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Article

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Does the Belt and Road Initiative boost industrialization? Empirical evidence from African economies

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ABSTRACT

Exploiting the economic dividends of the mega-infrastructure investments related to the Belt and Road Initiative as a timely global South-South cooperation model, this study follows the New Structural Economics theory to examine the effects of the BRI membership on Africa's industrialization. A panel fixed effects and Instrumental Variable (IV) estimation methods were employed to conduct an in-depth empirical analysis of BRI's impacts on Africa's industrialization. The study utilized country and firm-level datasets to provide comprehensive macro and micro empirical evidence for 51 African countries from 2000 to 2022. The baseline macro-level findings show that BRI membership and infrastructure investments promoted the aggregate industry value-added share of GDP in Africa. Moreover, the firm-level results provide solid empirical evidence by showing significant annual sales growth of manufacturing firms in African BRI member countries. However, juxtaposing various industry specification measurements, the results did not provide empirical evidence that BRI boosts the narrowly defined manufacturing value added. Meanwhile, consistently withstanding rigorous robustness and heterogeneous checks, the study findings provide evidence-based practical policy recommendations for the African economies. Designating BRI as a 21st-century industrialization-led development model, these policy recommendations have overarching implications for achieving economic transformation goals listed in the African Union Agenda 2063.

IMPACT STATEMENT

The tiny research on the BRI industrialization strand produced huge controversies with inconclusive results. Another major limitation of these BRI industrialization studies is the ambiguous explanation of the BRI's mechanism of influence, which relies solely on the BRI membership indicator as the channel of effects. To improve this deficiency, the study contributes to the existing literature in two ways. First, the study includes the values of BRI infrastructure construction projects as a closer indicator of the BRI's channel of impact on African industrialization. Second, the study combines macro and micro-level empirical evidence and conducts BRI's deep and shallow industrialization analysis using a large sample of African economies. Employing the panel fixed effects empirical estimation method; the study baseline results show that BRI membership significantly improves African industrialization despite lagging. Furthermore, the Instrumental Variable (IV) results of the firm-level analysis provide solid micro-level empirical validation for the impact of BRI's macro-industrialization.

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1. Introduction

The structural transformation theory postulates that successful industrialization, which shifts economic resources from low-productive agriculture to the more productive industry sector, is an engine of growth and economic development (Cornwall, 1977; Lewis, 1954). Robustly withstanding rigorous empirical tests for more than half a century, it is now a widely believed doctrine among mainstream economists that industrialization is a crucial factor guaranteeing unconditional convergence and development

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catch-up in income and productivity levels of developed and developing countries (Attiah, 2019; McMillan et al., 2017). The steady economic prosperity of the early and late developers in Europe, North America and Asia is chiefly attributed to effective industrialization and the advanced manufacturing sector. However, the industrialization-led development model did not work for Africa despite emulating the same structural transformation model (Samouel & Aram, 2016).

The intellectual explanations in the literature document the lack of essential capabilities in terms of infrastructure, skills, and institutions as the root sources of Africa's industrialization failure and underdevelopment puzzle (Escribano et al., 2010; Newman et al., 2016). Despite spending US\$4.6 trillion in aid and concessional loans in developing countries since the 1960s, numerous multilateral and bilateral development attempts have failed in the past (Lin, 2022). The African Development Bank estimates that Africa suffers an infrastructure financing deficit of about US\$130–170 billion per year (Lisinge, 2020). This study, confirming the necessity of the fundamentals, critically questions the suitability and effectiveness of the multilateral development models adopted, i.e. adjustments, stabilizations, and investment climate programs under the Washington Consensus framework, which extremely focused on the soft infrastructure institutions and underinvested the physical infrastructure.

Under the structural transformation literature, two diverse yet complementary strands of early and new structural theories exist. Following the traditional structural model of static endowments and state choice, the development plans of developing countries under the guidance of international development partners narrowly focused on the soft capabilities of liberalizations, institutions, and investment climate at the expense of desperately needed hard infrastructure. On the other hand, the New Structural theory redefines economic development as a process of dynamic structural transformation, featuring continuous resource endowments, technological innovation, industrial upgrading, and improvement in hard and soft infrastructure (Lin & Wang, 2017; Lin, 2022).

This study pushes the empirical frontiers of the new structural theory by exploiting the transformation dividends of the giant infrastructure investment projects in Africa under the Chinese flagship global cooperation program of the Belt and Road Initiative (BRI). The choice of suggesting BRI as a viable alternative development model for Africa is influenced by the volume and the focus of the initiative's investments shown in Figure 1. First, BRI sharply raised the trajectory of Chinese investments in Africa after the inauguration of the initiative in 2013, as shown in panel A. Secondly, the BRI's energy and transport infrastructure investment targets perfectly coincide with the critical barrier of Africa's economic transformation agenda, as shown in panel B.

Even though BRI is a global cooperation initiative, it is noteworthy that Africa has already attracted a fair share of the initiative's infrastructure investment funds. These include the US\$ 2.49 billion value of Addis-Djibouti railway, the US\$ 4.3 billion value of Nigeria Dangote Cement Expansion, US\$ 3.8 billion value of Mombasa-Nairobi standard gauge railway, US\$ 7 billion value of Tanzania Bagamoyo Port, US\$ 7 billion value of South Africa Modderfontein New City Project, US\$ 3.1 billion value of Mozambique Mphanda Nkuwa Dam and Hydroelectric station project, US\$ 7.16 billion value of Congo DRC Infrastructure for Mines Barter Deal and US\$ 5.6 billion value of Chad-Sudan Railway (Ehizuelen, 2017; Irandu & Owilla, 2020). As shown in Figure 2, the preliminary observations demonstrate that, by 2018, BRI membership augments physical infrastructure to promote industrialization in Africa.

