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RESEARCH ARTICLE

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Greening African economy: The role of Chinese investment and trade

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Abstract

Global warming and the rapid depletion of natural assets have made many countries anxious to find green growth strategies, including global partnerships and international business. China has positioned itself as the right partner for sustainable growth and development in Africa through different engagement routes. In this study, we employ fixed effects on a sample of 27 countries over 17 years to examine the impact of China's foreign direct investment and trade on green growth in Africa. Our results show that China's investment and trade affect green growth differently. We find that foreign direct investment and export have a negative impact on green growth. Contrarily, we find importation from China to increase green growth. Our results suggest that the growing presence of China in Africa through direct investment and exportation of natural resources is likely to hamper achieving the Sustainable Development Growth goals. However, countries can harness some benefits from importing sustainable products from China. Our study extends the green growth literature and informs policymakers of the need to pay attention to the effects of growing Chinese-Africa engagement on attaining sustainable and greener growth. The results are robust to different identification techniques, including two-stage least square and system generalised method of movement.

KEYWORDS

Africa, China; export; foreign direct investment; green growth; import

1 | INTRODUCTION

Over the last decades, Africa has experienced rapid economic growth (African Development Bank—AfDB, 2012). However, increasing aggregate demand for natural resources and continuous deforestation have raised concerns about the continent's future green growth. Although African countries' contribution to climate change is negligible (Gordon, 2012; United Nations Economic Commission for Africa, 2012), their CO_2 emissions are increasing at an increasing rate (AfDB, 2012). The continent is also becoming more vulnerable to the negative effect of climate change (Intergovernmental Panel on Climate Change—IPCC, 2007). Hence, these trends have necessitated green growth in Africa's environmentally sustainable economic growth (AfDB, 2012). The Organization for Economic Co-operation and Development—OECD (2011) defines green growth as fostering economic growth and development, ensuring that natural assets continue to provide the resources and environmental services on which humanity's well-being relies. Thus, green growth consists of economic

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growth compatible with reduced emissions, efficient use of natural assets, and protection of ecosystems (AfDB, 2012; OCED, 2011; World Bank, 2012).

As a continent besieged with low technology and infrastructure, one such way of advancing green growth in Africa could be foreign direct investments and international trade (Bosshard, 2008). As the leading intelligent technology and renewable energy provider, China has propelled itself as the right partner for Africa's green growth agenda (The Diplomat, 2018). Given the Chinese commitment to renewable energy and China being the most prominent development partner in Africa's energy sector (Gualberti et al., 2014), we examine the relationship between Chinese investment and environmental productivity in Africa. Following the pollution halo hypothesis, we argue that China, the leader in smart technology, will transfer environmentally efficient technologies to Africa, thereby increasing its trading partners' environmental productivity and furthering green growth in Africa.

We use data on 27 countries from 2002 to 2018 to test this conjecture. Data on green growth indicators are collected from the Organization for Economic Co-operation and Development (OECD) database. The OECD database defined green growth as the environmentally and economically efficient use of natural assets and materials in production and consumption. Chinese foreign direct investment and trade data are sourced from the China Africa Research Initiative (2020). Our econometric estimation techniques include a fixed-effect ordinary least square model, two-stage least square instrumental variables (2SLS-IV), and a System Generalised Method of Movements (S-GMM). We find a negative and significant relationship between Chinese investment and green growth. We also see a negative relationship between export and green growth. However, the results show that importation from China positively influences green growth. Our results suggest that FDI from China and export to China, mainly in natural resources, pose a challenge to achieving Sustainable Development Goals by 2030. Our results are also economically significant. For example, a one-point increase in Chinese foreign direct investment as a percentage of gross domestic product (GDP) will decrease green growth by 0.1665 points. In contrast to China's results, we did not find a significant relationship between USA-Africa engagement and green growth, probably due to the decline in USA investment and trade in Africa.

Our results imply that, despite its lead in renewables and smart technology, China's presence in Africa may not lead to green growth because of the excessive extraction of natural resources, a significant deterrent to green growth. Many argue that China is in Africa primarily to extract more resources to fuel Chinese rapid industrialisation (Chang, 2014; Cheung & Qian, 2009; Gordon, 2012; Koslstad & Wiig, 2012). China's hunger for natural resources and global market presence could lead to the deterioration of the environment by exporting inferior goods and excessive extraction of natural resources (Grossman & Krueger, 1995).

