S.I. : FISCAL POLICY INSTRUMENTS AND GREEN RECOVERY
IN THE POST-COVID-19 ERA

Financial inclusion and green economic performance for energy efficiency finance

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Abstract
Financial inclusion is fundamental for increasing the nation's performance and green economy has emerged as one of the dominant factors to ecological sustainability, but how will these two factors connect? This research analyzes the correlation between the two in the case of China, which is undergoing a transformation to a green economy, using state-level statistics from 2008 to 2020 to evaluate the connection between financial inclusion and the green economy. By taking into account the fast-expanding technology banking system, as well as the application of the minimum distance to the weak efficient frontier framework (MinDw), a comprehensive assessment of financial inclusion is created, as is an assessment of green economic productivity. The findings show that the expansion of financial inclusion may contribute to increased green economic proficiency, which is primarily achieved via the tightening of credit restrictions on carbon emitting companies. The results have more consequences for the implementation of a financial development strategy and the maintenance of healthy associations between the state, banking institutions, and businesses.

Keywords Green economic efficiency · Financial inclusion · MinDw model · Credit restrictions · DEA

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1 Introduction

Enhancing energy efficiency is one of the most important agenda issues for countries in modern times, and China has embraced the green economy's sustainable development objective. Ehsanullah et al. (2021) stated that the world's financial inclusion targets are to "promote inexpensive, efficient, and sufficient access to all forms of managed banking commodities and to expand their use by all social classes". Public assistance considerations identify under-served customer groups; microfinance companies construct their customers' value to maximize profit margins (Ma et al. 2021). These considerations emphasize accessibility limitations that may be in place depending on circumstances like nationality, identity, occupational prestige, or seniority (Wu et al. 2022) and (Lei et al. 2021) The uses of money managers and insurance schemes are some long-term investment inclusions. Patrons with somewhat desired qualities, like physical or learning disabilities, non-nuclear generational, or transportation, tend to constitute the preponderance of a user base or perhaps engage in inequitable activities based on their ethnicity (Wang 2020). If we can figure out which features of under-served communities are most closely aligned with existing market offers, we may begin to consider how representation problems could be addressed. As some studies have shown that macroeconomic periods are causally linked to economic cycles (Ullah et al. 2018; Zafar et al. 2021). In the recent study, Zafar et al. (2021) have discussed that due to the global financial development freeze, a connection is made between a narrower order to use this information and drearier economic forecasts. As a result, our business situations and market indexes serve as useful research instruments for objectively investigating the previously stated connections empirically (Zhuo et al. 2020) and (Hakuzimana and Masasi 2020).

For the promotion of economic growth, financial inclusion has emerged as a vital component of China's financial reform (Wang 2020). Our new database's purpose is to provide signs of potential for possible economic instabilities in their economic, institutional, and governmental aspects. A particular focus is placed on how much of the administrative structure that enables the timely implementation of the required financial markets to reduce the impacts of shocks (Sinha et al. 2020c). When it comes to financial inclusion, it is critical to ensure that everyone has access to the appropriate financial sector. In reality, this involves providing moderate families and remote towns with fair access to investment techniques as well as other financial derivatives that were previously inaccessible (Sinha et al. 2020a). Measurements of FI include things like the geographical barriers to investment bankers, the quantity of structured wealth leagues, and the total amount of term deposits. Expanding the financial intermediation company's overall scope and decreasing economic social marginalization are both important components of strengthening FI.

Mortgage repayments, income and profits for individuals and companies are highly dependent on the state of the economy at the present stage of the economic cycle. The connection among the macroeconomic economies and banking sector

works the other way as well—increasing portions of the accounting records of mortgage holders while the sector is in an economic growth period (Sinha et al. 2020b). Receding economies, on the other hand, result in lower profits and reliability. Money transmitters' payments and market share earnings include some constant cost ingredients, which are somewhat more relevant. It can be deduced that profit growth and preparing the financial point of the banking system are closely linked to accessing financial repayment capacity and, thus, reacting appropriately to fluctuating stock returns, leading to financial transitions between distinct theories of economic iterations (Shahbaz et al. 2020). Like the economic experts before them, Shahbaz et al. (2019) offer evidence of simultaneous changes in home and equity values at the same time. They put a 16-year limit on the length of international financial markets, which has been on the rise since the mid-1980s. The impacts of a recessionary period after a financial crisis incidence on the economy's rehabilitation process are studied by Sim and Zhou (2015) in a related development. Their analysis focused on market statistics, with emphasis on companies that are highly reliant on external funding for their activities.

Financial institution and exchange emergencies, economic wellbeing and viability of facilitators, banking system convergence, the budgetary environment in the industry, and interest rates and commercial bank capabilities all may have an impact on profitability (Schoderer et al. 2021). Addressing environmental challenges is a global issue that is handled at the state level. This is an especially interesting subject for future research since it relates to "Sustainable Switchover," which was one of the most major conclusions of COP 24 (COP24, Declaration, 2018). The Regime's Strategic Framework's Objective 11 directly related to sustainable consumption and production. This paper, meanwhile, mainly focuses on environmental consequences. On the other hand, one of the more specific aims of this study is global warming mitigation and adaptation efforts which are really carried out at the regional scale, rather than at the domestic and global level.

Conventional wealth distribution and sustainable economic development have been an attraction for several researchers (Urban et al. 2018) lately, however efforts to enhance sustainability and environmental sustainability have received less attention. In an effort to address this gap, this research utilizes DEA to assess green productive viability and the fundamental design of complexes in boosting green profitability beyond. Economic reform and revamping operations are enhanced by financial inclusions because they are actually confronted with higher credit limitations, which were already rationalized by analyzing greater CO_2 emitter-enterprises. Economic development in other words, enhances production network efficiency while revamping since they are directly confronted through longer repayment restrictions and limitations. This paper contributes to the existing previous research by (1) using the less-studied liquidity problems to vindicate the restricting impact of capital structure integration and (2) establishing a MinDW framework to calculate green profitability, which modifies the good organizational horizon in the conventional directional framework and adds to our comprehension of how financial inclusion reinforces green profitability.

The rest of the paper are organized as follows: the relevant literature is reviewed in Sect. 2. The framework definition, dataset and method of analysis are discussed in Sect. 3. The empirical findings and robustness tests are presented in Sect. 4. Conclusion and policy implications are provided in Sect. 5.

