Trade Effect of Chinese Belt and Road Initiative: Evidence from Sub-Saharan African Countries

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Declaration

This work or any part thereof has not previously been presented in any form, whether for the purposes of assessment, publication or for any other purpose. Information taken from published and unpublished work of others is cited and list of references are presented in the study. I confirm that the intellectual contents of the work are the result of my own efforts and no other person.

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Approval

The is to certify that the thesis prepared by Degu Zinabe Fentaw, entitled: "Trade Effect of Chinese Belt and Road Initiative: Evidence from Sub-Saharan African countries" and submitted in partial fulfillment of the requirements for the degree of Master of Science (Economics) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Table of Contents

Contents

List of tables

List of figures

List of Annexes

List of Acronyms

AcFTA	African Continental Free Trade Area
AGOWA	African Growth and Opportunity Act
AIIB	Asian Infrastructure Investment Bank
ASEA	Association Of Southeast Asian
BRI	Belt And Road Initiative
BER	Bilateral Exchange Rate
CEPII	Center For Prospective Studies And International Information
CEPII	Center For Prospective Studies And International Information
COMESA	Common Market For Eastern And Southern Africa
CGE	Computable Generalized Equilibrium Model
CES	Constant Elasticity Of Substitution
DOTS	Direction of Trade Statistics
EAC	East African Community
ECOWAS	Economic Community of West African States
EGLS	Estimated Generalized Least Square
FDI	Foreign Direct Investment
EGLS	Generalized Least Square
GMM	Generalized Method of Moments

GDP	Gross Domestic Product
GDP	Gross Domestic Product
IMF	International Monetary Fund
MSR	Maritime Silk Road
OBOR	One Belt One Road
OBOR	One Belt, One Road
OLS	Ordinary Least Squared
PCI	Per Capita Income Difference
PSM-DID	propensity score matching–difference-in-difference
PPML	Pseudo Poisson Maximum Likelihood
REC	Regional Economic Communities
SRF	Silk Road Fund
SSA	Sub-Saharan Africa
UNCTAD	United Nations Com Trade
UNCOM trade	United Nations Commodity Trade Statistics
VIF	Variance Inflation Factor
WDI	World Development Indicators
WTO	World Trade Organization

Abstract

Trade Effect of Chinese Belt and Road Initiative: Evidence from Sub-Saharan African countries

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Chinese Belt and Road Initiative (BRI) is the most recent and inclusive initiative launched in 2013 with the goals of policy coordination, facilities connectivity, unimpeded trade, financial integration and people to people interaction between China and member countries. Since BRI would bring improvement in the infrastructure gap, its contribution in deceasing cost of trade was expected very significant. But its real impact on the case of Sub-Saharan Africa region wasn't well indicated by other empirical studies. The main objective of the current study was to examine the trade effect of BRI on Sub-Saharan Africa region. This study employed a panel data set from 2018-2022 involving 26 reporting and 22 partner sampled countries. It used augmented gravity model with PPML estimation technique. According to the findings of this study, BRI has a positive contribution in trade; it resulted in up to 7.1% trade creation effect for Sub-Saharan Africa region. GDP of reporting countries, GDP per capita of both reporting and partner countries, bilateral exchange rate, land locked, common border, common colonizer and having common official language were significantly associated variables with the bilateral trade. BRI improves trade performance of Sub-Saharan Africa region. But it is strongly recommended that policy harmonization, addressing production bottlenecks particularly in the manufacturing sector, measurements in knowledge transfer should be emphasized to optimize the contribution of BRI.

Keywords: BRI, trade creation, trade diversion, regional economic communities and bilateral trade (export)

Chapter One: Introduction

1.1 Background of the study

China's transformation into an economic power house was resulted from the economic reforms in 1980s that allowed China's gross domestic product (GDP) to grow by seventy-five times-from $200 billion to around $15 trillion-between 1980 and 2020 (Amin Mohseni-Cheraghlou & Naomi Aladekoba, 2023). In 2013, as part of such an economic and development reforms Chinese President Xi Jinping launched a development plan entitled as Belt and Road Initiative (BRI) or informally known as the One Belt One Road (OBOR) (Githaiga, Burimaso, Wang, & Ahmed, 2019).

"The idea of China's 'One Belt One Road' (OBOR) initiative is derived from the ancient 'Silk Road', a route on land extending from the inland of China and provinces of western across central Asia, over the Middle East and ending of Europe where as the other road is also '21st Century Maritime Silk Road', which starting from China's Fujian sea board, to the Malacca Straits, round the horn of Africa and through the Red Sea into the Mediterranean, ending in Venice." (Weldegebriel Abrha Hagoss & Xia Youfu, 2021). Chinese Belt and Road initiative consists of two main components namely 'Silk Road Economic Belt', which is the 'Belt' part, while a '21st Century Maritime Silk Road is the 'Road' component (Githaiga et al., 2019). BRI has about five goals listed as policy coordination, facilities connectivity, unimpeded trade, financial integration and people to people interaction (Komakech & Ombati, 2023). But the ultimate purpose of this development initiative is explained as to bring a win–win mode of an integrative economic project that is free of geopolitical strategy at the regional level (Yu, Zhang, An, & Yu, 2020). Funds for BRI projects come from the main stakeholders. Those are Asian Infrastructure Investment Bank (AIIB), BRICS New Development Bank, sovereign wealth fund China Investment Corporation, USA Silk Road Fund (SRF) and others (Githaiga et al., 2019).

By January 2023, 152 countries from Asia, Europe and Africa signed BRI cooperation agreement and the Chinese government committed to investing USD 1 trillion over ten years from 2013 to 2023 (Komakech & Ombati, 2023). The initiation incorporates areas covering Asia, Oceania, Europe, Africa, and Latin America to stimulate cross border economic development and international trade (Singapore, 2020). BRI regions in the world accounts for approximately 80% of the world's population and 40% of the world's gross domestic product (GDP) (Lisinge, 2020).

Figure 1. Main Land and Maritime Routes
Source: Li, 2015

Over the last two decades, China has become the largest trading partner for the entire African continent, which means that while in 2000 the total trade volume stood at US$10.6 billion, in 2018 it reached US$204.19 billion (Tarrósy, 2020). To date, 52 African countries have joined the BRI while Egypt and South Africa were the first ones to sign the cooperative agreement (Mrdaković & Todorović, 2023). Particularly Sub-Saharan Africa (SSA) is becoming attractive for Chines BRI based investments due to untapped market potential, fast population growth rate with dominant number of youths, natural resources endowment and high infrastructure gap (Amin Mohseni-Cheraghlou & Naomi Aladekoba, 2023). China's share in total merchandise trade in SSA rose from 4 percent to 25.6 percent from 2001 to 2020; this puts China the leading trading partner by beating both USA and Europe (Tarrósy, 2020). Egypt, Keniya and Djibouti are the three pivots of BRI projects; showing that East Africa region is also very important area

due to geopolitical position of East Africa countries including Ethiopia with the second populated nation in Africa (Lisinge, 2020).

Despite there are such known evidences on overall insight of the BRI initiation, there is no clear evidence on trade effects of BRI projects implementation on both intra-continental trade and trade out of Africa (Y. Chen, Zhang, & Zhao, 2022).

1.2 Statement of the problem

The ambitious BRI initiation is expected to improve performance of international trade between BRI member countries with China and among BRI countries themselves by reducing the cost of trade. Although a number of authors indicate that BRI implementation has its own positive contribution, there is a debate on how member countries can achieve a net gain and optimize it sustainably especially for countries characterized by poor institutional capacity, lack of policy farmwork and strategies, narrow economic base (M. X. Chen & Lin, 2018).

Almost all Sub-Saharan African countries are typical examples for countries challenged with inadequate institutional capacity, lack of sound trade policies and binding strategies, weak productivity and low export size aggravated by recurrent civil war and political instability (Lisinge, 2020). According to Singapore Economic review study on Sub-Saharan Africa, further negative setbacks such as lack of central coordination, macroeconomic instability and financial risks, crowed out effect on domestic companies, political divergence and procurement corruption are raised in those Sub-Saharan Africa countries (Singapore, 2020). Some countries in the region like Keniya, Mozambique, Uganda, Ethiopia and Djibouti have looked BRI funds from China to spur their own developments due to lack of their own financial resources (Komakech & Ombati, 2023). According to Jubilee Debt Campaign, 2018 report the maximum number of African governments external debt owed to China is reported to be US$ 232 billion which accounts 56% of the total external debt (Jubilee Debt Campaign, 2018).

Trade performance of sub-Saharan Africa countries both within the region and with rest of the world is very low. According to Word Bank report in 2021 the total value of exports and imports was $ only 310,083 million and $305,528 million respectively (Cesar C. & Catalina C., 2021). Moreover, intra-Africa trade level was around 17% by 2021 and it is inadequate

comparing with intra-continental trade levels in Europe (69%), Asia (59%) (Francois, J., & Manchin, M., 2023). Minimum trade openness, ineffectiveness of regional integrations, lack of adequate infrastructures and limited export diversity were frequently mentioned as associated factors of low intra and extra trade performance of Sub-Saharan Africa countries (Pam Z., 2016). Thus, the concern of this study is that what happened after the implementation of BRI on Sub-Saharan Africa, having its promises in improving trade performance of least developed countries like Sub-Saharan Africa.

In this regard more studies were done in Asia region to evaluate the trade effect of BRI among Asian countries themselves and with China. A study done on the impact of China's One Belt One Road initiative on international trade in the Asian region indicated that BRI had a positive potential benefit not only for Asian countries but also for other member countries (Foo, N., Lean, H., & Salim, R., 2020). The author used panel data set from 2000-2016 and augmented gravity model was employed. This Asian based study did not incorporate African countries and it was potential study not on the basis of actual BRI implementation data. Another study done to examine the impact of China's BRI on international trade and global value chains using 186 reporters and 199 partners worldwide in the period of 2000 -2018 revealed that there was significant and positive correlation between participation in BRI and the bilateral export volume as different trade corridors were built between China and partner countries. This study used augmented gravity model and tried to estimate the trade effect for African countries using FE and OLS estimation techniques (Lu, Y., & Wolszczak J., 2020). But still the study was potential study and based on hypothetical data. Coming to Sub-Saharan Africa region a study done to investigate the effect of Chinese investment and trade under BRI Sub-Saharan Africa countries revealed that still Chinese investment and trade through BRI had significant contribution in increasing economic growth, FDI and decreasing debt of the region. But in this study difference in differences method was employed by preparing 'before' and 'after' groups of 2007-2011 as control whereas 2012-2018 as case using 36 Sub-Saharan Africa countries data (Hagoss, W. A., & Youfu, X., 2021). But we argue that based on the data base of Green Finance and Development Center only seven Sub-Saharan Africa countries (South Africa, Cameroon, Comoros, Kenya, Côte d'Ivoire, Madagascar and Somalia) joined BRI before 2018. As a result, the data used from case group countries might be unreliable. But another more robust one was done on the impact of China's financing on bilateral trade intensity under BRE initiative using

panel data set of 52 countries for the period of 2000-2021 showed China's financing and investment had positive effect on the bilateral trade of African countries to China (Wu, Y., Wang, X., & Hu, C., 2023). In this study the author employed GMM method and it was limited only China to African countries bilateral trade intensity without talks about Africa trade with other countries, other than China. Other empirical studies done in the context of Sub-Saharan Africa countries were qualitative based narrations on the prospective and possible impacts of Chinese BRI under African countries (ZiroMwatela, R., Changfeng, Z., 2016, WANG, Z.& NEGASH E., 2020, & Githaiga, Burimaso N., 2019). Hence there is no empirical evidences done on the trade effect of this global initiative particularly on Sub-Saharan Africa using panel data set after the implementation of the BRI initiative.

This study was done to fill such an existed evidence gap. The objective of this study was to determine trade effect of Belt and Road Initiative on bilateral trade performance of Sub-Saharan Africa countries. In this study augmented gravity model was employed with Pseudo Poisson Maximum Likelihood (PPML) estimation method. Panel data set from (2018-2022) was employed from 26 reporting Sub-Saharan and 22 partners including countries out of Africa. In this study it was expected that evidences on trade creation and diversion effects of BRI and significant determinants of bilateral trade would be examined.

1.3 Research questions

In this study the following basic research questions were addressed;

- What trade effects does BRI membership result in on bilateral trade of Sub-Saharan Africa?
- What trade effects does BRI have among member countries including Sub-Saharan Africa and partner countries from Asia and Europe?

1.4 Objectives

1.4.1 General objective

In this study the overall objective was to examine trade effect of Chinese Belt and Road Initiative (BRI) on Sub-Saharan Africa from 2018-2022.

1.4.2 Specific objectives

- To determine trade creation and diversion effect of BRI membership within Sub-Saharan Africa region;
- To examine trade creation and diversion effect of BRI among member countries including Sub-Saharan Africa and partner countries from Asia and Europe;

1.5 Significance of the study

This study would have a great deal of contributions for different stakeholders. Firstly, it would generate evidences on the actual trade effect of BRI initiation on Sub-Saharan Africa level and within the BRI bloc including Sub-Saharan Africa and partner countries from Asia and Europe. It could give good policy implications for formulating policies and strategies in connection to Sub-Saharan Africa international trade and strategies. Hence this study would result in some baseline data for concerned governmental officials, top level decision makers, economic advisors in the context of Sub-Saharan Africa countries. Not only this one but also it is thought to helpful for private sector firms by recommending wise-full strategies in maximizing their gains in doing cooperatively with the BRI implementation. Finally, the study would be used as a reference to encourage other researchers for further studies.

1.6 Scope of the study

This study focuses to determine the trade effect of Chinese Belt and Road Initiative on Sub-Saharan Africa countries. In this regard the static trade effect of BRI on Sub Saharan Africa and its effect on the member countries of the bloc out of Sub-Saharan Africa would be part of the current study. A number of selected Sub-Saharan Africa countries and other BRI partner countries from Asia, Erupe would constitute the panel dataset in time horizon from 2018- 2022.

1.7 Limitation of the study

In this study the major limitation was the short time horizon of BRI implementation in Sub-Saharan Africa countries. Since most of Sub-Saharan Africa countries have joined after 2018, only five years data on BRI implementation period was taken. Comparing it with the nature of BRI which aims to promote trade and investment by building infrastructures and increasing connectivity, more time span of BRI implementation would be required. For this reason, the current study was limited to show the static trade effect and it did not incorporate the dynamic

trade effect of BRI like its effect on investment, revenue and welfare. The other limitation was resources constraints as such studies demands more intensive investigation.

1.8 Organization of the paper

This study paper was organized in five chapters. Chapter one under the introduction part it consists of background of the study, statement of the problem, research questions, objectives, significance of the study, scope, limitation and organization of the paper. The next chapter is the literature review part and, in this session, theoretical and empirical literatures were discussed to show the study gap and the existed evidences. Chapter three is all about the research methods employed for this study. Chapter four is about the results of this study whereas the final chapter concludes by raising concluding remarks and policy implications.

Chapter Two: Literature Review

Introduction

In this session starting from defining the key words, pertinent literatures on the area of Belt and Road Initiative were reviewed systematically. The first part is the theory-based literatures stated from different books. Despite there was no clear and well-known theoretical framework for the current Chinese BRI investment, it was tried to raise related and updated concepts. In the second part of the literature review empirical evidences were discussed from global to regional level. All relevant studies done on the area of BRI were reviewed logically and in chronological order by focusing their findings, research methods and geographical coverage or their study area. Finally, in sum up all evidences gotten from reviewed literatures the study gap was identified. At the end of this chapter there is a conceptual framework that represents the relationship between the dependent and explanatory variables. This illustrates how those variables can interrelate and affect the dependent variable either in proximal or in distal path.

2.1 Definitions and concepts

A. Belt and Road Initiative

Belt and Road Initiative, also formally known as the One Belt One Road (OBOR), is a new Chinese development strategy that targets at policy coordination, unimpeded trade, financial integration, facilities and people to people connectivity between China to Asia, Africa, Europe and Latin America countries. It consists of two components namely Silk Road Economic Belt and 21st Century Maritime Silk Road. The Silk Road Economic Belt connects China to Europe passing through the South China Sea and the Indian Ocean essentially, it comprises land-based infrastructures like roads, rails, power grids and gas pipelines. The Maritime Silk Road (MSR), on the other hand, is its oceanic counterpart that includes networking the constructions of sea ports around South China sea, Indian sea, Indian ocean, Pacific oceans.

B. Trade effects

Static theory (trade creation and diversion)

Viner (1950) introduced the static theory of reginal trade integration through the concepts of trade creation and diversion. According to Viner (1950) trade creation happens when trade shift from high-cost supplier outside to lower cost suppliers in the union. This is the trade effect only happened due to the existence of the trade union (why it is called 'trade creation'). As a result of trade creation there will be welfare improvement. On the other side, investment diversion (which is investment flow from higher efficient to lower efficient production) will be resulted in within the reginal integration union. Tarde diversion is also similarly defined as trade shift from lower cost suppliers outside the trade bloc to higher cost supplier within the trade bloc due to the existence of reginal integration. This means that changes occurred in the equilibrium market price and quantity before and after the creation of the trade union or bloc (M Yayo Negasi & Asefa S., 2016).