Our study is motivated threefold, corresponding to three contributions. First, despite its low CO_2 emissions (Gordon, 2012; United Nations Economic Commission for Africa, 2012), Africa is one of the most vulnerable continents to the negative effect of climate change (AfDB, 2012; IPCC, 2007), and requires robust green growth to sustain its agrarian land. Therefore, we provide evidence that relying on external support through trade and foreign direct investment may not align with Africa's green growth agenda. Second, and more specifically, we are motivated by China's bold promise of a greener environment in Africa (Brookings, 2018; Gordon, 2012; The Diplomat, 2018). Our study provides empirical evidence suggesting that China's promise of green growth in Africa is far from materialised, at least in our sample countries. This is also evident in the sharp decrease in green growth in most African countries, especially over the last two decades, when China became the leading investor in Africa.

Third, we are motivated by the limited empirical studies on green growth, a vital research area, given increased climate change. Our study, which to the best of our knowledge, is the first of its kind on the relationship between international business and green growth, is distinctively different from existing literature on CO_2 emission (Bokpin, 2017; Demena & Afesorgbor, 2019; Kivyiro & Arminen, 2014; Shahbaz et al., 2015; Shahbaz et al., 2017; Xie et al., 2020). Unlike prior studies, we focus on how FDI and trade are associated with environmental productivity rather than environmental problems, as enshrined in many studies. We focus on whether FDI and trade can improve the efficient use of natural assets rather than carbon emissions. By this, our study contributes to the literature on the determinants of green growth.

Our study is timely as countries strive to achieve the Sustainable Development Goals by the 2030 deadline. Our results suggest that most actions by China could potentially retard African efforts regarding the achievement of the Sustainability Development Goals (SDG), specifically on Goal 13—*Take urgent action to combat climate change and its impacts*.

The remainder of the article is structured as follows. We present the background and review the literature in the next section. The research methods are shown in the third section. The fourth section presents the results and discussions. Policy implications are presented in the fifth section, and the paper concludes in the sixth section.

2 | BACKGROUND AND LITERATURE REVIEW

2.1 | China's investment in energy in Africa

China has paraded itself at the forefront of global climate diplomacy by having the most significant investment in renewable energy worldwide (AidData, 2014; The Diplomat, 2018). Since 2012, China has been the world's biggest investor in renewable energy at home and abroad (The Diplomat, 2015). As of 2015, China had about 24% of the world's renewable energy capacity, with $396 billion and $135 billion invested abroad in energy and transportation, respectively (The Diplomat, 2015). Chen (2010) argues that China's green leap forward policy, which includes a significant investment in renewable energy solutions, could help Africa avoid future emissions. China can supply energy to Africa's rural parts with zero emissions (Bosshard, 2008). A recent report by McKinsey Consulting Firm predicts a China-led digital revolution in Africa (Mckinsey and Company, 2017).

Among the numerous activities that contribute to negative green growth is energy consumption. The energy sector in Africa is rapidly developing and has become a front-runner for governments and international partners. ESI Africa (2019) gauges that just $12.6 billion have been committed to providing electricity to the residential energy user, representing just one-quarter of the expected annual global access of $51 billion investment. We briefly explore the funding for energy from China and other international partners to understand better the complex nature of energy structure and funding trends around public and private investment in promoting access to renewable energy and green growth.

An estimated $16 billion was invested in the energy sector of Africa by the Chinese government between 2002 and 2012, making China the largest developing partner in the energy sector of Africa with 41% commitments, higher than the European Union, which remained at 18% ($7 billion) and the United States 1% (500 million) (AidData, 2014). In 2004, $2 billion in loans were offered to Angola for infrastructure development (such as electricity, roads, water, telecom, and public works). Similarly, Nigeria and Sudan also benefited from similar loans, with about $390 million loaned in 2004 to help ease the electricity shortage in Nigeria and promote economic and trade cooperation between the two countries. At the same time, Sudan received $13 billion in finance for infrastructural development, particularly the El Gaili Combined Cycle Power Plant construction in 2001 and the Qarrel thermal station in 2002 (Institute of Developing Economies, DATE; Japan External Trade Organisation, 2020).

2.2 | Review of literature

Although there is a global momentum towards sustainable development (OECD, 2020), empirical studies on green growth are scarce. This is partly because green growth has only gained prominence since OCED launched its green growth strategy in 2011. Green growth involves cost-effective ways of reducing environmental pressures and demands new patterns of growth that make efficient use of natural assets. As a subset of sustainable development, green growth operational policies should achieve concrete, measurable progress at the interface of development and the environment (Guo et al., 2020; Lyytimäki et al., 2018; OECD, 2020). In effect, the green growth strategy requires new efficient and effective ways of increasing growth with minimal or no environmental impact. Although there is no one-size-fits-all approach to attaining green growth (AfDB, 2012), undoubtedly, developing countries need new ways to improve the effective and efficient use of resources. Accordingly, foreign direct investment and trade are mechanisms through which effective and efficient methods are transferred to developing countries (Ayamba et al., 2020; Chang, 2014; Cole & Elliott, 2003; Mihci et al., 2005; Pao & Tsai, 2011; Romer, 1993; Zhu et al., 2016).