2 Literature review and hypothesis development

Everything associated with green economy whether its economic growth supports environmental correctness, hinders it, or has no effect on it has become a hot debate among researchers. When it comes to the results of these relationships, different estimations, panelists (states), and durations studied examined (taking into consideration) for the study all have large discrepancies (Sharif et al. 2019). As a result, there are three different theories which have already been proposed in the research. The very first theory is that the established finance industry has an influence on global harm caused by industrialization and traditional energy use (Ramsey 1999). People may get customers credits for ancient hydrocarbon cars and electronic items from the nation's advanced economy industry, which raises typical power requirements and, as a result, causes ecological damage (Kovilage 2021). Organizations benefit from lower operational expenses when the banking industry is established because it allows them to purchase more equipment and materials and build additional components (plants) that increase incineration and generate additional dependence on fossil fuel use (Granger 1969). A well-developed financial services sector in the home nation also increases the rate of industrialization, which in turn raises the volume of environmental pollution and worsens contamination (Ngo et al. 2021) and (Umar and Akhtar 2021). Because of the extrinsic benefits of such a study, citation-based techniques have received much interest, and their numbers are actually steadily spreading across fields. Two studies by Cornish et al. (2006) and Sinha et al. (2021) have previously described the basic process of a methodical scientific cartography, which may be broken down into five phases. First stage, defines the study issue and choose suitable content analysis techniques that allows to address the issues asked.

The literature of this study aims to analyze the connection between investments in real business and to determine the awareness and intellectual framework. Thus, the objective is to establish important scientific achievements, researchers, and institutions that have had the strongest influence on the growth of the studied area. Investigating if times of greater technological prowess are correlated with financial or economic hardship might be intriguing as well. The project will also provide portions devoted to examining the implications of the findings.

2.1 Index of financial inclusion

Financial inclusion is a crucial element that boosts industrial performance, according to Setyawati (2020), who categorizes middle-income countries into three categories: "stuck intermediate civilizations, graduating middle-income societies, and rising middle markets". Taghizadeh-Hesary and Yoshino (2019, 2020) also found a positive relationship between economic growth and a rise in the value of equity in countries. Reis

et al. (2019), investigates the links among cash advancement, productivity expansion, and ecological equity using a sample of high-income economies (China) and finds a positive correlation between social advancement, banking sector growth, and productivity expansion. As with the research of Pyrgou et al. (2016), which examines the impact on bank planning and sustainable advancement in 42 developing nations, the results indicate a positive correlation studied.

The findings of other studies investigations are inconsistent and contradictory Lazzeroni et al. (2020) explore the impact of financial advancement on ecosystems and discover a link between the two. Using data from China, Lang et al. (2016) show an inverse relationship between financial inclusion and greenhouse gas emissions due to the ability of entrepreneurs to adopt sustainable processes as a result of growth in the financial sector. The findings by Huang et al. (2021) suggested that financial inclusion could boost remittances' growth-enhancing effect. According to Kwon (2018), financial growth may help improve green development by giving businesses access to cutting-edge energy-efficient technologies. Kazhamiaka et al. (2017), for example, studied that how economic growth impacts sustainable energy sources, study concluded that producing alternative sources is prohibitively costly. As a result, countries that have achieved financial inclusion are able to create green economic efficiency resources that have a less harmful effect on the environment. In both the complete sample and sub-samples, the study by Taghizadeh-Hesary and Taghizadeh-Hesary (2020) finds that financial institution access, depth, efficiency, and overall development have a significant beneficial impact on economic growth. They also discovered that capital, labor, energy consumption, and trade openness all play a role in promoting economic growth in these panels. Furthermore, financial inclusion has a greater influence on economic output in low-income and new-EU member countries than in high-income and old-EU member countries.

2.2 Hypothesis development

2.2.1 Assessment of financial inclusion and green economy performance

Current literature has shown that financial inclusion improves green economic efficiency. Comprehensive economics opens the door for customers to interact with green purchasing from a financial standpoint. Individuals' buying intentions may be sparked by aspirations of a renewable energy industry since environmental impacts are by far the most pressing societal considerations (Zapata Riveros et al. 2019). Allowance is given to ecological responsible investments that cater to product purchase behavior demands through economic advancement, and users' sustainable procurement behavior perpetuates the development of these efficient and sustainable installations, resulting in a sustainable consumption configuration for employment creation. Accessible companies (Talavera et al. 2019) benefit from funding, which has been linked directly to entrepreneurship, employment opportunities, and development (Reis et al. 2019). As an alternative, there are abundant data indicating the benefits of creating an enabling environment in predicting sustainable growth as well as in maximizing profits and bringing about technical progress (Pyrgou et al. 2016).

According to Zhao et al. (2021) a more effective business strategy will encourage entrepreneurs to participate in financial operations, reduce the borrowing barrier, ease their financial sanctions, and increase the number of economic transformations (such as equipment and technology upgrading). Luthander et al. (2016) in their study they claimed that comprehensive economics may assist businesses in broadening their financing streams by supplying funding assistance for capital expenses and research and development expenditure, as well as encouraging firms to pursue digital transformation. It also managed to increase ecologically sound investments in cleaner energy and resource systems, and to optimize the configuration of energy demand by pursuing alternative sources to enable new fuels, efficiently and successfully reducing waste generation, and promoting environmental effectiveness (Dong and Sigrin 2019; Cambini et al. 2020). There will be more companies engaged in the renewable energy industry as a consequence of the effective promotion of accessible financing (Taghizadeh-Hesary et al. 2021).

> Hypothesis 1: The expansion of financial inclusion improves the viability of the green economic development.

The component segments into the productivity of key parameters, such as worker productivity, renewable energy, financial returns, GDP cost-effectiveness, and ecosystem performance. We can learn which control signals are most affected by banking services on environmental regional economic productivity by looking at the effect on element efficiencies. Financial inclusion, according to research, has the ability to inspire people and has an effect on both energy production and the ecosystem. The growth of the financial sector and the use of energy have been shown to have a strong correlation (Esquivias et al. 2021; Ingrao et al. 2018). Population development may be seen when moving away from conventional energy sources (Invidiata et al. 2018). This suggests that making the switch to alternative energy sources is linked to employment generation. They also confirm that financial inclusion works in improving the environment, using the STIRPAT model in their study (Cabeza et al. 2014). Furthermore, inclusive banking directs financing to companies that use less energy and pollute less. Reduced deposit insurance for banks offering green financing is an important technique in an organization (Wijesiri et al. 2015).

> Hypothesis 2: Renewable energy and ecological sustainability are the primary ways in which financial inclusion affects the viability of green economics.

