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Disentangling China's Infrastructure Investment in Africa: A Symbiotic Partnership or an Unequal Substitute for African Resources?

Hong Bo,[1] Sofia Johan,[2] Rodiat Lawal[3] and Rilwan Sakariyahu[3]
[1]School of Finance and Management, AXA Chair in Global Finance, SOAS University of London, Russell Square, London, WC1H 0XG, UK, [2]College of Business, Florida Atlantic University, 777 Glades Rd, Boca Raton, FL, 33431, USA, and [3]School of Business, University of Dundee, 1–3 Perth Road, Dundee, DD1 4JW, UK
Corresponding author email: rsakariyahu001@dundee.ac.uk

This paper examines how China's infrastructure investment influences African exports to China. We analyse data from 46 African countries and 14 industries that have received China's infrastructure investment from 2005 to 2019. Our results show that China's infrastructure investment in the primary sector has led to more African exports to China (i.e. resource-seeking). In contrast, investment in the non-primary sector has had a substitution effect on African exports to China (i.e. market-seeking). We find that China's infrastructure investment in Africa is driven mainly by resource-seeking. We further document that both the host country's endowment of natural resources and the resources for infrastructure arrangement moderate the positive impact of China's infrastructure investment on African exports to China. These results consistently confirm that China's infrastructure investment in Africa has facilitated China's access to African natural resources.

Introduction

China has become Africa's most significant trading partner (UNCTAD, 2020). To put this into perspective, China's population is currently 1.49 billion, while Africa's is 1.3 billion. Africa's population, however, is projected to rise to 2.75 billion by 2060, while China's is projected to decrease to approximately 1.2 billion. Africa is thus projected to have more people than China and India combined and is also thought to potentially have a combined annual output of US$16 trillion (Luke, 2023). For these reasons, we believe an analysis and discussion of Africa's trading practices and partnerships with China may be warranted. We note that the average value of African exports to China from 2005 to 2019 ($45,801.17 million) is 14 times greater than the value of exports from 1990 to 2004 ($3242.85 million) (IMF, 2019). At the same time, China has significantly increased investment in African infrastructure. In 2005, only four African countries had received infrastructure investment from China. In contrast, by 2023, this figure had risen to 46, meaning around 83% of African countries have received China's infrastructure investment in the past two decades (China Global Investment Tracker, 2020). This suggests that African exports to China and China's infrastructure investment in Africa are interconnected, prompting our research question: Are African exports to China influenced by China's infrastructure investment in Africa?

China's infrastructure investment in Africa and African exports to China are intertwined in the following respects. First, China's infrastructure investment in Africa is strongly motivated by resource-seeking (Lema *et al.*, 2021; Zhang, 2021). This leads to greater exports to China because resource-seeking foreign direct investment (FDI) aims to increase the host country's exports of primary goods back to the home country (Onyekwena, Ademuyiwa and Uneze, 2017). Second, China's infrastructure investment often involves a bilateral loan agreement between the Chinese government and the host country, and Chinese infrastructure loans often use commodity/resource-backed repayment, known as 'resources for infrastructure' (R4I) (Brautigam and Gallagher, 2014; Deloitte, 2020). The R4I arrangement entails exporting resources from African host countries to China for some years; the proceeds are put into an escrow account as repayment of the infrastructure loan (Brautigam and Gallagher, 2014). Therefore, both the resource-seeking motive and the R4I arrangement suggest that African exports to China will increase along

with the scale of China's infrastructure investment in Africa, especially African exports in resource-related industries.

This paper examines the dynamics between China's infrastructure investment in Africa and African exports to China. We seek to determine whether China has used infrastructure investment in Africa to secure the supply of natural resources from Africa. Our research may be timely as Africa is abundant in natural resources and has become the centre of international competition due to the revamp of global supply chains and national security concerns, particularly in light of increasingly complex geopolitics. The export of African natural resources has become a focal policy issue amongst African policymakers and other countries facing a depletion of their natural resources. African governments face a serious dilemma over resource allocations. On the one hand, they are concerned about protecting the interests of the African public (the principal/shareholder) and the sustainability of long-term African economic development. On the other hand, African governments need to monitor how natural resources are used to repay creditors (the stakeholders) to obtain infrastructure loans. This is a typical example of the third type of agency problem in resource allocations (Savio *et al.*, 2024). Although Africa has attracted growing media attention regarding the resource-seeking strategy of China's infrastructure investment, extant research is mainly descriptive and anecdotal, and there is hardly any formal evidence on the impact of China's infrastructure investment in Africa on African exports to China. Consequently, policymakers have been guided mainly by media stories on individual cases rather than systematic evidence.

We believe our research contributes to the literature for a few reasons. First, the existing literature on the impact of China's infrastructure investment on recipient countries mainly focuses on the effects of growth and debt. On the one hand, evidence shows that infrastructure projects under China's Belt and Road Initiative (BRI) have generated growth effects on host countries, which can be attributed to enhanced connectivity and, hence, lower trade costs (World Bank, 2019). On the other hand, China's infrastructure investment has also negatively affected host countries due to debt overhang (Bandiera and Tsiropoulos, 2020; Horn, Reinhart and Trebesch, 2019; Hurley, Morris and Portelance, 2019). Especially in Africa, the debate has primarily centred on the debt trap associated with China's infrastructure investment (Bo, Lawal and Sakariyahu, 2024; IISS, 2022). Although both the growth effect and the debt effect of China's infrastructure investment are documented in the literature, little is known about how China's infrastructure investment affects host-country exports to China, particularly exports in Africa's primary sector. Although the trade literature examines African exports of resources to China (Baliamoune-Lutz, 2011; Meyersson, Padró i Miquel and Qian, 2008), existing studies do not formally relate these exports to China's infrastructure investment in Africa. Exports of African natural resources to China are crucial for African governments when making resource allocation decisions. This issue is closely related to the resource curse phenomenon, which has long bothered some African countries. Formal evidence is thus needed to understand the resource curse puzzle better. We hope to fill this gap. Importantly, we explicitly consider the impact of China's infrastructure investment in Africa on African exports in resource-related industries and highlight the moderating effect of both the R4I arrangement and the host country's endowment of natural resources. The evidence provided by our research can further aid the understanding of the efficiency of African resource allocations through the lens of China's infrastructure investment in Africa. To the best of our knowledge, our research is the first systematic empirical analysis that provides evidence of the connection between China's infrastructure investment and African exports to China, focusing on exports in African resource-related industries.

Second, we go beyond existing studies on China's investment in Africa, which rely mainly on country-level analysis. We derive econometric evidence not only from the country level but also from the industrial level. Our country-level panel data consists of 46 African recipient countries of China's infrastructure investment from 2005 to 2019. In addition, we examine 14 African industries that received China's infrastructure investment in the same period. These industries are classified into primary and non-primary sectors. The country-level and industry-level analyses lend confirmative robustness to each other. Moreover, the industry-level information enables us to distinguish between primary and non-primary sectors, providing insight into exports to China in African resource-related industries, which has not been documented.

We find an overall complementary (positive) relationship between China's infrastructure investment in Africa and African exports to China. This positive association exists only in the primary sector (i.e. resource-related industries). For industries in the non-primary sector, the relationship becomes substitutive (negative). We also find that the host country's natural resource endowment and the R4I arrangement reinforce the positive relationship between China's infrastructure investment in Africa and the host country's exports to China. These findings confirm that China's infrastructure investment in Africa is driven mainly by resource-seeking in the primary sector. In contrast, it is driven by market-seeking in the non-primary sector. Overall, our empirical results consistently show that China's infrastructure investment in Africa has facilitated China's access to African natural resources over the past two decades.

The rest of the paper is organized as follows. In the next section, we discuss the theoretical framework and hypothesis development. Then, we explain the data, empirical models and variable measurement. We discuss empirical results, present robustness tests and finally conclude.

