

Trade between China and 45 African countries: does the Gravity Model matter?

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Abstract

The population of Africa and that of China put together amounts to a little over one-third of the world's total. The theoretical justification of the gravity model is applied to analyze the factors influencing bilateral trade between China and African countries using the panel data regression technique, covering the period between 2002 and 2021 and with special consideration for the income level of the African countries. Empirical results and estimates reveal that the economic size as well as the population of trade partners positively affect China's trade with 45 African countries. The positive impact that distance has on trade is inconsistent with previous research. We conclude from the analysis that the factors affecting trade between China and African countries are, namely, the size of the population, the economic size represented by the GDP, and the distance between the countries. The indication of effects on the trade sector is important, and the sensitivity of the potential product to distance and countries varies considerably, giving a revealed comparative advantage. African countries should diversify their exports and improve their trade diplomacy.

Keywords: Gravity Model, Panel data regression, Trade, Africa, China.

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Commerce entre la Chine et 45 pays Africains: le modèle gravitationnel importe-il?

Résumé

La population de l'Afrique et celle de la Chine réunies représentent un peu plus d'un tiers de la population mondiale. La justification théorique du Modèle Gravitationnel est appliquée pour analyser les facteurs influençant le commerce bilatéral entre la Chine et les pays africains en utilisant la technique de régression sur les données de panel couvrant la période allant de 2002 à 2021 et avec une considération particulière pour le niveau de revenu des pays africains. Les estimations des résultats empiriques révèlent que la taille économique ainsi que la population des partenaires commerciaux affectent positivement le commerce de la Chine avec 45 pays africains. L'impact positif de la distance sur le commerce n'est pas conforme aux recherches précédentes. Nous concluons de l'analyse que les facteurs affectant le commerce entre la Chine et les pays africains sont, à savoir, la taille de la population, la taille économique représentée par le PIB et la distance entre les pays. L'indication des effets sur le secteur commercial est importante et la sensibilité du produit potentiel à la distance et aux pays varie considérablement, ce qui donne un avantage comparatif révélé. Les pays africains devraient diversifier leurs exportations et améliorer leur diplomatie commerciale.

Mots-clés: Modele gravitationnel, régression sur données de panel, commerce, Afrique, Chine.

Introduction

For a couple of decades now, China's economic growth has been constant at a high rate. Meanwhile, African exports to China are growing at an even faster rate than those to the United States and the European Union. Recent developments in economic relations between African countries and China have captured the attention of many development experts and practitioners. Africa's greatest interest lies in deepening its relationship with the Asian heavyweight, which presents both opportunities and challenges. Since 2000, China has become the continent's main trading partner. Investment and financial flows from China to Africa had a significant increase according to data collected from the 2020 Statistical Communiqué on China's Foreign Direct Investment. China is without any doubt becoming a main player, an ally with whom Africans must develop mutually profitable economic relations.

Different countries use policies of comparative advantage and absolute advantage and aim to ensure the availability of goods and services to consumers when they need them. International trade is sometimes hindered by trade barriers such as tariffs and quotas; it has become inevitable for the sustainable growth and development of a country. Africa is one of the developing continents with an estimated population of 1.3 billion. For the most part, the African continent, through the 54 countries it comprises or using economic bloc is participating in international trade. The continent has great potential in agriculture and its major exports are raw and semi-processed goods according to [Krugman & Obstfeld \(2008\)](#). The main imports of the continent are electronic products, motor vehicles, manufactured goods, and machinery. China, on the other hand, took over as the world's second-largest economy from Japan in September 2010.

The relationship between these two parties has grown exponentially over the last decades. We witnessed from the 1990s a 700 % increase in trade between China, and Africa, and China is presently the main trading partner of Africa. The Forum on China-Africa Cooperation (FOCAC) was established in October 2000 as an official forum to promote the relationship. In addition, Africa can leverage and tap into this plan for mutual support exchange sustainable development in its economy with the One Belt One Road initiative. Despite all that, the literature analyzing China's trade with African countries is still rather limited. Thus, it is interesting to investigate the trade between China and African countries in-depth. The paper undertakes a comprehensive look by applying the gravity model to investigate the bilateral trade between China and 45 African countries namely: Algeria, Angola, Benin, Burkina Faso, Burundi, Cote d'Ivoire, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Democratic Republic of the Congo, Djibouti, Egypt, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, Sudan, Togo, Tunisia, Uganda, Tanzania, Zambia, Zimbabwe, over a period from 2002 to 2021. The study examines with Panel regression analysis the motivation behind China's international trade engagement with Africa and the determinants of trade between both parties, with analysis indicating that China's trade interest with Africa is driven mainly by African countries' natural resources, market size, and infrastructure and to some extent foreign direct investment from China.

The main objectives of the current study are to identify significant factors affecting the trade between Africa and China and test the applicability of the gravity model to bilateral trade flows between Africa and China. What are some of the factors influencing the level of trade between Africa and China? Can Africa expect trade gains? Who stands to benefit more from free trade agreements between African countries and China? The study is focused on trade between China and African countries. It is delimited in time from 2002 to 2021 and considers only forty-five among all of the countries on the African continents because of some issues with data, namely missing or incomplete data evaluating the trade between China and African countries.