2.3 Mechanism

Currently available research on the connection between commodity price discrepancies and good grief relates to a specific element of commodity price deviation socioeconomic and environmental impact (Ismaeel and Elsayed 2018) and (Lavee and Menachem 2018). Economic activity is aided by reduced operating costs and relatively low gasoline prices as a consequence of industrial financial frictions (Syamni and Abd Majid 2016; Amelia and Hardini 2017). Low-cost energy is a huge boost to the economy, but it also has a detrimental effect on the environment. A number of studies have found that commodity price fluctuations impede the spread of fossil

fuels, causing environmental damage (Scanlon et al. 2019), increased use of high-emission energy sources as a consequence of disproportionate government influence on energy pricing worsens soil degradation, the price of crude inefficiencies (Wasiaturrahma et al. 2020), and boosted greenhouse gas emissions while hindering attempts to reduce pollutants (Biswas and Koufopoulos 2020). Corporate subsidies, according to Wang et al. (2017), harm energy efficiency and therefore increase carbon emissions, while removing them harms the national economy. Firm effectiveness, innovativeness, and socioeconomic development are all attributed to technology (Wu et al. 2021). However, financing restrictions may limit spending in companies' research and development projects since these initiatives are often marked by a substantial percentage of unpredictability, sophistication, and individuality (Wiser and Pickle 1998). Credit restrictions, on the other hand, are not the same for every business. Interestingly, entrepreneurs may have financial constraints when it comes to sustainability management since they have fewer prior earnings assortments and largely rely on external investment options for new initiatives (Mohsin et al. 2019), (Mohsin et al. 2020) and (Mohsin et al. 2021). Because of the knowledge mismatches among customers and banks, these companies are particularly susceptible to lending activities. Even if they can take advantage of those opportunities and have fewer total commodities, that might minimize the damage, but they have a greater limit than big manufacturing companies (Yildirim and Onder 2019) and (Geghamyan and Pavlickova 2019).

> Hypothesis 3: With financing restrictions, high-polluting companies can't grow as quickly as other, more efficient ones.

3 Data and methodology

3.1 Model specification

Non-parametric methods such as DEA do not need a growth model to assess efficiency when dealing with numerous inputs and outputs. Because of its adaptability, data envelopment analysis has steadily risen to prominence as the standard technique for assessing the energy crisis and environmental sustainability. Systems like CCR and Banker, Chames and Cooper (BCC) are classic circumferential theories used in initial DEA research. To determine how efficient a system is, these approaches increase the outcomes while decreasing the intakes. Greenhouse gases are an unintended side effect of the ACEP proposed study. Inappropriate data are commonly presented as a contribution or processed via data transformation prior to actually being used in the CCR or BCC. Neither method adheres to the work and make, despite having significant advantages in dealing with undesirable outcomes. As a result, the assessment will always deviate (Sun et al. 2019) and (Tiep et al. 2021).

Narayan and Sharma (2011) developed the DDF to eliminate undesirable outputs from the performance assessment system. The DDF included different contaminants as undesired outputs. The DDF is in compliance with the rules of organization since it does not need undesired outcomes to be processed. Therefore, to effectively

manage the growth of desired outputs, this model needs to assume that undesired outputs may be inadequately addressed and set the optimal choice of each impact test. So, the DDF has a high degree of subjectivity to it (Sun et al. 2020c), (Sun et al. 2020a) and (Sun et al. 2020b). According to this research, the MinDW is used to assess the GEE of energy consumption to address DEA issues. There is a key aspect to this new approach: no matter how efficient a DMU projection's location on the border is, it will always be near to the indifference curve. With this approach, you will not have to deal with the drawbacks of conventional DEA of CCR or SBM. With MinDW, arbitrary variables, such as data abnormalities and biases, are substantially reduced, and the reliability of efficiency assessment is significantly improved. Because the model's DMU-border range is so near to the indifference curve, adjustments in transmitter and receiver may be made with little impact on mobility or cost as the effectiveness improves (Agyekum et al. 2021) and (Zhang et al. 2021).

With reference to Gallagher et al. (2018), MinDW is set up throughout this work that has an undesirable consequence. Assume there are n DMUs in the manufacturing operation, which together has m intakes (x), p desired outputs (y), and q undesired by-products (b) in common. Matrices are used to represent the inputs $X = (x_1, x_2, \ldots, x_n) \in R_+^{m \times n}$, output values $Y = (y_1, y_2, \ldots, y_n) \in R_+^{p \times n}$, and undesired results $B = (b_1, b_2, \ldots, b_n) \in R_+^{q \times n}$ so that they may be easily understood. We will start with DMU $\text{DMU}_k = (x_k, y_k, b_k)$ as the kth candidate to be assessed. This means that the MinDW may be represented as combinatorial optimization using the equations: $m + p + q$ in Eqs. (1)–(4).

$$\max \beta_z, z = 1, 2, \ldots, \quad m + p + q \tag{1}$$

$$\text{s.t.} \sum_{j=1}^{n} \lambda_j x_{ij} + \beta_z e_i \leq x_{ik}, \quad i = 1, \ldots, m \tag{2}$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - \beta_z e_r \geq y_{rk}, \quad r = 1, \ldots, p \tag{3}$$

$$\sum_{j=1}^{n} \lambda_j b_{tj} + \beta_z e_t \leq b_{tk}, \quad t = 1, \ldots, q \tag{4}$$

$$\lambda = 0.$$

Components and corresponding outputs are represented by x, y, and b, respectively. • intake and production flexibility (i.e., the percentage of dependent and independent variables that may be decreased (increased)); The DEA's target weight is e_i, e_r, and e_i; the parameters are and each one of the 3 parameters is 1 during combinatorial optimization; some other 2 are 0 in Eq. 5:

$$e_i = 1 \quad \text{if} \quad i = z; \quad e_i = 0 \quad \text{if} \quad i \neq z \tag{5}$$

$$e_r = 1 \quad \text{if} \quad r = z - m - q; \quad e_r = 0 \quad \text{if} \quad r \neq z - m - q \tag{6}$$

$$e_t = 1 \quad \text{if} \quad t = z - m - p; \quad e_t = 0 \quad \text{if} \quad t \neq z - m - p. \tag{7}$$

Equation (7) characterizes the performance of any framework may be calculated using the following formula under the aforementioned restrictions:

$$\phi^* = \frac{1 - \frac{1}{m} \sum_{i=1}^{m} \beta_z^* \frac{e_i}{x_{ik}}}{1 + \frac{1}{p} \sum_{r=1}^{p} \beta_z^* \frac{e_r}{y_{rk}} + \frac{1}{q} \sum_{t=1}^{q} \beta_z^* \frac{e_t}{b_{tk}}}, \tag{8}$$

where $\phi^* = (\max \beta_z, z = 1, 2, \ldots, m + p + q)$ is the value of MinDW in Eq. (8).