Dynamic theory and welfare effect

According to Balassa (1961) economic welfare is measured using our typica criteria; change in quantities of commodities produced, change in degree of discrimination between domestic and foreign goods, income redistributions among consumers of different nations and income redistribution with in individuals of individual countries. The former two parameters are used to measure the welfare potential or in the static sense (improvement of the resource allocation in a certain point of time). The next two criteria measure welfare effects of income distribution. According to static theory only one of the above four criteria is enough to appraise the effect of global or regional trade initiations, but in the case of the later dynamic theory welfare is evaluated by considering all the above characteristics. In technical terms the economy operates by the movement of its production frontier in north east direction (T.U.I Peiris, M. Azali, M.S. Habibullah and A. Hassan., 2023). According to Balassa (1961) the dynamic efficiency of and economy is affected by factors like technological progress, the allocation of investment, uncertainty and inconsistency in economic decisions.

2.2 Theoretical review

2.2.1 BRI and the theory of soft power

The term soft power as originally conceptualized by Jhoseph Nye and it refers to the capacity to achieve an objective using attraction without coercion or other financial inducements (Nye Jr, 2008). Soft power seems to be more democratic as it is manifested by silent and appealing achievements of its own objectives unlike the principles of carrot and sticks of the hard power. China prefers to this soft power rather than classic approach of Western's domination through hard power, using coercive engagements, economic sanctions, instrumental financial aid (Hassen, 2023). Nye argues that the theory of soft power has three important pillars namely, culture, foreign or domestic policy, and political values (Nye Jr, 2008).

The republic of China announces Belt and Road Initiative (BRI) on the basis of this soft power principle. In sense of international cooperativeness, the country shows fruits and promises of BRI initiation if host countries join the agreement. Literally joining the BRI seems to be neither with enforcement nor as punishment instrument for member countries when the deviate from Chinese political ideology unlike USA has done as usual-for instance the sanction on Ethiopia, the case of African Growth and Opportunity Act (AGOWA) (Bharti, 2023). BRI can be seen into its five components listed as infrastructure development (which comprises constructions of ports, airports, railways, highways, and other forms of infrastructure), trade and investment, economic growth, people to people connectivity and environmentally sustainability issues (Komakech & Ombati, 2023). Thus, China is on fast track to show her strong influence not only in the economic regime but also in promoting her cultural, educational, political and other dimensions using her soft power diplomacy and foreign policy.

2.2.2 Infrastructure and trade

Although we haven't found well known theory which explicitly explains about countries' main infrastructures with their international trade performance Chang, Kaltani and Loayza showed infrastructures play a very important role in facilitating both domestic and international trade (Olarreaga, 2016). According to Paulr Kmpman book of international trade both hard infrastructures (physical infrastructure such as roads, railways, ports, ICT infrastructure, telephone lines etc.) and soft infrastructures (border and transport efficiency, and the business and regulatory environment etc.) affect international trade flows (Francois & Manchin, 2013; Kaczmarczyk, 2023).

The relationship between infrastructure and trade is further related with the Neo-technology theory of international trade developed by Borkakoti, James (1998). That states if there is technological gap, an innovation in another country can be the source of international trade with the other countries which lack that new technology. In the lens of the above theories the assumptions Chinese infrastructure-based BRI could be seen in such a way that the hyper-efficient giant projects built by Chinese enterprises in Sub-Saharan Africa countries could be taken as a good technological progress in their production frontier.

2.2.3 International trade and gravity model

The comparative cost theory which was developed for the first time by English economist David Ricardo in his Principles of Political Economy and Taxation published in 1817. According to this famous law of comparative advantage each country will specialize in the production of those commodities in which it has the greatest comparative advantage or the least comparative disadvantage. Thus, a country can export those commodities in which its comparative advantage is the greatest and import those commodities in which its comparative disadvantage is the least. Despite a number of scholars have made their own improvements, the basic concept of this theory serves as a base for many international trades still now days.

Starting with Tinbergen (1962) over the last half century, gravity model has become workhouse for many literatures in applied international trade (Shepherd, 2013). According to Leamer and Levinsohn (1995) gravity model is an important tool in modeling bilateral international trade flow by directly relating it with economic size and inversely with trade costs, usually proxied by geographical distance as an indicator of transport costs. Based on the critics and improvements of many international economists, a number of different versions of gravity models are developed. In the first form, basic gravity model has two important drawbacks. If there are countries A, B & C engaged in international trade and Countries A&B sign into some preferential trade agreement by lowering tariffs, the bilateral international trade flow between country C and with A or B could be affected even though country C doesn't engage in trade agreement. This is what we call trade creation and trade diversion effect. The intuitive gravity model doesn't consider such effect (Sen, 2020). The others short-coming of the basic gravity model is that if transport cost decreases in both trading countries due to some reasons like oil price drop, the basic theory confirms that trade volume between the countries will increase

proportionally. But this phenomenon is with no change on the relative price of the commodities and then we would expect consumptions patterns to remain constant for a given amount of total production (GDP).

Due to these critics, other economists were initiated to bring improved version of the basic gravity model. Hence, a variety of structural gravity models now exist. Which provide firm micro-foundations for gravity-like models for instance the Anderson and Van Wincoop (2003) gravity model which incorporates both outward multilateral resistance or all trade costs of exporting country A to country B, and inward multilateral resistance or all trade costs from supplier countries. The other gravity model version especially when someone is interested in policy variables is augmented gravity model (Krugman, 2018).

2.3 Empirical review

2.3.1 Trade effects of Belt and Road Initiative (world perspective)

According to a study done with panel data set from 2000-2018 using augmented gravity model focusing on Asian countries in order to assess the impact of China's One-Belt One-Road initiative on international trade and global value chains indicated that significant association was observed between OBOR participation and member countries' export and import volume (Y. Lu & Wolszczak-Derlacz, 2020). The author stated that six economic OBOR corridors, China-Pakistan, China-Mongolia-Russian Federation, and Bangladesh-China-India-Myanmar are found to play a major role in promoting gross bilateral trade and global value chain, but World Trade Organization (WTO) and Association of Southeast Asian (ASEA) are found to be more important than OBOR in increasing bilateral export and import performance. In this study we argue that WTO and ASEA were more influential than BRI because of its early-stage implementation period. Another more comprehensive study incorporated about 123 countries using panel gravity model with estimated generalized least square (EGLS) confirms that membership to the BRI initiation increases the trade flow between China and member countries. The estimation results also indicated entry to WTO had positive impact in improving bilateral trade flow.

Moreover, it is reported that BRI initiation has more positive impact in South Asian countries like India while lower impact is observed more peripheral regions of Latin America countries. But the author confirmed that lower coefficients are found for countries found in Sub-Saharan

Africa and Central Asia despite the first region is destination of Maritime Silk Road and the latter one is one of the principal silk Belt (Amani & Kaci, 2022). Similarly, a number of studies done on Asian countries conclude that BRI based projects have a positive contribution in enhancing bilateral trade flows and even with trade creation effects and spillover effects for domestic companies. This happens after the initiation is working in building main transportation infrastructures and industrial zones that in turn facilitate for more export opportunities (Foo, Lean, & Salim, 2020; Mahbub, 2021).

According to Yan Wu and Chunlai (2021) panel data study covering about 64countries worldwide using GMM model indicates that Chan's outward foreign direct investment through Belt and Road initiative has a positive impact on import intensity and negative impact on export intensity with BRI countries (Wu, Chen, & Trade, 2021). On the other-hand the empirical investigation of Shuai Lu and his colleagues confirms that BRI can alleviate trade deficit and domestic capital flight but it requires a longer period to see its effects on countries' trade status (S. Lu, Chen, Zhou, Li, & Finance, 2024). Furthermore GDP, common language between China and BRI partner countries has more influences on national export volume than religion and population number (Li, Lu, & Chen, 2020). A study using computable generalized equilibrium model (CGE) showed that in China, Central and West Asian countries have gained significant growth in GDP, employment, and economic welfare, whereas the economic impact of transportation infrastructure investment in the Central and West Europe is relatively minor (Prodi & Fardella, 2018; van Twillert & Halleck Vega, 2023). Unlike most of literatures conclusions on positive contributions of BRI initiation on expanding bilateral trade volume with other spillover effects, BRI initiation has limited or lower gains for European countries even though good opportunities are there like Chinese finance source for the BRI projects and some form of trade creation (Garcia Herroro & Xu, 2019).

By taking BRI as the source of infrastructures studies conducted to examine its effect on trade performance of partner countries reported almost similar findings. Their bilateral trade output is improved as far as they succeed in coordinating their BRI based infrastructure projects (Di Stefano, Iapadre, & Salvati, 2021).

2.3.2 Trade effects of Belt and Road Initiative in Africa

Empirical studies done in the context of Africa particularly in Sub-Saharan Africa region raised their own concerning issues in China Sino-Africa relationship. A study done in Southern Africa

region with a propensity score matching–difference-in-difference (PSM-DID) regression shows that BRI and foreign direct investment (FDI) inflows have positive association whereas market size and political stabilities the region has significant association with inward FDI flow. But the author indicates that trade openness and macroeconomic stability are found to be insignificant in attracting BRI based foreign direct investments (Sabola, 2023). According to Robert Agwot (2023) qualitative study on the case of African countries suggests that BRI initiation has benefits in terms of its policy coordinating and bring connectivity, technology transfer, African connectivity to China and the rest of the world by expanding facilities and high technology infrastructures, trade connectivity, job creation and economic growth. Not only this one but also BRI initiation is also important in financial integration which exposes African countries to get other financial sources, and there is also a contribution for people-to-people connectivity by exchanging students, culture, tourism (Komakech & Ombati, 2023). But the author argues that there are challenges which come in parallel with BRI implementation. In his conclusions low/lack of involvement of local stakeholders, high compensation prices for land owners and which puts a pressure on the land price, procurement corruption, labor violation, environmental hazards and increasing debt levels are strongly indicated as alarming issues of BRI initiation particularly in Keniya, Uganda, Egypt, Mozambique, Djibouti and Egypt. According to Weldegebriel A.& Xia Youfu (2021) suggestion, Chinese investments through BRI has a positive association with economic growth and business environment among those Sub-Saharan Africa countries, in line with this study reviewing BRI projects in Nigeria, Keniya and Ethiopia has direct contribution in increasing infrastructure stocks, economic growth, trade and debt (Weldegebriel Abrha Hagoss & Xia Youfu, 2021). Regarding the trade effect of BRI initiation, the letter author mentioned that there is increased trade effect in some sectors which are characterized by large market size and full of natural resource endowment, while there is decline trade effect in non-resource sectors ((Adeniran, Ekeruche, Onyekwena, & Obiakor, 2021).

A study done with a panel dataset approach on the bilateral trade and OFDI relations with 35 BRI SSA countries in the period of (2003–2018) concludes different findings. Unlike many of the empirical evidences on bilateral trade effect of BRI initiation the author shows that the BRI has a positive but insignificant effect in promoting the bilateral trade between China and the SSA countries (WANG, LU, ZHANG, & NEGASH, 2020). He adds that GDP, per capital income and

market size have a positive and significant impact on China- partner countries bilateral trade. But coming to another study done on Eastern Africa context reports that transport infrastructure has a positive impact on intensifying bilateral trade and economic growth in the (AcFTA) (Ibrahim, Bibi-Farouk, & Abdullahi, 2021). He mentioned that BRI initiative could be very important in discovering market potential of African countries as there is infrastructural deficit in the continent. Moreover, the author indicated that China's provision of such technology-based infrastructures helps African countries achieve the objectives of African continental free trade area (AcFTA) (Ibid).

According to Mesafint Tarekegn & Guo Changgang (2020) BRI based projects is helpful in facilitating trade and investment, job creation effects and providing hard infrastructures with positive implications particularly for land locked countries like Ethiopia (Yalew & Changgang, 2020). The author revels that, for instance, the establishment of Djibouti Ethiopia railway has reduced the transport cost and time from 3 days to 10 hours. Despite Belt and Road Initiative implementation has its own contribution in improving the existed infrastructure gaps, there are anti BRI claims like debt sustainability and Chinese dependence unless BRI projects net revenue for the country (Tarrósy, 2020; Yan & Sautman, 2023).

Table 2.1 Summarized empirical evidences of some of our empirical literatures

Title of the study	**Author and year**	**Methods**	**Target populations**	**Major findings**	**Our argument**
The impact of BRI on international trade & global value chains	Lu, Yuxin, 2020	Augmented gravity model with OLS, RE & FE using panel data set (2000-2018) from 186 reporters and 199 partners	In global level	BRI was positively correlated with international & global value chains	Since the study was to examine the potential study, it was based on the hypothetical data.
BRI on bilateral	Impacto de la iniciativa & his	Gravity model with RE estimation using panel data set	In global level	BRI has shown expected positive sign driven by reduction in	

trade flows	colleagues	(2012- 2019) from 123 countries worldwide		cost of transport, facilitating business & trade	
Impact of BRI on China& South Asia trade integration	Mst. Sahiba Mahbu, 2021	Gravity model with FE &RE using panel data set (2000-2017) from 16 countries	Asian region	BRI had significant b& positive impact on both China & South Asia countries & for the international trade	Only limited variables used (GDP, Governance indicator & BRI dummy)
The impact of BRI on international trade in Asia region	Nam Foo, 2019	Augmented gravity model with OLS & RE using panel data set (2009-2016) from 25 countries	Asian region	BRI dummy, common border & language were positive & significant with bilateral trade size	This potential study was based on hypothetical data.
The impact of China's financing on bilateral trade intensity under BRI	Yan Wu & his colleagues	GMM with instrumental variables using panel data (2000-2021) from 52 countries	African countries	China's financing under BRI countries played a positive role on export & import intensities	The study was concerned all about China's financing under BRI countries including before BRI financing.
New economic cooperation of China with Sub-Saharan Africa in	Weldegebriel Abrha Hagoss & Xia Youfu,	Difference in differences using control group of 36 countries from (2007-2011) and case group from (2012-2018) after	Sub-Saharan Africa	BRI has increased economic growth and FDI of Sub-Saharan Africa by 0.004 and 0.0425 respectively.	We argue that the data taken from the case group couldn't be reliable because only seven sub-Saharan Africa countries joined

BRI	2021	BRI			BRI before 2018.
BRI in developing countries: lessons from five Africa countries	Robert Agwot Komakech & and Thomas Ogoro Ombati, 2023	Qualitative based research on selected cases of Uganda, Kenya, Eygpt, Djibouti and Mozambique	Selected five Africa countries	Despite its contribution for infrastructures, it had negative consequences like debt trap, welfare issues like environmental hazards, labor violation unless it is properly managed	It did not use nay quantitative econometric analysis

In sum up Chinese investments through BRI initiation results in positive contribution for increasing bilateral trade between China and partner countries and even with other non-BRI countries in the context of Africa especially in Sub-Saharan region (Amin Mohseni-Cheraghlou & Naomi Aladekoba, 2023). GDP, per capital income, distance and common language are frequently mentioned variables with significant association with BRI initiation in gravity model analysis. Although BRI initiation is indicated to boost trade and investment and people to people cultural interaction in Sub-Saharan Africa, most empirical evidences show concern on debt trap, Chinese dependence and sustainability issues. Consequently, a number of authors recommend that sound debt management strategies, vertical accountability between government and society, ensuring peace and political stability, improving institutional capacity and business environment should be done appropriately. But still there was no a single study done using recent panel data set comprising actual BRI implementation data in the context of Sub-Saharan Africa.

2.4 Conceptual framework

A conceptual framework in researches shows the proximal and distal relationship between the dependent variable and other explanatory variables and even with the explanatory variables. In this study after reviewing both theoretical and empirical literatures the following conceptual framework was constructed. On the lefthand side there are time varying and dummy variables different boxes. The dependent variable bilateral trade is put on the right-hand side. The set of

dummy variables can be related with those independent variables as it is indicated by the arrow. Then, relationship between those independent variables and bilateral trade is through Belt and Road Initiative. In this path all independent variables are related with BRI, again BRI brings infrastructures and investment. The infrastructures and investment will improve the production system and cost of trade. That, in turn, affects the bilateral trade level at the end.