The rise of China as a global economic power and the timely launch of BRI provided a perfect alternative model for Africa's infrastructure investment and structural transformation. President Xi Jinping's BRI announcement in 2013 and the immediate membership of most African countries accelerated the already upward trend of China's African infrastructure investment to US\$153 billion by 2021, of which \$91 billion (almost 60% of it) provided during the BRI period (Alden & Jiang, 2019; Gallagher et al., 2023). The BRI objectives include infrastructure connectivity promotion, policy coordination, international trade facilitation, deep financial integration, and fastening people-to-people bonds (Chen et al., 2019; Herrero & Xu, 2017; Johnston, 2019). Although BRI is just ending its first decade of implementation, the program's giant infrastructure investments have already attracted a substantial amount of scholarly attention evaluating its economic impacts on broad aspects, including trade (Rehman & Noman, 2021), environment (Rauf et al., 2018), economic growth (Yang et al., 2020), foreign direct investments (Kang et al., 2018) and technological transfer (Razzaq et al., 2021).

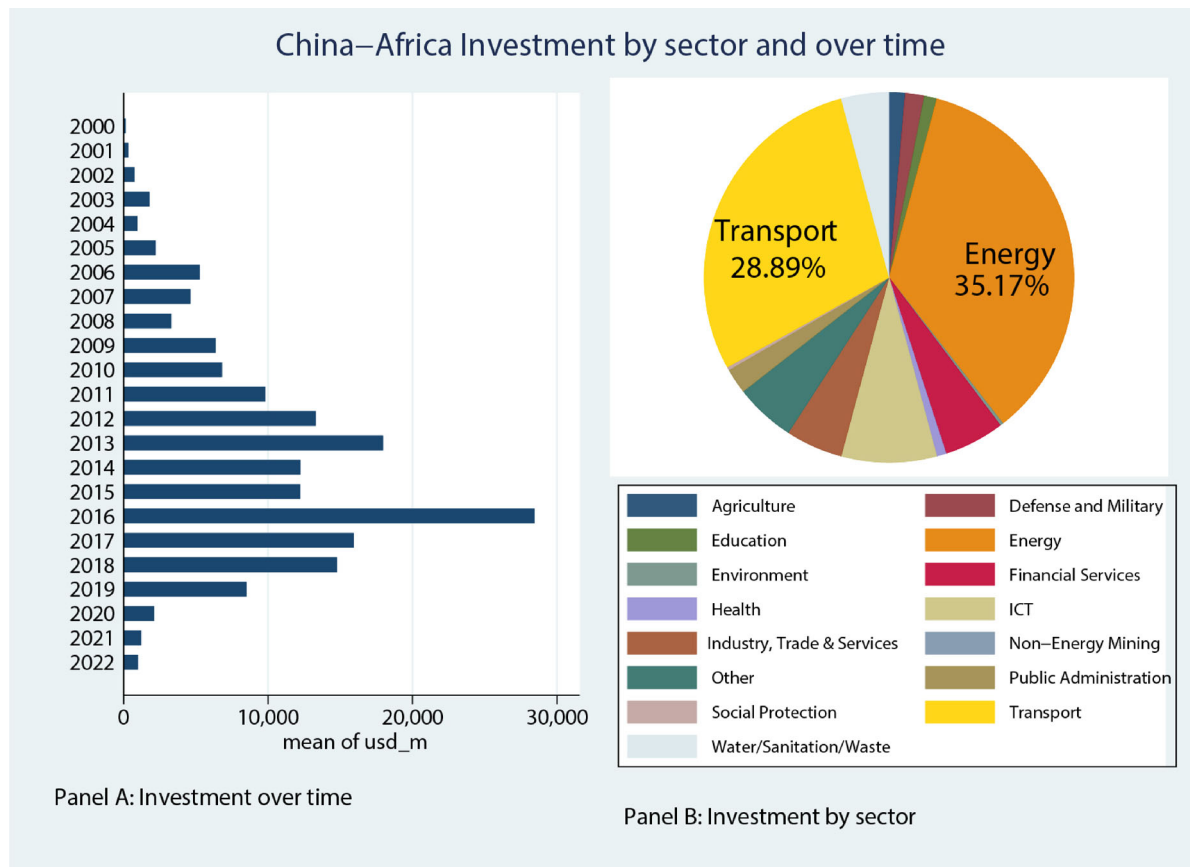


Figure 1. China–Africa investment by sector and overtime.