3.2 Measure of green economic efficiency

According to Criscuolo and Menon (2015), green economic efficiency can only be accurately assessed by taking into consideration combined planned and unintended outputs. Financial inclusion is factored into the equation in the performance evaluation paradigm of Arabi et al. (2014), who created the Malmquist–Luenburger (ML) index. To assess green economic efficiency, this metric has been widely used (Al-Najjar and Clark 2017). Each city is treated as a DMU in this research, and this is indicated by the letter k. For this research, the efficiency component is used as a conventional input element, utilizing (Cronqvist et al. 2012)'s approach, and a (PPS) is created that includes both desirable and unwanted outcomes. Think about how many categories there are in the input for every city (DMU) (Li et al. 2021), (Chien et al. 2021) and (Iqbal et al. 2021). A mixture of acceptable and undesirable results is produced as an output of the process. M classifications $x = (x_1, x_2, \ldots, x_N) \in R_N^+$ are included in the intended outcome y^g, which could also be represented as $y^g = (y_1^g, y_2^g, \ldots y_M^g) \in R_M^+$. It is possible to specify the kinds of unwanted output $y^b = (y_1^b, y_2^b, \ldots y_M^b) \in R_I^+$ have as well. Furthermore, given province k, the following manufacturing options may be shown for each time period t in Eq. (9):

$$P(x) = \left(x_{k,t}, y_{k,t}^g, y_{k,t}^b \right). \tag{9}$$

Equation can be further justified as Eq. (10)

$$P(x) = \left\{ \left(y^g, -y^b \right) : \text{the outputs of } x \text{ are} \left(y^g, -y^b \right) \right\}, \in R_N^+. \tag{10}$$

Because the manufacturing opportunities are considered to be restricted, they must comply with the following requirements: favorable outputs and inputs are completely dispensed of, whereas undesirable results appease the inadequate availability and accessibility hypothesis and the no combinations principle. Using comprehensive comparative methodology, we can simulate all of the aforementioned manufacturing options.

$$P_t\left(x_t\right) = \left\{ \left(y^g, y^b\right) \, : \, \sum_{k=1}^{K} \cdot \lambda_{t,k} y_{t,k,m}^g \geq y_{t,k,m}^g, \forall m; \sum_{k=1}^{K} \cdot \lambda_{t,k} y_{t,k,i}^b = y_{t,k,i}^b, \forall i; \sum_{k=1}^{K} \cdot \lambda_{t,k} x_{k,t,n} \leq x_{k,t,n}, \right. $$
$$\left. \forall n; \sum_{k=1}^{K} \cdot \lambda_{t,k} = 1, \lambda_{t,k} \geq 0, \forall k \right\} $$

(11)

Using a mediating effect approach in Eq. (11), it can be seen more clearly how transnational accumulation impacts green economic efficiency. To be more precise, and to denote operational city specialization $FS_{i,t}$ and technological development $TI_{i,t}$, accordingly, as the mediator variables, the preceding study aims to test if transnational concentration has a substantial impact on GEE.

$$M_{i,t} = \gamma_0 + \gamma_1 \text{poly}_{i,t} + \gamma_2 \text{poly}_{i,t}^2 + \xi_{\text{year,province}} + \varepsilon. $$

(12)

When the moderating effect parameters are denoted (Eq. 12) by an estimated coefficient through using hypothesis testing, it can be determined whether or not the chosen factors usually are truly significant conduits via which Regio centric centralization influences green economic efficiency.

3.3 Empirical models

To investigate the three components, several experimental analyses were done. Because the response variable, green economic efficiency, is a variable with a range of [0, 1], a panel data Tobit model is used. The accompanying model is used to investigate the correlation between financial inclusion and green economic efficiency for hypothesis 1.

$$\text{GEE}_{it} = \alpha_0 + \beta_1 \text{west}_{id_{it}} + \beta_2 \text{west}_{t_{it}} + \beta_3 \text{west}_{it} + \delta_{itk} \sum_{k=1}^{7} \cdot \vec{Z}_{itk} + \varepsilon_{it}. $$

(13)

In which the dependent variables west id and west t represent the area and time periods, correspondingly. When area I is part of the implementation group, then west id = 1 is available. It is worth noting that west t is always 0, except for when the period t falls until the year 2000. The expertise to develop green economic efficiency technologies is frequently provided by a better-quality work force. As a result, the procedure is outlined: When innovative elements are directed into western regions,

it helps achieve green economic growth by advancing institutional policy upgrades, urbanization, and labor quality improvements. This transmission mechanism's reliability is checked by performing the tests listed below, Eq. (14),

$$M_{it} = \alpha_0 + \beta_1 rdf_{it} + \delta_{itk} \sum_{k=1}^{4} \cdot \vec{Z}_{itk} + \varepsilon_{it} \tag{14}$$

$$M_{it} = \alpha_0 + \beta_2 rdf_{it} + \beta_3 rdf\_west_{it} + \delta_{itk} \sum_{k=1}^{4} \cdot \vec{Z}_{itk} + \varepsilon_{it} \tag{15}$$

$$\text{GEE}_{it} = \alpha_0 + \beta_4 west_{it} + \beta_5 M\_west_{it} + \delta_{itk} \sum_{k=1}^{4} \cdot \vec{Z}_{itk} + \varepsilon_{it}. \tag{16}$$

As Eq. (17) shows that the PSTR model employs a regression analysis method to effectively convert subsystems and is a generic version of the Hansen Panel Threshold model. As a result, a comprehensive minimum paradigm modification may be required. The following model has been created using transportation infrastructure improvement as an illustration, Eq. (18).

$$\text{GEE}_{it} = \alpha_0 + \beta_1 indus_{it} + \beta_2 indus * rdf_{it} \left[1 + g\left(rdf_{it}; \gamma_j; c_j\right)\right] + \delta_{itk} \sum_{k=1}^{4} \cdot \vec{Z}_{itk} + \varepsilon_{it} \tag{17}$$

$$g\left(rdf_{it}; \gamma_j; c_j\right) = \left[1 + \exp\left(-\gamma \prod_{j=1}^{m} \cdot rdf_{it} - c_j\right)\right]^{-1}, \gamma \emptyset, c_1 < c_2 < \cdots < c_m \tag{18}$$

$$\text{GEE}_{it} = \partial_0 + \beta_0 \text{Green economy} * rdf_{it} + i\text{efficiency}$$
$$* rdf_{it}\left(\theta_1 rdf_{it} + \theta_2 rdf_{it}^2 + \cdots + \theta_m rdf_{it}^m\right) + \varepsilon_{it}^*. \tag{19}$$