I. Overview of Trade between China and African Countries

I.I Historical backdrop

When Chinese and African officials shook hands for the first time, at the 50th anniversary conference commemorating activities in 2005, when Chinese and African countries, through joint efforts, established a new China - Africa strategic partnership; Although China and Africa are far apart, their friendly association endures. With the establishment of the People's Republic of China in the mid-twentieth century, and at a time when the bulk of African countries were obtaining independence, the friendship between China and Africa began a new era.

China and Africa have preserved a real and equal friendship for over five decades, be it in the fight for independence and emancipation or the development of the economy and the building of nations. Their productive collaboration resulted in notable advancements on both sides and made significant

contributions to humanity's progress as a whole. China and African nations jointly established the Forum on China Africa Cooperation (FOCAC) in 2000, which expanded operations in many areas, aggressively increased non-governmental exchanges, and launched a new era in China-Africa relations ([The State Council Information Office of the PRC, 2021](#)).

In the 1950s, there were only a small number of independent African nations, and China's struggling economy made it difficult for it to engage with Africa. In 1950, trade between China and Africa was worth a pitiful \$ 12 million US, but by 1960, it had increased to \$ 100 million US. China's trade with Africa increased from \$ 1 billion in 1980 to \$ 10 billion in 2000, all the while China's GDP has grown by an average of 9 percent per year since the 1980s began. This paved the way for China and Africa to engage in significantly greater economic activity ([The State Council Information Office of the PRC, 2021](#)).

I.2 China's economic revival in the early twentieth century

Cooperation between China and Africa has soared in the twenty-first century. At a time when Western countries were grappling with stock market bubbles combined with ill-considered real estate market and financial activities that culminated in 2008 in the worst economic crisis since the depression of the 1930s, China started to show its global economic dominance. The Chinese economy fared significantly better than the economies of the West. While China and its state-owned and private businesses greatly boosted their engagement in Africa at the same time that Western enterprises were leaving the continent, this was partly because of China's ravenous appetite for African raw materials. In those times, when European businesses and corporations were leaving Africa, China, and its government-owned and private corporations dramatically increased their involvement there. This was partly due to China's insatiable hunger for African commodities. Trade between China and Africa was over \$100 billion in 2008, declined to 91 billion due to the global economic downturn in 2009, then easily surpassed \$100 billion once more in 2010. 2009 saw China overtake the United States as Africa's top bilateral commercial partner. Africa only accounts for 4% of China's worldwide trade despite this extraordinary expansion in trade. On the other hand, China accounts for more than 10% of overall African trade. Although commerce between China and the 54 nations of Africa has been almost fair over the past ten years, there remain a few concerns. In 2009, China had a \$10 billion U.S. trade imbalance with Africa as a result of the decline in oil prices. Crude oil accounts for over 70% of Africa's exports to China, with raw commodities, primarily minerals, accounting for the remaining 15%. Due to their exports of oil and minerals, some fifteen African nations enjoy substantial trade surpluses with China, while more than thirty others experience sizable trade deficits. The trading arrangement appears to be unsustainable for African countries with persistently substantial trade deficits. China is making attempts to correct the situation, such as duty-free imports from lower-income African countries, but China's export strength just outnumbers most of its trading counterparts. Most African countries simply lack enough amounts of commodities other than raw materials that may enter the Chinese market according to [Hanauer et al. \(2014\)](#).

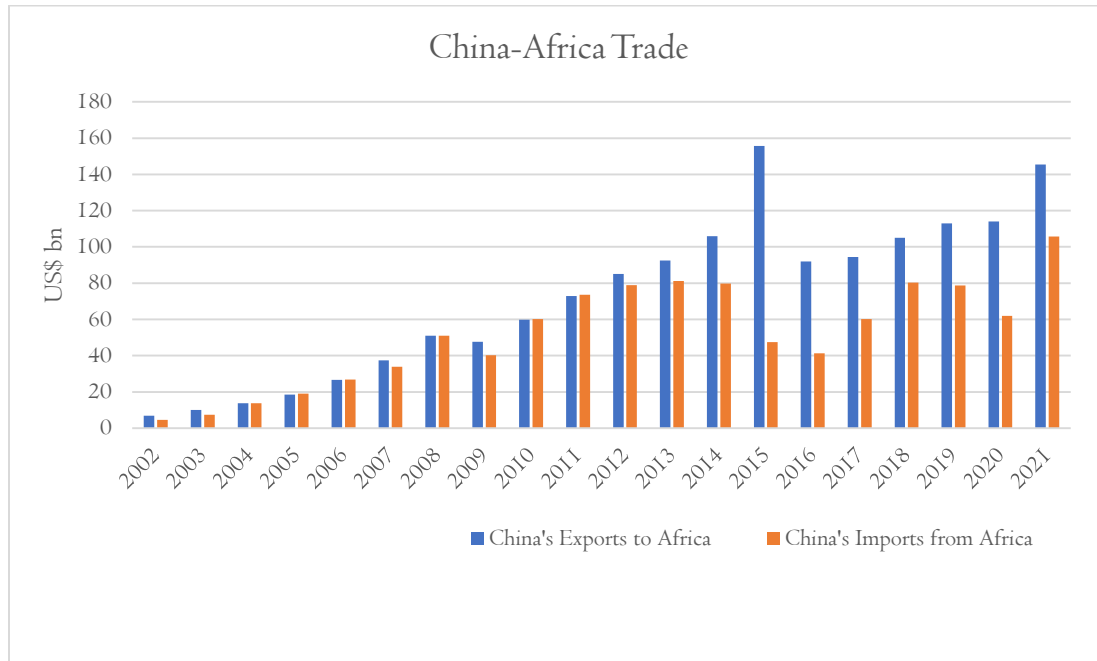


Chart I: China's Trade with Africa in US\$ billion (2002 to 2021)

Source: Compilation based on data from United Nations Comtrade, April 2023.

