variables, but traditional time series techniques are free from this condition (Bahmani-Oskooee et al., 2020; Sohail et al., 2022). The ARDL is more suitable in the case of a small sample size. This technique offers different estimates at different lags orders. In the end, we also applied the Lagrange Multiplier (LM) test for serial correlation, the Ramsey RESET test for model misspecification, the Breusch–Pagan test for heteroscedasticity, and the CUSUM test for stability.

## 3. Data

The study explores the impact of financial innovation and green finance on pollution emissions in China over the period 1996–2020. The time span of data has been chosen based on data availability. China is the second-largest economy in the world. Additionally, China is the top pollution emitter economy in the world. Thus, the country contributes immensely to worldwide climate change and threatens its own country's environmental sustainability. We have used two variables to proxy environmental concerns, i.e., carbon dioxide emissions (CO2) and greenhouse gas emissions (GHGs). The CO2 emissions are measured in kilotonnes, and GHGs are measured through kilotonnes of CO2 equivalent. Green finance in renewable energy in a million US$is used as a proxy of green finance. Research and development expenditure as a % of GDP is used to measure financial innovation. Among the control variables, GDP is calculated through GDP per capita constant and energy consumption through energy use in kg of oil equivalent per capita. Finally, the % of individuals using the internet is used to proxy the internet. The variables and their acronym, definitions, data sources, and descriptive statistics are presented in Table 1. The mean of CO2,

**Table 1.** Variables, sources, and data description.

| Variables | Mean | Median | Maximum | Minimum | Std. Dev. | Definitions | Sources |
|---|---|---|---|---|---|---|---|
| CO2 | 15.67 | 15.79 | 16.29 | 14.93 | 0.481 | CO2 emissions (kt) | WDI |
| GHGs | 15.89 | 15.99 | 16.45 | 15.28 | 0.421 | Total greenhouse gas emissions (kt of CO2 equivalent) | WDI |
| GF | 1.150 | 1.300 | 2.960 | −1.400 | 0.943 | Green finance in renewable energy projects (million usd at 2019 prices) | IRENA |
| FI | 1.505 | 1.446 | 2.432 | 0.563 | 0.577 | Research and development expenditure (% of GDP) | WDI |
| GDP | 3.645 | 3.673 | 4.016 | 3.218 | 0.264 | GDP per capita (constant 2015 US$) | WDI |
| EC | 7.361 | 7.422 | 7.930 | 6.768 | 0.421 | Energy use (kg of oil equivalent per capita) | WDI |
| INTERNET | 26.83 | 22.60 | 70.64 | 0.013 | 23.89 | Individuals using the Internet (% of the population) | WDI |

Source: Author's Estimation.

**Table 2.** Unit root testing.

| | DF-GLS | | | PP | | |
|---|---|---|---|---|---|---|
| | I(0) | I(1) | Decision | I(0) | I(1) | Decision |
| CO2 | −0.512 | −1.625* | I(1) | −1.325 | −4.356*** | I(1) |
| GHGs | −0.758 | −1.786* | I(1) | −1.756 | −4.785*** | I(1) |
| GF | −3.231*** | | I(0) | −3.320** | | I(0) |
| FI | 0.125 | −5.320*** | I(1) | −0.298 | −5.668** | I(1) |
| GDP | −1.635* | | I(0) | −1.485 | −2.698* | I(1) |
| EC | −0.501 | −4.658*** | I(1) | −0.775 | −4.887*** | I(1) |
| Internet | −0.145 | −1.687* | I(1) | 1.625 | −2.875* | I(1) |

Note: ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.
Source: Author's Estimation.

GHGs, GF, FI, GDP, EC, and the internet is 15.67 kt, 15.89 kt, 1.150 million US$, 1.505%, 3.645 US$, 7.361 kg, 26.83%, respectively.

## 4. Empirical results

This study explores the impact of green finance and financial innovation on environmental quality in China. The study uses time-series data, and non-stationarity mostly occurs in time-series data. Thus, it is essential to confirm the stationarity of the data series before employing any regressions technique. The study uses DF-GLS and PP unit root tests to perform this task. The outcome of both unit root tests is given in Table 2. After applying the DF-GLS unit root test, it is found that green finance and GDP per capita are level stationary series, and the rest of the series are stationary at their first difference. The findings of the PP test illustrate that green finance is level stationary series, and the rest of the series are stationary at first difference. Based on these findings, our study employed the ARDL approach for empirical investigation. The study uses two proxies to measure environmental pollution, i.e., CO2 emissions and GHGs. Table 3 reports the coefficient estimates of CO2 emissions and GHGs models in the long and short run.