Theoretical framework and hypothesis development

China's overseas infrastructure investment (OII) can be explained by state capitalism theory. The Chinese government is directly involved in all aspects of its OII operation, including project financing, procurement, construction, management and loan repayment. The state-led infrastructure financing is often tied to selecting project contractors, meaning that most of China's OII projects are undertaken by Chinese state-owned enterprises (SOEs) (Li *et al.*, 2022). Both state ownership and state intervention are features of state capitalism. According to Bremmer (2010), neomercantilism is where state capitalism is adopted for political objectives. The state capitalism theory and the neomercantilism argument predict that the government would use its SOEs as agents on the international stage so that the government can materialize its non-economic objectives through SOEs' international expansion, for example, investment in the energy and other natural resource sectors. Hence, SOEs pursue long-term energy and economic security and operate as capitalist foreign policy arms of their home-country governments (Bass and Chakrabarty, 2014). Moreover, SOEs' internationalization may be driven by the home government's motive of exercising power in the international sphere to raise the welfare of the home country, reflecting a mercantilist agenda (Clegg and Tardios, 2018; Cuervo-Cazurra and Li, 2021).

The state capitalism theory, explaining China's OII at the country level, corresponds to other relevant theories underlying Chinese SOEs' internationalization, such as institutional theory, the resource-based view and the strategic intent theory. Institutional theory is relevant because it predicts that home-country institutional arrangements are essential for building the comparative advantages of Chinese SOEs in host countries (Meyer and Peng, 2016). The resource-based view predicts that Chinese SOEs will receive direct assistance from the Chinese government in finance, resource input, management skills and employee training. Cuervo-Cazura and Li (2021) establish that the resource-based view is an important theory underlying the internationalization of state-owned multinationals. Given the focus of our paper, our discussion below will focus on the strategic intent theory.

According to the strategic intent theory proposed by Hamel and Prahalad (1989) and developed by Rui and Yip (2008), firms utilize FDI as a strategic tool to accomplish specific strategic objectives. These objectives may include ensuring a reliable source of natural resources and acquiring strategic capabilities to counteract competitive disadvantages resulting from their late entry into the international market (Wang and Yu, 2014). The motivation for FDI is important to understand the connection between FDI investment and host-country exports to the home country (Markusen, 1995). Suppose the motive of the investing company is to shift its production activities to the host country. In that case, the firm's strategic intent is to seek new product markets (market-seeking motive). Hence, market-seeking FDI does not increase exports from the host country to the home country. However, if the strategic intent is to export resource-based products from the host country (Markusen, 2002; Markusen *et al.*, 1996), then the investing firm outsources part of its production segment to the host country and uses this as an export platform to serve its home country (resource-seeking motive) (Kutan and Vuksic, 2007).

Markusen (1983) asserts that the resource-seeking approach is where investment could create export markets by taking advantage of the host country's factor endowments. Here, foreign firms fragmentize the production process amongst countries to reduce costs. This model recognizes economies of scale, trade barriers, transport cost, competition and product differentiation as factors that explain the relationship between foreign investment and trade (Collier, 2006; Helpman, 1984; Helpman, Melitz and Yeaple, 2004). Recent studies examine firm-level resource allocations (Audretsch and Belitski, 2024; Inceoglu, Vanacker and Vismara, 2024; Savio *et al.*, 2024). While the resource-seeking motive may benefit the investing company, the consequences for the host country are enormous. For example, Onyekwena, Ademuyiwa and Uneze (2017) present a commodity-proximity model to illustrate how West Africa's FDI affects the European Union (EU) exports. The authors explain that investments in the upstream market drive the extraction and processing of intermediate goods, which are then exported to the home country's downstream market for further processing. They find that the strategic intent of the FDI into the region is to increase the host country's exports of primary goods to the EU. They conclude that such a strategic arrangement results in the host country exporting jobs to the investing company, thereby creating unemployment and poverty. Similarly, Xin and Gyan (2020) examine the determinants of China–Africa intra-industry trade (IIT) from 2007 to 2018. The authors find a positive relationship between Chinese FDI and IIT and conclude that Chinese multinational companies invest in Africa to exploit abundant natural resources and low labour costs. Hence, the

final products are exported back to their home country. Given the foregoing, we therefore hypothesize that:

H1: Chinese infrastructure investment in Africa is resource-seeking and generally increases host-country exports to China, particularly in resource-related industries.

Another feature of China's infrastructure investment in Africa is that it often involves bilateral debt financing from the Chinese government to host-country governments. Moreover, Chinese infrastructure loans often use commodity/resource-backed repayment, that is, R4I (Brautigam and Gallagher, 2014). This type of investment involves using natural resources such as crude oil, cocoa, diamond and copper, amongst others, to secure infrastructure investments in Africa. For an R4I arrangement, the host country must export commodities/resources to China to repay infrastructure loans. China's infrastructure investment directly induces these natural resource exports to China. Hence, the larger the scale of China's infrastructure investment in Africa, the more likely R4I will be used since many African host countries are already heavily indebted and cannot obtain alternative infrastructure financing (IISS, 2022). The more frequent use of R4I suggests more African exports to China in resource-related industries. Hence, we hypothesize:

H2a: R4I arrangements moderate the positive impact of China's infrastructure investment on host-country exports to China in resource-related industries.

In addition to R4I having a moderating effect, if China's OII strategic intent is to export resource-based products from the host country, we argue that the larger the host country's endowment of natural resources, the more likely it is to attract resource-seeking Chinese infrastructure investment, which leads to more host-country exports to China in resource-related industries.

H2b: The host country's endowment of natural resources moderates the positive impact of China's infrastructure investment on host-country exports to China in resource-related industries.

In the literature, FDI is thought to be driven by a few common motivations, including market-seeking, technology (strategic asset)-seeking, efficiency-seeking and resource-seeking (Buckley *et al.*, 2007). We believe that in the context of China's infrastructure investment in Africa, both the efficiency-seeking and technology-seeking motives do not apply. Although the efficiency-seeking motive may apply to Chinese investment in African manufacturing, it does not apply to China's infrastructure projects because these construction projects are often undertaken in an enclave system in which China brings in its own labour, equipment and construction materials (Brautigam and Hwang, 2016). In addition, technology-seeking may not necessarily apply as China is a technological leader in infrastructure construction. Over the years, China has developed industrial capacity, management know-how and innovative technology in infrastructure construction, which are arguably weaker in many developing and emerging economies. China's comparative advantage in infrastructure technology cannot be substituted by other rivals (Kong and Gallagher, 2021). Since both the motives for efficiency-seeking and technology-seeking do not apply, China's infrastructure investment in Africa may be driven mainly by resource and market-seeking. Cheung *et al.* (2014) also use market-seeking and resource-seeking as primary drivers of China's contracted engineering projects in Africa. We believe that in market-seeking, China's infrastructure investment in Africa will have a substitution (negative) effect on host-country exports to China. This is because market-seeking FDI aims to serve the host country's market directly. We have already hypothesized that resource-seeking China's infrastructure investment increases host-country exports to China (H1). We therefore also hypothesize:

H3: Chinese infrastructure investment in Africa is market-seeking and decreases host-country exports to China in general, particularly in non-resource-related industries.

We summarize the above-mentioned theories and hypotheses in the analytical framework of Figure 1.

Data, summary statistics and empirical strategy

In our analyses, we use multiple data sources that offer different measures of bilateral trade, including China Global Investment Tracker (CGIT), the China Africa Research Initiative, the United Nations (UN) Comtrade database, the International Monetary Fund (IMF) direction of trade statistics, World Development Indicators (WDI) and the World Trade Organization (WTO) database. For the country-level analysis, we use annual data for all 54 African countries, including 46 countries that have received China's infrastructure investments from 2005 to 2019. The list of countries is shown in Appendix I and the list of African countries involved in resource for infrastructure is shown in Appendix II. For the industry-level analysis, we obtained annual data for 14 industries that have received China's infrastructure investment during the same period (see Figures 2–4).