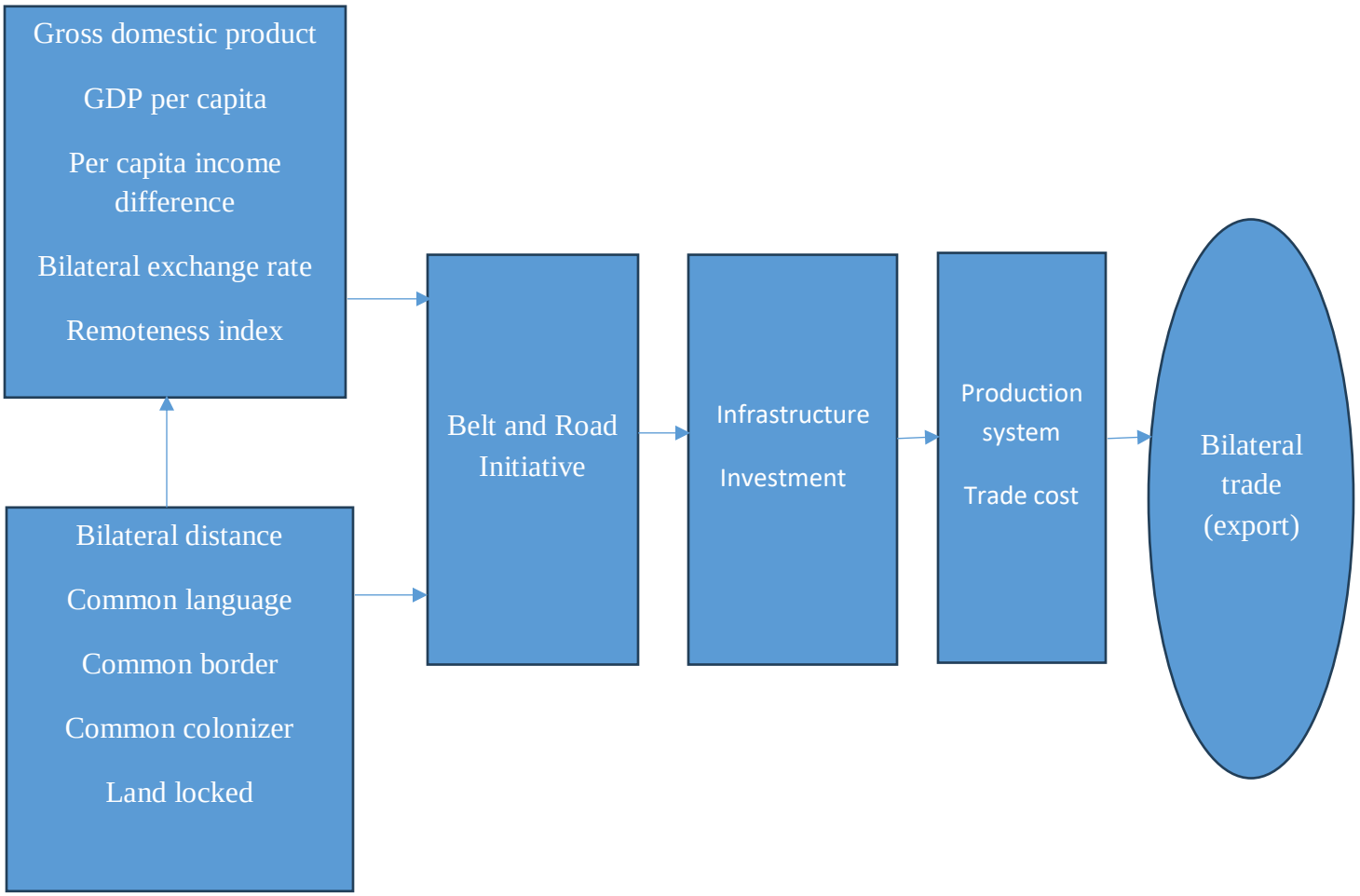

Figure 2.1 Conceptual framework; constructed from reviewed literatures

Chapter Three: Research Methods

3.1 Research design

In this study quantitative type of research approach was employed due to the nature of the study variables which should be quantifiable and measured in numerical data. This study uses a panel data set of Sub-Saharan Africa countries with secondary data in the time framework from (2018-2022). In this regard panel data was preferred to because of its advantages over cross sectional and time series data types. First panel data has more degrees of freedom than cross-sectional or time series, leading to more efficient estimates. It deals better with heterogeneity than cross-sectional data. Since panel data covers several entities over a defined period of time, it is able to capture more complexity than other series. Furthermore, in some circumstances computations and inferences are simpler in the case of panel data set analysis (Arancón Simal, 2019).

3.2 Data type and sources

Secondary type of data would be employed from different credible sources. Using criteria like relevancy, completeness of the required data, accuracy and credible source, the data was collected from different national and international sources for each variable. Data for the dependent variable, bilateral trade (export), was taken from UNCOM trade for 26 Sub-Saharan Africa and 22 other partner countries. For the variables GDP, GDP per capita and population the data was taken from World Development Indicators (WDI) database. Moreover, for other items including the dummy variables data sources like Center for Prospective studies and International Information (CEPII), World Bank open data, United Nations Com Trade (UNCTAD) bilateral FDI Statistics, Chinese Statistical Yearbook, Trade Law Center NPC (TRALAC) database were used accordingly.

3.3 Target populations and sampling issues

In this study to get panel data set, representative countries were selected from both the target populations (Sub-Saharan Africa region) and other BRI partner regions Asian, Europe and North America. Currently about 152 countries from Asia, Europe and Africa signed BRI cooperation agreement (Komakech & Ombati, 2023). According to Green Finance and Development Center out of the total 52 BRI African countries, 44 of them are found in the Sub-Saharan region. In this

study 48 sampled countries were taken, out of these countries 26 were treated as reporting countries in Sub-Saharan Africa region where as the rest 22 countries were taken from North Africa Europe and Asia including USA as trading partners. The criteria to select sample countries were year of joining BRI and data availability for all variables the model. According to the Green Finance & Development Center BRI data base most of Sub-Saharan countries, even other countries out of Africa, joined in the year 2018. Only few countries joined the bloc before that year. Therefore, considering its implementation period countries signed BRI in 2018 and before were incorporated. Thus, our sampled Sub-Saharan Africa countries were Angola, Benin, Burundi, CapeVerde, Cameroon, Comoros, Cote d'Ivoire, Ethiopia, Gabon, Gambia, Ghana, Kenya, Madagascar, Mauritania, Mozambique, Namibia, Nigeria, Rwanda, Senegal, Seychelles, South Africa, Tanzania, Togo, Uganda, Zambia and Zimbabwe. Other Sub-Saharan Africa countries weren't included due to some grounds. The first exclusion criterion was BRI membership after 2018, because most of Sub-Saharan Africa countries joined afterwards. The other reason was in connection to data availability. Of course, Sierra Leone, Sudan, South Sudan, Somalia, Chad, Guinea and Eritrea, signed the BRI initiative before 2018. But data for all our variables was not available for countries Sierra Leone, South Sudan, Sudan, Somalia and Eritrea. Based on UNCOM trade data base for the bilateral trade, there was no any export data from Guinea, but its import was available. In the case of Chad, its export level for partner countries was very low. Because of these reasons, only 26 Sub-Saharan Africa countries were purposively sampled as reporting countries.

Coming to the partner countries, nine countries from Europe (UK, France, Spain, Belgium, Italy, Austria, Portugal, Turkey and Poland), six countries from Asia (China, India, Japan, Rusia, Indonesia and Singapore), five countries from North Africa (Egypt, Morocco, Algeria, Tunisia and Libya) and USA were taken as partner countries for the aforementioned Sub-Saharan reporting countries. Non-member countries are included in the list of partner countries, because it is important to see trade diversion concept as one of the pair countries is not the member of BRI. Germany was not included as partner country, because surprisingly its import level from Sub-Saharan Africa region was fund to be very low. Out these total 22 partner countries Italy, Austria, Portugal, Turkey and Poland, India, Japan and USA are not members of BRI while the rest of them are member countries.

3.4 Model specification and estimation technique

3.4.1 Theoretical foundation of gravity model

Despite gravity model has been widely used in many empirical studies in international trade discipline, the model has its own critics. One of these critics is the lack of strong theoretical foundation. In order to overcome this problem, a number of international economists have tried their own contributions in providing better foundations and justifications. Among these, (Anderson [1979], Bergtrand [1985, 1989 and 1990], Deardorff [1998], Helpman [1987], Helpman and Krugman [1985], Eaton and Kortum [2002], Anderson and van Wincoop [2003] are mentioned in the frontline (Seid, 2013).

It was Anderson (1979) who first attempted to put the theoretical foundation for gravity model based on constant elasticity of substitution (CES) preferences and goods differentiated by country of origin which came to be known as the Armington assumption. The key implications of this assumption are that countries are in favor of consuming more goods with more varieties supplied in the international market regardless the price of the commodities. This implies that all countries will have opportunity to participate in the international trade and all supplied commodities will be traded as well. Consequently, the national income will be equal with the sum of home and foreign demand for the commodities that each country produces. This lies the theoretical perspective of basic gravity model which states that larger countries are intended to export more and import more.

According to Bergstrand (1985 and 1989) elaboration gravity model functions well based on monopolistic competition. That states identical countries can trade differentiated goods because of consumers preferences for consumption in variety.

Following that Helpman and Krugman (1985) bring another foundation for gravity model essentially known as a multi-country Dixit -Stiglitz model that elucidates increasing returns is the basis for international trade. Besides to this Deardorff (1998) formulates theoretical explanation like the simplest frictionless gravity model using Heckscher-Ohlin assumptions of factor endowment (Deardorff, 1998). Eaton and Kortum (2002) develop a Ricardian model of

international trade. This model was based on the differences in technology and geographic factors. Due to innovations and better technology of production in one country which is not found in the partner country, trade between them will be created. In connection to this Eaton and Kortum's model gives an expression that relates bilateral trade volumes to deviations from purchasing power parity, to technology or innovation and geographic factors.

Anderson and van Wincoop (2003) develop a theoretically grounded estimable gravity model most of it is known as a demand function model. Its final form is mostly based on the constant elasticity of substitution structure chosen for consumer preferences. This famous "gravity with gravitas" model of Anderson and Van Wincoop (2003) takes basic assumptions from both demand and supply or production side ((Anderson & Van Wincoop, 2003). In the demand side consumers love consuming in many verities than consuming more of the same commodity, whereas in the supply side this theory assumes that each firm produces unique and variety commodities under increasing returns to scale. This model assumes that large number of firms produce in constant markup pricing without competitive interactions. Then in equilibrium price, marginal cost of production is just enough to cover the fixed cost of market entry (Shepherd, Doytchinova, & Kravchenko, 2019).

3.4.2 Model specification

The traditional gravity model predicts the bilateral trade performance (export and imports) of partner countries taking the gross national product of exporting and importing countries and the distance between them as the determinant factors. The gross national product of exporting country indicates the supply capacity while gross national product of importing country indicates the demand potential. Gorss national product of both countries is directly proportional whereas the distance is negatively related with the trade flow between the two countries.

This can be presented mathematically as follows: $T_{ij} = \alpha {Y_i}^{\beta_1} {Y_j}^{\beta_2} {D_{ij}}^{\beta_3} \eta_{ij}$ ..... (1)

Where T_{ij} is bilateral trade (exports), $Y_{i(j)}$ is the GDP of the countries, Dij is the geographic distance between the countries, and α , β 's are parameters to be estimated, ηij is an error term assumed to be statistically independent of the regressors.

Anderson and van Wincoop (2003) argue that basic form of gravity model doesn't show the full bilateral trade between countries due to multilateral resistance issues or it ignores trading costs of all suppliers to import and trading cost of all possible export market to export.

Because of the above reason in this study the augmented gravity model was employed:

The augmented gravity model including the remoteness proxy is given:

$$T_{ij} = \alpha {Y_i}^{\beta_1} {Y_j}^{\beta_2} {D_{ij}}^{\beta_3} {GDPp_i}^{\beta_4} {GDPp_j}^{\beta_5} {BRI_{ij}}^{\beta_6} {RTA_{ij}}^{\beta_7} {A_{ij}}^{\beta_8} {REM_{it}}^{\beta_9} {REM_{jt}}^{\beta_{10}} {BER_{ijt}}^{\beta_{11}} {PCI_{ijt}}^{\beta_{12}} \eta_{ij} \eta_{ij}$$

……. (2)

Where: T_{ij} is the bilateral trade between country I and J (export), Y is GDP, D is the bilateral distance, GDPp represents GDP per capita, BRI is a dummy variable stands for Belt and Road Initiative membership, RTA shows membership in regional groups, REM denotes remoteness index which captures multilateral trade resistance term. BER is bilateral exchange rate between the two countries i& j, PCI denotes per capital income difference and η is the stochastic term. A is other relevant dummy variables in our case it includes common official language, being land locked, common border, common colonizer.

Then taking the natural logarithm form of the above equation gives us:

$$T_{ij} = \alpha {Y_i}^{\beta_1} {Y_j}^{\beta_2} {D_{ij}}^{\beta_3} {GDPp_i}^{\beta_4} {GDPp_j}^{\beta_5} {BRI_{ij}}^{\beta_6} {RTA_{ij}}^{\beta_7} {A_{ij}}^{\beta_8} {REM_{it}}^{\beta_9} {REM_{jt}}^{\beta_{10}} {BER_{ijt}}^{\beta_{11}} {PCI_{ijt}}^{\beta_{12}} \eta_{ij}$$

$$\ln Tij = \ln \alpha + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln D_{ij} + \beta_4 \ln GDPp_i + \beta_5 \ln NGDPp_j + \beta_6 \ln BRI_{ij} + \beta_7 RTA_{ij} + \beta_8 \ln A_{ij} + \beta_9 \ln REM_{it} + \beta_{10} \ln REM_{jt} + \beta_{11} \ln BER_{ijt} + \beta_{12} \ln PCI_{ijt} + \ln \eta_{ij} \ldots\ldots\ldots\ldots\ldots (3)$$

All the variables are put in the natural logarithm form; the reason behind is that it helps correct the skewed data to normal distribution which is the basic assumption of econometrics estimation.

3.4.3 Estimation technique

In this study for augmented gravity model Pseudo Poisson Maximum Likelihood (PPML) approach was employed due to a number of reasons. First PPML is helpful in treating the heteroscedasticity related bias mostly happened in international trade data with log-linearized OLS based estimation (Geda A, & Yimer, 2022). The other issue is the zero-trade report between two countries makes a problem in OLS estimation of logarithm gravity model unless the zero reports are eliminated or managed in some other way. But PPML contains naturally the zero trade values, hence it is preferable to fix this zero-trade problem. The other advantage of using Pseudo Poisson Maximum Likelihood estimation technique due to its addictive property the gravity fixed effects are found to be identical parallel to its structural terms. Furthermore, Pseudo Poisson Maximum Likelihood estimation technique enables us to calculate the general equilibrium effects of trade related initiatives. But the other estimation techniques (Fixed effects, Random effect) were also used in this study for comparison purpose with PPML estimation technique.

3.5 Variable description and measurement

Dependent variable

Bilateral trade or export size (Tij): on the previous model specification bilateral trade flow or export size denoted by 'Tij' between the two partner countries serves as the dependent in the augmented gravity models as shown on the left hand-side of equations 3 and 4. Exports are the components of international trade and which refers to the supply of goods and services produced in one country and purchased by the partner country abroad.

Independent variables

The augmented gravity model includes independent variables (gross domestic product and GDP per capita of both export and import countries, bilateral distance, Belt and Road Initiative membership, RTA, common language, land locked, bilateral exchange rate, remoteness index of countries.

Gross domestic product (GDP): It refers to the total worth of all final products and services within the territory of a given country within a given period of time, usually in a year. The nominal GDP is calculated by taking the product of quantities of outputs with the corresponding

prices. In gravity model the nominal GDP is given as the expenditure function. GDP is included because in standard gravity model it is one of the key determinants of international trade performance of partner countries.

GDP per capita: It is the total economic outputs of a country per person. Rather than taking only the total gross domestic product, dividing it by the number of populations is sounder indicator for prosperity measurement. Whereas per capita income is the amount of money earned per person. The latter one used to measure the standard and quality of living of individuals of that country.

Bilateral distance: it refers to the geographical distance between the pair of countries based on latitude and longitude of capital cities of both countries. In augmented gravity model the distance between the two countries is inversely related to the amount of bilateral trade volume as it imposes more cost the countries are more distant to each other.

BRI: Which refers to Belt and Road Initiative membership status of the sample countries in this study. It takes the value '1' when a country is member to BRI and '0' otherwise. BRI is the main variable in this study as the study aims to determine the economic effect of Belt and Road initiative.

REC: This variable stands for regional economic communities' dummy variables. In this study three Africa level regional economic communities were included; namely COMESA, ECOWAS and EAC.

Common language: It assumes the existence of common official language by both export and import countries. In this study it takes '1' if both countries have at least one common official language, and '0' otherwise. This variable is included in both models because many empirical studies show common official language is found to be the determinant of bilateral trade.

Common border: This indicates that whether the two trading partner countries have adjacency or sharing common border.

Common colonizer: This variable in our models represents whether trading countries have common colonizer as it could influence the trading partnership.

Land locked: This variable is about landlocked countries without any waterbody border. This is based on the assumption that most BRI projects are being built on lands. Because of that it has different implications for land-locked and other countries. That is why it is included in these models, and it takes the value '1' if a country is land locked, '0' otherwise.

Bilateral exchange rate: It is defined as the ratio of exporter's real exchange rate to importer's real exchange rate. This included as one of the explanatory variables in this study as it could affect the international trade performance of the partner countries.

REM: This variable is about remoteness of countries with other trade partners. It means that if there are two couple countries (X, Y) and (Z, W) with equal distance between each couple countries, but (X, Y) are closer to other partner countries, then (Z, W) will trade more than the trade between X & Y. Because they don't have alternative nearby trading partners like (X, Y). Therefore REM_{it} will capture this effect. Hence $REM_{it} = \sum_j w_{jt} D_{ij} \ for \ i \neq j$, where Dij is the bilateral distance, wjt is the ratio of Yjt and YG (the global GDP).