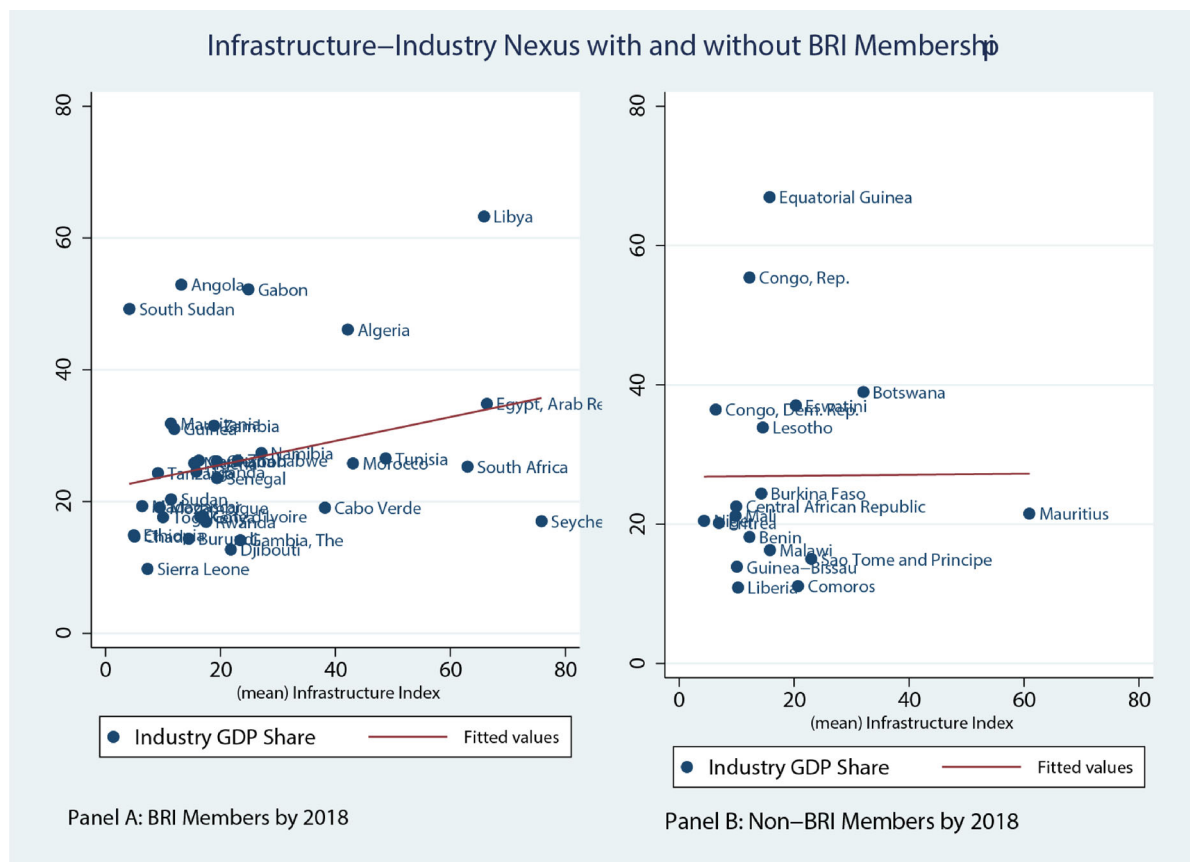


Figure 2. BRI membership and infrastructure-led industrialization.

As a separate strand under the vast BRI and BRI-Africa literature, the tiny research on the BRI industrialization strand produced huge controversies with inconclusive results. For instance, BRI stimulated industrial upgrading in Indonesia through the flying geese model (Negara & Suryadinata, 2021), had significant effects on Pakistan's industrial production through the China-Pakistan Economic Corridor (CPEC) (McCartney, 2022); promoted Cambodian manufacturing industries (Loughlin & Grimsditch, 2021); and accelerated the industrialization of member countries (Senadjki et al., 2022). However, another set of studies reports either mixed or insignificant BRI impact on industrialization (Jahangir et al., 2020; Luo et al., 2022; Megbowon et al., 2019; Zhou et al., 2023). A major limitation of these BRI industrialization studies is the ambiguous explanation of the BRI's mechanism of influence, which solely relies on the BRI membership indicator as the channel of effects. In addition, the literature lacks sufficient focus on the BRI's impact on African industrialization, covering both micro and macro-level perspectives and varying depths of industrialization. In addition, the existing literature does not sufficiently treat the BRI-Industrialization nexus in the African context. To improve this deficiency, we include the values of the Chinese infrastructure construction projects as a closer indicator of the BRI's channel of impact on African industrialization. Moreover, this study is the first to combine macro and micro-level empirical evidence and among the few to conduct BRI's deep and shallow industrialization analysis using a large sample of African economies.

Out of this incompleteness of the BRI industrialization literature, this study aims to investigate the impact of the BRI on African industrialization for 51 African countries from 2000 to 2022 by answering the following questions. How do the BRI infrastructure investments affect the growth of macro-level industry value-added share of GDP and micro-level manufacturing firms' output in Africa? How does BRI affect the industrialization of the narrowly defined manufacturing value-added growth compared to broadly defined industry value-added growth? How does BRI's industrialization impact on Africa vary with natural resource abundance, and to what extent are these effects immediate or lagged over time?

Using the panel fixed effects empirical method, the study baseline results show that BRI membership significantly improves African industrialization despite lagging. Furthermore, the Instrumental Variable (IV) results of the firm-level analysis provide solid micro-level support for the impact of BRI's macro-industrialization. However, due to the heterogeneous effects of various macro-level industry classifications and micro-level firm characteristics, careful policy considerations are necessary to reap the BRI's deep industrialization potential for Africa and ensure a fair distribution of BRI-related welfare gains among economic sectors and social groups. The rest of the paper is organized as follows. [Section 2](#) provides the theoretical framework, specifies the empirical estimation methods and describes the study datasets. [Section 3](#) presents the baseline and extensive robustness checks. [Section 4](#) provides comprehensive analytical discussions, while [Section 5](#) concludes the study with practical policy recommendations.

2. Methodology

The study aims to investigate the effect of the Belt and Road Initiative on African industrialization by empirically estimating the nexus between BRI membership and the growth of the industrial and manufacturing sectors. More specifically, the research assesses the BRI effects on industry and manufacturing value-added at both country and firm levels. To achieve this goal, the study adopted a panel fixed effects empirical estimation strategy for 51 African countries from 2000 to 2022. The choice of the number of countries included is influenced by the BRI membership, whereby fifty-one African countries are already members. Moreover, the study estimated an Instrumental Variables (IV) analysis to provide micro-level evidence for the output growth of 19,766 manufacturing firms in Africa.