Model specification

We use the Heckman two-stage selection model (Heckman, 1979) to assess the relationship between China's infrastructure investment in Africa and host-country

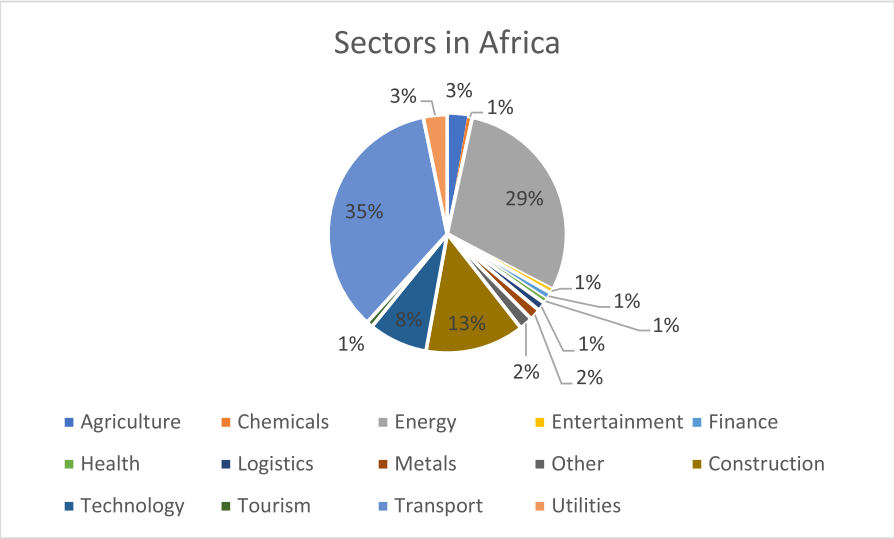


Figure 1. An analytical framework on the relationship between China's infrastructure investment in Africa and African exports to China.

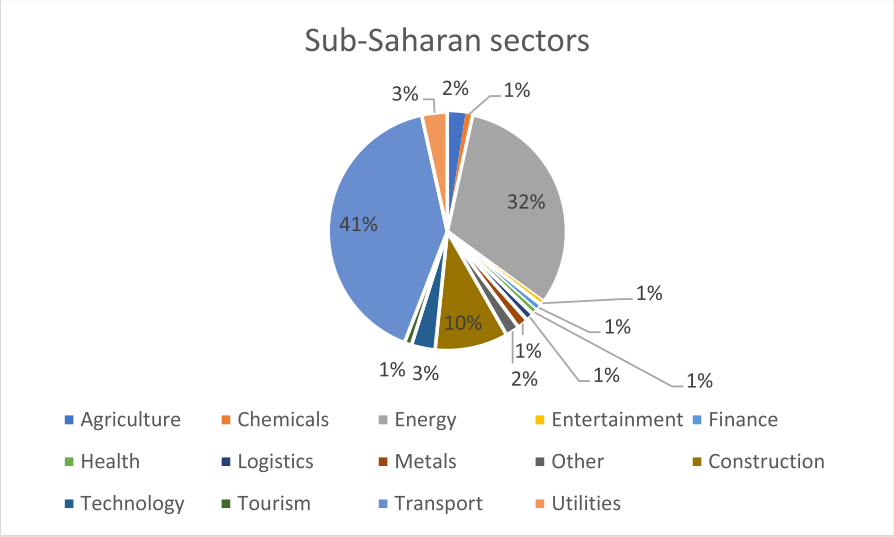


Figure 2. China's infrastructure investment across sectors in Africa

exports to China. The Heckman model has an econometric advantage over ordinary least squares since it reduces endogeneity (by the inclusion of exclusion restriction (ER) variables) and corrects for sample selection bias. A suitable ER variable reduces the correlation between the inverse Mills ratio (IMR) and the Z vector in the selection equation. Heckman and Vytlacil (2001) provide evidence supporting this claim, demonstrating that multicollinearity across predictors and correlation between error terms are reduced when at least one suitable ER variable is included in the selection equation.

Based on the existing literature, we construct a probit model that incorporates various macroeconomic variables to determine the probability of an African nation being a recipient country of China's infrastructure investment ($Prob(Recipient_{it} = 1)$). These variables include GDP per capita (GDP), natural resource endowment (NR), institutional quality (INQ), existing infrastructure (INF), trade openness (TO), African domestic existing investment (ADV), population (POPU) and legal origin (LO) (an exclusion restriction variable). Our model encompasses a total of 54 countries (i), spanning across 14 industries (j) and observed over 15 years (t). The probit model specification for the sample countries is as follows.

First stage.

$$\begin{aligned} Probability \quad (Recipient_{it} = 1) &= \beta_0 + \beta_1 GDP_{it-1} \\ &+ \beta_2 NR_{it-1} + \beta_3 INQ_{it-1} + \beta_4 TO_{it-1} \\ &+ \beta_5 LO_{it-1} + \beta_6 INF_{it-1} + \beta_7 ADV_{it-1} \\ &+ \mu_i + \varepsilon_{it} \end{aligned} \quad (1)$$

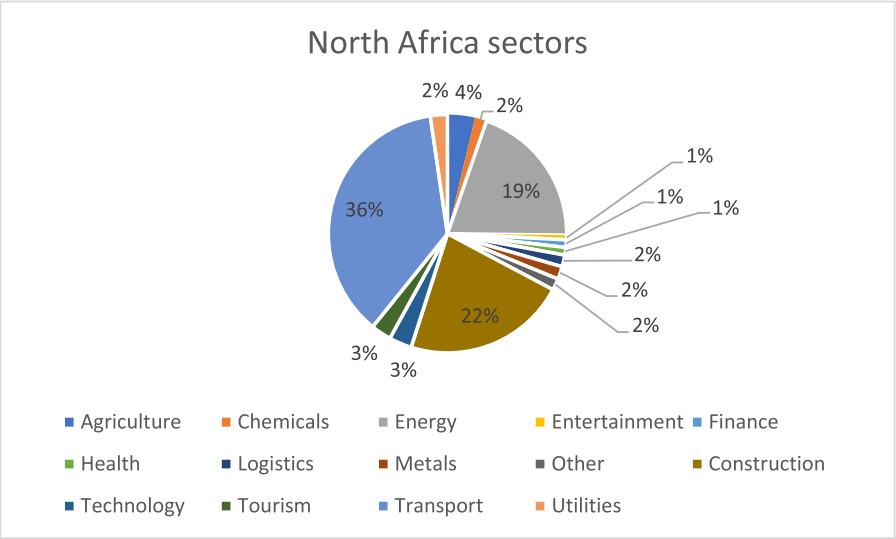
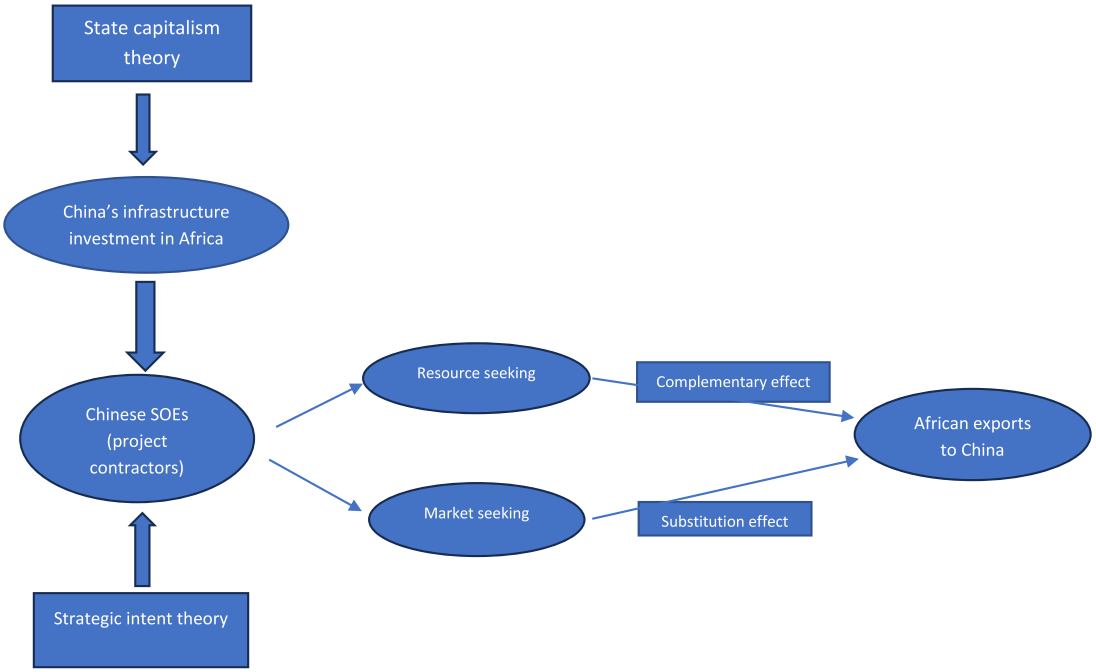