I.3 Motivations of China and the West in Africa

Incentives from China and Western nations in Africa are strikingly similar. For instance, they all believe that the countries in Africa are important sources of minerals and oil. Nearly a third of Africa's total oil exports are imported by the US and EU, compared to only 13 percent by China. The vast majority of the West's total oil consumption may be attributed to this. Oil makes up almost 90% of what African nations sell to the United States. Despite this, China imports more mineral goods from Africa than the US. Although they are doing the same thing on a larger scale, Western nations need to be cautious when condemning China's imports of raw materials from Africa. Due to its level of underdevelopment and economic hardship, Africa is not yet regarded as a significant export market for foreign goods on the global stage. Only approximately 3% of all Chinese exports and only about 2% of all US exports are purchased by Africa. However, given that Africa currently has a population of over 1 billion people and that over the previous five years, on average, African countries saw yearly GDP growth rates of roughly 5%, this scenario is bound to change. Africa is recognized by both China and the West as a growing market for their commodities. They want to be able to benefit from Africa's rising riches.

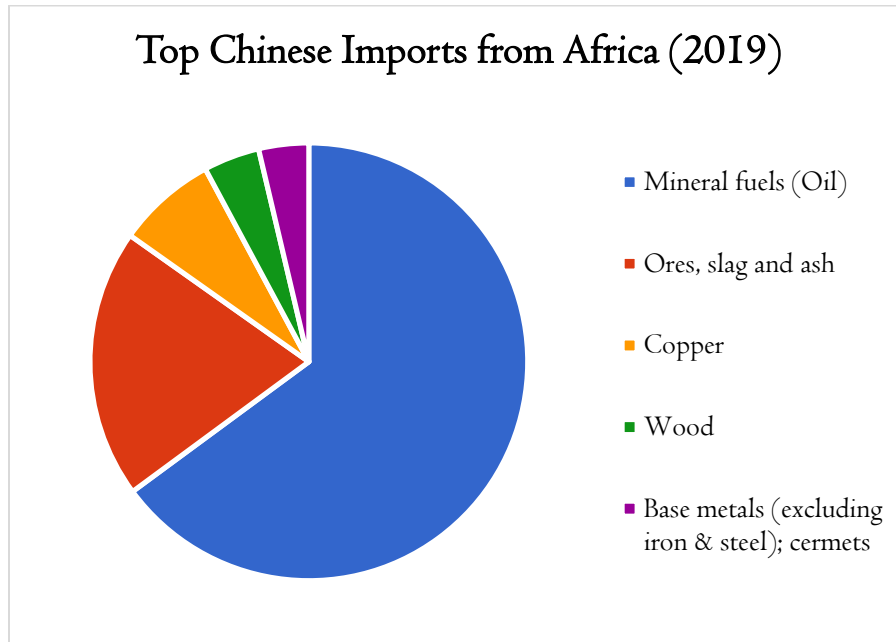


Chart 2: Top Chinese Imports from Africa (2021)

Source: Compilation based on data from UN Comtrade,

I.4 Mixed relations with other key players of African society

Governments are not the only players or actors in a society, which is a reality that is frequently missed. China hasn't had as much luck forging solid relationships with other important powers in Africa. China has not yet found a solution to the issue of contaminated and fake goods being exported to Africa, particularly medicines. Many African nations do not have powerful enough institutions to prevent the entry of these products onto the market. Regardless, China hasn't taken any action to stop private Chinese companies from sending them to Africa.

Numerous complaints have been made by African producers, particularly in the textile sector, who have been unable to compete with Chinese imports and local African merchants who have been driven out of business by Chinese merchants who opened up shops in their markets. Chinese traders may put in longer hours and go to less favorable rural areas of China. Other times, Chinese traders merely gain from integrated supply sources connected to friends and family. Because the government has minimal influence, China has attempted to address most of these difficulties, but with little effect, especially in regard to independent Chinese traders according to the [State Council Information Office of the PRC \(2021\)](#).

I.5 Recent Developments

According to the African Development Bank (AfDB) statistics for 2010, trade between Africa and China alone has hit the ten percent mark (total international trade in Africa has 10% trade with China). In 2008, China became Africa's top trading partner when they hit the bar of 106.8 billion U.S. dollars of trade value.

This was up from an estimated value of 10 billion U.S. dollars in 2000. The value of trade between the two partners is estimated to have increased by 33%. The report by [Sichere \(2011\)](#) went further and said that the trade as per September 2010 statistics amounted to a total of \$ 114 billion U.S. dollars, with \$ 52 billion U.S. dollars as exports and the remaining \$ 62 billion U.S. dollars being imports.