Following Bailey et al. (2017), the study exploits the United Nations General Assembly Voting similarity score (UNGAVSS) of African countries with that of China as an instrument to tackle the latter bias. The concept is that the higher the voting similarity in the UNGA between China and African countries, the higher the foreign policy alignment, and hence, the more likely it is to apply and get admitted into BRI membership. As a typical viable instrument, we assume that the political distance between China and Africa is correlated with the choices of application and the approval of BRI membership but reasonably unrelated to the output and sales performance of African manufacturing firms and hence accepted

as a valid instrument. The IV first-stage estimation results presented in the [Appendix](#) section confirm the validity of this assumption and hence suggest UNGA as a valid instrument.

2.1. Theoretical framework

The study adopts a modified version of Murphy et al. (1989) Big Push theory initially developed by Rosenstein-Rodan (1943), which is a proxy of the new structural transformation theory as the basic theoretical framework to answer the research questions. As a model of infrastructure-industrialization effects, building a railroad is especially important as it reduces production costs, facilitates transport logistics, and thus enhances industrialization. Initially, the model considers a two-period living representative consumer whose intertemporal utility maximization problem is given below:

$$U = \left(\int_0^1 x_1^\gamma(q) dq \right)^{\theta/\gamma} + \beta \left(\int_0^1 x_2^\gamma(q) dq \right)^{\theta/\gamma} \quad (1)$$

The consumer is endowed with L units of inelastically supplied labour in which a fraction of R investments are needed to build the railroad, and profit will accrue for the consumer. For simplicity, the model assumes that $\theta = 1$ and $\beta = 0$, implying that the consumer is indifferent about when he consumes his income and spends equal shares of his income in each period on all goods. Furthermore, the model also assumes that the consumer's time discount factor (β) equals one, implying that the equilibrium interest rate is always zero. The model considers two economic activities: constant returns to scale (CRS) technologies cottage production that doesn't need railroad construction and increasing returns to scale (IRS) technologies manufacturing production that requires railroad construction. The model further regards that industrialization cannot be achieved in the absence of the railroad. In addition, the model assumes n -firms with F_1 fixed costs and $n-1$ firms with F_2 fixed costs that generate labour productivity of (α) in the second period, and $F_2 > F_1$. To emphasize the coordinated investment, the model further assumes that the low-fixed-cost firms cannot solely generate enough surplus to pay for the railroad as:

$$n \left(\frac{aL}{1 - \alpha n} - F_1 \right) < R \quad (2)$$

where $a = 1 - 1/\alpha$

Hence, the sufficient condition to cover the railroad investment costs so that all firms industrialize is:

$$\alpha \alpha L - nF_1 - (1-n)F_2 > R \quad (3)$$

This final condition (3) of the Big Push theory demonstrates that, if all n -firms invest in railroad construction, the transport infrastructure improves and economy-wide industrialization will be achieved. In this study, we conceptualize the massive BRI-related infrastructure investments as the Big Push effect to augment infrastructure to facilitate Africa's economic transformation.

2.2. Empirical specification model

The study specifies macro-level panel fixed effects and micro-level instrumental variables (IV) empirical estimation strategies to provide country and firm-level evidence of BRI industrialization impacts on African states.

2.2.1. Macro-level model

Following the industrialization-led engine of growth literature (Attiah, 2019; Guadagno, 2016; McMillan et al., 2017; Samouel & Aram, 2016) and BRI literature (Kang et al., 2018; Wu et al., 2020), the study proposes the following panel fixed effects model as a macro empirical estimation strategy to evaluate BRI African industrialization effects.

$$\text{Ind_VA}_{it} = \alpha + \beta \text{BRI}_t + \gamma \text{infrast}_{it} + \theta X_{it} + \lambda_i + \mu_t + \varepsilon_{it} \quad (4)$$

where Ind_VA_{it} is the dependent variable, which is, according to the literature, measured in two ways: (i) as industry value added share of GDP and (ii) as manufacturing value added share of GDP for the

country i at time t ; BRI_i is a dummy variable that equals 1 for all countries after 2013 and 0 otherwise; $infrast_{it}$ is the value of the Chinese infrastructure construction investment projects in Africa; X_{it} is a vector of control variables selected as per the relevant literature; λ_i is a vector of variables that capture all country-fixed effects that are time invariants; μ_t is a vector of variables that captures all time-fixed effects that are country invariants and ε_{it} is the final idiosyncratic error.

2.2.2. Micro-level model

The study also conducts a firm-level analysis to check the validity of the aggregate country-level results by employing World Bank Enterprise Survey data on sales growth and other firm characteristics for 19,766 manufacturing firms from 32 African countries. The inclusion choice of the variables for the empirical analysis is informed by the relevant BRI and non-BRI industrialization literature (Cao et al., 2022; Chu & Hoang, 2022; Razzaq et al., 2021). Hence, the study suggests the following micro-level empirical model to assess the impact of BRI membership on the annual sales growth of manufacturing enterprises in Africa.

$$Mnf_Firm_Growth_{ijt} = \alpha + \beta BRI_t + \delta Firm_Charac_{ijt} + \gamma CV_{ijt} + \lambda_i + \mu_t + \varepsilon_{ijt} \quad (5)$$

where for country i , firm j at time t ; $Mnf_Firm_Growth_{ijt}$ is the outcome variable measured as an annual sales growth of the manufacturing firm, BRI is the policy factor measured as 1 for all countries after 2013 and 0 otherwise. The model also controls a host of firm characteristics like age, ownership, size, trade participation, and legal status of the establishment. The parameter of interest, β , captures the potential impact of BRI membership on local manufacturing firms.