Per capita income difference: per capita income is calculated by dividing the total national income of a country by its population number to get how much an average person earns. So, after calculating each country's per capital income, it is easy to get the difference in per capita income of countries. This is the bilateral independent variable between the export and import countries and it is included in Anderson and van Wincoop (2003) model.

Table 3.1 Variables measurement and their expected sign

Variables	**Symbol**	**Measurement**	**Expected sign**	**Data sources**
Bilateral trade (export)	Tij	In US dollar	NA	UNCOM trade
Gross domestic product	GDP	In US dollar	+	WDI (2023)
GDP per capita	GDP per	In number	+	WDI (2023)

Bilateral distance	D	In kilometers	-	CEPII
Belt and Road Initiative membership	BRI	It takes '1' for BRI members, '0' otherwise	+	Green Finance & Development Center BRI data base
Regional economic communities dummy	REC	It takes '1' for BRI members, '0' otherwise	+	Own Computation
Common language	CL	It takes '1' if countries do have, '0' otherwise	+	CEPII
Land locked	LL	It takes '1' for landlocked countries, '0' otherwise	+	CEPII
Bilateral exchange rate	BER	In US dollar	+	Computed based on Darvas (2023) REER data
Remoteness index	REM	In number	+	Own Computation
Common border	CB	It takes '1' if countries do have, '0' otherwise	+	CEPII
Common colonizer	C	It takes '1' if countries do have, '0'	+	CEPII

		otherwise		
Per capita income difference	PCI	In US dollar	-	WDI (2023)

Source: own computation

3.6 Method of data analysis

In this study both descriptive and econometric analysis were employed. Panel data set of about 48 countries, out of them 26 Sub-Saharan African countries as reporting and 22 partner countries from Europe, Asia and North Africa for the period (2018 -2022) was taken. After the proper data was collected from trustful sources, the data management works was done using excel including codding, checking missed or omitted variables. Then After the data was imported to STATA all necessary econometric diagnostic tests were performed before the data analysis. The standard augmented gravity model was utilized by PPML estimation technique after checking fixed effect and random effect models. Bilateral trade (export) was treated as the dependent variable with the list of explanatory variables. Finally, the data was analyzed using STATA and EViews.

3.7 Tests for robustness

3.7.1 Heteroskedasticity

According to theoretical econometrics a random variable y is Saied to be heteroskedastic if it has scattered pattern of the error terms. This means that its variance is different for different observations in the data set. Indeed, this is against the classic linear regression model assumption which states there should be constant error term for all observations or the situation of homoscedasticity (Williyam E. & Guay C., 2018). The most common framework to deal with heteroskedasticity in general linear model expressed in the form of: $Y_i = X'_i\beta + e_i$

Where, Xi, represents n th dimensional vector of observations on the set of explanatory variables,

β is n th dimensional vector of coefficients to be estimated,

Yi, denotes kth observation (i=1,2,3…) on the dependent variable.

In this study there are a number of explanatory variables with the dependent variable, bilateral trade. So, heteroskedasticity was done whether or the error terms have zero mean or not.

3.7.2 Multicollinearity

In multivariate statistical analysis, the situation when there is interrelationship among the independent variables is known as multicollinearity. Although the presence of multicollinearity doesn't violate the assumptions of multivariate statistical analysis, it is a problem in the generalizability of the model used. In connection to reporting the level of the relationships among the independent variables, a high degree of multicollinearity or statistically (> 0.85) is mostly taken as the sufficient but not necessary condition to declare the problem of multicollinearity.

In the current study which employed augmented gravity model with core variables of the model and additional variables, the existence of multicollinearity would be done to confirm the robustness of the results.

3.7.3 Wooldridge's test for serial correlation

One of necessary tests in panel data set is serial correlation test to see whether variables have association with their own lagged values. Despite, there are different types of tests Wooldridge's test is very attractive because of its very few requirements or assumptions. It can be done with or without the presence of conditional homoscedasticity, balanced or unbalanced data, gaps in the individual series.

Let us take a linear one model as follows:

$$Y_{it} = \alpha + X_{it}\,\beta_1 \; + Z_i\,\beta_2 + \mu_i \; + \varepsilon_{it}$$

Where Yit is the dependent variable, Xit denotes a (1×N1) vector of time varying covariates;

Zi represents a ((1×N2) vector of time invariant covariates; α , β_1 & β_2 *are 1 + N1 +N2 parameters.*

Wooldridge's test uses the residuals form a regression in first difference to remove the individual level effect. That is

$$Y_{it} - Y_{it-1} = (X_{it} - X_{it-1})\beta_1 \; + \varepsilon_{it} - \varepsilon_{it-1}$$

$$\Delta Y_{it} = \Delta X_{it}\beta_1 + \Delta\varepsilon_{it}$$

For instance, in this hypothetical linear model, Wooldridge's test for serial correlation begins by estimating the parameters β_1 by running the regression ΔY_{it} on ΔX_{it} to get the residuals $\hat{e}_{it}$ (Williyam E. & Guay C., 2018).

3.7.4 Normality test)

According to Berna and Senay (2017) study on a comparison of various tests of normality, there are about 40 different types of normality tests such as Chi-square, Kolmogorov-Smirnov, Anderson -Darling and Shapiro -Wilk (Yazici B. & Yolacan S., 2017). Normality test is important to see the distribution of data set before proceeding other parametric tests and data analysis. When the sample increases the power tests increases. Jarque-Bera is the most powerful test for log -normal distribution, while Shapiro -Wilk is the common in many statistical software. Nevertheless, researchers choose different types of tests in accordance to their purpose, sample size, t-distribution, simplicity of tests. In this study normality test for the normal distribution or skewness and kurtosis was done accordingly.

3.7.6 Panel root test

In econometric analysis estimators would be inefficient if the variables in the panel data set were not cointegrated or non-stationary. Panel root tests are designed to show whether such variables are stationary or not. First generation panel root tests developed by Maddala and Wu (1999) assumes all the cross-sections have the same panel unit root. This means that first generation panel root tests assume the cross-section units to be independent where second generation panel root tests allow cross-sectional dependence (Bhattarai K., 2019). In panel root test the null hypothesis assumes that the series contains a unit root while the alternative hypothesis is that the series is stationary.

Chapter Four: Result

Introduction

This study was done using a panel data set of 48 selected exporting and partner countries for the time period of five years (2018- 2022). Out of the total sampled countries 26 exporting countries were taken from Sub-Saharan Africa while the rest ones are their major trading partners from Europe, Asia and North Africa. The data set has 12715 observations and it was analyzed into two parts. The first result part is descriptive statistics showing the trend of trade performance of Sub-Saharan Africa region with China, trading partners and among Sub-Saharan Africa countries themselves. The second result session of this study was the econometric analysis of trade effect of Belt and Road Initiative which was done using augmented gravity model.

4.1 Descriptive analysis

Chenise Belt and Road Imitative was launched in 2013, but member countries have joined at different times. As it is shown in the annex XV most of Sub-Saharan Africa countries joined in 2018. Few countries, for instance South Africa, became member of the cooperation before the aforementioned year whereas some other countries have joined it afterwards. In this study, countries joined in 2018 and before have been incorporated. Hence the time framework for this study was selected to be from 2018 to 2022. But for comparison purpose and to show the trend of trade flows, prior data set starting from BRI launching year 2013 was used in two descriptive graphs.

4.1.1 Trade between Sub-Saharan Africa and China

The aim of Chinese Belt and Road Initiative was mentioned previously as that would facilitate trade and investment between China and member countries. Considering its different infrastructures as means of reduction for cost of trade, the level of trade performance of Sub-Saharan Africa region was evaluated in this study by selecting a number of countries. Therefore, based on the data taken starting from 2013 up to 2022, it was found that the amount of export of Sub-Saharan Africa region exceeded its import level from China. Besides to this the export of

Sub-Saharan Africa countries had an increasing trend despite there was a sharp decline by the year 2020 probably due to Covid 19 pandemic as an external shock.

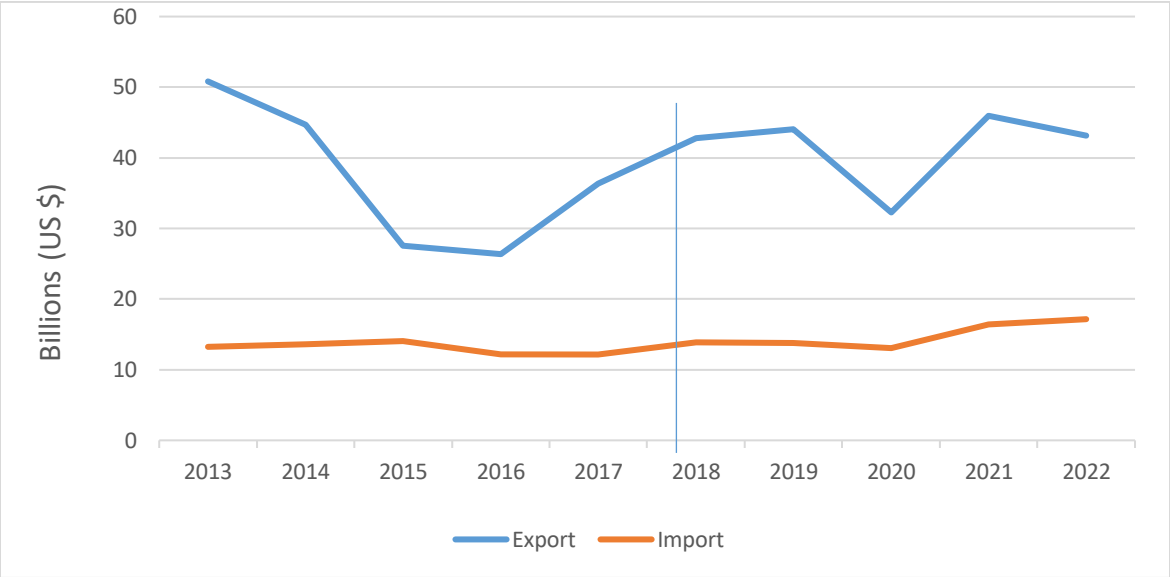

Figure 4.1 Sub-Saharan Africa trade with China

Source: own computation based on collected data from UNCOM trade, 2024

4.1.2 Sub-Saharan Africa export

In this study sampled countries from Sub-Saharan Africa region were treated as reporting countries to their major trading partners from Europe, Asia and other North Africa countries. Since the study employed disaggregated data the export commodities were taken from four different sectors namely food and live animals, crude materials, minerals and fuels and manufacturing commodities. In this study the major export commodities were found in the sector of minerals and fuels followed by manufacturing goods. Based on the selected 26 Sub-Saharan Africa countries trade data, it was observed that there was increasing volume of export during the period of 2018-2022, as shown on the following chart.

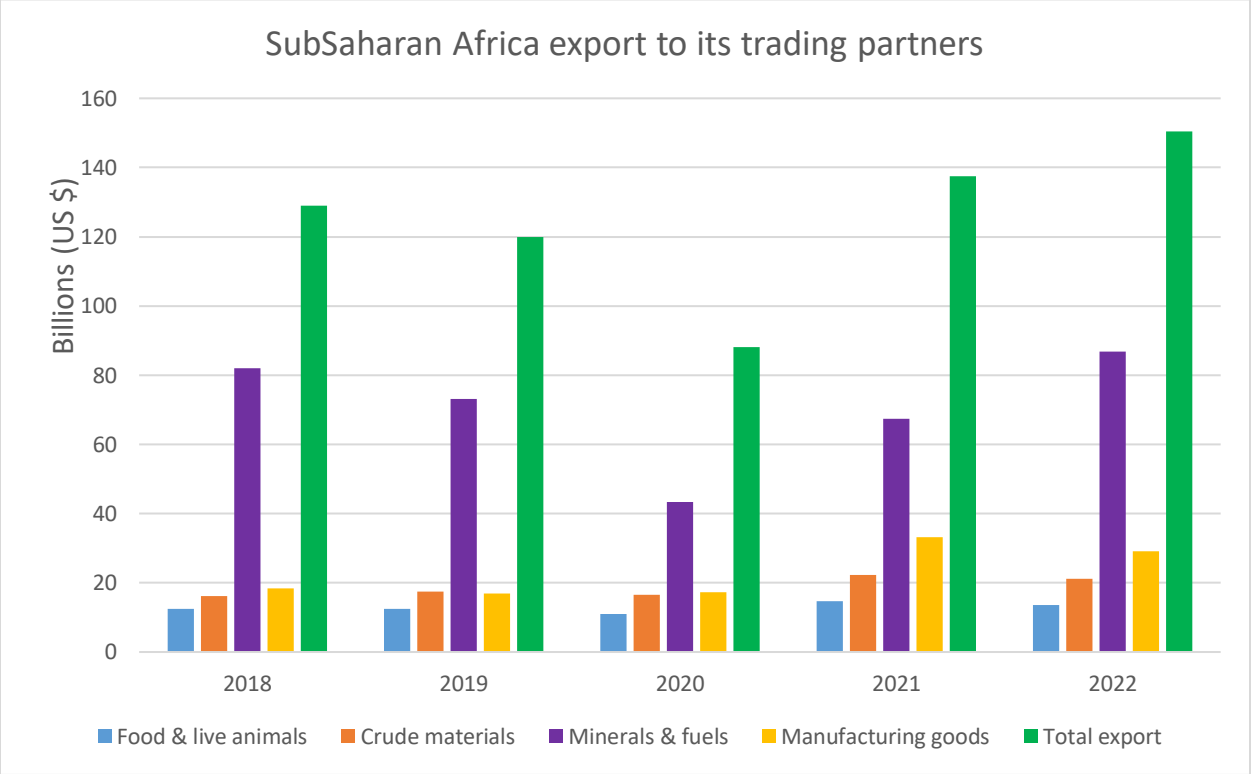

Figure 4.2 Export of Sub-Saharan Africa

Source: own computation based on collected data from UNCOM trade, 2024

The next table 4.1.3 shows the total export value of sampled BRI member Sub-Saharan Africa countries not only to partner countries out of Africa but also it includes the intra Sub-Saharan Africa a export level. By taking base year (2018) and the last year, in this context (2022), the total export level to both major trade partner countries and other Africa countries was put in US dollar with the corresponding share percentage out of the total sampled BRI Sub-Saharan Africa total exports. Based on UNCOM trade database the four commodity categories are all crude materials or primary products, food and live animals, minerals and fuels and manufacturing goods. In this regard South Africa took the lion sharing export share of the total Sub-Saharan Africa export in both years, 2018 and 2022, followed by Nigeria, Namibia and Rwanda. Whereas

Comoros and Benin were found to be other Sub-Saharan Africa BRI countries with least export share in the base year. Similarly, Cape Verde and Gambia were found with the least export share in 2022.

Table 4.1.3 Share of total export value of Sub-Saharan Africa trade by BRI members (in US dollar)

Country/Year	2018	2022	As % of Sub-Saharan to world (partners)	
			2018	2022
Angola	36407521656	39776412631	6.07	8.12
Benin	379185720.8	279184034.4	0.06	0.06
Burundi	27036970260	2172620656	4.50	0.44
CapeVerde	405013621.4	33033177.09	0.07	0.01
Cameroon	27173291939	1221184340	4.53	0.25
Comoros	345456741.2	37109849.33	0.06	0.01
Cote d'Ivoire	8916224887	11329779749	1.49	2.31
Ethiopia	3732100676	1022013777	0.62	0.21
Gabon	3694362494	2895782592	0.62	0.58
Gambia	3690449225	8291888.365	0.62	0.01
Ghana	6777544861	7072932741	1.13	1.44
Kenya	6142445754	8505019790	1.02	1.74

Madagascar	5536574491	8265376917	0.91	1.69
Mauritania	4583410408	7412964247	0.76	1.51
Mozambique	48987789192	50661504353	8.18	10.35
Namibia	50702638272	50650716899	8.46	10.34
Nigeria	50031732829	50519602764	8.35	10.32
Rwanda	49767423905	50065547372	8.32	10.22
Senegal	49760457274	50138607818	8.31	10.24
Seychelles	21625942777	30820828497	3.61	6.29
South Africa	153346000000	55292151405	25.58	11.29
Tanzania	1620620770	2836145432	0.27	0.58
Togo	377820807.7	524031553	0.06	0.11
Uganda	1979804852	1464268242	0.33	0.3
Zambia	3894479663	5903454560	0.65	1.21
Zimbabwe	32568761698	50766207249	5.43	10.37
Intra Sub Saharan Africa	**5.99484E+11**	**4.89675E+11**	**100**	**100**

Source: own computation based on collected data from UNCOM trade, 2024

4.1.3 Intra Sub-Saharan Africa trade effect

The assumption of this study was already stated that Chinese Belt and Road Initiative would be helpful in improving the infrastructure gap of least developing countries like Sub-Saharan Africa region. So, in this regard based on trade data taken from sampled countries the extent of intra Sub-Saharan Africa trade was assed expecting the positive contribution of BRI for these member countries. As the next stacked area chart shows the total value of trade which is the sum of export and import at intra Sub-Saharan Africa exhibited an increasing trend starting from the base year of Belt and Road Initiative launching year. But it was not possible to take as it was increasing smoothly; there was some decline especially by the year 2020. In similar way all the previous descriptive charts results showed, the trade performance was reported with sharp decline by the year 2020. Probably this could be related in connection to Covid 19 pandemic in that year.