Figure 3. China's infrastructure investment across sectors in SSA



An analytical framework on the relationship between China's infrastructure investment in Africa and African exports to China

Figure 4. China's infrastructure investment across sectors in North Africa. Source: China Global Investment Tracker (2020)

The dependent variable, denoted as ($Recipient_{it}$), is a binary variable that equals 1 if an African country received China's infrastructure investment, and 0 otherwise. Legal origin (LO) is the instrument utilized in this study. LO determines the development of a country's financial sector (La Porta *et al.*, 1999). Hence, a country's LO impacts FDI decisions, but this variable does not directly affect the country's exports. ε_i represents the individual-specific error component, while ε_{it} represents the error component.

Second stage. Considering the impact of China's infrastructure investment on African exports, we use exports to China (EXP) as the dependent variable. China's infrastructure investment (INV) is the primary explanatory variable. We control the standard determinants of exports and include the inverse Mills ratio (IMR)

generated from the first stage (model 1). We obtain the following empirical model:

$$EXP_{it} = \beta_0 + \beta_1 INV_{it-1} + \beta_2 GDP_{it-1} + \beta_3 NR_{it-1} + \beta_4 INQ_{it-1} + \beta_5 INFLA_{it-1} + \beta_6 DIST_{it-1} + \beta_7 POPU_{it-1} + \beta_8 TO_{it-1} + \beta_9 ADV_{it-1} + \beta_{10} IMR + \mu_i + \varepsilon_{it} \quad (2)$$

where INV_{it-1} is the amount of Chinese infrastructure investment and EXP is the African countries' exports to China. GDP is the per capita GDP of country i and INQ is the institutional quality of country i. INFLA is the inflation rate of host countries. DIST is the distance between the host country's capital and China's capital (in kilometres). POPU represents the host country's labour force. TO is the trade openness of the host country. ADV is the existing domestic investment in the host country. T stands for time. ε_{it} is the error term.

Measurement of variables, data sources and descriptive statistics

The variable definitions and summary statistics of the variables used in the empirical analyses are provided in Table 1. It shows that the mean value of exports to China is \$1317.489 million. The average value of China's infrastructure investment received by host countries is \$520.901 million. The mean value of debt to China held by host countries is \$175.223 million. About 4.9% of the country-year observations involve an R4I arrangement. Institutional quality has a negative mean of −0.685, indicating poor governance in Africa. The sample countries have an average of 0.701 for trade openness to the world (excluding China), which shows that African countries are open to the rest of the world in international trade. Tables 2a and 2b display the correlation matrix and variance inflation factor (VIF). In general, the observed correlations between variables indicate a lack of significant multicollinearity amongst the variables. The VIF test reveals that their values remain below the established threshold of 10. Hence, multicollinearity in this study is not a significant concern.

Empirical results

The first-stage estimation: Whether an African country is a recipient of China's infrastructure investment

The results of the first stage of the Heckman selection model are presented in Table 3. The model explains the likelihood of an African nation being designated as a beneficiary of China's infrastructure investments. The result reveals a significant positive relationship (at the 1% level) between GDP per capita and natural resource endowment and the likelihood of an African country receiving China's infrastructure investment. This suggests that African countries, endowed with abundant natural resources and substantial market potential, are more inclined to receive China's infrastructure investment. These results support both resource-seeking and market-seeking strategies behind China's infrastructure investments in Africa. The estimated coefficient for institutional quality is positively significant at the 10% level, which suggests that the quality of a country's institutions in Africa increases the likelihood of receiving China's infrastructure investment. The estimated coefficient for the population is also significantly positive at the 1% level. This implies that African nations with a more significant labour force are more likely to receive China's infrastructure investment. The estimated coefficient for LO is also positively significant, which suggests that African nations adhering to the British common law system are more prone to attracting China's infrastructure investment.

The Wald chi-square test statistics show satisfactory model performance. According to Heckman (1979), a highly significant Wald test of the probit model demonstrates that explanatory variables significantly contribute to the model. Similarly, the reported value for the McFadden pseudo-R-squared is 0.2820, which shows that the model fits the data relatively well. McFadden (1977) suggests that a decent McFadden's pseudo-R-squared should have a value between 0.2 and 0.4 as a rule of thumb.

Impact of China's infrastructure investment on African exports to China

The second-stage results of estimating the Heckman model, including the inverse Mills ratio (IMR), are presented in Table 4. The dependent variable is the host country's export to China (EXP). The estimated coefficient for infrastructure investment is positively significant in explaining host-country exports to China. This result suggests that China's infrastructure investment serves as a complement to host-country exports to China. This aligns with the resource-seeking motive for China's infrastructure investment in Africa, which supports H1. Regarding other variables, the estimated coefficients for GDP per capita and natural resource endowment are highly and positively significant in explaining host-country exports to China. Our results suggest that host-country exports to China are influenced by both the size of the host country's markets and the host country's endowment of natural resources. The estimated coefficient for trade openness is negatively significant. This implies that host-country exports to the rest of the world and China are substitutes. The estimated coefficient for population is positively significant at the 1% level. This suggests that an increase in the size of the active labour force in the host country increases its exports

Table 1. Variable definitions and summary statistics

Variable name	Definition	Obs.	Mean	SD	Min	Max
Export to China (EXP) ($ million)	Host-country exports to China scaled by host-country GDP. Annual data sourced from United Nations Comtrade, IMF Direction of Trade Statistics, World Trade Organization	810	1317.489	4648.147	0	48313.94
Infrastructure investment (INV) ($ million)	Amount of China's infrastructure investment received by the host country/industry each year, scaled by host-country GDP. Source: China Global Investment Tracker	810	520.901	1242.432	0	12200
Recipient (RE)	A dummy variable taking the value 1 if a country/industry in Africa received China's infrastructure investment in a year, and 0 otherwise. Source: China Global Investment Tracker	810	0.379	0.485	0	1
Debt to China (DEBT) ($ million)	Amount of Africa's debt to China. Source: China Africa Research Initiative database	810	175.223	819.466	0	19343
Natural Resources (NR)	Value of the natural resource endowment of the host country. Source: World Bank Development Indicators (WDI) database	810	0.049	0.217	0	1
GDP per capita (GDP)	GDP per capita of the host country. Source: World Bank Development Indicators (WDI) database	810	7.258	1.045	5.022	10.041
Inflation rate (INFLA)	Annual percentage change in the country's consumer price index. Source: World Bank Development Indicators (WDI) database	810	0.074	0.111	−0.253	1.007
Trade openness (TO)	Ratio of trade with the rest of the world of a host country to host-country GDP. The value of trade with the rest of the world is the difference between global trade and trade with China. Source: World Bank Development Indicators (WDI) and United Nations Comtrade databases	810	0.701	0.439	0	3.480
Institutional quality (INQ)	An indicator of governance efficiency of the host country. It is the arithmetic mean of scores of six indices of government performance (respect for the rule of law, efforts to combat corruption, citizen participation in decision-making, political stability, government efficiency and lack of violence and terrorism). Countries are given ranks on each indication between 2.5 and −2.5. Source: World Bank Development Indicators (WDI) database	810	−0.685	0.636	−2.449	0.854
Existing infrastructure (INF)	Number of broadband subscribers per 100 people. Indicates the presence of communication services and infrastructure in the host country. Source: World Bank Development Indicators (WDI) database	810	0.964	2.708	0	27.598
Natural resource (NR)	Ratio of host country's total natural resources to GDP. Source: World Bank Development Indicators (WDI) database	810	12.27	13.193	0	68.79
African domestic investment (ADV)	Ratio of host-country gross capital formation to GDP. Source: World Bank Development Indicators (WDI) database	810	21.609	12.29	−0.098	77.89
Population (POPU)	Total number of people between the ages of 15 and 64 (the active labour force) in the host country. Source: World Bank Development Indicators (WDI) database	810	15.329	1.557	10.94	18.494