2.2.2.1. Instrumental variable (IV) model. The study designed an Instrumental Variable (IV) identification strategy to avoid the potential BRI self-assignment bias. As such, the Africa-China UNGA voting similarity score is assumed to have correlated with the BRI membership but not directly related to the performance of African firms, and hence, it was chosen as an instrument for tackling BRI endogeneity. The following model shows the design of the IV model.

$$Mnf_Firm_Growth_{ijt} = \alpha + \beta Predicted_BRI_{it} + \delta Firm_Charac_{ijt} + \gamma CV_{ijt} + \lambda_i + \mu_t + \varepsilon_{ijt} \quad (6)$$

The value for the predicted BRI variable in (6), instrumented with the China-Africa UNGA Vote similarity scores, is recovered from the first stage probit regression model as shown in Equation (7)

$$BRI_{it} = \alpha + \beta Vote_imilarity_score_{it} + \delta Firm_Charac_{it} + \gamma CV_{it} + \varepsilon_{it} \quad (7)$$

2.3. Data and variables

This study used datasets from different sources, including the industrialization, GDP and other aggregate from World Bank Development Indicators (WDI), governance from World Governance Indicators (WGI), human capital from Barro and Lee Educational Attainment database, and BRI and Chinese Africa investments from China-Africa Research Initiative Database. The dependent variable of the study is measured as the industry and manufacturing value-added shares of GDP (Guadagno, 2016; Samouel & Aram, 2016). The main explanatory variables are the BRI membership and the values of the Chinese infrastructure construction investment projects in Africa as a proxy for the infrastructure investment role hypothesized by the New Classical and Big Push theories. The control variables include real GDP per capita as an indicator of development level, FDI inflows and gross capital formation as an indicator of investment and financial development, trade GDP share as a proxy for openness, school enrollment as an indicator of human capital development, WGI governance indicators as a proxy for institutional quality, total population and urbanization as an indicator for market size and natural resources rent as an indicator for resource abundance. Similarly, firm-level data of all variables, except the UNGA voting similarity score, are sourced from the World Bank Enterprise Survey database conducted over several years from different countries pooled together. Finally, the UN voting similarity score data is collected from the Harvard 'United Nations General Assembly Voting Dataverse, V29'. Table 1 shows the summary statistics for the variables used in the study at both macro and micro levels.

Table 1. Summary statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Panel 1: country level dataset					
Industry value-added	1028	23.150	9.0122	3.243	48.303
Manufacturing VA	965	10.368	4.7213	.233	24.557
BRI	1173	.434	.495	0	1
Infrastructure (Log)	1122	4.5203	2.281	2.302	9.0400
GDP (Log form)	1072	23.140	1.590	18.867	26.974
Trade GDP share	999	71.394	38.904	.757	347.997
FDI inflow (net)	1080	4.334	7.789	−18.918	103.337
Natural resources rent	1081	11.694	11.873	.002	88.592
Governance	1062	29.800	18.453	.313	77.958
Population (log form)	1122	15.812	1.509	11.303	18.579
Urbanization (log form)	1122	14.861	1.374	10.619	17.607
Gross capital formation	981	22.677	10.265	−3.946	79.401
School enrollment	1173	47.030	24.535	5.508	114.715
Panel 2: firm-level dataset					
Annual sales growth	19385	−1.274	32.330	−99.99	100
BRI	19766	.897	.304	0	1
lnGDP PC	19766	11.33	1.973	0	15.334
Firm R & D spending	13346	15.623	36.308	0	100
Firm legal status	19623	3.054	1.034	1	6
Firm size	19766	1.685	.762	1	3
Firm age	19352	18.929	15.844	0	139
Manager experience	19443	17.259	10.979	0	60
Firm total employees	19271	72.522	187.860	0	4000
UN vote similarity	19766	.873	.333	0	1

3. Results

This section presents the study results. After estimating the baseline panel macro results, the study conducts several robustness checks to verify the external validity of the results with IV microanalysis. First, to test the depth of BRI Africa's industrialization impact, the study specifies two industrialization measurements, i.e. industry share of GDP and manufacturing share of GDP, and contrasts the heterogeneous effects. Second, the study compares the potentially differential effects of BRI membership on resource-rich and resource-poor countries. Third, the research checks if the impact of BRI industrialization is instantaneous or lagging. Finally, the study estimates the primary IV and several other heterogeneous analyses for the firm-level results by checking the effects of firm-specific factors like age, ownership, size, trade participation, and legal status of the establishment.

3.1. Macro-level analysis

Using Equation (4) panel model, the results in Table 2 present the main macro results of the study. As shown in columns one and two, the BRI membership significantly boosted industrialization in Africa. Furthermore, the findings reveal that BRI-related Chinese infrastructure construction investment projects in Africa have a significant and positive impact, as shown in columns three and four. Controlling various confounding variables, including GDP, Trade GDP share, FDI, population, urbanization, governance and education, the analysis also captured cross-country differences in development levels, market size, financial development, openness and institutional and human capital quality. It is worth mentioning that most of the controls confirm the priori expectation as GDP, resource ownership, openness, urbanization, and financial development improve industrialization in Africa in all sub-model specifications.

Next, the study further examines whether BRI promotes industries across the board as defined in the International Standard Industrial Classification (ISIC) from 5 to 43 divisions to deepen the analysis presented in Table 2. Following the United Nations Department of Economic and Social Affairs Statistics Division, the study defines industries from 5 to 43, including mining, quarrying, manufacturing, electricity, gas, steam and air conditioning supply, water supply, sewerage, waste management and construction, as the 'industry value added'. In contrast, the second categorization of the outcome variable, including the ISIC sub-industries from 10 to 33, is defined as the 'manufacturing value added'. In this regard, the results in Table 3 present the differential impact of BRI membership on these industry sub-groups. The first two columns present the BRI empirical effect on Africa's broad industrialization, while

Table 2. Baseline results.