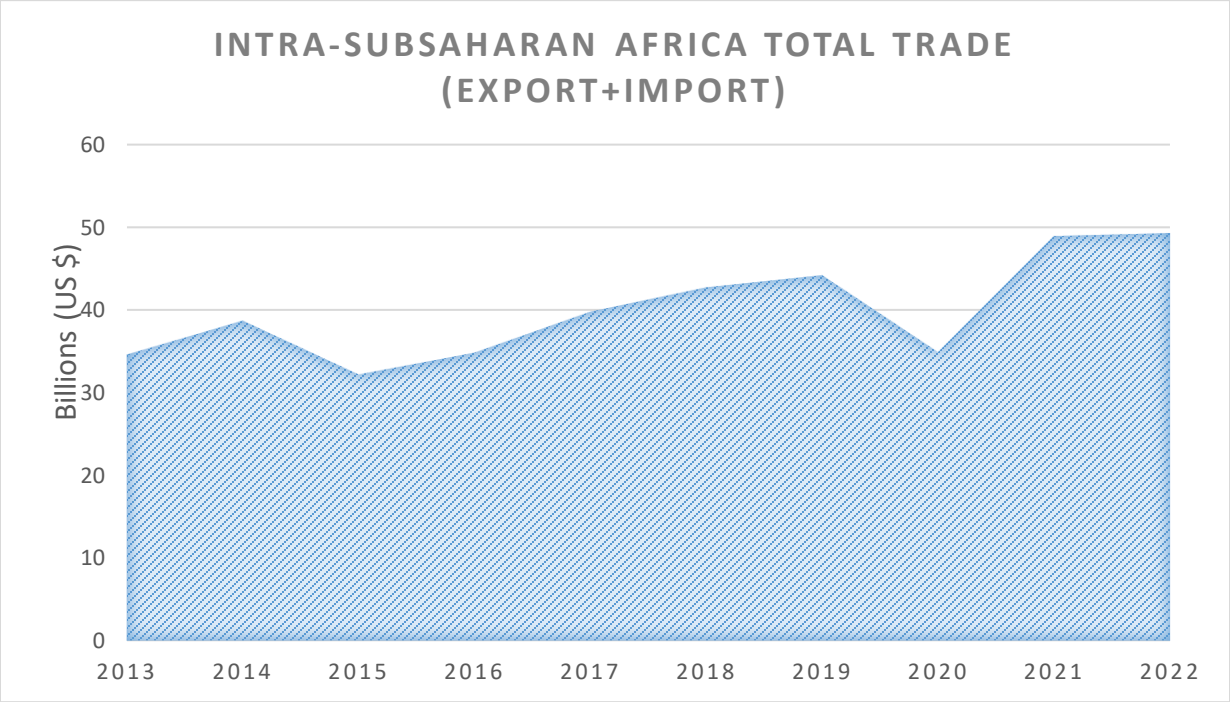

Figure 4.3 Intra Sub-Saharan Africa trade

Source: own computation based on collected data from UNCOM trade, 2024

As the next table 4.1.4 indicates the total export level of BRI member Sub-Saharan Africa countries themselves. This is to describe the effect of Belt and Road Initiative on the member countries on their intra-regional trade performance on the four major export sectors, crude materials, food and live animals, manufacturing goods and minerals and fuels. Taking the two years data to show its trend, it is possible to say that there is some improvement or increscent in intra Sub-Saharan Africa trade level. But as our empirical evidences indicate comparing it with other regions like Asian countries intra Africa (Sub-Saharan Africa in this study) is still inadequate. Almost all Sub-Saharan Africa BEI member countries had the maximum export level in minerals and fuels sector followed by infrastructure sector within the region. But still now the intra Sub-Saharan Africa export level was heavily occupied by few South and Weast Africa countries like South Africa and Nigeria. This can be justified as there is better infrastructure in these countries and their production system including the manufacturing sector is also more efficient than other Sub-Saharan Africa countries. This makes them to export more to other Sub-Saharan Africa countries.

Table 4.1.4 Total export value of BRI Sub-Saharan Africa countries by sector for the years 2018 and 2022 (in US dollar)

Year	**2018**				**2022**			
Country/ Sectors	Crude materials	Food & live animals	Manufacturing gods	Minerals & fuels	Crude materials	Food & live animals	Manufacturing gods	Minerals & fuels
Angola	115962003.4	3261408.44	3112727.5.1	1147128834	135761 9.669	120003 41.18	5509706 8.49	350002 763.7
Benin	4760915.582	3677773 5.44	1621409 6.62	703043.755	188401 79.16	106313 64.34	4266902 8.04	12551.427
Burundi	7359778.325	8261183.899	802272.178	3573544.129	108382 9.629	623810 9.543	1874754.211	626639 8.314
CapeVer	1271.97	2204.06	2371.71	27974.4	1289.32	2429.45	23801	30204.1

de				9	3			8
Cameroon	26107042.66	38914808.37	57329528.41	37565476.28	25007042.66	39925808.37	66129528.04	39967456.53
Comoros	1171.42	1971	2481.96	3019.026	1971.075	2204.598	3121.16	3081.752
Cote d'Ivoire	19385221.46	14069813 9.7	88480723.9	32282160 5.9	41955806.23	23519844 4.7	96447361.71	42302862 3.2
Ethiopia	1366244.499	24082221.98	3295848.422	1019.267	2088026	31813921	19282825.36	1700.58
Gabon	4268869.44	738075.054	18288888.64	11572705.56	4137951.572	5385086.142	22089645.36	78480334.95
Gambia	24572.032	53177.837	159766.606	849029.966	59452.322	451219.36	42764.694	98.674
Ghana	10505404.16	85581857.79	46221878.78	88200796 6.1	7160610.586	173282751	21799119 3.4	167931392
Kenya	79813429.72	18993916 8.4	24390579 7.1	78308716.75	101643436.9	24360713 9.7	45880727 1.5	39990 71.702
Madagascar	2142573.043	12396739.16	35888231.47	10862127.9	4807578.736	12141919.25	14362807.46	15480271.86
Mauritania	844854.44	20665430 1.6	273544.72	29333544.57	1669409.974	26205821 1.8	2977506 .771	30003126.86
Mozambi	15066055.6	13283617 5.2	16979293 6	68596435 3.1	11446410.47	11576027 5.3	65210912.52	11139354 88

que								
Namibia	6748119 2.1	5510743 26.4	2464634 26.3	8952836 .638	107369 803.2	251060 662.8	1297820 82.1	554019 33.83
Nigeria	3251317 .111	5519783 8.87	8252222 0.29	7458063 159	598962 9.762	318003 68.98	9112031 1.29	483780 7502
Rwanda	1416838 8.06	3969418 9.14	2269861 .202	1123235 9.33	391730 6.22	532054 10.03	3205586 .91	109267 53.09
Senegal	1228027 7.18	2401437 98	1004840 55.6	3860591 7.13	197312 47.12	313766 888.3	1871536 25	724177 37.7
Seychelle s	9866.37 8	4057623 .422	121819. 191	2303.12 1	10097.6 61	782698 2.243	230451. 551	2743.68 3
South Africa	1122372 803	1690997 539	2924130 910	1431202 180	186549 1763	200968 6528	3571833 348	195623 7073
Tanzania	1413511 9.43	2651351 50	2135601 73.1	2967977 2.81	107306 201	176143 7451	3825700 64.1	112191 775.7
Togo	5483651 .188	1494030 7.46	8653039 6.75	1164606 50.2	105637 95.77	397327 61.64	5084367 7.84	447904 15.6
Uganda	1728981 8.16	4918103 18.4	1533768 15.1	5784698 2.97	291436 28.21	373468 433.8	1386102 83.1	544543 20.59
Zambia	2790787 1.22	1928232 29.4	3101985 02.6	3430169 5.51	303471 46.4	305098 489.5	2597545 80.4	154382 448.2
Zimbabw	6482963 68.2	1179631 21.2	3389453 93	7081697 .8	225646 7908	100219 240.2	2525256 76.9	931889 12.94

e								
Intra Sub Saharan Africa	2141710 00000	2146160 00000	2125420 00000	2141270 00000	449956 00752	451505 60058	4481068 4481	443349 79204

Source: own computation based on collected data from UNCOM trade, 2024

4.2 Econometric analysis

4.2.1 Econometric diagnostic tests

Best estimator among (OLS), fixed effect (FE) and random effect (RE)

A. Breusch and Pagan Lagrangian multiplier test

In this panel data set the appropriate estimation models should be applied to get unbiased and consistent estimators. The data collected for this study was taken randomly, consequently there would be random observations. Therefore, to test whether ordinary least squared (OLS) estimation model has advantage or not over the other two (fixed effect and random effect) models Breusch and Pagan Lagrangian multiplier random effect test was done firstly. OLS estimation model assumes that there is no panel effect by ignoring the time series part of the data. It is frequently reported that there is a problem of omitting the heterogeneity of sample cross-sectional entities individual differences as OLS estimation technique used to use the pooled effect for all entities (Williyam E. & Guay C., 2018).

Thus, Breusch and Pagan Lagrangian multiplier random effect test was done with the following hypotheses.

Ho: No panel effect

HA: There is panel effect

As annex I shows Ho should be rejected and the alternative hypothesis could be true since the p-value shows significant association. Therefore, OLS estimation model was not preferred than random effect or fixed effect estimation models (look annex I for more detail).

RE and FE models

The rationale to use fixed effect model is that when someone is interested in analyzing the impact of variables that vary over time. One basic assumption of this model is that something with in the individual entities may bias or impact the independent variables and it is important to control it. In fixed effect model time invariant individual characteristics are unique to individuals and shouldn't be correlated with other individual characteristics (Williyam E. & Guay C., 2018).

In the case of random effect model the variations across entities are assumed to be random and uncorrelated with the independent variables. The entities error term shouldn't correlate with the independent variables and this model gives the advantages of incorporating time invariant variables.

B. Hausman test

Hausman test is useful to distinguish the appropriateness of fixed and random effect model in econometric analysis. Hence, in this study once OLS estimation technique was ruled out the next procedure was to check whether random or fixed effect model works without bias. Thus, for this purpose Hausman test was done with null hypothesis of random effect mode is appropriate than fixed effect model.

Based on Hausman test result the null hypothesis should be rejected in favor of the alternative hypothesis which states that random effect is appropriate than fixed effect model (look annex II for the detail).

C. Shapiro-Wilk (Normality test)

Skewness and kurtosis test for normality distribution of panel data is important before other parametric tests are done. Therefore, for this study panel data set both histogram or graphical observation and Shapiro-Wilk test were done to confirm the data was normally distributed or not. The null hypothesis of Shapiro-Wilk test is that the data are normally distributed. Hence according to the test result of p-value showed no significant association. This implies that we fail to reject the null hypothesis. The skewness and kurtosis of histogram representation was also normally distributed except small departure from zero, as it is put in the annex III.

D. Heteroskedasticity

In order to select the most optimal estimation technique heteroskedasticity is one of the most important tests for the panel dataset in this study. The problem of heteroskedasticity shows a

situation where the variance of residuals or error terms is unequal over range of measured values or when there is the scatter of the errors depending different values of the independent variables. It is the complementarity of homoscedasticity. If there is heteroskedasticity, the basic assumption of classical linear regression which states the error terms are homoscedastic as a result the regression results would be invalid (Yazici B. & Yolacan S., 2017).

As annex I shows Breusch-Pagan / Cook-Weisberg test was done for our panel data set and it exhibited the existence of heteroskedasticity. For this reason, efforts were done to correct it by checking the presence of outliers, incorrect data transformation, mixing observations with different measures of scale, but the problem of heteroskedasticity wasn't avoided. (Look annex IV for more detail).

E. Multicollinearity

One of the basic assumptions of classical linear regression model is that there is no perfect multicollinearity or no exact linear relationship among the explanatory variables included the regression model. For this purpose, variance inflation factor (VIF) test which measures the extent of multicollinearity has increased the variance of an estimated coefficient. It shows the degree by which an explanatory viable is explained by all other variables in the model. In this study the problem of multicollinearity was found as shown on annex V. But the problem of multicollinearity was better handled by selecting PPML estimation technique which is helpful in treating the multicollinearity problem.

F. Serial correlation

Serial correlation which measures the degree of association between the same variables with their previous or lagged values. Its value lies between -1 and 1, the interval from 0 to 1 indicates the positive autocorrelation while values from -1 to 0 shows negative autocorrelation. In this study Breusch-Godfrey LM test was done, the insignificant value of its p-value confirms statistically not to reject the null hypothesis, there is no serial correlation in the panel data set (look annex VI for more detail).

E. Endogeneity

The situation of endogeneity happens when independent variables are found to be correlated with the error term and such variables are said to be endogenous. On the other side, variables outside the regression model or uncorrelated variables with the error term are exogenous. Since the existence of endogenous variables affects negatively the estimated coefficients, the problem of endogeneity should be handled properly. In this study the problem of endogeneity was detected by running each explanatory variables as if they were dependent variables using EViews software to check their correlation with the error term. As a result, population, GDP and bilateral exchange exhibited correlation with the error term. Therefore, to overcome this endogeneity instead of population and GDP per capita was taken as original variable and for rest ones their one period lagged values were used as instrumental variables. Consequently, the problem of endogeneity became improved at some extent.

4.2.2 Descriptive statistics summary

As the table below shows before the regression analysis the descriptive statistics summary was done to show the mean, standard deviation, minimum and maximum values with total observations of study variables.

Table 4.1.5 Descriptive statistics summary

Variable	Obs	Mean	Std. Dev.	Min	Max
Lntij	1274	26.153	4.034	11	37
lnGDPrep	1274	23.041	5.05	3.799	26.887
lnGDPpar	1274	25.981	2.785	2.918	30.866
lnGDPperre	1274	7.428	.845	5.379	9.732
lnGDPperpar	1274	8.626	1.539	5.379	11.324
lnPCI	1274	8.292	1.91	-2.75	11.321
lnBidista	1274	8.398	.856	4.382	9.67
lnBiexcha	1274	.044	.138	0	1
lnRemrepo	1274	26.278	2.4	2.949	30.655
lnRempart	1274	25.964	5.099	5.584	32.105
Landrep	1274	.211	.408	0	1
Landpar	1274	.014	.117	0	1
Cocolony	1274	.163	.37	0	1
Coborder	1274	.088	.283	0	1
Colang	1274	.248	.432	0	1
BRIboth	1274	.085	.279	0	1
BRIpar	1274	.086	.28	0	1
COMESAboth	1274	.084	.278	0	1
COMESApar	1274	.105	.307	0	1
ECOWASboth	1274	.063	.244	0	1

ECOWASpar	1274	.107	.309	0	1
EACboth	1274	.031	.172	0	1
EACpar	1274	.063	.243	0	1

4.2.3 Regression analysis using Poisson Pseudo- Maximum Likelihood

In this study in order to estimate more efficiently Poisson Pseudo- Maximum Likelihood (PPML) estimation technique was employed to determine the association of explanatory variables and the dependent variable bilateral trade. The primary reason to select PPML estimation technique is that there was the problem of heteroskedasticity and multicollinearity in this panel data set which couldn't be addressed by other techniques. Because PPML estimation technique is important in handling serial correlation, heteroskedasticity and multicollinearity. The other point was that the over advantage of PPML than other estimation models in handling zero trade values. Moreover, due to the additive property of PPML estimator, the gravity fixed effects would be kept identical to their corresponding structural terms.

Bilateral trade (export size) was the dependent variable with a number of explanatory variables in the augmented gravity model.

Despite PPMl estimation technique was selected as the robust one for this paper interpretation and discussion, the gravity model analysis was also done using random and fixed estimation models (look random effect and fixed effect estimation results, annex VII and VIII).

The objectives of this study were to evaluate trade effect of Belt and Road Initiative on Sub-Saharan countries and to identify associated determinants of bilateral export. Therefore, table 4.1.6 shows trade creation and diversion of Belt and Road Initiative and other regional integration dummy variables while table 4.1.5 is about regression outputs of the remaining determinants. In this analysis five regression models were administered to estimate coefficients of variables in the four sectors (crude materials, food & live animals, manufacturing, minerals & fuels) and in the total four sectors.