Table 1. (Continued)

Variable name	Definition	Obs.	Mean	SD	Min	Max
Distance (DIST) (km)	Geographical distance between the host country and China's capital. Source: CEPII obtained from an Indonesian website (www.indo.com/distance)	810	10,362.148	1478.219	6744	12567
Resources for infrastructure (R4I)	A dummy variable that takes the value 1 if the host country is involved in R4I deals, and 0 otherwise. Source: China Global Investment Tracker	810	0.049	0.217	0	1
Legal origin (LO)	A binary variable that takes the value 1 if the country adheres to the common law of the United Kingdom, and 0 if the country adheres to the civil law of France. Source: La Porta *et al.* (1999)	810	0.370	0.483	0	1

Note: GDP per capita and population are in log form.

Table 2a. Correlation matrix

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
EXP	1.00													
INV	0.14*	1.00												
NR	0.24*	0.20*	1.00											
DEBT	0.25*	0.27*	0.34*	1.00										
GDP	0.28*	0.06	0.07	0.05	1.00									
INFLA	0.06	0.09*	0.17*	0.09*	−0.13*	1.00								
TO	0.02	−0.11*	−0.01	−0.04	0.30*	−0.10*	1.00							
INQ	0.00	−0.15*	−0.16*	−0.08*	0.29*	−0.11*	0.09*	1.00						
INF	0.01	−0.01	−0.08*	−0.04	0.42*	−0.12*	0.14*	0.37*	1.00					
NR	0.16*	0.15*	0.17*	0.07	0.14*	0.19*	0.24*	−0.47*	−0.21*	1.00				
ADV	0.03	0.08*	0.02	0.06	0.22*	−0.08*	0.35*	0.23*	0.23*	0.13*	1.00			
POPU	0.21*	0.36*	0.17*	0.15*	−0.26*	0.16*	−0.31*	−0.25*	−0.09*	0.02	0.09*	1.00		
DIST	0.06	−0.08*	0.04	−0.04	−0.04	−0.07	0.21*	0.26*	−0.22*	0.05	0.17*	−0.24*	1.00	
LO	0.05	0.04	0.02	−0.02	−0.09*	0.15*	0.02	0.19*	−0.16*	−0.16*	−0.09*	0.12*	0.23*	1.00

Note: GDP per capita, population and distance are in log form. See Table 1 for the definition and measurement of variables. * denotes significance at 10%.

Table 2b. Variance inflator factor

	VIF	1/VIF
Institutional quality (INQ)	2.194	0.456
Natural resource (NR)	2.084	0.480
Gross domestic product (GDP)	2.023	0.494
Population (POPU)	1.628	0.614
Distance (DIST)	1.535	0.651
Trade openness (TO)	1.450	0.690
African domestic investment (ADV)	1.382	0.724
Inflation rate (INFLA)	1.160	0.862
Infrastructure investment (INV)	1.082	0.925
Mean VIF	**1.767**	.

to China. The estimated coefficient for domestic investment is significant at the 5% level. This implies a positive impact of the level of development of the host country's economies on its exports to China. The estimated coefficient for distance is negatively significant at the 1% level. This suggests that geographical proximity between China and African host countries increases African exports to China. In Table 4, the estimated coefficient for the inverse Mills ratio (IMR) is significant, suggesting sample selection bias, hence necessitating the use of the Heckman model as a suitable corrective measure.

Impact of motivations for China's infrastructure investment on African exports to China

As discussed previously, China's infrastructure investment in Africa is driven mainly by resource-seeking and market-seeking motives. Table 4 shows that for an average sample host country, China's infrastructure investment leads to more exports from the host country to China. The results in Table 4 support the notion that resource-seeking is more critical than the market-seeking motive. As we see from Table 4, after controlling the host country's endowment of natural resources, the estimated impact of China's infrastructure investment on host-country exports is positive. The

Table 3. First-stage estimation: Whether an African country is a recipient of China's infrastructure investment

Variables	Dependent variable Prob(Recipient = 1)
Gross domestic product (GDP)	0.2333
	(0.001)
Natural resource (NR)	0.0176
	(0.003)
Trade openness (TO)	−0.0008
	(0.773)
Institutional quality (INQ)	0.2535
	(0.072)
Existing infrastructure (INF)	−0.0247
	(0.527)
African domestic investment (ADV)	0.0033
	(0.580)
Population (POPU)	0.5852
	(0.000)
Legal origin (LO)	0.3745
	(0.004)
Constant	−1.4841
	(0.000)
Pseudo R^2	0.2820
Wald chi^2	190.39
	(0.000)
Countries	54

Note: This table reports on the first-stage results of estimating the Heckman model. The dependent variable is whether an African country is a recipient of China's infrastructure investment. All explanatory and control variables are lagged by 1 year. Year and regional dummies are included. The p-values are in parentheses. Wald test chi-squared and pseudo-R-squared represent the overall performance of the model. See Table 1 for the definition and measurement of variables.

Table 4. Impact of China's infrastructure investment on African exports to China

	Exports (EXP)
Infrastructure investment (INV)	0.4457
	(0.000)
Gross domestic product (GDP)	0.2178
	(0.019)
Natural resource (NR)	0.0536
	(0.000)
Trade openness (TO)	−0.0403
	(0.023)
Institutional quality (INQ)	0.4201
	(0.011)
Inflation rate (INFLA)	0.0013
	(0.198)
Population (POPU)	1.2288
	(0.000)
African domestic investment (ADV)	0.0033
	(0.0037)
Distance (DIST)	−2.0503
	(0.005)
Inverse Mills ratio (IMR)	2.5253
	(0.000)
Constant	1.9733
	(0.000)
Countries	46
R-squared	0.341

Note: This table reports the Heckman second-stage regression results. The dependent variable is host-country exports to China. All explanatory and control variables are lagged by 1 year. The inverse Mills ratio computed from the probit regression in the first-stage estimation is added. Year, industry and country dummies are added. The p-values are in parentheses. See Table 1 for the definition and measurement of variables.

resource-seeking motive can explain this positive effect because market-seeking predicts a negative impact of FDI on exports to the home country. In this section, we explicitly determine whether the results shown in Table 4 vary depending on the motivation for China's infrastructure investment. Specifically, we introduce two interaction terms to capture China SOEs' strategic intent of resource-seeking and market-seeking motives, respectively. These are included in columns (1) and (2) of Table 5, respectively. In Table 5, the estimated coefficient for the inverse Mills ratio (IMR) is significant, which again justifies using the Heckman two-stage selection model. The estimated results regarding control variables align with those in Table 4. We focus here on the results regarding China's infrastructure investment motivations. In column (1), the estimated coefficient for the interactive term between China's infrastructure investment and the host country's natural resources endowment (Infrastructure investment * Natural resource) is positively significant at the 1% level. This result suggests that more resource-rich host countries export more to China in connection with China's infrastructure investment. This result is in line with H2b. This is evidence that China's infrastructure investment in Africa is designed to gain access to natural resources in Africa and to export them back to China. In column (2), the estimated coefficient for the interactive term between China's infrastructure investment and the market size of the host country (Infrastructure investment * Gross domestic product) is negatively significant at the 1% level, which means that the market-seeking motive of China's infrastructure investment in Africa weakens the complementary relationship between China's infrastructure investment and host-country exports to China. This result is in line with H3. Combining the results in Table 4 with those in Table 5, we can conclude that although there is evidence of a market-seeking motive, overall, the resource-seeking motive is more important, which can explain why the overall net impact of China's infrastructure investment on African exports to China is positive (see Tables 4 and 5).