Dependent variable:	Industry value-added			
	(1)	(2)	(3)	(4)
BRI	.121*** (.026)	.102*** (.027)		
Infrastructure			.037*** (.006)	.030*** (.006)
Population	−.295*** (.076)	−.276*** (.074)	.04 (.19)	−.057 (.218)
Openness	.053*** (.02)	.039* (.02)	.020 (.019)	.013 (.02)
Resources	.011*** (.001)	.012*** (.001)	.011*** (.001)	.011*** (.001)
GDP growth	.002** (.001)	.001 (.001)	.003*** (.001)	.002** (.001)
FDI inflows	.003** (.001)	0.01 (.001)	.002* (.001)	.001 (.001)
Urbanization	.401*** (.075)	.371*** (.073)	.317*** (.123)	.336** (.133)
Governance		.002** (.001)		.002* (.001)
Education		.031 (.021)		.011 (.022)
Capital formation		.004*** (.001)		.004*** (.001)
_cons	1.62*** (.455)	1.57*** (.434)	−2.411 (1.883)	−1.264 (2.219)
Observations	959	902	959	902
Countries	51	51	51	51
Country FE			Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R-squared	.424	.459	.225	.239

Robust Standard errors are in parentheses.

***p < .01, **p < .05, *p < .1.

Table 3. Industry classification analysis.

Dependent variable	Industry value-added		Manufacturing value-added	
	(1)	(2)	(3)	(4)
BRI	.102*** (.027)		−.039 (.046)	
Infrastructure		.030*** (.006)		.042*** (.011)
CV	Yes	Yes	Yes	Yes
_cons	−11.354** (4.628)	−11.723* (6.441)	−28.672** (12.796)	−25.784** (10.669)
Country FE		Yes		Yes
Year FE	Yes	Yes	Yes	Yes
Observations	902	902	853	853
Countries	51	51	51	51
R-squared	.459	.239	.117	.155

Robust standard errors in parentheses.

***p < .01, **p < .05, *p < .1.

the results in the last two columns show the impact of narrow industrialization. As evident in [Table 3](#), BRI enhanced Africa's general industrial sectors, including mining and construction, but not the manufacturing sector per se.

Although it is a relatively new field of study, the BRI literature has already had its fair share of controversy over its intentions and the development impacts on African countries. One particular aspect widely debated in the literature is the critical factors influencing BRI investment choice in member countries. The argument of this literature strand suggests that BRI investments are overly focused on the member countries with abundant natural resources. Hence, to incorporate this issue into our analysis, we conducted a heterogenous analysis of BRI's industrialization impact on resource-rich and resource-poor African states. As demonstrated in [Table 4](#), the comparative results reveal no significant differences in BRI industrialization impact attributable to natural resource ownership, suggesting that BRI offered a level playing field of development opportunities for African countries.

Table 4. Resources abundance analysis.

Dependent variable	Industry value-added			
	Resource abundant		Resource scarce	
	(1)	(2)	(3)	(4)
BRI	.096** (.041)		.162*** (.033)	
Infrastructure		.047** (.022)		.034*** (.007)
CV	Yes	Yes	Yes	Yes
_cons	-.373 (.364)	13.197* (7.058)	4.707*** (1.073)	-4.186 (2.607)
Country FE		Yes		Yes
Year FE	Yes	Yes	Yes	Yes
Observations	147	147	747	747
Countries	18	18	33	33
R-squared	.764	.702	.772	.132

Robust standard errors in parentheses.

***p<.01, **p<.05, *p<.1.

Table 5. Instantaneous vs. lagging impact analysis.

Dependent variable:	Industry share of GDP			
	(1)	(2)	(3)	(4)
BRI	.114* (.061)	.115* (.059)	.106* (.059)	.109* (.061)
BRI*2014	-.002 (.027)			
BRI*2016		-.009 (.038)		
BRI*2018			.169** (.074)	
BRI*2020				.098 (.089)
CV	Yes	Yes	Yes	Yes
_cons	-22.746*** (7.817)	-22.773*** (7.844)	-22.063*** (7.691)	-23.311*** (7.834)
Year FE	Yes	Yes	Yes	Yes
Observations	902	902	902	902
Countries	51	51	51	51
R-squared	.917	.917	.918	.918

Robust standard errors in parentheses.

***p<.01, **p<.05, *p<.1.

Another objective of this study was to check if BRI's impact on African industrialization is instantaneous or lagging. As a typical mega infrastructure investment project, the impact is so rare to be immediate, given the fixed macro and institutional factors involved. In this section, the study interacts with the BRI membership and the post-period to capture the gradual effects of the program over time. As shown in Table 5, the effects were even negative in 2014, turned positive after two more years in 2016, albeit insignificant, before finally showing significant positive impacts by 2018. These lagging effects imply that the BRI's impact on Africa's industrialization was not instantaneous, and the expected effects showed up after time, given the relevant factors controlled.

3.2. Micro-level analysis

A major novel contribution of this study to the BRI industrialization literature is combining macro and micro-level evidence to lend more credibility to the country-level empirical results. In this section, the study presents the firm-level results using the baseline micro-model (5) and the final instrumental variable (IV) Equation (6). The results in columns 2 and 3 of Table 6 show that, with the IV model, BRI membership effectively promotes firm-level manufacturing growth despite being ineffective in the column one panel baseline model. These firm-level results augment the macro-level findings and lend more empirical validity to the BRI-industrialization impact in Africa. Moreover, the results also demonstrate the appropriateness of the IV, which is significantly correlated with the endogenous BRI membership but

Table 6. Firm-level IV results.