In the long run, findings illustrate that green finance reports a negative effect on CO2 emissions and GHGs emissions as both coefficient estimates are statistically significant and negative. The coefficient estimates reveal that a 1% rise in green finance

**Table 3.** Short- and long-run estimates of ARDL.

| | CO2 | | | | GHGs | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob.* | Coefficient | Std. Error | t-Statistic | Prob.* |
| **Short-run** | | | | | | | | |
| GF | −0.381* | 0.214 | −1.783 | 0.091 | −0.315** | 0.128 | −2.461 | 0.024 |
| GF(-1) | −0.203*** | 0.060 | −3.369 | 0.005 | −0.181** | 0.076 | −2.386 | 0.033 |
| FI | 0.080 | 0.091 | 0.878 | 0.396 | 0.062 | 0.073 | 0.842 | 0.415 |
| FI(-1) | 0.365*** | 0.100 | 3.653 | 0.003 | 0.304*** | 0.080 | 3.807 | 0.002 |
| GDP | 1.126*** | 0.333 | 3.385 | 0.005 | 1.056*** | 0.267 | 3.952 | 0.002 |
| GDP(-1) | 0.784*** | 0.186 | 4.225 | 0.001 | 0.685*** | 0.128 | 5.352 | 0.000 |
| EC | 0.849*** | 0.170 | 5.010 | 0.000 | 0.732*** | 0.131 | 5.591 | 0.000 |
| EC(-1) | 0.212** | 0.105 | 2.015 | 0.079 | 0.159* | 0.085 | 1.870 | 0.098 |
| INTERNET | 0.004 | 0.004 | 0.982 | 0.344 | 0.004 | 0.003 | 1.314 | 0.212 |
| INTERNET(-1) | −0.007* | 0.004 | −1.884 | 0.082 | −0.006* | 0.003 | −1.875 | 0.084 |
| **Long-run** | | | | | | | | |
| GF | −0.492*** | 0.070 | −7.065 | 0.000 | −0.456*** | 0.078 | −5.867 | 0.000 |
| FI | −0.819*** | 0.219 | −3.737 | 0.003 | −0.720*** | 0.188 | −3.819 | 0.002 |
| GDP | 2.072*** | 0.716 | 2.892 | 0.013 | 2.077*** | 0.639 | 3.251 | 0.006 |
| EC | 1.563*** | 0.262 | 5.959 | 0.000 | 1.440*** | 0.229 | 6.278 | 0.000 |
| INTERNET | −0.007*** | 0.002 | −2.991 | 0.010 | −0.004** | 0.002 | −2.245 | 0.043 |
| C | 10.69*** | 1.294 | 8.263 | 0.000 | 11.92*** | 1.108 | 10.76 | 0.000 |
| **Diagnostics** | | | | | | | | |
| F-test | 7.658*** | | | | 6.325*** | | | |
| ECM (-1) | −0.542*** | 0.030 | −17.87 | 0.000 | −0.508*** | 0.026 | −18.96 | 0.000 |
| LM | 1.965 | | | | 1.654 | | | |
| RESET | 1.654 | | | | 0.364 | | | |
| CUSUM | S | | | | S | | | |
| CUSUM-sq | S | | | | S | | | |

Note: ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.
Source: Author's Estimation.

reduces CO2 emissions by 0.492% and GHGs by 0.456%. Our findings confirm that green finance significantly influences environmental quality. A similar linkage is reported by (Umar, Ji, Mirza, & Naqvi et al., 2021), who disclosed that an upsurge in green finance level and applications of green technologies & green projects expands green financial innovation and financial efficiency and promotes overall improvement of society and the environment. Moreover, green finance expands the financial flows from the private and public sectors for sustainable environmental development.

Similarly, financial innovation exerts a negative effect on CO2 emissions and GHGs emissions in the long run. It discloses that financial innovation enhances the environmental quality in China in the long run. The coefficient estimates reveal that a 1% rise in financial innovation reduces CO2 emissions by 0.819% and GHGs by 0.720%. Our findings illustrate a negative association between financial innovation and environmental concerns in the long-run and short-run. This finding is supported by (Chishti & Sinha, 2022). It is argued that green finance and financial innovation significantly improve China's environment. Moreover, green finance and financial innovation can reduce waste generation, water consumption, and pollution emissions in China, significantly improving overall environmental quality. This finding is also consistent with (Su & Gao, 2022), who noted that financial innovation positively impacts green growth by reducing carbon emissions in China. This means that financial innovation improves the welfare of households by improving their financial security and enhancing the consumption of clean energy, hence improving environmental quality. Furthermore, financial innovations improve human well-being and boost environmental health by eradicating the consumption of fossil fuels by providing access to finance facilities. Another possible reason is that green finance increases renewable energy production, which improves green growth by reducing pollution. (Huo et al., 2022) supported our findings by arguing that financial innovation accompanied by efficient management of liquidity and credit and better risk management capabilities significantly improves the quality of the environment. The process carries out financial innovation, and product innovations help improve environmental and economic sustainability. (Chishti & Sinha, 2022) denoted that financial innovation under strict environmental regulation is considered a significant tool is supporting green environmental-related projects.