Moderating effect of R4I on African exports to China

In this section we provide evidence that China's infrastructure investment in Africa increases African exports of natural resources to China. Based on the results in

Table 5. Motivations for China's infrastructure investment and African exports to China

	(1) Resource-seeking	(2) Market-seeking
Infrastructure investment (INV)	0.2449	0.3462
	(0.013)	(0.001)
*Infrastructure investment * Natural resource (INV*NR)*	0.0108	−0.6475
*Infrastructure investment * Gross domestic product (INV*GDP)*	(0.001)	(0.019)
Gross domestic product (GDP)	0.2849	0.2333
	(0.002)	(0.011)
Natural resource (NR)	0.0458	0.0527
	(0.000)	(0.000)
Trade openness (TO)	−0.0451	−0.0401
	(0.008)	(0.022)
Institutional quality (INQ)	0.3111	0.4050
	(0.046)	(0.013)
Inflation rate (INFLA)	0.0008	0.0013
	(0.422)	(0.207)
Population (POPU)	1.1083	1.1984
	(0.000)	(0.000)
African domestic investment (ADV)	0.0041	0.0031
	(0.283)	(0.422)
Distance (DIST)	−2.3063	−2.1478
	(0.001)	(0.003)
Inverse Mills ratio (IMR)	2.2797	2.4757
	(0.000)	(0.000)
Constant	−2.5686	−2.4327
	(0.000)	(0.000)
Countries	46	46
R-squared	0.381	0.346

Note: This table reports the Heckman second-stage regression results. The dependent variable is host-country exports to China. All explanatory and control variables are lagged by 1 year. The inverse Mills ratio computed from the probit regression in the first-stage estimation is added. Year, industry and country dummies are added. The p-values are in parentheses. See Table 1 for the definition and measurement of variables.

Tables 4 and 5, if resource-seeking dominantly drives China's infrastructure investment in Africa, then the R4I arrangement should enhance the complementary relationship between China's infrastructure investment in Africa and host-country exports to China. R4I entails that China provides infrastructure loans to host countries, but the recipient country is responsible for paying the loan using its natural resources. According to the China Africa Research Initiative database, 10 countries on the African continent participated in a resource-backed loan in the sample period. These countries are Angola, Sudan, Congo, Ghana, Equatorial Guinea, the Democratic Republic of Congo, Ethiopia, Guinea and Zimbabwe. Therefore, we add the R4I dummy and the interactive term between China's infrastructure investment and the R4I dummy in the Heckman second-stage estimation (model 2).

Table 6 shows that the estimated coefficient for infrastructure investment is positively significant at the 10% level, indicating that it is positively related to host-country exports to China. More importantly, the estimated coefficient for the interactive term between China's infrastructure investment and the R4I dummy (Infrastructure investment * R4I) is positively significant at the 1% level in explaining African exports to China. Therefore, it can be deduced that the R4I arrangement strengthens the complementary relationship between China's infrastructure investment and host-country exports to China. This result supports H2a. Our result further proves that acquiring natural resources drives China's infrastructure investment in Africa. The estimated coefficients for natural resources, trade openness, institutional quality, African domestic investment and population all impact African countries' ability to export goods to China, and these estimates are consistent with the results presented in Tables 4 and 5. Additionally, the Heckman two-stage model once again justifies the estimated coefficient for the inverse Mills ratio (IMR).

Robustness tests

Industry-level empirical analysis

In this section, we conduct a robustness test based on the industrial-level data. During the sample period, China's infrastructure investment covered 14 industries across host countries in Africa. We obtained annual data for these 14 industries (China Global Investment Tracker, 2020). We classify industries that received Chinese infrastructure investment into the primary sector

Table 6. Moderating effect of R4I on African exports to China

	Exports (EXP)
Infrastructure investment (INV)	0.3527
	(0.000)
Resources for infrastructure (R4I)	0.0579
	(0.711)
*Infrastructure investment * R4I (INV*R41)*	1.3254
	(0.002)
Gross domestic product (GDP)	0.1236
	(0.194)
Natural resource (NR)	0.0489
	(0.000)
Trade openness (TO)	−0.0286
	(0.085)
Institutional quality (INQ)	0.4236
	(0.014)
Inflation rate (INFLA)	0.0014
	(0.180)
Population (POPU)	1.0793
	(0.000)
African domestic investment (ADV)	0.0033
	(0.414)
Distance (DIST)	−1.6414
	(0.026)
Inverse Mills ratio (IMR)	2.2242
	(0.000)
Constant	4.7757
	(0.001)
Countries	46
R-squared	0.371

Note: This table reports the Heckman second-stage regression results. The dependent variable is host-country exports to China. All explanatory and control variables are lagged by 1 year. The inverse Mills ratio computed from the probit regression in the first-stage estimation is added. Year, industry and country dummies are added. The p-values are in parentheses. See Table 1 for the definition and measurement of variables.

(agriculture, metals, energy and chemicals) and non-primary sector (machinery and electricity, textiles, consumer goods, transportation, financial, construction, travel, entertainment, logistics and telecommunication). The amount of China's infrastructure investment in industries is obtained from the CGIT database. By separating industries between the primary and non-primary sectors, we can better understand the nature of China's infrastructure investment (whether it is resource-related) and how it affects host-country exports to China.

Table 7a presents the second-stage results of estimating the Heckman model for the primary versus non-primary sectors. In column (1), the estimated coefficient for infrastructure investment in the primary sector is positively significant at the 1% level in explaining African exports to China. This result suggests that for the industries in the primary sector, more Chinese infrastructure investments in these industries lead to more African exports to China. Once again, H1 is supported. This aligns with the findings of Onyekwena, Ademuyiwa and Uneze (2017). Given that industries in the primary sector are all resource-related, this result further emphasizes the resource-seeking motive for China's infrastructure investment in Africa. More importantly, we observe the difference in the result between the primary sector and the non-primary sector. Column (2) of Table 7a shows that the estimated coefficient for infrastructure investment in the non-primary sector is negatively significant at the 1% level in explaining exports to China. This result provides evidence that for industries in the non-primary sector, China's infrastructure investment does not have a complementary but a substitution effect on African exports to China. It suggests that more infrastructure investment in the industries in the non-primary sector corresponds to fewer African exports to China. Again, H3 is supported. This result is consistent with market-seeking FDI. The comparison of the result between the primary and non-primary sectors justifies that African exports to China are dominated by exports in the resource-related industries in the primary sector. It explains why the overall net impact of China's infrastructure investment on African exports to China is positive (see Tables 4–6).

We go further to carry out the industry-level analysis for each industry in the primary sector (Table 7b) and the non-primary sector (Table 7c), respectively. The purpose of doing so is to provide more insight into the nature of China's infrastructure investment and its impact on African exports to China. As shown in Table 7b, the estimated coefficients for China's infrastructure investment in agriculture, metal and energy are highly and positively significant. It is interesting to observe from Table 7c that the estimated coefficients for China's infrastructure investment in consumer goods, transportation and construction are negatively significant and consistent with the market-seeking motive for China's infrastructure investment in these non-resource-related industries. The estimated coefficient for the investment in logistics is positively associated with African exports to China, which is logical because the logistics industry is highly and positively related to African exports to China.

Overall, our industrial-level analysis results shown in Tables 7a–7c reinforce our earlier results (Tables 4–6) on the relationship between China's infrastructure investment and African exports to China. They demonstrate that Chinese SOEs' investment activities in the primary sector industries are resource-seeking, whereas in the non-primary sector industries they are market-seeking.