Model	Annual sales growth			
	Baseline model		IV model	
Dependent variable				
BRI	.554 (6.801)	.275*** (.085)	.283*** (.085)	.262*** (.086)
GDP PC	.175 (1.818)	.008* (.005)	.008* (.005)	.007 (.005)
Firm R & D spending	0.01* (0.00)	.001** (0.01)	.001** (0.01)	.001** (0.01)
Firm legal status	.004 (.007)	.004 (.007)	.007 (.007)	.003 (.007)
Firm size	.021 (.025)	-.017* (.01)	-.017 (.011)	.02 (.025)
Firm age	-.016 (.011)	-.035*** (.01)	-.022** (.011)	-.022** (.011)
Manager experience	-.017 (.012)		-.039*** (.012)	-.034*** (.012)
Firm total employees	-.021 (.014)			-.026* (.014)
_cons	1.953 (30.615)	3.079***	3.055*** (.62)	3.102*** (.457)
Observations	12410	12,862	12,686	12,410
Country FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
First stage F-statistics	–	2250.7	2275.88	2199.96
Sargan statistics	–	0.3172	0.4311	0.4095
R-squared	0.0710	0.0500	0.0513	0.0501

Robust standard errors in parentheses.

***p<.01, **p<.05, *p<.1.

Table 7. Firm size and age effects.

Dependent variable:	Annual sales growth				
	Small size firms (1)	Medium size firms (2)	Large size firms (3)	Young firms (4)	Old firms (5)
BRI	.195* (.113)	.102 (.151)	.578*** (.222)	.144 (.097)	.434** (.169)
CV	Yes	Yes	Yes	Yes	Yes
_cons	2.321*** (.135)	2.383*** (.189)	1.934*** (.286)	2.259*** (.11)	2.127*** (.202)
Observations	5867	4170	2373	6951	5459
Country FE	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	.019	.008	.020	.015	.023

Robust standard errors in parentheses.

***p<.01, **p<.05, *p<.1.

does not belong to the original model. Finally, the significant first-stage results confirm the relevance of the IV, while F and Sargan statistics suggest its validity and strength.

Entity unique characteristics matter for the effectiveness of government macro policies, such as the decision to join the Belt and Road Initiative (BRI). The study conducts four micro-level heterogeneity analyses in this section to solidify the firm-level BRI industrialization results presented in Table 6. First, the firm's age and size influence the output growth during external policy shock. Hence, Table 7 shows that BRI membership was particularly beneficial for small, large, and older firms compared to mid-sized and younger entities.

Second, firm ownership and trade participation are other firm-specific characteristics that influence firm output when interplay with an external policy. According to the findings in Table 8, locally-owned firms significantly grew better than foreign-owned ones. Citizen affirmative action or local protection policies popular in Africa could be a plausible explanation. On the other hand, the findings also reveal that exporting firms did not benefit much from the BRI membership compared to the non-exporting firms. A realistic justification for this could be that African manufacturing firms do not export much and are hence underrepresented in the export business sector.

Table 8. Firm ownership and trade effects.

Dependent variable:	Annual sales growth of the manufacturing firm			
	Domestic (1)	Foreign (2)	Non-exporter (3)	Exporter (4)
BRI	.326*** (.108)	-.048 (.161)	.248*** (.094)	.184 (.274)
CV	Yes	Yes	Yes	Yes
_cons	2.133*** (.107)	2.926*** (.222)	2.225*** (.102)	2.663*** (.242)
Observations	10799	1467	10352	1809
Country FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R-squared	.006	.022	.006	.028

Robust standard errors in parentheses.

***p<.01, **p<.05, *p<.1.

Table 9. Firm legal status effects.

Dependent variable:	Annual sales growth				
	Listed with tradable stock (1)	Listed without tradable stock (2)	Sole proprietorship (3)	Partnership (4)	Corporations (5)
BRI	2.021* (1.19)	1.882*** (.684)	.085 (.1)	-.28** (.142)	-.072 (.134)
CV	Yes	Yes	Yes	Yes	Yes
_cons	.691 (1.274)	1.286** (.583)	2.209*** (.11)	2.6** (.177)	2.57** (.209)
Observations	664	2209	5907	1690	1791
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	.022	.020	.021	.021	.013

Robust Standard errors in parentheses.

***p<.01, **p<.05, *p<.1.

Finally, as informality is normal in the African economic environment, the legal status of the establishment is another critical factor for the output growth of the firm and the effectiveness of public policies. This section shows how an entity's legal structure affects its sales performance. Unlike other firm-level aspects, differences in legal status demonstrate a huge heterogenous impact on BRI Africa industrialization, as shown in Table 9. The results show that more professional and formally-listed firms perform better with BRI membership, while more traditional enterprises in partnerships and corporations lose.

4. Discussion

The study baseline results demonstrate significant positive impacts after controlling the relevant country-level confounders like the level of development, trade openness, the ownership of natural resources, the size of the local market, institutional quality, human capital and local and foreign-sourced financial development. The immediate implications of the target BRI and infrastructure construction results confirm the new classical hypothesis postulating the importance of BRI membership as a proxy for better physical infrastructure facilities to promote industrialization (Lin, 2011, 2022; Lisinge, 2020). The findings also strongly support the argument suggesting that BRI is an alternative development model for the 21st-century developing countries and, more particularly, for the African member countries (Loughlin & Grimsditch, 2021; McCartney, 2022; Negara & Suryadinata, 2021; Senadjki et al., 2022). Furthermore, several robustness checks were conducted to check the validity of these main results, and they produced consistent evidence backing the BRI's African industrialization-led development impact.