The SBM-DEA system is capable of avoiding directional and angular velocity variance. This approach may also assess efficiency while generating undesired results (Guo et al. 2011). The SBM-DEA approach is used in this research to compute the green economic efficiency of China's regions because of this. Here is how it works, Eq. (19) and its constraints in Eqs. (20) and (21):

$$\min \rho = \frac{1 - \frac{1}{m} \sum_{i=1}^{m} \cdot \frac{s_i^-}{x_{i0}}}{1 + \frac{1}{q_1 + q_2}\left(\sum_{r=1}^{q_1} \cdot \frac{s_r^+}{y_0} + \sum_{t=1}^{q_2} \cdot \frac{s_t^b}{b_{t0}}\right)} \tag{20}$$

$$\text{s.t.} = \begin{cases} x_0 = \sum_{j=1}^{n} x_j \lambda_j + s^- (i = 1, \ldots, m) \\ y_0 = \sum_{j=1}^{n} y_j \lambda_j - s^+ \left(r = 1, \ldots, q_1 \right) \\ b_0 = \sum_{j=1}^{n} b_j \lambda_j + s^b \left(t = 1, \ldots, q_2 \right) \\ \lambda_j, s_i^-, s_r^+, s_t^{b-} \geq 0 (j = 1, \ldots, n) \end{cases}. \tag{21}$$

3.4 Control variables

Environmental management and financial capital investment extent are monitored by referencing because a municipality seems to be more inclined to take part when China has implemented a series of optimistic green economy goals (Mohan et al. 2021). The proportion of a city administrations pollution abatement expenditure to city-level GDP is used to calculate ecosystems. National sustainable economic efficiency rises in direct proportion to global management. Financial expenditure and economic growth in the sector contributed measures the form of state involvement. Furthermore, the research monitors the Northeast regions of China and differentiates between both the Western region of China and the Southeast and Southwest regions of China, due to the fact that China's various regions show various levels of economic development in financial inclusion in China (Peng and Zheng 2021). Study analysis also includes the normalized values of international economic reliance (the proportion of total imports and exports to GDP) and the normalized valuation of FDI dependence on direct investment, even though trade liberalization has been shown to have a significant effect on financial development by bringing competition and international goods to local producers that are more productive (Huang et al. 2018).

Ultimately, Rd_{it} and HR_{it} are used to measure provincial and municipal research, and innovation and human resource management spending. Rd_{it} is based on the amount of money a municipality spends on research and development activities compared to the territory's gross domestic product. It is a measure of the institutional capital investment proportion for municipal governments since intellectual capital may have increased by capturing the professional skills of workers (Greenwood and Jovanovic 1990). Optimal utilization of human assets successfully moves real growth points forward to generate a comprehensive, improving green economy efficiency through teaching and research (Hauner and Kyobe 2010).

3.5 Data and variables

On the premise of data availability, the research objects selected in this paper are 244 regional-level cities in China. The research objects come from Ultimate sample consisted of 244 regional-level cities from 2008 to 2020 from the China urban data

analysis. In this research, the important contributors are labor, power, and resources. To begin, the labor contribution is calculated using the workload per team at the end of the year, as in prior research (Geddes et al. 2018). The data are all from the China Stock Market and Accounting Research Database (CSMAR) and the world development indicators. According to the information disclosures in annual reports, social responsibility reports, environmental reports and sustainable development reports of listed cities.

Multiple elements of multiple shapes, i.e., input, desired output, and undesirable efficiency, to maintain the summary statistics similar and trustworthy for measuring green economic efficiency are used. Our energy intake predictions are based on the yearly economic powerhouse use in areas with reasonably accurate statistics, which were adopted from Ji and Zhang (2019). The "accounting system procedure" of physical capital estimate and the corresponding output of the financial assets of regional capital cities predicated on depreciating years of dependency on the government are used as an indication of plant and equipment input for the evaluation of national wealth.

To calculate the intended output, the city's true Gross domestic product in 2010 used as the desired output. To be more detailed, study computed the real local gross domestic product and gross domestic product inflation figures index (the year 2004) for every regional capital city using the gross domestic product from the China *n* Urban Official Book, which represents genuine gross domestic product (last year 100). When an undesirable result is produced, industrial pollution releases are released into the atmosphere. Diverse types of pollutant emissions lead to various environmental indicators that may be utilized in several investigations. Three criteria, industrial effluent release, commercial particulate disposal, and commercial sulfur dioxide release, are chosen as undesired outcomes for the explanatory parameters in this article because of the analysis of information and the earlier studies by Ahmad et al. (2016). It is important to keep in mind that all three determinants are included in the analysis at around the same time, independently. Equations may be used to determine the efficiency of every unwanted output. Considering the weighted mean of the efficiency of the unwanted by-products, they may provide an overall increasing environmental efficiency and pollution prevention efficiency.

4 Results and discussion

4.1 Financial inclusion and green economic efficiency

Model 1 takes into account the environment, fiscal spending, regional disparities, and the relationship between economic growth and corporatization. Model 2 regulates the competitiveness of the company, research and development spending, and human resources spending. Regression Model 2 is used to test the robustness of our findings toward a number of different parameters, whereas regression Model 1 is used to examine the sensitivity of our findings. There must be substantial positive factors of financial inclusion for all three indices, suggesting that increased financial inclusion improves green economic efficiency. Increasing access to quality health

Table 1 Financial inclusion impact on green economic performance

Indicators	(1)	(2)	(1)	(2)	(1)	(2)
Financial inclusion total	0.007 (0.001)	0.005			0.014	0.02
Financial inclusion width			0.009 (0.003)	0.006	− 0.003	− 0.001
Environmental governance	0.298 (0.081)	0.291 (0.081)	0.298 (0.081)	0.341 (0.082)	0.321 (0.083)	0.298 (0.081)
Environmental governance						− 0.01
Fiscal expenditure	− 0.059	− 0.041	− 0.059	− 0.041	− 0.061	− 0.041
Fiscal expenditure						
Region	0.013 (0.007)	0.016 (0.009)	0.016 (0.009)	0.015 (0.007)	0.013 (0.007)	0.016 (0.009)
Region						
Trade openness	0.002	0.002	0.002	0.002	0.002	0.002
Marketization	− 0.001	− 0.001	− 0.001	− 0.001	− 0.001	− 0.001
Industrial structure	− 0.079	− 0.078	− 0.082	− 0.081	− 0.089	− 0.07
						− 0.041
R&D investment		0.039		0.041		0.061
		− 0.038		− 0.040		− 0.039
HR investment		− 0.211		− 0.209		− 0.241
						− 0.451
		− 0.069		− 0.071		− 0.131
		− 0.169		− 0.171		− 0.171
N	1023	1023	1023	1023	1023	1023
Wald Chi2	59.57	62.23	57.84	60.21	61.72	62.54

care can have a major impact on the economy, enhancing economic activity and payment information, which then results in more income and a strong credit foundation for the mortgage company (Sadiq et al. 2021). This allows business owners to solve shortfalls and put more money into the renewable energy industry. The more local firms use wealth management, the fewer financial constraints they would face, which will allow them to focus on their core business rather than worrying about money. This will free up capital for them to participate in other areas of their business, such as research and development, manufacturing, and marketing (Guo et al. 2011). To evaluate and oversee the practical applicability of the green economy, environmental policy is essential (Bai-Chen et al. 2012). The very significant level shows cultural development in affecting green market prosperity. According to Shao et al. (2020b) findings, China's green economy expansion is uneven, with moderate bandwidth and companies (Table 1).