However, the existing literature provides contrasting views on how foreign investment and trade affect the host country's environment. Findings of earlier studies on the subject matter provide evidence of the negative effect of foreign investment and trade on the environment based on the argument that multinational companies move their pollution-intensive operations to developing countries. These findings are supported mainly by the pollution haven hypothesis (Pethig, 1976; Walter & Ugelow, 1979). On the contrary, recent studies on the foreign business-environment nexus have begun acknowledging the positive effect of foreign investment and trade on the environment. These recent findings are supported by the pollution halo hypothesis, which posits that foreign investment and trade are instruments to transfer good technology and knowledge from advanced countries to developing (Birdsall & Wheeler, 1993). Hence foreign investment and trade promote sustainable and sound environmental practices (Cole & Elliott, 2003; Mihci et al., 2005; Pao & Tsai, 2011; Zhu et al., 2016; Ayamba et al., 2019; Jijian et al., 2021). For instance, Wang et al. (2022) report a negative association between export and carbon emissions, suggesting that exporting reduces carbon emissions.

According to Pazienza (2019) and Bakhsh et al. (2017), the pollution haven hypothesis is based on foreign investors' capitalist perspectives, focusing on efficient production with no interest in environmental performance. This implies that firms maintain a strategic distance from environmental guidelines by moving to places with weak environmental policies and laws. Baek (2016) shows that FDI negatively affects the environment in five ASEAN countries, supporting the pollution haven hypothesis. Similarly, Malik et al. (2020) find FDI to have a negative effect on the environment in both the short-run and long-run in Pakistan. This is because the FDI in Pakistan is directed to the service sector, which has frequently set off contaminations. However, Yu and Xu (2019) state that FDI to China's western region neither improves nor deteriorates environmental quality. However, the FDI at the national level improves environmental quality due to technological advancement investment. An increase in FDI flow adequately improves technological innovation, promoting the quality of the environment (Wang & Luo, 2020). Zhang and Zhang (2018), Wang et al. (2017), and Jiang et al. (2015) find that trade has negative impacts on China's CO_2 emissions, while FDI inflows have positive implications for China's CO_2 emissions.

Regarding trade and the environment nexus, Zhang (2020), Kirkpatrick and Scrieciu (2008), and Schmitz et al. (2012) argue that international trade in intermediate goods is more prone to damaging the environment in developing countries than in developed countries. The authors argue that intermediate goods are capitally intensive, and such goods further undergo industrial production, causing pollution. Li and Fang (2011) also argue that unsustainable export worsens the environment, but that can be improved by promoting technological innovation and industrial restructuring. However, Aller et al. (2015) claim that the population growth of trading partners causes more harm to the environment than it improves. Muhammad et al. (2020) contend that both import and export improve the quality of the environment, supporting the pollution halo hypothesis.

The effect of trade and FDI on environments differs from developing to developed economies. This is because developed economies often transfer high emission-intensive production units to developing economies, causing the developing country to increase CO_2 emissions while developed economies achieve emission reduction (Essandoh et al., 2020). Shahbaz et al. (2019) and Xu et al. (2020) affirmed a comparative finding on the United States and China, respectively. However, Haug and Ucal (2019), Chakraborty and Mukherjee (2013), and Forslid et al. (2018) find that FDI and export do not aggravate environmental quality while imports aggravate environmental health, most notably in the long run.

Arguably, considerable literature supports both the negative and positive effects of FDI and trade on the environment, making it impossible to predict a specific direction. The direction of the foreign business environment becomes more complicated and unique in the case of the China-Africa partnership for two reasons. First, China claims to have invested significantly in Africa's renewable and greener energy sources (AidData, 2014; The Diplomat, 2018). Hence, these investments should improve energy efficiency and greener growth. However, most African governments have pledged most of their natural resources as the price for these Chinese investments and trade (Brautigam, 2011; Zhao, 2014). Second, these pledges have resulted in the continent's rapid extraction of natural resources (Simbao, 2012), leading to low environmental productivity and economic growth.