The growth of trade between China and Africa, according to a 2013 United Nations report, is occurring at a breakneck pace, from about 10.5 billion U.S. dollars a year in 2000 to 166 billion U.S. dollars in 2011. Since then, it has continued at the same impressive pace. However, this development has been followed by several measures, including loans from China worth billions of dollars to African nations to help them build the desperately needed infrastructure. More funding was provided for the African Talents Program, which aims to train 30,000 African professionals in different sectors. Therefore, it is not surprising that in 2009, China surpassed the United States as Africa's top trading partner. This brings the trade deficit in Africa with China to 10 billion U.S. dollars. Europe has for a long period been Africa's largest trading partner, but since the 1990s, the trade has reduced by over 50% and only enjoys slightly above 30% of trade exports with Africa; nevertheless, it is still the major importer, but the trend is declining. Besides being the largest African economy, South Africa is also the largest trading partner with China, followed by Nigeria. They account for 20% of the total trade. Equally important, the economic growth of Rwanda after years of war is sparking growing interest. China is playing a great role in this development, according to the African Development Corporate Website.

1.6 Co-operation and Mutual Agreements

The reason for the increased trade between China and Africa has been analyzed by economists to be a result of deliberate strategic moves made by the two partners to grow their trade relations. China has developed mechanisms to ensure that it can operate in the growing African market. The Beijing Summit of 2008 is one of those strategies which aimed at addressing issues related to trade relations between African countries and China. At the summit, one of the proposed methods to ease and render relations between African countries and China was trading facilitation. In the negotiations, mechanisms have been put in place to ensure mutual benefit. To follow the requirements of the summit, an evaluation carried out in 2008 revealed that China had invested more than \$ 5 billion U.S. dollars in Africa.

The summit noted that Africa has for a long enough time depended on foreign aid, subsidies, and investment meanwhile it has its development potential. In light of all that, China has invested in infrastructure development, and local as well as regional infrastructure projects in African countries in order to facilitate the transportation of people, goods, and services.

China is currently working on a road development project in Kenya aimed at facilitating trade between both countries. The trade between China and most African countries has been thriving on service and technology which is exported to African countries from China according to [Geda & Meskel \(2008\)](#).

I.7 Comparative Advantage and Absolute Advantage Trading

Africa is a developing continent and suffers from a lack of state-of-the-art infrastructures and facilities. This is the case although the continent is extremely rich in terms of natural resources. The climate is, of course, one of those resources of the continent. The continent has favorable weather conditions that facilitate the growth of agricultural feeds in an efficient, effective, and inexpensive way.

The African continent is also rich in minerals like oil but their level of exploitation is not very efficient. In these fields, Africa has a comparative edge and uses them as a stronghold. On the other hand, China is considerably advanced in technology. It exports technology and processed goods to Africa for assistance in various developmental issues.

Major exports from African countries to China include Cotton, timber, agricultural produce, and oil. Africa imports from China include machinery, technology, education, electronics, textiles, and hi-tech products. Tourism is also growing drastically between the two partners with Africa as the major benefit, according to [Geda & Meskel \(2008\)](#).

I.8 Problems Facing the China-Africa Trade

Even though trade between the two partners keeps growing, some problems arise.

Non-tariff barriers: China has been suspected of making use of non-tariff trade barriers to regulate trade between the two partners. An example is the standards that the country has put on South African fruits. They are Sanitary and phytosanitary requirements; these are considered unnecessary and unattainable by South Africa. When shipping the fruits, they are expected to go through a grey channel meaning they need to pass through Hong Kong instead of going straight to China.

The requirement to have high cold chain sterilization is considered an obstacle to effective trade since fruits lose their competitiveness when they are kept under these conditions and their quality is affected before they get to China.

Brainwash/brain drain: The two partners have education exchange programs where Chinese students, as well as African students, can study in either of the partner countries. This is through scholarships and information sharing. although this could be considered a good move, on many occasions African talented professionals fail to return to their home country after completing their studies. This has resulted in the African continent being drained from experts and professionals.

2. Literature Review

2.1 China and Africa trade relations and trends

Trade relations between China and African countries could be traced back to the first Han emperors of the Second Century B.C., according to historical data. The tale of the Chinese navigator Zheng He, who reached the coast of Africa four times, going ashore in Somalia and Kenya, in the early 15th century, is the

foremost illustration. Nevertheless, the period of exploration was followed by many centuries of detachment from the rest of the world. It was not until the creation of the People's Republic of China in 1949 that China showed renewed interest in other developing countries, especially after the Bandung Conference. The main goal of this conference was the promotion of Afro-Asian economic and cultural cooperation according to [Richer \(2008\)](#).

China's relationship with African countries evolved shortly after Deng Xiaoping initiated the opening up of China's economy, a dramatic shift from the policies followed under Chairman Mao. Relationships were no longer focused mainly on ideological issues, except the sensitive issue of Chinese Taiwan. In reality, the official terms of agreements, namely equality among partners, mutual benefit, respect for sovereignty, use of interest-free grants and loans, beneficiary capacity building, compliance with obligations, provision of equipment made in China, and the same living conditions for both Chinese and local experts, did not change, say [Larkin \(1971\)](#) and [Chaponnière \(2009\)](#). On a more recent note, China's growing dependence on energy has led to Africa gaining prominence on its agenda.