A novel contribution of this study is conducting a broad versus narrow industry classification analysis following the deep and shallow industrialization literature (Steinfeld, 2004; Wei & Wang, 2019). By doing so, the paper found mixed effects, revealing that BRI did not promote the narrowly defined manufacturing sectors compared to that of broadly industry value added and hence confirm the inconclusive BRI literature strands (Jahangir et al., 2020; Luo et al., 2022; Zhou et al., 2023). This kind

of deep analysis was motivated by the fact that manufacturing, unlike other industries like mining, contributes to economy-wide performance in increasing returns to scale, capital accumulation, and technological spillover (Timmer & Szirmai, 2000). Likewise, checking the BRI differential industrialization impact on the abundance of natural resources, the findings suggest no significant heterogeneous effects, implying that BRI presents equal development opportunities for all African member states. Moreover, as a typical mega infrastructure investment project, BRI development impact is not expected to be immediate as it depends on other country-level rigid institutional and environmental factors. The study results, therefore, confirm this hypothesis as the initiative's African industrialization impacts lagged till the 5th year after its establishment. Another innovative contribution of this study is to augment the country-level analysis with firm-level analysis by exploiting the manufacturing firms' annual sales growth as a proxy for micro-industrialization, and the results significantly confirm the macro-BRI industrialization effects.

5. Conclusion

Suggesting BRI as an alternative industrialization-led development model for member African countries, the study presented country and firm-level empirical evidence. The preliminary findings in both macro and micro-level analysis provide strong supporting evidence for the BRI's effectiveness as a South-South cooperation model and African industrialization agenda. The results also demonstrate significant heterogeneous impacts of the BRI membership due to the differences in geographic and institutional factors and inherent firm-based capability differences. Nonetheless, the study findings convey several vital and timely policy recommendations. First, the study designates BRI membership as a 21st-century development model through industrialization opportunity for Africa and hence strongly suggests that policy-makers strategically opt for long-term BRI membership. Second, as BRI enters its second phase of implementation, with a renewed emphasis on smaller, strategic investments that are increasingly green and digitally oriented, African member nations should realign their strategies by prioritizing realistic, high-impact projects that will accelerate the continent's industrialization efforts. Third, the research findings recommend prudent sector-specific BRI investment allocation policies to ensure deep industrialization through fully-fledged manufacturing sector, which is not sufficiently achieved at the current BRI level. In particular, African leaders can strategically direct BRI investments towards renewable energy and transport infrastructure which are essential for stabilizing power supply and enhancing logistics, thereby driving industrialization. Fourth, as a typical public policy, the results show that the current BRI-related economic benefits are not evenly distributed among local economic sectors. Therefore, the study urgently suggests that African countries develop suitable inclusive policy mechanisms to ensure a fairer distribution of BRI welfare gains and avoid public distrust that could jeopardize the already achieved goals. Fifth, the study recommends improving broader institutions and investment climate in member states as BRI-related hard infrastructure can produce the intended full industrialization benefits only if coupled with conducive soft infrastructure in governance and skills. Finally, since BRI is an international macroeconomic policy that lags to produce the expected outcomes, a parallel move of local economic and social policies in the same direction is necessary. Hence, the paper finally calls for enabling local micro and macro-economic policies among member countries to push BRI to its most beneficial limits in industrialization and beyond.

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Disclosure statement

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About the author

Dr. Abas Omar Mohamed is an economist with a B.A., M.A., and Ph.D. in Economics. He earned his Bachelor of Arts in Economics from Mogadishu University and completed a Master of Arts in Economics, specializing in Economic Policy Management, at Makerere University in Kampala, Uganda. He received his Ph.D. in Industrial Economics from the Research Institute of Economics and Management (RIEM) at the Southwestern University of Finance and Economics (SWUFE) in Chengdu, Sichuan, China. Currently, He serves as the director of the Center for Research Excellence (CRE) at Mogadishu University. He is also a faculty member in the Department of Economics at Mogadishu University. His primary research interests lie in Development Economics, focusing on economic growth through structural transformation and the role of human capital and education in fostering development.

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Data availability statement

The study employed country and firm-level datasets from various public and restricted databases, including World Bank World Development Indicators (<https://databank.worldbank.org/source/-world-development-indicators>), Johns Hopkins University's China Africa Research Initiative (<https://green-bri.org/databases-for-the-belt-and-road-initiative-bri/>), World Bank Enterprise Survey (<https://www.enterprisesurveys.org/en/data>), and Harvard University's 'United Nations General Assembly Voting database' (<https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/LEJUQZ>).

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Appendix.

First stage estimates for Table 6.

BRI	Coef	St.Err	t-value	p-value	[95% Conf	Interval]	Sig
Vote similarity	1.487	.047	31.74	0	1.395	1.579	***
GDP PC	.024	.008	2.93	.003	.008	.041	***
R and D spending	-.002	.001	-3.26	.001	-.003	-.001	***
Legal status	-.053	.019	-2.84	.004	-.09	-.016	***
Firm size	.09	.066	1.36	.173	-.039	.219	
Firm age	.184	.026	7.06	0	.133	.236	***
Manager expert	-.032	.029	-1.10	.273	-.088	.025	
Total_employees	.037	.038	0.95	.34	-.039	.112	
Constant	-.431	.146	-2.95	.003	-.718	-.145	***
Mean dependent var		0.934		SD dependent var		0.249	
Pseudo r-squared		0.185		Number of obs		12410	
Chi-square		1117.605		Prob > chi2		0.000	
Akaike crit. (AIC)		4946.078		Bayesian crit. (BIC)		5012.914	

***p<.01, **p<.05, *p<.1.