Therefore, unlike previous studies that focused on the global flow of FDI and trade to Africa (Bokpin, 2017; Demena & Afesorgbor, 2019; Kivyiro & Arminen, 2014; Shahbaz et al., 2015, 2017; Xie et al., 2020), this current study focuses on only a single country source. Hence, we offer essential reference to the literature and policymakers to understand and design specific environmental policies that can target the environmental footprint of Chinese foreign activities as China continues to dominate global investment and trade.

3 | RESEARCH METHODS

3.1 | Data

Although 54 recognised countries in Africa (member states of the United Nations) exist, we use the best available data resources to generate substantial panel data on 27 countries over 17 years (2002–2018) due to difficulties obtaining information. Our sample selection is strictly based on data availability. Expressly, our sample period and size are limited by data on green growth.

3.2 | Variable definitions and measurement

Green growth is characterised by the environmentally and economically efficient use of natural resources and materials in production and consumption. We use the OECD green growth indicator, measured by a country's environmental and resource productivity (OECD Statistics, 2020). According to Tawiah et al. (2023), green growth captures how economic growth is becoming greener. It includes areas usually not included in economic and accounting measurements of a country's performance (OECD, 2020). Although green growth is recent compared to other environmental performance measurements, it is widely used in the literature (Gavurova et al., 2021; Smulders et al., 2014; Tawiah et al., 2021, 2023).

3.2.1 | Foreign direct investment (FDI)

The total level of direct investment from China to Africa. This includes the value of the foreign investors' equity in and net loans to the enterprise resident in African countries (China Africa Research Initiative, 2020). Foreign direct investment is one of the key routes of Chinese investment in the energy sector of most African countries (Bosshard, 2008).

3.2.2 | Export/import

Export and import is the annual value of goods and services traded between African countries and China. Data on exports and imports to and from China are collected from the China Africa Research Initiative (2020) at Johns Hopkins University. We deflate FDI, export, and import proportionate to the respective country to control country size differences. However, we present the figures in millions of US dollars in the descriptive statistics for straightforward interpretations.

3.2.3 | Control variables

In line with previous studies on the environmental consequences of foreign businesses, we control for other potential drivers of green growth. Prior studies (Baek, 2016; Demena & Afesorgbor, 2019) used GDP growth, energy consumption, and GDP per capita to control economic growth, energy use, and development. Also, we use the population to control for direct human activities on the environment. More so, we use environmental technologies as a proxy for economic opportunities and policy; and total natural resources rent as a proxy for natural resources to account for the environment-related technologies development and the effect of natural resources extraction. The source of each variable is presented in Table 1.

3.3 | Estimation technique

Following Chakravarty and Mandal (2016) and Bernard and Mandal (2016), we use a fixed-effect model to estimate the impact of Chinese trade and investment on green growth in Africa. The fixed effect

TABLE 1 Variables description and sources.

Variable	Description	Sources
Green growth	Environmental and resources productivity	OECD statistics
Foreign direct investment	The total level of direct investment from China to Africa as a percentage of GDP	China Africa Research Initiative (2020)
Import	Imports of goods and services from China as a percentage of GDP	China Africa Research Initiative (2020)
Export	Exports of goods and services from African countries as a percentage of GDP	China Africa Research Initiative (2020)
Economic development	Gross domestic product per capita 2010 US$	World development indicators
Institutional quality	A composite index of the six worldwide governance indicators	Worldwide governance indicators
Population	Total population	World development indicators
Energy Consumption	Energy use (kg of oil equivalent) per $1000 GDP	World development indicators
Renewable energy	Renewable energy consumption (% of total final energy consumption)	World development indicators
Environmental technologies	Development of environmental-related technologies (% all technologies)	OECD statistics
Natural resources	Total natural resource rent as a percentage of GDP	World development indicators

Abbreviations: GDP, gross domestic product; OECD, Organization for Economic Co-operation and Development.

approach was chosen because it accounts for the country-fixed effect (Bilan et al., 2019). The fixed effect also allows the individual and time-specific effects to be correlated with explanatory variables. Including the country-level effects makes the individual parameter effect viable for making inferences. More so, including fixed effects enables us to control for the average differences across countries in any observable predictors by absorbing all the cross-group action. Fixed effects models also take care of omitted variables bias. Hence, we specify our models as follows:

$$\begin{aligned} \textit{Green growth}_{it} = \alpha_0 &+ \alpha_1 \textit{Foreign direct investment}_{it} \\ &+ \alpha_2 \textit{Economic development}_{it} + \alpha_3 \textit{Population}_{it} \\ &+ \alpha_4 \textit{Energy consumption}_{it} \\ &+ \alpha_5 \textit{Renewable energy consumption}_{it} \\ &+ \alpha_6 \textit{Environmental technologies}_{it} \\ &+ \alpha_6 \textit{Natural resources}_{it} + e_{it} \end{aligned} \tag{1}$$