The impact of GDP per capita is positive on the CO2 in the long run, revealing that the CO2 increase in China is due to an upsurge in GDP per capita. The impact of GDP is positive on GHGs in the long run, revealing that environmental performance deteriorates in China due to an increased GDP per capita increase. The coefficient estimates describe that a 1% escalation in GDP enhances CO2 by 2.072% and enhances GHGs by 2.077% in the long run. The impact of energy consumption is found to be statistically significant and positive on CO2 and GHGs in the long run, revealing that the quality of the environment declines in China due to a significant rise in energy consumption. The coefficient estimates describe that a 1% upsurge in energy consumption enhances CO2 by 1.563% and GHGs by 1.440% in the long run. The internet's impact is statistically significant and negative on both proxy measures of the environment in the long run, revealing that environmental quality improves in China due to the rise in internet use. The coefficient estimates describe that a 1% upsurge in internet use reduces CO2 by 0.007% and GHGs by 0.004% in the long-run.

The short-run findings show that green finance significantly negatively affects CO2 and GHGs in China. Conversely, financial innovation does not significantly affect CO2 and GHGs in the short run. GDP per capita is positively attached to environmental proxy measures revealing that environmental quality deteriorates due to an upsurge in GDP per capita. EC is positively associated with GHGs and CO2 emissions, confirming that the environmental quality reduces due to the short-run rise in energy consumption. Internet does not significantly affect CO2 emissions and GHGs emissions in the short run. In the end, the results estimate of the diagnostics test confirms the validity of ARDL estimates. The long-run cointegration association is confirmed, as illustrated by significant coefficient estimates of the F-test and ECM test. Moreover, the associated sign with ECM is negative, revealing that any disequilibrium may converge toward long-term stabilization. Additionally, the findings of the LM test (autocorrelation test), Ramsay RESET test (model specification test), and both CUSUM tests (stability test) are according to our expectations. Table 4 shows unidirectional causality between FI & CO2 and FI & GHGs. In contrast, causality does not exist between GF & CO2 and GF & GHGs in the case of China.

**Table 4.** Results of causality test.

| Null Hypothesis: | F-Stat | Prob. | Null Hypothesis: | F-Stat | Prob. |
|---|---|---|---|---|---|
| GF → CO2 | 1.189 | 0.327 | GF → GHGS | 1.280 | 0.302 |
| CO2 → GF | 0.979 | 0.395 | GHGS → GF | 0.889 | 0.428 |
| FI → CO2 | 7.629 | 0.004 | FI → GHGS | 8.793 | 0.002 |
| CO2 → FI | 0.112 | 0.894 | GHGS → FI | 0.093 | 0.911 |
| GDP → CO2 | 2.117 | 0.149 | GDP → GHGS | 2.496 | 0.111 |
| CO2 → GDP | 1.411 | 0.270 | GHGS → GDP | 1.522 | 0.245 |
| EC → CO2 | 3.712 | 0.045 | EC → GHGS | 3.444 | 0.054 |
| CO2 → EC | 0.200 | 0.821 | GHGS → EC | 0.175 | 0.841 |
| INTERNET → CO2 | 1.641 | 0.222 | INTERNET → GHGS | 2.197 | 0.140 |
| CO2 → INTERNET | 0.960 | 0.402 | GHGS → INTERNET | 0.891 | 0.428 |
| FI → GF | 0.816 | 0.458 | FI → GF | 0.816 | 0.458 |
| GF → FI | 2.428 | 0.117 | GF → FI | 2.428 | 0.117 |
| GDP → GF | 3.092 | 0.070 | GDP → GF | 3.092 | 0.070 |
| GF → GDP | 1.206 | 0.323 | GF → GDP | 1.206 | 0.323 |
| EC → GF | 0.445 | 0.648 | EC → GF | 0.445 | 0.648 |
| GF → EC | 3.203 | 0.065 | GF → EC | 3.203 | 0.065 |
| INTERNET → GF | 7.981 | 0.003 | INTERNET → GF | 7.981 | 0.003 |
| GF → INTERNET | 5.949 | 0.010 | GF → INTERNET | 5.949 | 0.010 |
| GDP → FI | 3.928 | 0.038 | GDP → FI | 3.928 | 0.038 |
| FI → GDP | 1.076 | 0.362 | FI → GDP | 1.076 | 0.362 |
| EC → FI | 0.311 | 0.736 | EC → FI | 0.311 | 0.736 |
| FI → EC | 3.180 | 0.066 | FI → EC | 3.180 | 0.066 |
| INTERNET → FI | 4.067 | 0.035 | INTERNET → FI | 4.067 | 0.035 |
| FI → INTERNET | 1.050 | 0.371 | FI → INTERNET | 1.050 | 0.371 |
| EC → GDP | 1.735 | 0.205 | EC → GDP | 1.735 | 0.205 |
| GDP → EC | 3.359 | 0.058 | GDP → EC | 3.359 | 0.058 |
| INTERNET → GDP | 12.55 | 0.000 | INTERNET → GDP | 12.55 | 0.000 |
| GDP → INTERNET | 2.605 | 0.102 | GDP → INTERNET | 2.605 | 0.102 |
| INTERNET → EC | 0.812 | 0.460 | INTERNET → EC | 0.812 | 0.460 |
| EC → INTERNET | 2.331 | 0.126 | EC → INTERNET | 2.331 | 0.126 |