Table 4.1.6 Regression results of all four sectors

Estimation technique: Poisson Pseudo- Maximum Likelihood (PPML)	
Dependent variable:	**Export sectors**

Ln (Tij): bilateral export					
Explanatory Variables	Crude materials	Food & live animals	Manufacturing	Mineral & fuels	Total
Ln (GDP) of reporter	1.462** (0.651)	1.200 (1.607)	1.446 (1.667)	1.305 (2.819)	0.813** (0.526)
Ln (GDP) of partner	2.380** (0.606)	0.499 (1.560)	0.602 (1.637)	0.741 (2.803)	0.609 (0.905)
Ln (GDP per capital) of reporter	0.032*** (0.003)	0.015*** (0.003)	0.040*** (0.003)	0.024*** (0.005)	0.028*** (0.001)
Ln (GDP per capital) of partner	0.017*** (0.003)	0.013*** (0.003)	0.006** (0.003)	1.867 (0.005)	0.009*** (0.001)
Ln (per capita difference)	-0.002 (0.002)	0.000 (0.002)	9.510 (0.002)	0.001 (0.003)	-0.0005 (0.001)
Ln (bilateral distance)	-0.883 (2.280)	-1.716 (2.225)	-0.856 (2.316)	-2.026 (3.921)	-0.228 (1.283)
LN (bilateral exchange rate)	-0.090*** (0.016)	-0.098*** (0.015)	-0.110*** (0.018)	-0.112** (0.040)	-0.110*** (0.009)
Ln (remoteness) of reporter	-2.364 (1.606)	0.510 (1.560)	-0.588 (1.637)	0.732 (2.803)	-0.597 (0.905)
Ln (remoteness) of partner	1.463 (1.651)	1.201 (1.607)	1.450 (1.667)	1.301 (2.819)	0.815 (0.926)
Land locked dummy of reporter	-0.050*** (0.006)	-0.020*** (0.006)	-0.024*** (0.006)	-0.061*** (0.012)	-0.032*** (0.003)
Land locked dummy of partner	-0.166*** (0.018)	-0.171*** (0.019)	-0.110*** (0.017)	-0.292*** (0.065)	-0.158*** (0.011)

Common border dummy	0.117*** (0.010)	0.097*** (0.009)	0.126*** (0.010)	0.070*** (0.015)	0.085*** (0.005)
Common colonizer dummy	0.032*** (0.007	0.034*** (0.007)	0.011 (0.007)	-0.006 (0.011)	0.023*** (0.004)
Common official language dummy	-0.009 (0.007)	0.005 (0.006)	0.041*** (0.006)	0.017* (0.010)	0.011*** (0.003)
Constant	6.287 (23.107)	-15.292 (22.554)	-8.838 (23.441)	23.805 (39.629)	-1.492 (12.994)
Number of observations		3744	3667	1932	12714
R-Squared	0.429	0.414	0.471	0.325	0.424

Note: ***, **, * indicates the level of significance at 1, 5, and 10%level of significance, respectively. The prefix "ln" refers to the natural logarithm of the variable under consideration.

Comparison of Poisson Pseudo- Maximum Likelihood, Random effect and Fixed effect estimation results (for table 4.1.6)

Comparing the results of the above PPML estimation results with random effect and fixed effect estimation results, we found with little differences. As the table 4.1.6 shows the PPML estimation results, the primary variables of our augmented gravity model GDP of reporter, GDP per capita of both reporting and partner countries, bilateral exchange rate, land locked dummy, common border, common colony, common official language were found to be significant in the total sector. Surprisingly, almost similar findings were also founded in random and fixed model estimation results. As annex VII shows in random model estimation GDP per capita of both reporting and partner countries, bilateral exchange rate, landlocked, common border, common colonizer and common official language dummies show significant association with the bilateral trade on the total sector. But in random effect estimation GDP of both reporting and partner countries did not show any significant association, rather it appeared with negative estimated coefficients except for the total and minerals & fuel sectors. As annex VIII shows in the fixed effect estimation similar variables were found significantly associated with bilateral trade in the total sector (look annexes VII &VIII for estimated results of RE & FE).

Table 4.1.7 Regression results of all four sectors (BRI and REC dummy variables

Estimation technique: Poisson Pseudo- Maximum Likelihood (PPML)					
Dependent variable: Ln (Tij): bilateral export	Export Sectors				
Explanatory variables	Crude	Food & live animals	Manufacturing goods	Minerals	Total
BRI membership (both reporter and partner are members) dummy	0.014* (0.008)	0.029*** (0.008)	0.002 (0.008)	0.033** (0.015)	0.042*** (0.005)
BRI (only reporter is member) dummy	-0.014* (0.007)	-0.009 (0.007)	0.009 (0.007)	0.014 (0.012)	-0.057*** (0.004)
COMESA (both reporter & partner are members) dummy	-0.020* (0.010)	0.008 (0.009)	-0.009 (0.009)	-0.011 (0.016)	-0.003 (0.006)
COMESA (only partner is member) dummy	-0.042*** (0.008)	-0.057*** (0.008)	-0.058*** (0.008)	-0.019 (0.016)	-0.056*** (0.005)
ECOWAS (both reporter & partner are members) dummy	0.018 (0.012)	0.048**** (0.011)	0.079*** (0.011)	0.063*** (0.017)	0.059*** (0.006)
ECOWAS (only partner is	-0.040***	-0.050***	-0.034***	-0.055***	-0.050***

member) dummy	(0.008)	(0.008)	(0.008)	(0.015)	(0.005)
EAC (both reporter & partner are members) dummy	0.110*** (0.015)	0.086*** (0.014)	0.087*** (0.015)	0.050** (0.021)	0.107*** (0.008)
EAC (only partner is member) dummy	-0.050*** (0.011)	-0.021** (0.010)	-0.026*** (0.009)	-0.039** (0.019)	-0.036*** (0.006)
Constant	6.287 (23.107)	-15.292 (22.554)	-8.838 (23.441)	23.805 (39.629)	-1.492 (12.994)
Number of observations		3744	3667	1932	12714
R-Squared	0.429	0.414	0.471	0.325	0.424

Note: ***, **, * indicates the level of significance at 1, 5, and 10%level of significance, respectively. The prefix "ln" refers to the natural logarithm of the variable under consideration.

Comparison of Poisson Pseudo- Maximum Likelihood, Random effect and Fixed effect estimation results (for table 4.1.7)

Coming to the comparison of the estimated coefficients of REC dummy variables including BRI, again almost similar findings were also found in the total sector but there are also some differences across the four sectors. In the entire sector regression model for comparison purpose, BRI had both trade creation and diversion effects in all three estimation techniques. Both reporting and partner countries BRI dummy was estimated with coefficient of 1.078 and 1.091 in random effect model and fixed effect models respectively. Indeed, these estimated coefficients were more than the PPML one which was 0.042. COMESA exhibited trade diversion in all three estimations of the total sector while ECOWAS and EAC had trade creation effects (look annexes VII &VIII for more detail). But in both random effect and fixed effect estimations ECOWAS didn't show statistical significancy in the crude materials and the minerals & fuel sectors, rather it indicated trade diversion effect. This means that trade of the member countries out of the regional integration is rising in cost of reduction intra-regional bloc trade. But in PPML estimation we found that ECOWAS had both trade creation and diversion effects across all sectors except in the crude sector, which became with positive estimated coefficient with no

statistical significancy. EAC also exhibited statistically significant had both trade creation and diversion effects in all four sectors in PPML.

Therefore, considering the more robustness of PPML estimation especially in the RECs dummies, the final discussion and interpretation was based on the results of Poisson Pseudo-Maximum Likelihood estimation technique.

4.3 Discussion

A. The core variables of gravity model

The estimated coefficients were obtained from the regression results of five regression models. As the table 4.1.5 shows the core variables of gravity model were tested using PPMl estimation technique. According to these results the coefficients of GDP of both exporter and partner countries exhibited positive signs in the four export sectors and in the sector. Furthermore, the GDP of reporter was found to be significantly associated with the bilateral export size in crude and total sectors. In this regard their estimated coefficients implied that, for instance, in the crude sector when the GDP of exporter country increases by one unit, the bilateral export size of Sub-Saharan Africa region would increase by 1.462 times and the same thing is true for the total sectors. This positive association of GDP size with export size is in line with the theoretical assumption of gravity model (Shepherd, B., Doytchinova, H., & Kravchenko, A., 2019). But on the other side GDP of partner countries did not show significant association with the dependent variable in all models. This might be due to the fact that the major partner countries out of Africa in this study were developed countries almost similar and high GDP with large share in the international trade.

In this study GDP per capita of both reporting and partner countries were found to be significantly associated with the bilateral export in sectors. This finding is also consistent with the theoretical foundation of gravity model and also with other empirical evidences (Sahar, H., 2019 and M Yayo Negasi & Asefa S., 2016). Moreover, as study done in the case of Uganda's economy with panel data set and augmented gravity model to assess the determinants of the country's level of export showed that GDP per capita was significantly associated with the export level in similar with this current study (Karamuriro T. & Nahamya W., 2022). We argue

that countries with higher income are expected to trade better, export more as the function of their production capacity and import more with higher consumption better competition in the international market.

The other variable which was significantly associated with bilateral export size was bilateral exchange rate of reporter and partner countries, and its coefficients was found to be negative. This finding was in line with a study done in SAARC member countries which includes Afghanistan, Bangladesh, Bhutan, Maldives Nepal, Pakistan and Sri Lanka with panel data set (Banik B., & Kumar C., 2021). Similarly, the negative relationship between bilateral exchange rate and bilateral export size was also found in another empirical study done in Ethiopian context (Zeray N., & Gachen D., 2014). But a study done on trade effect of African continental free trade agreement by Geda A. reveled the positive association between real bilateral exchange and bilateral export size in contrast to the current study (Geda A., & Yimer A., 2022).

Bilateral distance was found to be insignificant but its coefficients appeared negative as usual theoretical expectations. In the foundation of gravity model, distance between trading countries deters the trade between the countries. Bilateral per capital income difference was also found to be insignificant with negative estimated coefficients in the crude materials sector and total sectors and it was positive for the remaining sectors. These findings were found to be in line with our empirical studies like a study done on regional integration and trade in Africa done by Horn Economic and Social Policy Institute (Seid, E. H., 2013). When the difference between the per capital income of both reporting and partner countries becomes higher, theoretical explanations discuss it as a negative factor for the bilateral trade volume. That is why negative relationship is more favorable in many empirical studies.

In this study remoteness index of both reporting and partner countries appeared with positive coefficients but it did not show any significant association with our dependent variable. The estimated coefficients of remoteness index of partner country exhibited positive sign in all regression models while the same is true for reporting countries except in the sectors of crude materials, manufacturing and the total sector. In theories remoteness index (which was introduced to capture the multilateral resistance in gravity model) is expected to appear with positive coefficients because as two trading countries become more distant from the remaining trading world, then bilateral trade size between each other would be increased.

In this study landlocked dummy for both reporting and partner countries was significantly associated. For instance, their estimated coefficients in the entire sector (-0.032) for reporting and (-0.158) partner countries indicate that being land locked for a reporting country the bilateral trade size will decrease by 0.032 times and being land locked for partner country will also decrease by 0.158 times the probability of improvement of bilateral trade if that country wouldn't have been land-locked. The above result was also consistent with economic theories of landlocked countries because land locked countries face high transportation cost of trade with the rest of the world (Yalew, M. T., & Changgang, G., 2020). Besides to this the negative relationship of the landlocked dummy of this study was also similar with another empirical study in African context (Geda A., & Yimer A., 2022). But in the context of this study, it was expected that Chinese investment through BRI would improve the trade performance of land locked countries by increasing access to basic infrastructures.

Common border dummy of this study was significantly associated in all sectors whereas common colonizer dummy was also significantly associated except in sectors of manufacturing and minerals & fuel sectors. Their estimated coefficients also exhibited positive relationship with bilateral export size. In the total sector regression model 0.085, 0.023 and 0.011 were estimated coefficients for common border, common colonizer and common official language respectively. This indicates that having common border increases the bilateral trade size by 0.085 times the probability the same couple reporting and partner countries wouldn't have common border. Common colony also increases the bilateral trade by 0.023 times the probability the same countries would make trade without common colonizer. The same is true for common official language dummy, it boosts the bilateral trade by 0.011 times the probability of the same two countries would have trade without common official language. These results were also consistent with the findings of other studies (Amani, I., & Kaci, N., 2022 and Arancón Simal, E., 2019). This might be due to the fact that most of Sub-Saharan Africa countries have had strong bond with their former colonizers not only with trade but also with other non-economic affairs. Furthermore, in this study out of the total 16 non-Africa partner countries the majority ones nine of them were from European countries who had previous colony history with almost all Sub-Saharan Africa countries. Common official language was also found to be significantly associated with positive coefficients in the sectors of manufacturing, mineral and fuels and the entire sector. This finding also aligned with the basic assumption of gravity model that states

having common official language between two trading partners can facilitate the bilateral trade between them.

B. Belt and Road initiative and other regional economic community (REC) dummies

The main objective of this study was to evaluate the trade effect of Belt and Road Initiative focusing on Sub-Saharan Africa region. Therefore, the effect of BRI was analyzed in two ways. The first method was by taking the BRI membership as one economic bloc, and it was tried to examine its static trade effect (trade creation and diversion). For that purpose, a dummy variable when both reporter and partner countries were the member of BRI and another dummy when reporting countries where the member of BRI were created. In this study since all Sub-Saharan Africa countries have joined Chinese BRI, the second dummy was in the case of partner countries weren't the member of BRI from Europe or Asia. The second method was by analyzing its trade effect in terms of other regional economic communities in Sub-Saharan Africa.

Thus, BRI membership exhibited significant association on the sector of food & live animals with estimated coefficients of 0.029 while the BRI dummy in the case of only reporting countries are member were insignificant. The former one with the positive sign indicated that there is trade creation effect in this sector. The percentage change was also calculated by taking the natural exponent of coefficients of the dummy variables and then subtract one from it, and then by multiplying by 100. Hence the percentage change of trade creation would **be [{exp (0.029)}-1] *100 = 2.94%**. Therefore, BRI membership brings trade enhancement by 2.94% in food and live animal sector. Because Sub-Saharan Africa countries have comparative advantage in exporting primary products of food and live animals than their trading partners. BRI membership became insignificant in the manufacturing sector. This could be justified by the fact that most of Sub-Saharan Africa countries have production bottle necks especially in the manufacturing sector due to lack of appropriate technology and skilled manpower comparing with their trading partners in Europe and Asia. But it did in mineral & fuel sector. The positive sign of estimated coefficient of the dummy variable again exhibited trade creation effect in the BRI economic bloc. Its percentage enhancement would be **[{exp (0.033)}-1] *100 = 3.36%**. This implies that when

being the member of BRI for both reporting and partner countries, their bilateral trade volume would be increased by 3.36% in minerals & fuel sector. The reason behind could be as it was shown on the descriptive analysis part Sub-Saharan Africa countries have comparative advantage in exporting more in minerals and fuel sectors. Because there a number of countries in the region that are endowed with natural gas and minerals like Nigeria and Angola. Interestingly, why BRI membership became effective in trade creation in the two sectors could be that for Sub-Saharan Africa countries the major export commodities are minerals & fuels and agricultural products of food & live animals. Most of Sub-Saharan Africa countries except some Southern part of Africa countries like South Africa, their economy is based on these sectors. Furthermore, the descriptive analysis of this study showed that also the primary export commodities of Sub-Saharan Africa countries was in the sector of minerals and fuels. Inversely why BRI membership did not show significancy level at manufacturing sector might be due to low production capacity, lack of infrastructures and high competitiveness in the international trade.

The two BRI dummy variables also exhibited significant association in the total sectors regression model. The positive estimated coefficient 0.042 showed trade creation effect while the negative estimated coefficient -0.057 revealed trade diversion in the BRI dummy of only reporting countries were members. This implies that because of BRI economic bloc the bilateral trade between the member countries is increased in cost of reduction in extra BRI trade. Its percentage change can be calculated as **[{exp (0.042)}-1] *100 = 4.30%**. This means BRI economic bloc brought 4.30% trade improvement for member countries found not only in Sub-Saharan Africa but also in Europe and Asia. On the other side the negative estimated coefficient implied that there was also trade diversion effect (trade out of BRI) quantified by 5.87% which was in the cost of reduction in intra BRI trade level. This trade effect result of BRI was supported by a number of empirical evidences. A study done to assess the impact of BRI in international trade in Asian region, another study done on the impact of Belt and Road Initiative (BRI) on China and South Asia trade integration and a study to analyze the impact of China's financing to Africa on bilateral trade intensity under the Belt and Road Initiative all revealed that BRI had positive contribution in facilitating international trade of member countries (Foo, N., Lean, H. H., & Salim, R., 2020, Mahbub, S. h., 2021 and Wu, Y., Wang, X., & Hu, C., 2023).

In this study the other approach of analyzing the trade effect of BRI was by using regional integration blocs in Sub-Saharan Africa region. Thus, as the table 4.1.6 shows above in the crude sector COMESA dummy with only the partner belongs, revealed negative sign and it was statistically significant whereas COMESA dummy for both reporting and exporting countries are members was found to be slightly significant. Particularly for COMEASA, there was trade diversion, implying that the extra trade out of COMEAS is increasing in the cost of reduction in the intra COMEASA trade. This might be due to that fact that this study consisted of members only in the Sub-Saharan region characterized by inadequate infrastructures, low connectivity among the member countries except counties like South Africa. In this crude sector ECOWAS dummy with only partner member was found to be statistically significant with negative sign, -0.040. Similarly, ECOWAS exhibited trade diversion effect. But EAC appeared with both trade creation and diversion with estimated coefficients of 0.110 and -0.050 respectively.

In this crude sector the minimum trade creation and maximum trade creation number is the same, 0.110. Combing it with maximum and minimum trade diversion of the sector gives us 0.06 and 0.07. This means that in the crude sector BRI has brought the minimum trade creation of 6% and its maximum trade creation was 7%. These figures were found to be small because of low potency of variables in the regression results. This could be due to similar economic characteristics of these Sub-Saharan Africa countries.