$$\begin{aligned} \textit{Green growth}_{it} = \alpha_0 &+ \alpha_1 \textit{Import}_{it} + \alpha_2 \textit{Economic development}_{it} \\ &+ \alpha_3 \textit{Population}_{it} + \alpha_4 \textit{Energy consumption}_{it} \\ &+ \alpha_5 \textit{Renewable energy consumption}_{it} \\ &+ \alpha_6 \textit{Environmental technologies}_{it} \\ &+ \alpha_6 \textit{Natural resources}_{it} + e_{it} \end{aligned} \tag{2}$$

$$\begin{aligned} \textit{Green growth}_{it} = \alpha_0 &+ \alpha_1 \textit{Export}_{it} + \alpha_2 \textit{Economic development}_{it} \\ &+ \alpha_3 \textit{Population}_{it} + \alpha_4 \textit{Energy consumption}_{it} \\ &+ \alpha_5 \textit{Renewable energy consumption}_{it} \\ &+ \alpha_6 \textit{Environmental technologies}_{it} \\ &+ \alpha_6 \textit{Natural resources}_{it} + e_{it} \end{aligned} \tag{3}$$

where *it* represented country and time, respectively, and e_{it} is the associated error. All other variables are defined in Table 1.

4 | RESULTS AND ANALYSES

4.1 | Univariate analyses

Table 2 shows the descriptive statistics of the variables used in the analysis. The average export value is ($1459 million), with a high SD of 4013, indicating significant variations among the sample countries.

TABLE 2 Descriptive statistics.

Variables	Obs	Mean	25 percentile	Median	75 percentile	SD
Green growth	459	7.917	4.506	5.046	11.276	4.661
Foreign direct investment (million)	458	510.5	26.07	113.6	540.8	957.7
Import (millions)	459	2044	241.7	725.7	2183	3706
Export (millions)	459	1459	77.03	252.1	1055	4013
Economic development	459	3442	951.7	1628	4830	3720
Population	459	16.52	15.78	16.75	17.47	1.346
Energy consumption	457	133.2	35.56	97.33	180.4	131.8
Renewable energy	455	44.60	5.763	44.48	81.58	36.72
Environmental technologies	459	7.917	4.506	6.592	11.28	4.661
Natural resources	459	13.71	3.921	8.571	18.92	13.57
Number of years	17	17	17	17	17	17

The average statistics of foreign direct investment by China to Africa over the period ($510.5 million) is less than the import from China to Africa ($2044 million), indicating that China benefits more from Africa than its investment. As expected, the average import to Africa ($2044 million) is higher than the export to China from Africa ($1459 million).

The results for the Pearson pairwise correlation are presented in Table 3. The coefficient of all variables is below the threshold of 0.8 for multi-collinearity issues (Field, 2000; Tabachnick & Fidell, 2013).

4.2 | Multivariate analyses

The results from the fixed effect estimations are presented in Table 4. The results in column 1 show that the coefficient of *Foreign direct investment* (−5.659e + 07***) is negative and significant at 1%, suggesting that FDI by China negatively and significantly affects green growth. Given their quest for natural resources, Zhu and Ye (2018) argued that China would likely invest in highly polluting industries such as oil and gas. In economic terms, a one-point increase in Chinese foreign direct investment as a percentage of GDP will decrease green growth by

TABLE 3 Pairwise correlation.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Foreign direct investment	1.000							
Import	0.602	1.000						
Export	0.362	0.232	1.000					
Economic development	0.068	0.021	0.108	1.000				
Population	0.321	0.503	0.061	−0.306	1.000			
Energy consumption	−0.208	−0.155	−0.102	−0.339	0.146	1.000		
Renewable energy	−0.232	−0.223	−0.073	−0.479	0.140	0.658	1.000	
Environmental technologies	0.019	0.055	−0.053	−0.032	0.093	0.083	0.069	1.000
Natural resources	−0.048	−0.075	0.319	0.372	−0.006	0.149	0.012	−0.072

TABLE 4 Main results.