Trade between China and Africa has exponentially increased. China's trade with Africa was minimal until 1954. Trade then increased steadily but did not rise significantly until 1974, before China opened up. The progressive liberalization of the Chinese economy that began in 1978 was followed by a steady growth in trade with Africa. Nevertheless, Africa remains a marginal trading partner compared to China's trade with other regions. China's trading relationships have reflected its political ties: the Soviet Union was China's principal trading partner until the early sixties, but bilateral trade nosedived later on, and before President Nixon's visit in 1972, China had had zero trade with the United States since 1951. Western Europe's trade shares have been volatile, but since the mid-sixties, Europe has ranked second among China's partners, mainly due to trade with Germany. Asia has had a growing share since the early 1960s and now accounts for more than half of China's trade, as per [Renard \(2011\)](#).

On the one hand, over 60% of Chinese exports to Africa are bound for six countries: South Africa (21%), Egypt (12%), Nigeria (10%), Algeria (7%), Morocco (6%), and Benin (5%). Over 70% of Chinese imports, on the other hand, come from four countries: Angola (34%), South Africa (20%), Sudan (11%), and the Republic of Congo (8%). The significance of crude oil (70 percent of imports from Africa), which makes up nearly all of China's imports from Angola and Sudan, may help to explain this high country concentration of imports by China. Despite making up a large portion of imports from numerous African nations, China's agricultural imports only account for a small portion of total imports. Even though manufactured items, handicrafts, as well as machinery and transport equipment, make up the vast bulk of total imports, African imports from China are rather more diversified. Less than 10% of all imports are made up of chemicals and foods. [Renard \(2011\)](#) concluded that the major African trading partners share a similar structure of imports from China, with manufactured goods and machinery making up a sizable portion of the major African exporters' crude oil-dominated oil exports to China. The determinants of China's trade with Africa were outlined by [Cheung et al. \(2012\)](#) as China's motives for trade with Africa: market-seeking motive, resource-seeking purpose, and risk-avoiding motivation. The authors established that market opportunities (measured regarding a country's economic size and the

number of Chinese contract projects in that country) and, to an extent, the availability of natural resources (such as oil and minerals) in an African country were strong positive factors that drove China's motivation for trade with African countries. Oyejide et al. (2004) reported that China's exports of manufactured products have a lot of dispersion in the African market, with China's imports from Africa concentrated in countries that export minerals, petroleum, and metals. Besada, Wang, and Whalley (2008) also showed that China's involvement with the African continent is motivated by factors such as improvement in African countries' infrastructure availability as well as the search for new habits to deploy sizeable foreign exchange reserves. Results from Dzigbede's (2014) study indicate that China's trade engagement with most African countries is driven mainly by natural resources, market size, availability, and previous bilateral cooperation with China. From his findings, macroeconomic and infrastructural risk factors do not emerge from his estimations as significant considerations in Africa-China trade engagement.

2.2 Trade Theories

Why do nations engage in commerce with one another? Do all nations gain from trade? How big are the trade flows there? These queries might be resolved using trade theory.

Comparative and absolute advantages: The Adam Smith absolute advantage theory is the first and is regarded as the originator of trade theory. In *The Wealth of Nations*, Adam Smith made a comparison between countries and families. The same principle that applies to nations should also apply to tailors who manufacture shirts and then trade them for shoes with shoemakers. Depending on their absolute advantage, nations specialize in the manufacture of particular items, Lindert (1991). Smith's argument is persuasive, but only for the nation that enjoys an absolute advantage; it is unable to justify why a nation without an absolute advantage should engage in international trade.

Ricardian model: In response to problems posed by Adam Smith, David Ricardo developed the concept of comparative advantage, which is now regarded as the cornerstone of international trade theory. According to this theory, "a nation, like a person, gains from trade by exporting the goods or services in which it has its greatest comparative advantage in productivity and importing those in which it has the least comparative advantage" (Lindert, 1991). According to the Ricardian model, comparative advantage and disadvantage refer to whether one country has a lower or greater opportunity cost than another to produce a good. The foundation of international trade is comparative advantage. The Ricardian model is still lacking in some key areas, though.

Heckscher-Ohlin model: Two Swedish economists, Eli Heckscher and Bertil Ohlin, expanded the Ricardian theory and created a significant theory of trade, the Heckscher-Ohlin model, sometimes known as a factor endowment theory. According to the paradigm, "countries export products that use their abundant factors intensively and import the products using scarce factors intensively" (Lindert, 1991). The simple Ricardian model was updated by the Heckscher-Ohlin (H-O) model by adding capital as a second element of production in addition to labor, which was the initial factor in the classical model.

New Trade Theory: The New Trade Theory relaxes the rigid assumptions of the Classical Theory of Constant Return to Scale, Perfect Competition, and Homogeneous Goods to explain global trade based on economies of scale, imperfect competition, and product differentiation. According to these hypotheses, each nation can focus on producing a smaller variety of goods on a larger scale with higher productivity and less cost. Then, through commerce, it can broaden the range of commodities that are offered to its customers. Even when nations have equal access to resources and technological advancements, trade still takes place (Markusen et al., 1995; Krugman and Maurice, 2005).