In the food & live animal export sector COMESA resulted in trade diversion effect with the estimated coefficient of -0.057. ECOWAS and EAC showed both trade creation and diversion effects. The minimum trade creation was found to be 0.048, combined with the maximum trade diversion effect of COMESA, -0.057 gives us the minimum net trade creation of effect of -0.009. Which implies in the worst scenario BRI membership could results in 0.9% of trade diversion in the sector of food & live animals. But its maximum net trade creation would be the maximum trade creation in the sector, 0.086 combined with the minimum trade diversion of the sector, 0.021. That gives us 6.5% trade creation effect. This implies due to BRI initiative the Sub-Saharan Africa region got trade creation by 6.5% in the food& live animal sector.

In the manufacturing sector COMESA exhibited trade diversion again while ECOWAS and EAC appeared with both trade creation and diversion effects. In similar way computation like the previous sectors, in the manufacturing sector the minimum net trade creation effect and

maximum net trade creation effect were 0.021 and 0.061 respectively. This implies that due to the implementation BRI initiation in Sub-Saharan Africa there was trade enhancement from 2.1% to 6.1% in manufacturing sector. In the mineral sector only the estimated coefficients of ECWAS and EAC were found to be statistically significant with both trade creation and trade diversion effects in similar with the previous sectors. As it was indicated due to membership overlap in both RECs it was important to calculate the net minimum net trade creation and maximum trade creation effects in this sector. Consequently -0.005 and 0.024 respectively. This implies that due to BRI implementation there was trade effect from 0.5% of trade diversion to the maximum 2.4% of trade creation advantage in the manufacturing sector.

Now to evaluate the trade effect of BRI implementation in the sum of all the four sectors in terms of these RECs, ECOWAs and EAC exhibited trade creation and diversion effects whereas COMESA appeared with only trade diversion effect similar with the previous sectors. The individual analysis of these economic regional integrations gives us the insights of trade diversion for COMESA. The negative coefficient, -0.056 indicates that the member countries were trading less than above the average indicated by that coefficient. This implies there was increasing in extra COMESA trade growth in the cost of intra trade reduction the bloc. We argue that poor implementation of the binding rules, tariffs and regional agreements to facilitate their trade could be the reasons behind. This in turn indicates that COMESA bloc was found to be very weak in inducing trade creation within the member countries. But ECOWAS and EAC were found to be better in facilitating trade creation effect for the Sub-Saharan member countries. Nevertheless, taking the minimum trade creation effect with the maximum trade diversion effect of the total sector and combining the maximum trade creation coefficient to the minimum trade diversion coefficient resulted in 0.003 the net minimum trade creation and 0.071 net maximum trade creation effect. This implies that BRI implementation resulted in trade enhancement effect from 0.3% to 7.1% for BRI member Sub-Saharan Africa countries in the total of the four export sectors.

Chapter five

Conclusions and policy implications

5.1 Conclusion

In this study trade effect of Chinese Belt and Road Initiative was examined using augmented gravity model for the panel data set. The analysis was done by considering BRI as one economic bloc and its trade creation and diversion effect was evaluated by incorporating partner countries outside Sub-Saharan Africa region. But the main target of the study was on Sub-Saharan Africa region. According to the augmented gravity model analysis, GDP of reporting countries, GDP per capita of both reporting and partner countries, bilateral exchange rate, land locked, common border, common colonizer and having common official language variables were the determinants of bilateral trade. Out of these variables GDP of reporting countries GDP per capita of both reporting and partner countries, common border, common colonizer, common official language were significantly associated with the bilateral export size with positive estimated coefficients. Whereas the remaining bilateral exchange rate and land locked-ness of both reporting and partner countries were negatively associated with bilateral export. Other variables distance and per capital income difference were found to be statistically insignificant in this study, but in line with our empirical literatures their estimated coefficients became negative.

Coming to the trade effect of BRI it had both trade creation diversion effect for BRI member countries which are not only in Sub-Saharan Africa but also in Europe and Asia incorporated in this study. The implementation of BRI initiation in Sub-Saharan Africa, Europe and Asia has resulted in only 4.30% trade creation with 5.87% trade diversion effect in the total sectors of crude materials, food & live animals, manufacturing and minerals & fuels.

The main interest of this study was to examine the effect of BRI in Sub-Saharan Africa region. Therefore, in this regard its effect was evaluated in crude materials, food & live animals, manufacturing, minerals & fuels and in the entire sectors. Therefore, according to the regional dummy variables estimated coefficients the implementation of BRI in Sub-Saharan Africa region provided net trade creation effect by 6% to 7% in crude sector followed by net trade creation

enhancement by up to 6.5% in the sector of food & live animals. Moreover, the trade creation effect of BRI in manufacturing and minerals & fuel sectors was found to be positive but it was very limited. This might tell us most of Sub-Saharan Africa countries are still depend on exporting crude or primary agricultural products including food and live animals. Countries endowed with natural resources like minerals and fuels enjoy more comparative advantage in their bilateral trade (export). On the other side their bilateral export volume of most of Sub-Saharan Africa in manufacturing sector is still underground due to lack of adequate infrastructures and the existence of high competitiveness from other industrialized countries.

Taking the total sector, BRI had positive contribution in facilitating intra Sub-Saharan Africa trade by up to 7.1% net trade creation effect. In connection to regional economic communities, ECOWAS and EAC were effective in facilitating trade among the member countries despite they also exhibited trade diversion. But in the case of COMESA, it was ineffective to facilitate the intra-bloc trade, rather it showed persistent trade diversion effect or aggravation on the extra COMESA trade in all sectors including the total one.

5.2 Policy implications

This study concluded that trade effect of BRI on improving both intra Sub-Saharan Africa level and within the BRI bloc was found to be positive but very limited. Our first insight in this study is that since BRI initiation seems to be at its infancy stage to provide its promises it requires more implementation time with intensive investment and infrastructures establishment for Sub-Saharan Africa.

Next to this Sub-Saharan Africa countries should make their own homework in policy harmonization of economic integrations to improve their trade complementarity and to smooth international trade. Moreover, these African countries should strive on improving their institutional quality which could adversely affect their trade and bilateral export level from different perspectives. In order to optimize the impact of BRI especially to boost intra Africa trade performance, more commitment and efforts should be done to implement the binding rules and common stands of reginal integrations. Not only BRI but also important adjustments and policies should be prescribed to improve the effectiveness of other regional economic communities like COMESA. The other recommendation here is that policy makers and decision makers should think differently to encourage knowledge sharing and technology transfer when countries are engaged in huge international economic communities like BRI. This might help improve their production and export level particularly in the manufacturing sector.

Finally, our advice is to researchers to encourage for further studies on this area particularly on the dynamic effects and on related measurements in the course of BRI implementation.

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Annexes

Annex I Breusch and Pagan Lagrangian multiplier test for random effect

Breusch and Pagan Lagrangian multiplier test for random effects

lntij[Repcode,t] = Xb + u[Repcode] + e[Repcode,t]

Estimated results:

	Var	sd = sqrt(Var)
lntij	16.27697	4.034473
e	10.82961	3.290838
u	.2914867	.5398951

Test: Var(u) = 0

chibar2(01) = 59592.16

Prob > chibar2 = 0.0000

Annex II Hausman test for RE versus FE

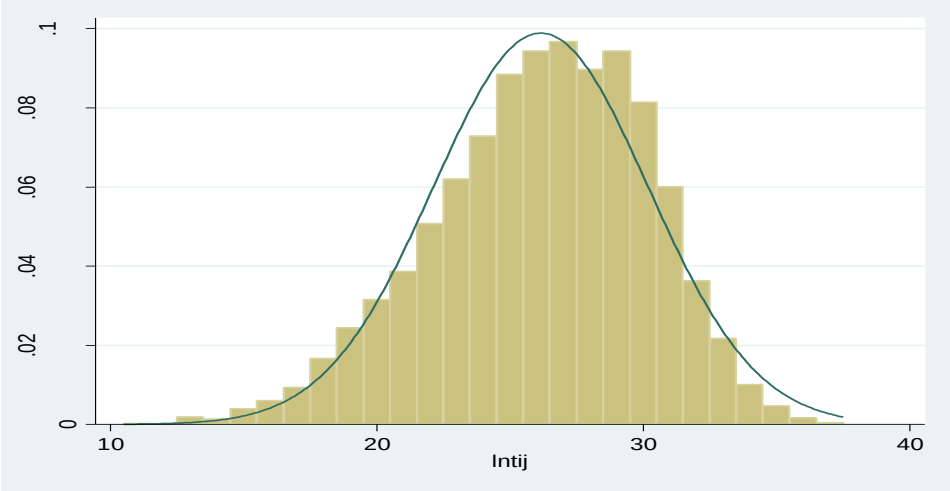
Hausman (1978) specification test	
	Coef.
Chi-square test value	194.365
P-value	0.000

Annex III Normality test

Skewness/Kurtosis tests for Normality

------- joint ------

Variable	Obs	Pr (Skewness)	Pr (Kurtosis)	adj_chi2(2)	Prob>chi2
Lntij	1.3e+04	0.0583	0.0762		0.0625



Annex IV Heteroskedasticity test

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of lntij

chi2(1) = 12.15

Prob > chi2 = 0.0005

Annex V Multicollinearity test (VIF)

Variance inflation factor

	VIF	1/VIF
lnRempart	15334960	0
lnGDPrep	15039991	0
lnGDPpar	4373330	0
lnRemrepo	3246337.3	0
lnBidista	830522.19	0
lnGDPperpar	5.624	.178
lnPCI	3.973	.252
ECOWASboth	1.969	.508
Coborder	1.873	.534
Colang	1.781	.561
Cocolony	1.676	.597
ECOWASpar	1.67	.599
EACboth	1.616	.619
BRIboth	1.6	.625
COMESAboth	1.591	.628
Landrep	1.509	.663
COMESApar	1.49	.671
EACpar	1.379	.725
lnGDPperre	1.377	.726
BRIpar	1.26	.794
lnBiexcha	1.17	.855
Landpar	1.045	.957
Mean VIF	1764781	.

Annex VI Test for serial correlation

Breusch-Godfrey LM test for autocorrelation chi2	Df	Prob>Chi2
5.000	1	0.052

H0: no serial correlation

Annex VII Random effect estimation result

VARIABLES	(Crude materials) Lntij	(Food and live animals) Lntij	(Manufacturing goods) Lntij	(Minerals & fuel) lntij	(Total sectors) lntij
lnGDPrep	-14.23	-8.875	-15.01	49.85	1.602
	(39.23)	(37.13)	(36.66)	(61.43)	(22.64)
lnGDPpar	62.36	8.223	33.94	52.77	35.27
	(38.14)	(36.02)	(36.02)	(60.76)	(22.14)
lnGDPperre	0.382	-0.0808	0.805***	0.179	0.438***
	(0.344)	(0.378)	(0.249)	(0.652)	(0.129)
lnGDPperpar	0.601***	0.567***	0.389***	-0.0889	0.350***
	(0.0823)	(0.0754)	(0.0715)	(0.124)	(0.0461)
lnPCI	-0.0896	0.0180	-0.0648	0.0458	-0.0118
	(0.0580)	(0.0522)	(0.0499)	(0.0828)	(0.0315)
lnBidista	-47.69	0.302	-19.35	-102.2	-36.68
	(54.24)	(51.46)	(51.02)	(85.52)	(31.43)
lnBiexcha	-1.446*	0.445	-2.036***	-2.672*	-1.613***
	(0.744)	(0.699)	(0.669)	(1.491)	(0.401)
lnRemrepo	-61.91	-7.831	-33.51	-52.50	-34.90
	(38.14)	(36.02)	(36.02)	(60.76)	(22.14)
lnRempart	14.26	8.920	15.07	-49.73	-1.551
	(39.23)	(37.13)	(36.66)	(61.43)	(22.64)
Landrep	-1.281	-0.968	-0.273	-2.690	-0.954***
	(0.893)	(1.075)	(0.600)	(1.864)	(0.297)
Landpar	-4.508***	-5.264***	-3.333***	-7.454***	-4.319***
	(0.428)	(0.421)	(0.372)	(1.245)	(0.257)
Cocolony	0.701***	0.692***	0.226	-0.128	0.406***
	(0.193)	(0.172)	(0.167)	(0.265)	(0.106)
Coborder	2.637***	2.056***	2.524***	2.418***	2.027***
	(0.253)	(0.238)	(0.232)	(0.338)	(0.144)
Colang	-0.178	0.278*	1.076***	0.931***	0.412***
	(0.170)	(0.156)	(0.152)	(0.241)	(0.0938)
BRIboth	0.152	-0.507***	-0.0763	0.797**	1.078***

	(0.209)	(0.195)	(0.192)	(0.339)	(0.141)
BRIpar	-0.212	-0.338**	0.173	0.109	-1.415***
	(0.179)	(0.166)	(0.164)	(0.268)	(0.121)
COMESAboth	-0.651**	-0.0742	-0.224	1.023***	0.0620
	(0.254)	(0.221)	(0.226)	(0.366)	(0.139)
COMESApar	-1.351***	-2.143***	-1.777***	-0.427	-1.757***
	(0.210)	(0.196)	(0.183)	(0.364)	(0.119)
ECOWASboth	0.105	0.736***	1.917***	0.393	1.020***
	(0.294)	(0.272)	(0.272)	(0.419)	(0.176)
ECOWASpar	-0.960***	-0.996***	-0.805***	-0.991***	-1.130***
	(0.203)	(0.194)	(0.183)	(0.337)	(0.126)
EACboth	2.831***	1.741***	2.615***	0.937*	2.635***
	(0.386)	(0.367)	(0.358)	(0.481)	(0.224)
EACpar	-1.087***	-0.332	-0.678***	-1.019**	-0.896***
	(0.253)	(0.237)	(0.213)	(0.419)	(0.144)
Constant	383.0	-15.49	131.7	1,034	332.0
	(549.6)	(521.6)	(516.3)	(864.8)	(318.2)
Observations	3,372	3,744	3,666	1,932	12,713
R-squared					
Number of countries	26	26	26	25	26

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Annex VIII Fixed effect Estimation result

VARIABLES	(Crude materials) Lntij	(Food & live animals) Lntij	(Manufacturing goods) Lntij	(Minerals & fuel) lntij	(Total sectors) lntij
lnGDPrep	-14.38	-8.635	-13.87	48.77	2.893
	(39.22)	(37.14)	(36.24)	(61.50)	(22.49)
lnGDPpar	62.56	8.566	38.15	53.76	38.12*
	(38.13)	(36.03)	(35.62)	(60.83)	(22.00)
lnGDPperre	0.552	-0.332	1.121**	0.441	0.233
	(0.558)	(0.544)	(0.489)	(0.930)	(0.319)
lnGDPperpar	0.600***	0.571***	0.405***	-0.0907	0.357***
	(0.0823)	(0.0755)	(0.0708)	(0.124)	(0.0459)
lnPCI	-0.0857	0.0189	-0.0666	0.0499	-0.00809
	(0.0580)	(0.0522)	(0.0494)	(0.0829)	(0.0314)
lnBidista	-47.82	-0.286	-24.82	-102.1	-40.90
	(54.22)	(51.48)	(50.46)	(85.62)	(31.22)
lnBiexcha	-1.448*	0.626	-1.983***	-2.846*	-1.190***
	(0.780)	(0.718)	(0.714)	(1.542)	(0.454)
lnRemrepo	-62.11	-8.172	-37.71	-53.50	-37.74*
	(38.13)	(36.03)	(35.62)	(60.83)	(22.00)

lnRempart	14.35	8.690	13.84	-48.69	-2.878
	(39.22)	(37.14)	(36.24)	(61.50)	(22.49)
lnLandrep	-6.813***	0.258***	-2.838***	4.129	-4.007***
	(0.23)	(0.0486)	(0.247)	(33.58)	(0.275)
lnLandpar	-4.525***	-5.281***	-3.392***	-7.467***	-4.367***
	(0.427)	(0.421)	(0.367)	(1.247)	(0.255)
Cocolony	0.729***	0.690***	0.246	-0.109	0.408***
	(0.193)	(0.172)	(0.166)	(0.265)	(0.105)
Coborder	2.624***	2.044***	2.461***	2.439***	2.003***
	(0.253)	(0.238)	(0.229)	(0.339)	(0.143)
Colang	-0.189	0.281*	1.082***	0.921***	0.415***
	(0.170)	(0.156)	(0.150)	(0.241)	(0.0935)
BRIboth	0.148	-0.508***	-0.0462	0.785**	1.091***
	(0.209)	(0.195)	(0.190)	(0.340)	(0.141)
BRIpar	-0.210	-0.336**	0.162	0.108	-1.430***
	(0.179)	(0.166)	(0.163)	(0.268)	(0.120)
COMESAboth	-0.649**	-0.0782	-0.216	1.054***	0.0917
	(0.254)	(0.222)	(0.224)	(0.366)	(0.139)
COMESApar	-1.376***	-2.153***	-1.797***	-0.436	-1.796***
	(0.210)	(0.196)	(0.181)	(0.365)	(0.119)
ECOWASboth	0.0897	0.728***	1.989***	0.385	0.995***
	(0.294)	(0.273)	(0.270)	(0.420)	(0.175)
ECOWASpar	-0.972***	-0.990***	-0.821***	-0.990***	-1.133***
	(0.203)	(0.194)	(0.181)	(0.337)	(0.125)
EACboth	2.823***	1.727***	2.626***	0.909*	2.610***
	(0.386)	(0.367)	(0.355)	(0.483)	(0.223)
EACpar	-1.075***	-0.327	-0.681***	-0.996**	-0.888***
	(0.253)	(0.237)	(0.211)	(0.420)	(0.143)
Constant	384.3	-7.901	182.6	1,030	374.4
	(549.4)	(521.7)	(510.6)	(865.9)	(316.2)
Observations	3,372	3,744	3,666	1,932	12,713
R-squared	0.346	0.303	0.342	0.123	0.249
Number of Repcode	26	26	26	25	26