An alternative proxy for China's infrastructure investment in Africa

To further test the robustness of the results, we check our baseline result in Table 4 by using another variable, 'debt to China' (DEBT), as the primary explanatory

Table 7a. Impact of China's infrastructure investment on African exports to China: Primary versus non-primary sector

	(1) Exports in primary industry	(2) Exports in non-primary industry
Infrastructure investment (INV primary)	0.2604	
	(0.004)	
Infrastructure investment (INV non-primary)		−0.2279
		(0.029)
Gross domestic product (GDP)	0.2972	0.2187
	(0.061)	(0.165)
Natural resource (NR)	0.1106	0.1123
	(0.000)	(0.000)
Trade openness (TO)	−0.0278	−0.0202
	(0.323)	(0.497)
Institutional quality (INQ)	1.0835	1.1085
	(0.000)	(0.000)
Inflation rate (INFLA)	0.0001	0.0008
	(0.951)	(0.705)
Population (POPU)	1.9412	2.0316
	(0.000)	(0.000)
African domestic investment (ADV)	−0.0017	−0.0004
	(0.827)	(0.952)
Distance (DIST)	1.5480	1.6025
	(0.295)	(0.290)
Inverse Mills ratio (IMR)	4.1851	4.3184
	(0.000)	(0.000)
Constant	−2.3089	−5.2048
	(0.007)	(0.006)
R-squared	0.353	0.497

Note: This table reports the Heckman second-stage regression results. The dependent variable is African exports to China in primary and non-primary sectors, respectively. All explanatory and control variables are lagged by 1 year. The inverse Mills ratio computed from the probit regression in the first-stage estimation is added. Year and country dummies are added. The p-values are in parentheses. See Table 1 for the definition and measurement of variables.

Table 7b. Impact of China's infrastructure investment on African exports to China: Industries in the primary sector

Variables	Agriculture	Metal	Energy	Chemicals
Infrastructure investment (Agriculture)	0.2259			
	(0.002)			
Infrastructure investment (Metal)		0.5999		
		(0.000)		
Infrastructure investment (Energy)			0.0046	
			(0.023)	
Infrastructure investment (Chemicals)				0.9562
				(0.3529)
Control variables	Yes	Yes	Yes	Yes
Inverse Mills ratio	0.0061	0.5120	0.2050	0.5518
	(0.006)	(0.020)	(0.042)	(0.038)
R-squared	0.348	0.340	0.247	0.256

Note: This table reports the Heckman second-stage regression results. The dependent variable is the export of industries in the primary sector. All explanatory and control variables are lagged by 1 year. The inverse Mills ratio computed from the probit regression in the first-stage estimation is added. Year and country dummies are added. The p-values are in parentheses. See Table 1 for the definition and measurement of variables.

variable. This is sourced from the China Africa Research Initiative database. During the sample period, 46 African countries received China's infrastructure investment, and these infrastructure projects were financed mainly by bilateral loans from the Chinese government to the host-country government. Therefore, the host country's debt to China can be used as a suitable alternative proxy for China's infrastructure investment in

Table 7c. Impact of China's infrastructure investment on African exports to China: Industries in the non-primary sector

Variables	Machinery & electricity	Textiles	Consumer goods	Transportation	Financial
Infrastructure investment (Machinery & electricity)	0.9780				
	(0.197)				
Infrastructure investment (Textiles)		−0.0124			
		(0.301)			
Infrastructure investment (Consumer goods)			−1.1541		
			(0.034)		
Infrastructure investment (Transportation)				−0.1275	
				(0.048)	
Infrastructure investment (Financial)					0.5409
					(0.497)
Control variables	Yes	Yes	Yes	Yes	Yes
Inverse Mills ratio	0.2228	0.6924	1.0663	−0.0025	0.5921
	(0.217)	(0.002)	(0.013)	(0.380)	(0.000)
R-squared	0.208	0.271	0.333	0.177	0.230

Variables	Construction	Travel	Entertainment	Logistics	Telecommunication
Infrastructure investment (Construction)	−1.4137				
	(0.004)				
Infrastructure investment (Travel)		−4.6111			
		(0.449)			
Infrastructure investment (Entertainment)			−0.1464		
			(0.589)		
Infrastructure investment (Logistics)				0.9121	
				(0.028)	
Infrastructure investment (Telecommunication)					−0.0371
					(0.081)
Control variables	Yes	Yes	Yes	Yes	Yes
Inverse Mills ratio	0.0137	0.6985	0.2190	0.5912	0.2193
	(0.001)	(0.000)	(0.322)	(0.011)	(0.098)
R-squared	0.174	0.271	0.208	0.230	0.208

Note: This table reports the Heckman second-stage regression results. The dependent variable is the export of industries in the non-primary sector. All explanatory and control variables are lagged by 1 year. The inverse Mills ratio computed from the probit regression in the first-stage estimation is added. Year and country dummies are added. The p-values are in parentheses. See Table 1 for the definition and measurement of variables.

the country. The model is specified as follows:

$$\begin{aligned} EXP_{it} = {} & \beta_0 + \beta_1 DEBT_{it-1} + \beta_2 GDP_{it-1} + \beta_3 NR_{it-1} \\ & + \beta_4 INQ_{it-1} + \beta_5 INFLA_{it-1} + \beta_6 DIST_{it-1} \\ & + \beta_7 POPU_{it-1} + \beta_8 TO_{it-1} + \beta_9 ADV_{it-1} \\ & + \beta_{10} IMR + \mu_i + \varepsilon_{it} \end{aligned} \quad (3)$$

The Heckman second-stage regression results are reported in Table 8. The estimated coefficient for debt to China is highly significant with a positive sign, which suggests that the host country's debt to China complements the country's exports to China. Because African host countries' debt to China is highly correlated with China's infrastructure investment in the host country, the results shown in Table 8 once again confirm that the complementary (positive) relationship between China's infrastructure investment in Africa and host-country exports to China can be explained by the resource-seeking strategy. The estimated results regarding control variables are in tandem with the results obtained in Table 4.

An alternative estimation procedure

In this section we further test the robustness of our baseline result in Table 4 using the generalized method of moments (GMM) technique. According to Arellano and Bover (1995) and Blundell and Bond (1998), GMM can overcome the estimation problems caused by unobservable heteroscedasticity, simultaneity and dynamic endogeneity and produce unbiased and consistent estimates by employing valid internal instruments in the estimation. The GMM model is specified as follows:

$$\begin{aligned} EXP_{it} = {} & \beta_0 + \beta_1 EXP_{it-1} + \beta_2 INV_{it-1} + \beta_3 GDP_{it-1} \\ & + \beta_4 NR_{it-1} + \beta_5 INQ_{it-1} + \beta_6 INFLA_{it-1} \\ & + \beta_7 DIST_{it-1} + \beta_8 POPU_{it-1} + \beta_9 TO_{it-1} \\ & + \beta_{10} ADV_{it-1} + \beta_{11} IMR + \mu_i + \varepsilon_{it} \end{aligned} \quad (4)$$

The GMM results are reported in Table 9. We use two different dependent variables in the GMM estimation, respectively. The recipient is a dummy variable that takes the value 1 if a host country received China's

Table 8. Impact of debt to China on African exports to China

	Exports (EXP)
Debt to China (DEBT)	0.1521
	(0.001)
Gross domestic product (GDP)	0.2723
	(0.119)
Natural resource (NR)	0.0829
	(0.000)
Trade openness (TO)	−0.0016
	(0.956)
Institutional quality (INQ)	0.7688
	(0.004)
Inflation rate (INFLA)	−0.0009
	(0.623)
Population (POPU)	1.9426
	(0.000)
African domestic investment (ADV)	0.0163
	(0.051)
Distance (DIST)	1.4540
	(0.330)
Inverse Mills ratio (IMR)	3.8690
	(0.000)
Constant	4.2112
	(0.006)
Countries	46
R-squared	0.536

Note: This table reports the Heckman second-stage regression results. The dependent variable is African exports to China. All explanatory and control variables are lagged by 1 year. The inverse Mills ratio computed from the probit regression from the first-stage estimation is added. Year, industry and country dummies are added. The p-values are in parentheses. See Table 1 for the definition and measurement of variables.