A lot of research has been done at the micro-level to better understand how trade balance affects the management of micro-businesses, focusing mostly on strategy

Table 2 Green economic efficiency analysis

Indicators	(1)	(2)	(4)	(5)	(6)
Financial inclusion total	0.007				
Insurance		0.006			
Environmental governance			− 0.004		
Credit				0.003	
Fiscal expenditure				− 0.002	0.021
Environmental governance Region	0.389 (0.081)	0.291 (0.079)	− 0.004	− 0.002	− 0.006
				− 0.081	0.262
					− 0.251
Trade openness	− 0.051	− 0.019	− 0.069	− 0.001	0.024
					− 0.089
Marketization	− 0.081	− 0.081	− 0.139	− 0.061	− 0.139
	− 0.041	− 0.042	− 0.040	− 0.031	− 0.03
Industrial structure	0.02	0.02	0.01	− 0.002	0.004
	0.004	0.004	0.003	0.002	0.006
Financial inclusion total	0.011	0.013	0.019	0.011	0.018
	0.007	0.007	0.008	0.008	0.008
Environmental governance	0.041	0.03	− 0.029	0.091 (0.041)	− 0.069
	− 0.039	− 0.039			− 0.061
R&D investment	− 0.261	− 0.231	− 0.502	− 0.401	− 0.519
					− 2.365
HR investment	− 0.009	− 0.112	0.432 (0.122)	− 0.179	− 0.365
					− 0.521
N	1023	1023	489	1021	249
Wald Chi2	62.49	62.01	20.2	47.95	20.73

development, acquisitions, and the proper deployment of current assets (Zhang et al. 2016). Existing research mainly offers two conflicting perspectives on whether a start-up export growth impacts its management. However, when businesses are confronted with an increasing exchange rate, larger firms will correctly direct measure, analytically answer, and make aggressive adjustments. Public funding from financial assistance and legislation helps create a favorable country's economy for firms, which helps them achieve long-term growth in their effectiveness. This is a win–win situation. On the other hand, when confronted with an uncertain austerity development, entrepreneurs are more likely to take a conservative stance and think more carefully before engaging. This is because it is impossible to anticipate the potential world, which really is unfavorable for the strategies of companies (Table 2).

4.2 Financial services and green economic performance

A company's ability to increase organizational effectiveness while also enhancing its credibility is aided by becoming green. According to Cull et al. (2017), operators in Southern California are less productive than refineries situated abroad that are not susceptible to almost the same environmental quality restrictions. As a result of these regulations, manufacturers in Southern California incur higher costs, but they also produce more quickly than samples obtained. As a result, strict environmental regulations aid production efficiency indirectly by pressuring companies to use environmentally friendly manufacturing methods. In other research, ecological operations have been shown to create growth, particularly in companies with strong organizational capital. By making payments in formal financial institutions more popular through technological communications and virtual means, even those who do not have a bank account will be able to make payments more easily and efficiently. This kind of cost-effective payment method will help increase overall economic efficiency, including green economic efficiency, while also saving money (Xiao et al. 2019). As the reimbursement industry expands, it has the potential to offset the uncertainties correlated with increasing using security to provide monetary support and facilitate social administration, as well as contribute to sustainable growth itself. Additionally, financial inclusion benefits entrepreneurs by lowering their related costs of investment, easing capital constraints, and lowering their credit benchmark. The elevated use payment official investigation businesses can also solve the ambiguity in enterprises investments and mitigate the possibility of banking institutions lending to enterprises with adverse credit archives (Sadiq et al. 2021). As a result, small businesses with decent credit archives are somewhat more successful in obtaining lines of credit that will help them convert into modern industries.

4.3 Factor efficiency analysis

It is also possible that the connection exists, but it is difficult to see since the indices fluctuated so much throughout the study period. The bottom line is that drawing

Table 3 Green economic performance and financial inclusion

Variables	LE	EE	CE	ENE	ECNE
Financial inclusion total	0.089	0.039	− 0.009	0.039	0
	− 0.021	− 0.031	0.006	− 0.01	0
Environmental governance	− 0.761	− 0.008	0.765	− 0.389	− 0.001
	0.681	5.053	− 0.623	0.301	0.002
Fiscal expenditure	0.221	0.031	0.439	− 0.289	− 0.002
	− 0.351	− 0.498	− 0.289	0.278	0
Region	0.112	0.231	0.092	0.081	0
	− 0.043	− 0.089	− 0.039	− 0.041	0
Trade openness	0.041	0.038	− 0.019	0.009	0
	− 0.032	− 0.042	0.031	− 0.011	0
Marketization	0.079	− 0.378	− 0.181	− 0.187	0.002
	− 0.239	0.711	0.376	0.289	0
Industrial structure	− 0.289	0.007	− 0.312	− 0.199	0.002
	0.489	3.367	0.421	0.029	0
R&D investment	− 5.832	− 8.239	0.009	3.763	− 0.009
	8.246	3.893	− 4.265	− 3.672	0
HR investment	3.562	3.762	3.632	4.091	0.007
	0.019	4.652	4.934	2.831	0.001
N	1023	1023	1023	1023	1023
Wald Chi2	41.37	39.76	19.42	21.68	20.76

conclusions are based on unreliable assessments of the sequences. As a first step in proving the validity of our hypotheses, numerous researches have been conducted to determine the functional consequences of repatriation in recipient nations due to the increase in the amount and significance of these payments. The results of the few studies that have looked at this nexus have been equivocal. According to Long et al. (2019), remittances have a large influence on accumulating capital but have little effect on increasing in TFP. However, the absence of a performance influence or a potential detrimental impact on macroeconomic performance could make the net contribution to the economy unclear because of these results. Contributions may influence gross domestic product in a variety of ways, as shown by Li et al. (2013). LE, EE, CE, ENE and ECNE shows efficiency in terms of labor energy capital environment and economic respectively (Table 3).