2.3 The Gravity Model of Trade

Contrary to popular opinion, Ravenstein and Zipf were the first to employ the gravity equation in the nineteenth century. However, the model's formal use dates back to Tinbergen (1962a, b). The early version of the model explained bilateral exports from origin to destination by economic masses proxied by traders' income and geographical distance. For the past half-century, substantial work has been expended in understanding bilateral trade quantities by estimating a gravity equation. The use of this equation has grown significantly in popularity and "dominated the international trade literature as the major econometric technique," according to Baier et al. (2014). Studies seeking evidence of a trade-enhancing effect of country integration seek to forecast the additional bilateral commerce that might be expected if two or more countries integrate. The "gravity equation" has been used to evaluate the ex-post partial or occasionally direct effects of economic integration agreements, national borders, currency unions, language, and other trade cost measures on bilateral international trade flows (Bergstrand and Egger, 2011). The basic gravity equation models trade between two countries as a rising function of their sizes and a decreasing function of their distance apart. The gravity model, one of the most popular empirical economic models, illustrates a significant amount of variance with a single equation whose coefficients are considered economically important and statistically well characterized (Frankel and Rose, 2002). Although the gravity model cannot be used to examine the validity of any of these trade theories on its own, its proven effectiveness can be attributed to its capacity to integrate the majority of the empirical phenomena that are regularly observed in international commerce. However, its popularity stems mostly from its empirical effectiveness in comprehending the impact of free trade and measuring the effects of spatial allocations and trade deals on trade flows. In the literature, the gravity model is being heavily relied upon to examine bilateral trade. Numerous methods in the economic literature employ the gravity model to explain the factors influencing bilateral trade. Söderling (2005) examined export performance in the Middle East and North Africa (MENA) using a gravity model applied to panel data. Simwaka (2007) used an econometric gravity model to analyse Malawi's trade with its major trading partners. Rahman (2010) used the gravity model approach and panel data estimation techniques to evaluate Australia's global trade potential, using data from Australia and its 57 trading partners. Adekunle and Gitau (2011) used the gravity model to study the trade flow between China and Sub-Saharan Africa.

Few studies have used the gravity model approach to examine the variables affecting Egypt's exports in the international market. Researchers Hatab, A., Romstad, and Huo, X.X. (2010) to examine the key variables affecting Egypt's agricultural exports to its primary trade partners, used the gravity model approach. Based

on the gravity model used in [Abutaleb, Taha, Hamad., Hamdy, and Salem \(2013\)](#), they looked at the major factors influencing the growth of commerce between Egypt and 50 OIC nations.

Estimates from the fixed effects model (FEM) model ordinary regression coefficients. The effects of time-invariant trade flow drivers, such as distance, a shared language, shared boundaries, etc., cannot be estimated using the FEM according to [Kabir, Salim, and Al-Mawali \(2017\)](#).

According to [Bergeijk and Brakman \(2010\)](#), the gravity model's concentration on bilateral commerce—which only explains an increase or reduction in a bilateral trade flow—is one of its drawbacks. However, the gravity model is frequently utilized in situations involving trade integration where trade creations and diversions are important ideas. By assumption, the model is unable to account for substitutions between flows. [Elshehawy, Shen, and Ahmed \(2014\)](#) stressed that the intuitive gravity model is not without challenges if more complex notions from the trade literature are incorporated in their research work on gravity model analysis of Egypt's commerce.

The value of bilateral trade flows is directly related to the home and destination economies (represented by GDP) and inversely proportional to the distance between two places in the conventional Tinbergen-Pöyhönen-Pulliainen variant of the gravity model. An exporter's output (GDP) indicates their capacity to supply, whereas an importing nation's output reflects their tendency to import. Distance is a trade-resisting factor because it affects import demand by raising the price of traded goods due to higher transportation expenses. Geographic proximity, on the other hand, helps improve trade flows and is thus advantageous for economic regionalism in achieving reciprocal gains from trade. However, instead of just the GDP of the origin and destination, three key explanatory variables are utilized in theory-based alternative specifications:

- (i) The bilateral overall nation size as determined by the total of the real GDPs of the two nations;
- (ii) a 'similarity index' (SIM) of two trading nation's GDPs as a measure of relative nation size;
- (iii) And the maximum variation in relative factor endowments (RFE) between two trading nations. ([Serlenga and Shin 2007](#); [Kabir and Salim, 2010](#); [Salim et al., 2014](#); [Kabir and Salim, 2016](#); [Zhang and Yang, 2016](#)).

This model is based on Newtonian physics, which asserts that two bodies attract each other proportionally to the product of their respective masses (in kilograms) divided by the square of their respective centers of gravity (in meters). [Rahman \(2010\)](#) The gravity model is assumed to connect bilateral commerce to the economic mass of the two economies, the distance between them, and other potential impacts such as dummy variables. The gravity equation has the following general structure:

$$X_{(ij)} = \alpha_k Y_i^\beta Y_j^\beta N_i^\xi N_j^\delta D_{ij}^\mu U_{ij}$$

Where X_{ij} is the flow of exports between countries i and j , k is a constant, are coefficients, weighted geometric averages, Y_i and Y_j are GDP in countries i and j , respectively, N_i and N_j are populations in countries i and j , and D_{ij} is the distance between their capitals. $E(\ln U_{ij}) = 0$. The U_{ij} is a lognormal

distributed error term. Dummy variables are frequently used in models to account for preference trade factors between i and j .