Source: Author's Estimation.

## 5. Conclusion and implications

According to the WHO, health is not just the absence of physical illness but a state of mental, physical, and social well-being. A healthy person can perform his duties efficiently and become an asset to society. Conversely, a person with a sick body or mind can lag behind others in society and become a liability to the family and society. It is a well-recorded fact that there is a positive link between health status and the nation's economic well-being. Goal three of the sustainable development agenda of the United Nations also emphasized the availability of health services at the doorstep and easy accessibility to health services by the majority population. Poor quality of the environment and pollution are considered the major causes behind the deterioration of human health. Therefore, empirics have shifted toward environmental concerns. Green finance and financial innovation concepts have recently gained popularity in the finance literature. These notions are related to the financial sector development, which has played a crucial role in developing every sector by providing necessary funds. The environmental sector is no exception. However, not much empirical evidence is available that has analysed the impact of financial development on the environment. Therefore, we aim to scrutinize the impact of green finance and financial innovation on the environmental quality in China.

Before formal empirical analysis, we checked the stationarity of the variables. To that end, we have employed DF-GLS and PP as unit root tests. From the results of both these tests, we confer that the variables are I (0) and I (1). Based on these findings, we have utilized the ARDL model to deal with the variables of a different order of integration. Findings of the ARDL model confirm that the long-run estimates attached to green finance are significant and negative in both the CO2 and GHGs models. Likewise, the long-run estimated coefficient of financial innovation is negative and significant in the CO2 and GHGs models, implying that an increase in financial innovation enhances the environmental performance in China. In the short run, only green finance reports a significant negative effect on CO2 emissions and GHGs in China. Moreover, the causality results confirm the unidirectional causality links between financial innovation & CO2 and financial innovation & GHGs. At the same time, causality does not exist between green finance and environmental concern variables.

Based on these findings, we have proposed some policies for stakeholders. Firstly, the policymakers should divert the flow of green finance towards green productive activities and renewable energy projects that may improve the environmental quality in China. Secondly, the policymakers in China may induce the financial institutions to provide loans to stakeholders and industrialists to update their machinery and transform their structure towards green energy sources. Thirdly, causal results also imply that to improve the environmental quality in China, the financial and environmental policies should be integrated and designed to complement each other. Lastly, the policymakers should direct the financial sector to provide the necessary funds to invest in green environment-related infrastructure at a subsidized rate. Government should provide interest-free loans for environmental innovation. To get the maximum benefits of green finance, there is a need to adopt green and low-carbon-based production techniques. Thus, enterprises should diffuse the traditional productivity techniques and transform them towards renewable energy and green technology-based production methods. Moreover, financial institutions should expand green financial support for enterprises.

The study explores the effect of green finance and financial innovation on China at the aggregate level. It does not capture the impact at the disaggregated level due to data constraints. In future studies, the analysis should be performed for the disaggregated level in China to provide more appropriate policy suggestions at the disaggregated level. Future studies should also consider other indicators that directly or indirectly influence environmental quality in China. Asymmetries in the associations can undermine deep linkages among selected variables; hence, asymmetric links can be explored to overcome this problem.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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