For example, under Mundaca's conceptual model, transfers may have a large impact on growth. In addition, with work revenue, families get contributions, which they invest in lending institutions, as per his research. By allocating these payments to effective initiatives, these financial institutions may affect actual economic performance. This approach has been used in other empirical studies (Ouertani et al. 2018) to assess the effect of money transfers and economic deepening on output growth. They believe that the banking system can replace money transfers and that this reduces the overall growth-pushing impact of these transfers. Giuliano et al. (2009) claim that now the banking system can also compensate for transfer payments, on

Table 4 Credit restrictions analysis

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Financial inclusion total	0.007 (0.001)	− 0.005				
		0.004				
Environmental governance			0.009 (0.003)		0.014	
					− 0.003	
Fiscal expenditure				− 0.006		0.02
				0.001		− 0.001
Environmental governance Region	0.298 (0.081)	0.291 (0.081)	0.298 (0.081)	0.341 (0.082)	0.321 (0.077)	0.298 (0.081)
Fiscal expenditure Trade openness	− 0.059	− 0.041	− 0.059	− 0.041	− 0.061	− 0.01
						− 0.041
Region	0.013 (0.007)	0.016 (0.009)	0.016 (0.017)	0.015 (0.007)	0.013 (0.007)	0.016 (0.0018)
Marketization	0.002	0.002	0.002	0.002	0.002	0.002
	− 0.003	− 0.001	− 0.001	− 0.001	− 0.001	− 0.001
Industrial structure	− 0.079	− 0.078	− 0.082	− 0.081	− 0.089	− 0.07
						− 0.041
R&D investment		0.039		0.041		0.061
		− 0.038		− 0.04		− 0.039
R&D investment		− 0.211		− 0.209		− 0.241
						− 0.451
HR investment		− 0.071		− 0.071		− 0.131
		− 0.169		− 0.171		− 0.171
N	1023	1023	1023	1023	1023	1023
F	59.57	62.23	57.84	60.21	61.72	62.54

the other hand, Lin and Xu (2020) described a comparable result. Capital inflows have a beneficial effect on economic growth because of the economic development. It is possible that the disparities across empirical research are due to the various empirical methods used, the wide range of nations examined, and the stock market development metrics that were employed.

4.4 Financial inclusion and green economic performance

Advancement and rationalization of the structural transformation may influence GEE via significant effects, which primarily entail competitive effects and economic effects as well as technological advancement. Promoting industrial improvement will unavoidably result from excessive rivalry among local businesses, leading to an environment of natural selection and survival (Shan et al. 2017). By increasing their investments in research and development, businesses will be compelled to enhance their production processes constantly while simultaneously reducing their natural resource intake (Sun et al. 2012).

Table 4 shows that the trade openness, financial flows, and import substitution are all characteristics of global capitalism, and they all have an effect on economic growth as well as environmental stewardship. Improved globalization may enhance the impact of hydrocarbon resources, which may lead to a rise in pollutants if operational volumes are increased. Other people believe that financial integration may help enhance soil sustainability by transferring clean technologies. In spite of this, some academics believe that equity fund decisions may even worsen environmental protection via price marketing practices. The effects of globalization on present and future generations and the achievement of SDGs have been well documented (Shao et al. 2020a). Sustainable energy advocates (Xiao et al. 2021) urge globalization and greater prosperity while conserving natural resources and reducing waste generation, (see Table 5). Ecology or ecological entrepreneurship is called for as part of a new industrial fundamental change.

To obtain optimal estimates, the impact of a few key variables is mitigated. Local economic growth and performance are strongly influenced by the availability of assets as an "additional stimulus" (Apergis and Payne 2014). Connectivity may also facilitate the transfer of information between regions, speed up the spread of new technologies, and enhance greenhouse gas reduction systems in an indirect way. Regional development output is directly influenced by expenditure. Government interference, according to Luo et al. (2020), has an impact on green economic efficiency. Economic expansion necessitates large amounts of energy consumption, but it may also offer a substantial foundation for environmental protection. The sector of the economy often generates trash that contributes to pollution or creates climate change. There is evidence to suggest that urbanization has a significant impact on per capita energy usage and may be utilized to help curb that use. Having better-quality workers means having more information resources to invest in hydrocarbon technological improvements, strengthening local research and innovation exchanges, which aids economic development innovation, deployment of network infrastructure (Gallagher et al. 2018). As a result, these factors must be taken into consideration.

Table 5 Financial inclusion and credit constraints

Indicators	(1)	(2)	(1)	(2)	(1)	(2)
KZ	0.004	0.004	0.004	0.004	0.004	0.004
	0.003	0.001	0.003	0.001	0.001	0.002
Financial inclusion total	0.007 (0.001)	0.003				
		0.006				
Financial inclusion width			0.009 (0.003)	0.006		
				0.002		
Environmental governance					0.014	0.01
					0.010	0.008
Environmental governance					−0.003	−0.001
Fiscal expenditure	0.298 (0.081)	0.291 (0.081)	0.298 (0.081)	0.341 (0.082)	0.321 (0.083)	0.298 (0.081)
Fiscal expenditure	−0.059	−0.041	−0.059	−0.041	−0.061	−0.01
Region						−0.041
Region	0.013 (0.007)	0.016 (0.009)	0.016 (0.009)	0.015 (0.007)	0.013 (0.007)	0.016 (0.009)
	0.002	0.002	0.002	0.002	0.002	0.002
	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001
Trade openness	0.079	0.078	0.082	0.081	0.089	0.06
	0.002	0.003	0.001	0.001	0.002	0.010
Marketization						0.039
						0.002
Industrial structure		0.034		0.040		0.060
		0.002		0.003		0.001
		0.038		0.040		0.039
R&D investment		0.211		0.210		0.238
		0.001		0.005		0.452
HR investment		0.070		0.069		0.128
		0.169		0.171		0.171
N	489	489	489	489	489	489
p value	0.02	0.03	0.03	0.03	0.02	0.03

Table 6 Financial inclusion on green economic performance (fiscal expenditure)

Indicators	(1)	(2)	(1)	(2)	(1)	(2)
Financial inclusion total	0.007 (0.001)	0.005				
Financial inclusion width			0.009 (0.003)	0.006		
Environmental governance					0.014	0.02
					0.003	0.001
Environmental governance	0.298 (0.081)	0.291 (0.081)	0.298 (0.081)	0.341 (0.082)	0.321 (0.083)	0.298 (0.081)
Fiscal expenditure	(0.059)	(0.041)	(0.059)	(0.041)	(0.061)	0.01
Fiscal expenditure	0.002	0.003		0.001	0.006	0.041
Region	0.013 (0.007)	0.016 (0.009)	0.016 (0.009)	0.015 (0.007)	0.013 (0.007)	0.016 (0.009)
Region	0.002	0.002	0.002	0.002	0.002	0.002
Trade openness	0.001	0.001	0.001	0.001	0.001	0.001
Marketization	(0.079)	(0.078)	(0.082)	(0.081)	(0.089)	0.07
	0.010	0.002	0.009	0.005	0.002	0.041
Industrial structure		0.039		0.041		0.061
		0.038		0.040		0.039
R&D investment		0.211		0.209		0.241
						0.451
HR investment		0.069		0.071		0.131
		0.169		0.171		0.171
N	962	962	962	962	962	962
Wald Chi2	33.78	39.56	46.89	42.67	59.08	61.55

Table 6 shows that GEE is significantly affected by financial inclusion, mostly via financing restrictions placed on contaminating companies. Including more people in the financial system does not seem to have any effect on green economic efficiency. To summarize, the access to finance of financing restrictions on close-to-the-edge businesses substantially validates the approach. Financial inclusion may make it harder for damaged companies to get loans, which will speed up and improve the efficiency of economic growth and modernization.