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Annex IX PPML estimation result in total bilateral export

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LNGDPREP	0.813779	0.526037	9.878776	0.0038
LNGDPPAR	0.609487	0.905862	0.672825	0.5011
LNGDPPERRE	0.028186	0.001665	16.92380	0.0000
LNGDPPERPAR	0.009041	0.001878	4.815368	0.0000
LNPCI	-0.000512	0.001273	-0.402274	0.6875
LNBIDISTA	-0.228143	1.283198	-0.177793	0.8589
LNBIEXCHA	-0.110942	0.009815	-11.30309	0.0000
LNREMREPO	-0.597534	0.905861	-0.659631	0.5095
LNREMPART	0.815743	0.926035	0.880898	0.3784
LANDREP	0.032599	0.003672	8.878290	0.0000
LANDPAR	-0.158648	0.011175	-14.19720	0.0000
COBORDER	0.085318	0.005734	14.87947	0.0000
COCOLONY	0.023233	0.004204	5.526465	0.0000
COLANG	0.011195	0.003717	3.011504	0.0026
BRIBOTH	0.042773	0.005451	7.846378	0.0000
BRIPAR	-0.057049	0.004992	-11.42909	0.0000
COMESABOTH	-0.003265	0.005576	-0.585421	0.5583
COMESAPAR	-0.056936	0.004893	-11.63734	0.0000
ECOWASBOTH	0.059451	0.006895	8.622323	0.0000
ECOWASPAR	-0.050727	0.005150	-9.850338	0.0000
EACBOTH	0.107813	0.008730	12.34902	0.0000
EACPAR	-0.036781	0.006007	-6.122918	0.0000
C	-1.492236	12.99453	-0.114836	0.9086

R-squared	0.424689	Mean dependent var	26.15314
Adjusted R-squared	0.423345	S.D. dependent var	4.034411
S.E. of regression	3.555447	Akaike info criterion	5.601253
Sum squared resid	160429.5	Schwarz criterion	5.614731
Log likelihood	-35584.16	Hannan-Quinn criter.	5.605761
Restr. log likelihood	-36480.41	LR statistic	1792.485
Avg. log likelihood	-2.798817	Prob(LR statistic)	0.000000

Annex X PPML estimation result in Crude sector

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LNGDPREP	1.462414	0.651455	10.88553	0.0038
LNGDPPAR	2.380519	0.606375	12.48192	0.0014
LNGDPPERRE	0.032555	0.003129	10.40344	0.0000
LNGDPPERPAR	0.017759	0.003448	5.150141	0.0000
LNPCI	-0.002291	0.002418	-0.947301	0.3435
LNBIDISTA	-0.883045	2.280089	-0.387285	0.6985
LNBIEXCHA	-0.090677	0.016300	-5.562903	0.0000
LNREMREPO	-2.364467	1.606368	-1.471933	0.1410
LNREMPART	1.463440	1.651451	0.886154	0.3755
LANDREP	0.050575	0.006456	7.833873	0.0000
LANDPAR	0.166866	0.018975	8.793794	0.0000
COBORDER	0.117117	0.010356	11.30865	0.0000
COCOLONY	0.032083	0.007941	4.039886	0.0001
COLANG	-0.009555	0.006977	-1.369576	0.1708
BRIBOTH	0.014668	0.008682	1.689366	0.0911
BRIPAR	-0.014002	0.007574	-1.848708	0.0645
COMESABOTH	-0.020568	0.010664	-1.928790	0.0538
COMESAPAR	-0.042138	0.008920	-4.723919	0.0000
ECOWASBOTH	0.018582	0.011976	1.551665	0.1207
ECOWASPAR	-0.040186	0.008603	-4.671093	0.0000
EACBOTH	0.110888	0.015480	7.163192	0.0000
EACPAR	-0.050090	0.011057	-4.530143	0.0000
C	6.287745	23.10717	0.272112	0.7855

R-squared	0.429227	Mean dependent var	25.88760
Adjusted R-squared	0.424820	S.D. dependent var	3.927570
S.E. of regression	3.227258	Akaike info criterion	5.522427
Sum squared resid	34880.49	Schwarz criterion	5.564193
Log likelihood	-9287.811	Hannan-Quinn criter.	5.537361
Restr. log likelihood	-9618.823	LR statistic	662.0238
Avg. log likelihood	-2.754392	Prob(LR statistic)	0.000000

Annex XI PPML estimation result in Food sector

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LNGDPREP	1.200873	1.607110	0.747225	0.4549
LNGDPPAR	0.499853	1.560786	0.320257	0.7488
LNGDPPERRE	0.015535	0.002910	5.338277	0.0000
LNGDPPERPAR	0.013515	0.003250	4.158267	0.0000
LNPCI	0.000516	0.002230	0.231362	0.8170
LNBIDISTA	-1.716196	2.225413	-0.771181	0.4406
LNBIEXCHA	-0.098307	0.015849	-6.202710	0.0000
LNREMREPO	0.510256	1.560780	0.326924	0.7437
LNREMPART	1.200959	1.607106	0.747280	0.4549
LANDREP	0.020655	0.006200	3.331336	0.0009
LANDPAR	-0.171450	0.019427	-8.825267	0.0000
COBORDER	0.097112	0.009948	9.762424	0.0000
COCOLONY	0.034796	0.007251	4.798921	0.0000
COLANG	0.005453	0.006525	0.835726	0.4033
BRIBOTH	0.029837	0.008502	3.509376	0.0004
BRIPAR	-0.009366	0.007190	-1.302598	0.1927
COMESABOTH	0.008206	0.009346	0.878008	0.3799
COMESAPAR	-0.057880	0.008458	-6.843527	0.0000
ECOWASBOTH	0.048947	0.011169	4.382306	0.0000
ECOWASPAR	-0.050427	0.008416	-5.992146	0.0000
EACBOTH	0.086729	0.014915	5.814962	0.0000
EACPAR	-0.021624	0.010442	-2.070885	0.0384
C	-15.29289	22.55447	-0.678042	0.4977

R-squared	0.414209	Mean dependent var	26.76950
Adjusted R-squared	0.409563	S.D. dependent var	3.812254
S.E. of regression	3.389343	Akaike info criterion	5.583847
Sum squared resid	42745.52	Schwarz criterion	5.622106
Log likelihood	-10429.96	Hannan-Quinn criter.	5.597454
Restr. log likelihood	-10649.59	LR statistic	439.2600
Avg. log likelihood	-2.785780	Prob(LR statistic)	0.000000

Annex XII PPML estimation result in Manufacturing sector

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LNGDPREP	1.446692	1.667129	0.867774	0.3855
LNGDPPAR	0.602378	1.637800	0.367797	0.7130
LNGDPPERRE	0.040626	0.003007	13.51242	0.0000
LNGDPPERPAR	0.006407	0.003239	1.978294	0.0479
LNPCI	9.51E-05	0.002226	0.042732	0.9659
LNBIDISTA	-0.856851	2.316138	-0.369948	0.7114
LNBIEXCHA	-0.110533	0.018067	-6.118002	0.0000
LNREMREPO	-0.588572	1.637781	-0.359372	0.7193
LNREMPART	1.450703	1.667126	0.870182	0.3842
LANDREP	-0.024410	0.006526	-3.740110	0.0002
LANDPAR	-0.110116	0.017737	-6.208365	0.0000
COBORDER	0.126386	0.010017	12.61752	0.0000
COCOLONY	0.011194	0.007359	1.521099	0.1282
COLANG	0.041345	0.006607	6.257786	0.0000
BRIBOTH	0.002441	0.008698	0.280598	0.7790
BRIPAR	0.009123	0.007500	1.216271	0.2239
COMESABOTH	-0.009121	0.009999	-0.912149	0.3617
COMESAPAR	-0.058610	0.008357	-7.013586	0.0000
ECOWASBOTH	0.079186	0.011498	6.887108	0.0000
ECOWASPAR	-0.034719	0.008264	-4.201441	0.0000
EACBOTH	0.087969	0.015107	5.822870	0.0000
EACPAR	-0.026696	0.009876	-2.703179	0.0069
C	-8.838322	23.44100	-0.377045	0.7061

R-squared	0.471120	Mean dependent var	25.46496
Adjusted R-squared	0.466719	S.D. dependent var	3.896515
S.E. of regression	3.336656	Akaike info criterion	5.527954
Sum squared resid	40569.65	Schwarz criterion	5.566886
Log likelihood	-10112.50	Hannan-Quinn criter.	5.541815
Restr. log likelihood	-10407.85	LR statistic	590.6944
Avg. log likelihood	-2.757705	Prob(LR statistic)	0.000000

Annex XIII PPML estimation result in Minerals & fuel sector

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LNGDPREP	1.305689	2.819915	0.463024	0.6433
LNGDPPAR	0.741181	2.803427	0.264384	0.7915
LNGDPPERRE	0.024628	0.004837	5.091951	0.0000
LNGDPPERPAR	1.87E-06	0.005571	0.000335	0.9997
LNPCI	0.001079	0.003735	0.288995	0.7726
LNBIDISTA	-2.026532	3.921020	-0.516838	0.6053
LNBIEXCHA	-0.112040	0.040711	-2.752090	0.0059
LNREMREPO	0.732139	2.803426	0.261159	0.7940
LNREMPART	1.301676	2.819916	0.461601	0.6444
LANDREP	-0.061284	0.012808	-4.784915	0.0000
LANDPAR	-0.292842	0.065493	-4.471367	0.0000
COBORDER	0.070035	0.014978	4.675787	0.0000
COCOLONY	-0.006567	0.011844	-0.554450	0.5793
COLANG	0.017849	0.010578	1.687251	0.0916
BRIBOTH	0.033512	0.015398	2.176446	0.0295
BRIPAR	0.014128	0.012381	1.141053	0.2538
COMESABOTH	-0.011407	0.016388	-0.696045	0.4864
COMESAPAR	-0.019348	0.016012	-1.208345	0.2269
ECOWASBOTH	0.063796	0.017797	3.584659	0.0003
ECOWASPAR	-0.055457	0.015518	-3.573792	0.0004
EACBOTH	0.050423	0.021104	2.389275	0.0169
EACPAR	-0.039579	0.019010	-2.081937	0.0373
C	23.80533	39.62985	0.600692	0.5480

R-squared	0.325809	Mean dependent var	26.73188
Adjusted R-squared	0.315734	S.D. dependent var	4.600403
S.E. of regression	4.326007	Akaike info criterion	5.856215
Sum squared resid	35725.67	Schwarz criterion	5.922481
Log likelihood	-5634.104	Hannan-Quinn criter.	5.880589
Restr. log likelihood	-5730.317	LR statistic	192.4261
Avg. log likelihood	-2.916203	Prob(LR statistic)	0.000000

Annex XIV UNCOM trade data base Codes and Labels of sampled commodities under Standard International Trade Classification (SITC)

Sector one: Food and live animals (sample commodities)

0	Food and live animals
00	Live animals other than animals of division 03
001	Live animals other than animals of division 03
01	Meat and meat preparations
011	Meat of bovine animals, fresh, chilled or frozen
012	Other meat and edible meat offal
016	Meat, edible meat offal, salted, dried; flours, meals
017	Meat, edible meat offal, prepared, preserved, n.e.s.
02	Dairy products and birds' eggs
022	Milk, cream and milk products (excluding butter, cheese)
023	Butter and other fats and oils derived from milk
024	Cheese and curd
025	Birds' eggs, and eggs' yolks; egg albumin
03	Fish, crustaceans, molluscs and preparations thereof
034	Fish, fresh (live or dead), chilled or frozen
035	Fish, dried, salted or in brine; smoked fish
036	Crustaceans, mollusks and aquatic invertebrates
037	Fish, aqua. invertebrates, prepared, preserved, n.e.s.
04	Cereals and cereal preparations
041	Wheat (including spelt) and meslin, unmilled

Sector two: Crude materials (sample commodities)

222	Oil seeds and oleaginous fruits (excluding flour)
223	Oil seeds & oleaginous fruits (incl. flour, n.e.s.)
23	Crude rubber (including synthetic and reclaimed)
231	Natural rubber & similar gums, in primary forms
232	Synthetic rubber
24	Cork and wood
244	Cork, natural, raw & waste (incl. blocks, sheets)
245	Fuel wood (excluding wood waste) and wood charcoal
246	Wood in chips or particles and wood waste
247	Wood in the rough or roughly squared
248	Wood simply worked, and railway sleepers of wood
25	Pulp and waste paper
251	Pulp and waste paper
26	Textiles fibres and their wastes
261	Silk
263	Cotton
264	Jute, other textile bast fibre, n.e.s., not spun; tow
265	Vegetable textile fibres, not spun; waste of them
266	Synthetic fibres suitable for spinning
2	Crude materials, inedible, except fuels
21	Hides, skins and furskins, raw
211	Hides and skins (except furskins), raw
212	Furskins, raw, other than hides & skins of group 211
22	Oil seeds and oleaginous fruits

Sector three: Manufacturing goods (sample commodities)

6	Manufactured goods
61	Leather, leather manufactures and dressed furskins
611	Leather
612	Manufactures of leather, n.e.s.; saddlery & harness
613	Furskins, tanned or dressed, excluding those of 8483
62	Rubber manufactures, n.e.s.
621	Materials of rubber (pastes, plates, sheets, etc.)
625	Rubber tyres, tyre treads or flaps & inner tubes
629	Articles of rubber, n.e.s.
63	Cork and wood manufactures (excluding furniture)
633	Cork manufactures
634	Veneers, plywood, and other wood, worked, n.e.s.
635	Wood manufacture, n.e.s.
64	Paper and paper manufactures
641	Paper and paperboard
642	Paper & paperboard, cut to shape or size, articles
65	Textile yarn and related products
651	Textile yarn
652	Cotton fabrics, woven
653	Fabrics, woven, of man-made fabrics
654	Other textile fabrics, woven
655	Knitted or crocheted fabrics, n.e.s.
656	Tulles, trimmings, lace, ribbons & other small wares
657	Special yarn, special textile fabrics & related
658	Made-up articles, of textile materials, n.e.s.
659	Floor coverings, etc.
66	Non metallic mineral manufactures, n.e.s.
661	Lime, cement, fabrica. constr. mat. (excludingglass, clay)
662	Clay construction, refracto. construction materials

Sector four: Minerals and fuels (sample commodities)

3	Mineral fuels, lubricants and related materials
32	Coal, coke and briquettes
321	Coal, whether or not pulverized, not agglomerated
322	Briquettes, lignites and peat
325	Coke & semi-cokes of coal, lign., peat; retort carbon
33	Petroleum, petroleum products and related materials
333	Petroleum oils, oils from bitumin. materials, crude
334	Petroleum oils or bituminous minerals > 70 % oil
335	Residual petroleum products, n.e.s., related mater.
34	Gas, natural and manufactured
342	Liquefied propane and butane
343	Natural gas, whether or not liquefied
344	Petroleum gases, other gaseous hydrocarbons, n.e.s.
345	Coal gas, water gas & similar gases (excludinghydrocar.)
35	Electric current
351	Electric current
4	Animal and vegetable oils, fats and waxes
41	Animal oils and fats
411	Animals oils and fats

Annex XV List of sampled BRI member Sub-Saharan Africa & partner countries

No	Sampled Sub-Saharan African countries (Reporting)	Joining year to BRI	Partner countries	Joining year to BRI
1.	Angola	2018	UK	Not joined yet
2.	Benin	2018	France	Not joined yet
3.	Burundi	2018	Spain	Not joined yet
4.	CapeVerde	2018	Belgium	Not joined yet
5.	Cameroon	2015	Italy	2018
6.	Comoros	2015	Austria	2015
7.	Cote d'Ivoire	2017	Portugal	2018
8.	Ethiopia	2018	Turkey	2015
9.	Gabon	2018	Poland	2015
10.	Gambia	2018	India	Not joined yet
11.	Ghana	2018	Japan	Not joined yet
12.	Kenya	2017	China	2013
13.	Madagascar	2017	Russia	2015
14.	Mauritania	2018	Indonesia	2018
15.	Mozambique	2018	Singapore	2018
16.	Namibia	2018	Egypt	2016
17.	Nigeria	2018	Morocco	2017
18.	Rwanda	2018	Algeria	2018
19.	Senegal	2018	Tunisia	2018
20.	Seychelles	2018	Libya	2018
21.	South Africa	2015	USA	Not joined yet
22.	Tanzania	2018		
23.	Togo	2018		

24.	Uganda	2018		
25.	Zambia	2018		
26.	Zimbabwe	2018		

Source: Green Finance & Development Center, 2024