The linear form of the previous gravity equation can be written as follows:

$$\ln(X_{ij}) = \alpha + \beta_1 \ln(Y_i) + \beta_2 \ln(Y_j) + \beta_3 \ln(N_i) + \beta_4 \ln(N_j) + \beta_5 \ln(D_{ij}) + U_{ij}$$

2.4 The Augmented-Gravity Flow Model Specifications

According to [Benedictis and Vicarelli \(2004\)](#), "Over the last four decades, the gravity flow model has become a popular formulation for statistical analysis used to predict bilateral trade flows between different geographical entities based on the economic sizes of the different locations or countries." Newton's "Law of Universal Gravitation," which was put forward in 1687, is where the model gets its start. According to the aforementioned law, the attraction force between two objects i and j is thought to be a positive function of their masses (M_i and M_j) and a negative function of their separation (D_{ij}). This draw is supplied by:

$$(1) F_{ij} = G[(M_i M_j | D_{ij}^2)]$$

The gravitational constant, denoted as G , is solely dependent on the units of measurement for mass and force. In this equation, F_{ij} is the annotation used to represent the attractive force. M_i and M_j stand for the respective masses of objects i and j .

According to the basic gravity flow model, the supply and demand conditions in each country's origin and destination as well as any forces that might be acting to encourage or constrain those flows, influence the magnitude of trade flows between two nations. This can be shown as

$$(2) F_{ij} = R \frac{M_i^\alpha M_j^\beta}{D_{ij}^\theta}$$

F_{ij} , M_i , and M_j , which are used to describe the trade flow from source to destination j , stand for the economic mass (GDP) of the exporting country and the economic mass (GDP) of the importing trading partner, respectively. R (remoteness) is utilized in place of the gravitational constant G to describe the distance (D) between the two countries' economic centers. Natural logarithms can be calculated using the multiplicative nature of the model to provide the linear relationship seen in equation (3).

$$(3) \ln F_{ij} = \alpha \ln M_i + \beta \ln M_j - \theta \ln D_{ij} + \delta \ln R_j + \varepsilon_{ij}$$

The augmented-gravity flow model can be expressed as specified below:

$$(4) \ln F_{ij} = \alpha \ln M_i + \beta \ln M_j - \theta \ln D_{ij} + \delta \ln P_i + \gamma \ln P_j + \rho \ln R_j + \varepsilon_{ij}$$

Where P_i and P_j respectively stand for the populations of country i and the population of country j .

3. Methodology

3.1 Model

The study focuses on 45 of China's trade partners in Africa (Algeria, Angola, Benin, Burkina Faso, Burundi, Cote d'Ivoire, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, the Democratic Republic of the Congo, Djibouti, Egypt, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, Sudan, Togo, Tunisia, Uganda, Tanzania, Zambia, Zimbabwe). They were selected based on the fact that they have been consistent trading partners over the past twenty years. This study concentrates on panel data collected over 20 years from 2002 to 2021. We use a model with all the selected countries and later group the countries by income level and run the respective models according to the grouping of the African countries to evaluate the determinant of trade between China and the selected 45 African nations and also the determinants specific to each country group.

This period was chosen because the study wants to track the evolution of China's African trading partners while keeping the predicted coefficients comparable. The benefits of this strategy are as follows: first, panels can record the relevant interactions among variables across time; second, panels can monitor the individual effects of unobservable trading partner pairings. If individual effects are associated with the independent variables, OLS results that exclude them will be skewed. In light of this, we applied panel data methods to our empirical gravity model of trade.

The estimated gravity model can be resumed in the following regression equation:

$$\ln \text{Trade} = \alpha_{ij} + \beta_1 \ln(\text{GDP}_{it}) + \beta_2 \ln(\text{GDP}_{jt}) + \beta_3 \ln(\text{POP}_{it}) + \beta_4 \ln(\text{POP}_{jt}) + \beta_5 \ln \text{Dij} + \beta_6 \text{llk} + \beta_7 \text{fdi} + \beta_8 \text{hist} + \beta_9 \text{crisis} + e_{ijt}$$

Where:

J= 1, 2... 45 African countries

I= 1 (China)

T=2002, 2003... 2021

Tijt = China's trade with country j during year t

GDPit = GDP of China in year t

GDPjt = GDP of country j in year t

POPit = Population of China in year t

POPjt = Population of country j in year t

Dij = Distance in Kilometers between China and country j

llk = landlocked country dummy variable takes the value 1 if the African country is landlocked, and the value 0 otherwise.

fdi = Foreign Direct Investment dummy variable takes the value 1 for every year the African country received FDI from China, and the value 0 otherwise.

hist = Trade history dummy variable takes the value 1 if the African country started trading with China before the year 2000, and the value 0 otherwise.

e_{ijt} = Error term

The annual trade (exports plus imports) between China and its African partners is the dependent variable. The International Trade Center (ITC) database contains the information for this variable for the years 2002 through 2021. CSY, the China Statistical Yearbook, is another source of trade information. CSY gathers its data from those supplied by China Customs and their archives span beyond. The trade data provided by United Nations Comtrade are based on country-specific reports or data that Comtrade has downloaded from authorized sources. Data from Comtrade closely resembles that from China Customs and the China Statistical Yearbooks. Comtrade data is consistently updated.