Table 9. Impact of China's infrastructure investment on African exports to China: GMM estimation

	Exports (EXP) (1)	Exports (EXP) (2)
Export (EXP) lagged	0.8807	0.8528
	(0.002)	(0.006)
Recipient (RE)	0.1875	
	(0.041)	
Infrastructure investment (INV)		0.4065
		(0.063)
Gross domestic product (GDP)	0.1856	0.1922
	(0.044)	(0.027)
Natural resource (NR)	−0.7210	−0.8967
	(0.715)	(0.643)
Trade openness (TO)	−0.0110	0.0486
	(0.956)	(0.887)
Institutional quality (INQ)	−0.2348	−0.2365
	(0.051)	(0.036)
Inflation rate (INFLA)	0.0926	−0.0188
	(0.333)	(0.346)
Population (POPU)	−1.1539	0.7601
	(0.414)	(0.470)
African domestic investment (ADV)	0.0887	0.0730
	(0.605)	(0.088)
Distance (DIST)	0.1894	0.2962
	(0.565)	(0.734)
Model diagnostics		
AR(1)	−2.21	−2.13
	(0.027)	(0.033)
AR(2)	0.65	−0.08
	(0.357)	(0.389)
Hansen p-value	25.07	23.08
	(0.158)	(0.285)
Number of groups	46	46
Number of instruments	44	44

Note: This table reports one-step system GMM results. The dependent variable is African exports to China. The explanatory variables (recipient and infrastructure investment) and control variables are lagged by 1 year. Year, industry and country dummies are added. The p-values are in parentheses. See Table 1 for the definition and measurement of variables. AR(1) and AR(2) are tests for the absence of second-order serial correlation with the null of no serial correlation. The Hansen test represents the overidentifying restriction asymptotically distributed as chi-squared under the null of instrument validity. The instruments used in the estimations are lagged by two or more of the dependent, independent and control variables.

infrastructure investment in the sample period, and 0 otherwise. Infrastructure investment refers to the amount of China's infrastructure investment in a host country in a year scaled by the host country's GDP. As shown in Table 9, the estimated coefficients for both the recipient dummy and infrastructure investment positively explain African exports to China. This result is consistent with the results we obtained from estimating the Heckman two-stage model, which confirms that China's infrastructure investment has resulted in more African exports to China. The results regarding the control variables are in tandem with those obtained in the Heckman two-stage model. Furthermore, the p-values in Table 9 for the Hansen test indicate that the instruments used are valid. We see that AR(1) is significant, but AR(2) is not significant, which indicates no second-order autocorrelation.

Further discussions and conclusion

Our empirical analysis documents that African exports to China are intertwined with China's infrastructure investment in Africa. Also, although there is evidence of a market-seeking motive in African industries in the non-primary sector, China's infrastructure investment in the primary sector (resource-related industries) is driven by the resource-seeking strategy. We find that the overall net effect of China's infrastructure investment in Africa on African exports to China is positive, suggesting that resource-seeking is more critical than the market-seeking motive for China's infrastructure investment in Africa. Consequently, China's infrastructure investment in Africa has resulted in more exports of natural resources from African host countries to China. We believe that by conducting our empirical analyses based not only on country-level data but also on industrial-level data to compare the results between industries in

the primary sector with industries in the non-primary sector, and by examining the moderating effects of both the host country's endowment of natural resources and the R4I arrangement, we can better determine the motivation for infrastructure investments made by China. We are aware of the limitations of our research due to the potential for sample selection bias and unobserved factors. Therefore, we apply both the Heckman two-stage and the GMM estimation procedures. For additional robustness, we use the host country's debt to China as an alternative proxy for China's infrastructure investment in Africa.

Our results have significant policy implications. First, the evidence derived from our research provides insights for African policymakers to understand better the nature of China's infrastructure investment in Africa. The dominant motive for China's infrastructure investment in Africa is indeed resource-seeking. This insight can guide the formulation of host-country industrial policies regarding restricting or accommodating Chinese infrastructure investment. Second, our evidence can help African policymakers revisit the resource curse phenomenon that has been a long-lasting problem for some African countries. African countries are heavily dependent on exporting natural resources as their primary source of revenue. However, there is weak evidence that such exports have led to the economic growth of these countries (i.e. the resource curse). The conventional discussion of the resource curse problem in Africa does not formally consider exporting resources to China in connection with China's infrastructure investment in Africa. We provide new insights for African policymakers to consider whether resource exports to China facilitated by China's infrastructure investment have aggravated or lessened the resource curse problem for host countries. In the Chinese case, exports of resources to China have brought physical infrastructure to African host countries. The challenge for African policymakers is properly evaluating whether China's infrastructure investment in Africa can generate long-term economic benefits for host countries. If so, then the resource curse problem may become less significant. Hence, African policymakers may consider the trade-off between simply exporting resources to the rest of the world for revenue (which might be used for purposes other than economic growth) and exchanging resources for some much-needed infrastructure. In this respect, our research is important for African policymakers when making resource allocation decisions. The evidence helps African policymakers strike a better balance between protecting the long-term interests of the African public (the principal/shareholder) and exchanging natural R4I financing from the Chinese government (debtholder) (Savio *et al.*, 2024). African policymakers can exercise prudence in formulating policies that attract Chinese infrastructure investments and safeguard African natural resources from being exploited. Third, our result shows that although there is evidence of market-seeking in some African industries in the non-primary sector, the overall net effect of China's infrastructure investment in Africa on host-country exports to China is positive, suggesting that the dominant driver of China's infrastructure investment in Africa is resource-seeking and that market-seeking activities are weak. This result provides insights for African policymakers regarding how to set up suitable regulations and policies to attract more market-seeking FDIs in non-resource-related industries. Compared with resource-seeking, market-seeking FDIs have more room to interact with local economic participants in terms of local job creation and productivity spillovers on local firms, which is much needed for African countries to undergo industrialization and modernization. This is especially relevant in the context of China's infrastructure investment in Africa. In response to geopolitical tension and the reshuffling of global supply chains, China has already adjusted its investment strategy in Africa, which shows a trend of localizing China's infrastructure investment in host countries (Bo and Zhu, 2025). The new challenges faced by African policymakers are how to build up local capacity to absorb Chinese investment in manufacturing and tech-oriented projects and how to mutualize host countries' institutions. It is also crucial for African policymakers to establish some mechanisms that safeguard African local firms from becoming redundant.

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Hong Bo is AXA Chair in Global Finance and Director of the Centre for Global Finance (CGF) at the School of Finance & Management, SOAS University of London. Her research interests cover topics in financial economics, including firm investment decisions under uncertainty, capital market imperfections, comparative financial systems, corporate finance, corporate governance, the Chinese economy and China's state-financed overseas infrastructure investment across the globe.

Sofia Johan is Associate Professor of Finance at Florida Atlantic University, USA. She is also affiliated with InnoLab, University of Vaasa and Tilburg Law and Economics Centre (TILEC). She holds a PhD from Tilburg University in the Netherlands. Her research is focused on alternative finance (including, but not limited to, crowdfunding, peer-to-peer lending and cryptocurrencies) and alternative investments (including, but not limited to, hedge funds, venture capital, private equity, real estate investment trusts and IPOs).

Rodiat Lawal is a Lecturer in Finance at the University of Dundee, UK. She has a PhD in Finance from SOAS University of London, fully sponsored by the Commonwealth Scholarship Commission, UK. Rodiat finished top in her undergraduate and postgraduate classes, with first-class honours, and was awarded best graduating student in the department. Her research focuses on financial, socio-economic and China–Africa infrastructural partnerships. Rodiat's research has been published in top journals.

Rilwan Sakariyahu is a Senior Lecturer in Financial Economics within the Economics Discipline of the University of Dundee Business School. He has previously worked with Manchester Metropolitan University and Edinburgh Napier University in the UK. He holds a PhD in Financial Economics from Edinburgh Business School, Heriot-Watt University, UK. Rilwan's research interests are in the areas of behavioural corporate finance, financial economics, financial markets, development and sustainable finance. His research has been published in top journals.

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