	(1)	(2)	(3)
Variables	Foreign direct investment	Import	Export
Foreign direct investment	−5.659*** (1.160)		
Import		8.457** (3.998)	
Export			−23.68*** (5.313)
Economic development	0.002* (0.001)	0.002* (0.001)	0.002 (.001)
Population	−24.580*** (3.982)	−33.940*** (4.180)	−28.910*** (3.822)
Energy consumption	−0.009*** (0.002)	−0.004* (0.002)	−0.005** (0.002)
Renewable energy	−0.003 (0.009)	−0.006 (0.009)	−0.006 (0.009)
Environmental technologies	−0.002 (0.009)	−0.003 (0.010)	0.001 (0.009)
Natural resources	0.031 (0.027)	0.001 (0.028)	0.037 (0.027)
Constant	184.700*** (28.670)	250.400*** (30.110)	215.900*** (27.580)
Observations	454	454	454
R^2	0.210	0.174	0.203
Number of countries	27	27	27

Note: This table presents the baseline regression on the relationship between Chinese investment and trade and carbon emission in Africa. SE in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

TABLE 5 Moderating effect of institutional quality.

Variables	(1) Foreign direct investment	(2) Import	(3) Export
Foreign direct investment	−5.359*** (1.245)		
Foreign direct investment × institutional qualities	−6.177 (4.153)		
Import		9.812** (4.298)	
Import × institutional qualities		−4.928 (4.146)	
Export			−27.260*** (5.601)
Export × institutional qualities			−5.215** (2.101)
Institutional qualities	−0.370 (0.330)	−0.389 (0.374)	−0.0170 (0.377)
Economic development	0.004* (0.002)	0.000465** (0.001)	0.001 (0.001)
Population	−25.160*** (4.044)	−34.740*** (4.199)	−27.030*** (3.909)
Energy consumption	−0.010*** (0.002)	−0.004 (0.003)	−0.006** (0.002)
Renewable energy	−0.005 (0.009)	−0.008 (0.009)	−0.006 (0.009)
Environmental technologies	−0.003 (0.010)	−0.003 (0.010)	−0.002 (0.010)
Natural resources	0.031 (0.027)	0.004 (0.028)	0.040 (0.027)
Constant	188.700*** (29.06)	255.800*** (30.23)	202.300*** (28.19)
Observations	454	454	454
R^2	0.213	0.183	0.219
Number of countries	27	27	27

Note: This table presents the moderating effect of institutional quality on the relationship between international business and carbon emissions in Africa. SE in parentheses.
***p < 0.01; **p < 0.05; *p < 0.1.

0.1665 points. (Economic significant is calculated as (coefficient *SD)/ mean of green growth [(−5.659e + 07 × 2.33e−08[1])/7.917]).

The result of imports from China is in column 2, and export is in column 3. The coefficient of *Import* (8.457**) indicates that importation from China drives green growth in Africa. However, the negative and significant coefficient (−23.68***) of *export* suggest that the continuous exportation from Africa to China is slowing green growth in most African countries due to the excessive extraction of natural resources such as crude oil, iron ore, cotton, diamond, and other natural resources and primary goods. Economically, a one-point increase

[1]Note that we use the SD based on GDP deflated figures.

TABLE 6 The US analysis.

Variables	(1) Foreign direct investment	(2) Import	(3) Export
Foreign direct investment	−3.210 (7.116)		
Import		−9.258 (9.726)	
Export			0.504 (4.291)
Economic development	0.000329* (0.000200)	0.000319 (0.000198)	0.000346* (0.000196)
Population	−30.12*** (3.941)	−29.84*** (3.918)	−29.88*** (3.951)
Energy consumption	−0.00523** (0.00244)	−0.00523** (0.00244)	−0.00520** (0.00244)
Renewable energy	−0.00194 (0.00957)	−0.00132 (0.00957)	−0.00183 (0.00958)
Environmental technologies	−0.00235 (0.0103)	−0.00125 (0.0103)	−0.00264 (0.0103)
Natural resources	0.0117 (0.0283)	0.0149 (0.0284)	0.0112 (0.0288)
Constant	223.6*** (28.51)	221.6*** (28.32)	221.8*** (28.57)
Observations	459	459	459
R^2	0.156	0.158	0.156
Number of countries	27	27	27

Note: SE in parentheses.
***p < 0.01; **p < 0.05; *p < 0.1.

in imports as a percentage of GDP will lead to an increase in green growth by 0.0985 points [(8.457 × 0.092219)/7.917], but a similar increase in export will lead to a decrease of 0.231 points in green growth [(−23.68 × 0.0773760)/7.927]. The results show that export has the largest and most significant influence on green growth.

Most of the control variables are consistent with the standard assumptions. For example, the economic development proxy by GDP per capita is positive and significant in most cases, implying that economic development plays a significant role in achieving green growth. However, population and energy consumption are negative and significant, which impedes green growth in African countries.