4.5 Robustness analysis

Statistical assessments, such as using various assessment approaches and incorporating control variables, determine the reliability of the findings. While GEE may help with financial inclusion, it can also have adverse effects on economic organizations like businesses.

Xiang et al. (2021) saw economic progress as being inextricably linked to state interference. In the opinion of Xiang et al. (2021), government-implemented carbon reduction measures may hasten the growth of the effort to develop while decreasing contamination risks and the endurance of potential pollution. Public expenditure on ecological sustainability is a major source of finance for ecological sustainability in China. A framework for GEE has been used to arrive at these conclusions. It is called the MinDW model. The measurement of the MinDW is less stringent than the conventional radical framework requirements of a "strong production possibility frontier" and the SBM approach communications network.

Tables 7 and 8 show the robustness analysis. In principle, the more urbanized a country or region is, the more developed its economy is. There are several debates going on right now about the connection between urbanization and green economic efficiency. There is always the argument that as cities grow and as businesses expand, energy requirements rise rapidly, culminating in more contaminants and a decrease in energy efficiency (Shen et al. 2021). Other people believe that as cities get more developed, their economic and environmental efficiency will increase as well. It is sufficient to justify a better ecological environment since they live in cities where there are so many of them. In response to the regional administration's increased concern for environmental conservation, local businesses are obliged to make changes and adopt new technologies to decrease energy demand and emission levels. According to Tian et al. (2021), urbanization benefits local sustainability. The effect of urbanization level on green economic efficiency is a subject of debate.

5 Conclusion and policy implications

This research is a pioneering effort to establish a connection between financial inclusion and environmental sustainability. Since the 21st Democratic Party session, China has made increased attempts to improve reserves and reduce environmental impact, strengthening the strategic framework that clear rivers and green hills are

Table 7 One-period lagged regressions analysis

Indicators	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Financial inclusion total	0.007 (0.001)	0.005				
Financial inclusion width			0.009 (0.003)	0.006		
Environmental governance					0.014	0.02
Environmental governance					0.003	0.001
Fiscal expenditure	0.298 (0.081)	0.291 (0.081)	0.298 (0.081)	0.341 (0.082)	0.321 (0.083)	0.298 (0.081)
Fiscal expenditure	(0.059)	(0.041)	(0.059)	(0.041)	(0.061)	0.01
Region	0.002	0.003		0.001	0.006	0.041
Region	0.013 (0.007)	0.016 (0.009)	0.016 (0.009)	0.015 (0.007)	0.013 (0.007)	0.016 (0.009)
Trade openness	0.002	0.002	0.002	0.002	0.002	0.002
	0.001	0.001	0.001	0.001	0.001	0.001
Marketization	(0.079)	(0.078)	(0.082)	(0.081)	(0.089)	0.07
	0.010	0.002	0.009	0.005	0.002	0.041
Industrial structure		0.039		0.041		0.061
R&D investment		0.038		0.040		0.039
		0.211		0.209		0.241
						0.451
HR investment		(0.069)		(0.071)		0.131
		0.169		0.171		0.171
N	962	962	962	962	962	962
Wald Chi2	33.78	39.56	46.89	42.67	59.08	61.55

Table 8 Robustness analysis

Variables	(1)	(2)	(1)	(2)	(1)	(2)
Financial inclusion total	0.008 (0.001)					
Financial inclusion width		0.005	0.009 (0.003)			
Environmental governance				(0.006)	(0.014)	(0.002)
				0.002	0.001	0.005
Environmental governance	0.298 (0.081)	0.291 (0.081)	0.298 (0.081)	0.341 (0.082)	0.003	0.001
Fiscal expenditure					0.321 (0.083)	0.298 (0.081)
Fiscal expenditure	(0.059)	(0.041)	(0.059)	(0.041)	(0.061)	0.01
Region	0.002	0.003		0.001	0.006	0.041
Region	0.013 (0.007)	0.016 (0.009)	0.016 (0.009)	0.015 (0.007)	0.013 (0.007)	0.016 (0.009)
Trade openness	0.002	0.002	0.002	0.002	0.002	0.002
	0.001	0.001	0.001	0.001	0.001	0.001
Marketization	(0.079)	(0.078)	(0.082)	(0.081)	(0.089)	0.07
	0.010	0.002	0.009	0.005	0.002	0.041
Industrial structure		0.039		0.041		0.061
		0.038		0.040		0.039
R&D investment		0.211		0.209		0.241
						0.451
HR investment		(0.069)		(0.071)		0.131
		0.169		0.171		0.171
N	1023	1023	1023	1023	1023	1023
Wald Chi2	35.78	40.56	44.89	43.67	60.08	59.55

essential pieces. An important aspect of economic growth frameworks is to look at the connection among economic advancement and GEE, as well as how to promote sustainable economic growth. A number of empirical results provide credence to the theories. For the latter, component segmentation shows that financial inclusion has a significant impact on GEE, particularly in terms of energy and climate change performance. Another finding from the research shows that financial inclusion may boost GEE by tightening credit restrictions on contaminating companies and speeding up those firms' becoming green via structural revolution and modernization.

In addition, the results have significant ramifications for nations like China, which are rapidly recognizing the need to move to a green economy. Benefits of financial inclusion include improved labor conditions, increased eco-efficiency, and a more sustainable environment. However, benefits in terms of financial inclusion ought to be incorporated into policies promoting financial inclusion. This will assist in redistributing resources effectively, which promotes environmental and economic efficacy. It is also critical that new ties be established between governments, banking firms, and businesses to encourage economic development that is also ecologically sound. A green economy requires social, commercial, and technological activities all at once. These initiatives include making the changeover, an extremely important part of the policy platform, improving the financial system's inclusion, and updating corporate technologies and institutions. The synchronization of accessible financing and the modification of specific RRR is another important factor in raising credit restrictions on polluting companies and promoting structural revolution and innovation performance.

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