4.3 | Accounting for institutional quality

Prior studies suggest that the impact of foreign investment and trade largely depends on the availability of quality institutions to formulate and police environmental regulations (Peres et al., 2018; Sabir et al., 2020; Tamazian & Bhaskara Rao, 2010). Hence, our main results that Chinese trade and investment significantly affect green growth may be driven by the country's underlying institutional quality. Therefore, in this section, we check whether the institutional quality of a country plays a significant role in shaping the outcome of Chinese investments and trade regarding green growth. To do this, we follow prior studies (Elamer et al., 2017; Konara & Shirodkar, 2018; Tunyi et al., 2020) to use Principal Component Analysis to develop an institutional quality index from the Kaufmann and Kraay (2018) six Worldwide Governance Indicators. Next, we interact the institutional quality variable with each of the different routes (foreign direct investment import and export) to create a moderating term. Suppose our assumption that institutional quality shapes China's foreign business-green growth nexus is valid. In that case, we expect the moderating term's coefficient to be significant, larger, or in the opposite direction of the main variable of interest. As presented in Table 5, the results show that the moderating terms of foreign direct investment and import are insignificant. Although the moderating term of export is significant, the coefficient is smaller than the main variable (−5.215** < −27.26***), suggesting an insignificant role of institutional quality in explaining the effect of export to China and green growth. In effect, the coefficient of the moderating term in all three columns of Table 5 implies that the country's institutional quality does not drive our main results. Specifically, institutional quality does shape how Chinese investment and trade affect green growth. Our results are probably due to the general weak institutional environment in Africa.

4.4 | Comparison analysis

The United States is the primary competitor of China in terms of foreign investment and trade with Africa. Gordon (2012) argues that China is likely to invest in areas that appear environmentally problematic to Western countries. Therefore, this section examines the relationship between US foreign business and green growth in Africa to compare the results to China. As presented in Table 6, the results show that US trade in Africa does not significantly impact green growth. This contradicts the significant results found in the case of China's investment and trade in Table 4. We argue that the insignificant impact of US investment and trade on green growth is partly due to the downward trend of the United States presence in Africa following the increasing investment and trade from China. Chinese annual

TABLE 7 Two-stage least square—China.

Variables	(1) Foreign direct investment	(2) Import	(3) Export
Foreign direct investment	−7.653** (3.001)		
Import		38.750** (16.52)	
Export			−104.600** (51.58)
Economic development	0.002* (0.001)	−0.001 (0.002)	0.001 (0.002)
Population	0.107 (0.579)	−1.949 (1.300)	0.519 (0.959)
Energy consumption	−0.008*** (0.002)	−0.001 (0.002)	−0.0148** (0.00645)
Renewable energy	0.0504*** (0.00859)	0.028** (0.014)	0.081*** (0.021)
Environmental technologies	−0.013 (0.013)	−0.019 (0.0155)	0.007 (0.0284)
Natural resources	0.036* (0.0211)	0.053* (0.027)	0.341** (0.166)
Constant	6.047 (4.763)	23.060** (11.090)	1.342 (7.334)
Observations	454	454	454
R^2	0.037	0	0

Note: This table presents the two-stage least square regression to check endogeneity on the relationship between international business and carbon emission in Africa. SE in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

TABLE 8 System generalised moment of method—China.

Variables	(1) Foreign direct investment	(2) Import	(3) Export
Foreign direct investment	−1.176** (5.950)		
Import		2.363** (1.197)	
Export			−2.751** (1.158)
Lagged dependent	0.585*** (0.044)	0.574*** (0.045)	0.604*** (0.044)
Economic development	0.001* (6.175)	0.001* (6.042)	0.001** (6.080)
Population	0.060 (0.303)	−0.004 (0.318)	0.152 (0.299)
Energy consumption	−0.004*** (0.001)	−0.003** (0.001)	−0.004*** (0.001)
Renewable energy	0.022*** (0.005)	0.0212*** (0.005)	0.0229*** (0.005)
Environmental technologies	0.001 (0.008)	0.001 (0.008)	0.001 (0.008)
Natural resources	0.008 (0.011)	0.007 (0.011)	0.014 (0.013)
Constant	1.914 (2.346)	2.392 (2.506)	0.830 (2.283)
Observations	427	427	427
Number of ID	27	27	27

Note: This Table presents the two-step system generalised method of moments on the relationship between international business and carbon emission in Africa. SE in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

flows to Africa have surpassed those from the United States since 2014, with a total investment from $75 million in 2003 to $5.4 billion in 2018 (China Africa Research Initiative, 2020).

4.5 | Endogeneity: Two-stage least square instrumental variable

We have used fixed-effects as the common estimator for panel data; however, the technique needs to account for endogeneity and reverse causality. As such, the fixed results will likely suffer from endogeneity, most notably when the independent and control variables are not strictly exogenous (Imai & Kim, 2019; Semykina & Wooldridge, 2010). Therefore, we use two additional estimation techniques to mitigate potential endogeneity problems. First, we use the two-stage least square instrumental variable.

To identify an appropriate instrument, we look out for factors that have been found to influence foreign direct investment and trade but are less likely to influence green growth. Our reading of the literature indicates that inflation (Peres et al., 2018; Uddin et al., 2019) is an appropriate instrument for the IV analysis. The results of 2SLS IV are presented in Table 7. The results are similar to the main results in Table 4, confirming that our results are not sensitive to possible endogeneity problems.

For further robustness, we adopt the System Generalised Method of Moments (S-GMM) to capture the endogeneity within our models. More importantly, S-GMM is a reliable and robust econometric methodology for studying dynamic environmental resource productivity models. S-GMM also overcome the limitations such as model misspecifications and linear approximations bias (Jagannathan et al., 2002).

The results of S-GMM estimation are presented in Table 8. The results in columns 1 and 3 show that foreign direct investment and export are associated with a decrease in green growth, similar to the main results in Table 4. The results in column 2 for imports are also qualitatively similar to the main results. Importation from China will likely increase green growth, suggesting our results are not sensitive to reverse causality.

5 | POLICY IMPLICATION

Our empirical results indicate that foreign direct investment has a significant negative impact on green growth, implying that Chinese investment in Africa makes it difficult to promote green growth. More specifically, we attribute this finding to the fact that Chinese investments target projects that contribute to pollution, such as road construction and exploration of natural resources; hence, it reduces green growth. Similarly, despite improving institutional quality in Africa, Chinese investment discourages green growth. These findings imply that Chinese foreign direct investment is associated with a reduction in green growth across African countries. Policymakers are advised to formulate policies that will strengthen the institutions, which will significantly promote green growth.

Further, our findings indicated that increased imports promote green growth in African countries. Based on this finding, raising the importation of green products such as clean technologies might encourage green growth; hence, it has a positive effect.

Our results regarding export support the findings of Akinyemi et al. (2015), who found that Africa's export structure discourages environmental sustainability. A significant portion of exports from the region are from natural resource exploration. Hence, it is necessary to intervene with an environmental policy that will discourage pollution. Policymakers and governments should further strengthen their exporting structures to increase green exports.

6 | CONCLUSION

Although there are growing concerns about China's dominance in Africa and its ramifications on the continent's sustainable growth (Gordon, 2012), little is known about how China's investment and trade affect green growth in Africa. China has promised sustainable investment and growth, especially in the energy sector. Still, it comes at the cost of excessive natural resource extraction and possibly dumping Chinese products on the African market. Therefore, the China–Africa relationship provides a unique setting for examining how foreign investment and trade affect green growth, a new economic and environmental development approach concept.

Consequently, using panel data on 27 African countries between 2002 and 2018, we provide empirical evidence that different approaches in Chinese engagement with Africa affect green growth differently. Specifically, we find a negative relationship between foreign direct investment and green growth, similar to export to China. However, the association is much stronger with export than foreign direct investment. We attribute this finding to the fact that Chinese investment targets projects that contribute to pollution, such as road construction and extraction of natural resources. Hence, it reduces green growth. Through importation, the Africa-China engagement is positively and significantly associated with green growth by increasing the importation of green products such as solar panels.

In further analyses, we did not find any evidence that the level of institutional quality moderates the relationship between Chinese investment and trade on green growth. Also, US investment and trade do not significantly affect green growth, probably due to the decreasing trend of US investment and trade in Africa. Our results are robust to different estimation techniques, such as the two-stage least square instrumental variable and two-step system generalised method of movement, which account for potential endogeneity problems.

The results offer significant policy implications. As shown in the results, Chinese foreign direct investment and trade will likely leave a different environmental footprint. Therefore, our study provides some indication to policymakers in choosing more environmentally sustainable routes with other countries and China in particular. Given our findings, policymakers should aim at strengthening the direction of Chinese investments in Africa, particularly in environmentally sustainable projects such as renewable energy sources. Further, policymakers should formulate policies to enhance the trade structure with specific policies on imports and exports. For instance, the government can provide incentives for importing renewable energy technologies from China while limiting the exportation of natural resources to China.

Despite our robust results using different estimation techniques, our results could have been more comprehensive without limited period and sample coverage due to data availability on green growth. The study would also benefit from a cross-continent comparison of countries across Asia or South America. However, data on Chinese investment and trade in these regions is limited.

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