As a gauge of economic size, China and its partner nations in Africa use their gross domestic products. This variable is anticipated to have a strong, favorable relationship with trade promotion. The International Monetary Fund's (IMF) database is used to acquire information on each nation's GDP. They are initially transformed using the GDP deflator provided by the IMF into the constant US price of 1996 from US current dollars.

The population is included in the collection of variables since it is used to calculate each country's market size, a significant factor influencing international trade. Market size is expected to have a favorable influence or effect since a country trades more when its market is larger. Population data for China and the 45 African partners is derived from World Bank (WB) yearly statistics.

Annual flows of Chinese Foreign Direct Investment (FDI), also called OFDI ("Overseas Foreign Direct Investment") in Chinese official publications, have fluctuated during the past ten years. China's direct investment in Africa increased at a compound annual growth rate of 20.5% between 2009 and 2012, according to one of the most recent white papers on China-Africa Trade and Economic Cooperation. Even though this was due to the purchase of 20% of the shares of Standard Bank in South Africa, flows peaked in 2008 at 5.5 billion US dollars. The top 5 African countries for Chinese FDI appeared to be Algeria, Zambia, Kenya, the Republic of Congo, and Nigeria in 2014. Algeria received more than 20% of all Chinese FDI flows to Africa in 2014. These numbers seem to be lower than anticipated. The earliest reports of Chinese Overseas Direct Investment (ODI) data are from 2003. The China Statistical Yearbook (CSY) and the Statistical Bulletin of China's Outward Foreign Direct Investment (SB) first made reports public in 2007. Although many of these faults are also shared by other nations' official FDI data, it has a lot of issues, according to the website chinaafricarealstory.org.

The distance variable shows how far apart the capital cities of China and its partners in Africa are geographically. A website that tracks the distances between cities globally provided the information for country-to-country lengths.

Data on FTA membership was collected from the China Free Trade Website. The data were input, coded, and cleaned in the computer program Statistical Package for Social Scientists (SPSS). A summary of

descriptive statistics was generated, including percentages, means, standard deviations, and t-statistics. The information was then uploaded to STATA version MP for empirical analysis. The total bilateral trade variable was calculated by adding China's exports and imports with each trading partner. The natural logarithms of the remaining variables, namely total bilateral trade, GDP, population, and distance, were also generated, except for the dummy variables. Nine variables were studied in the econometric analysis for forty-five trading partners, including China. This resulted in a panel with 900 observations. Descriptive statistics of model variables presented in Table 3.I reveal that from 2002 through 2021, the overall mean trade flow of China with African countries was approximately worth 1.5 billion US dollars. For the entire study period, China's mean population was 1.3 billion people, as compared to about 20 million people (mean) from her African trading partners (Table 3.I). Seychelles was also noted as having the smallest population of about seventy-seven thousand people as compared to 190 million people, the largest population in Nigeria. Finally, results from Table 4.I show that the mean distance of all trading partners was about 10601 kilometers away from Beijing, China's capital city. Cairo in Egypt is the closest trading partner at 7551.418 kilometers away from Beijing, while Praia in Cabo Verde and Conakry in Guinea are the most distant trading centers at approximately 12656.15 and 12651.77 kilometers away from Beijing, respectively.

The tested variables mean, maximum, minimum, and variance are as follows:

Table 3.I: Stationary test of variables

Variable		Mean	Std. Dev.	Min	Max	Observations
trade flows	overall	1515.795	3784.213	0.11968	48752.15	N = 900
(Millions US\$)	between		2513.034	15.5167	14714.66	n = 45
	within		2852.846	-13008.51	43255.24	T = 20
GDP	overall	25.15257	56.08123	0.2038464	568.4989	N = 900
(Billions US\$)	between		45.11595	0.4327609	228.4395	n = 45
	within		33.95261	-171.2823	365.212	T = 20
China GDP	overall	5039.842	3917.285	961.604	12237.7	N = 900
(Billions US\$)	between		0	5039.842	5039.842	n = 45
	within		3917.285	961.604	12237.7	T = 20
population	overall	20.02977	27.60117	0.077319	190.8863	N = 900
(Millions)	between		27.37598	0.0859741	149.0365	n = 45
	within		5.315851	-15.03165	61.87961	T = 20
China Population	overall	1314.434	45.25815	1230.075	1386.395	N = 900
(Millions)	between		0	1314.434	1314.434	n = 45
	within		45.25815	1230.075	1386.395	T = 20
distance	overall	10601.19	1456.36	7551.418	12656.15	N = 900

(Kilometers)	between		1472.038	7551.466	12655.2	n =	45
	within		0.1978496	10601.05	10603.05	T =	20
llkd	overall	0.2666667	0.4424508	0	1	N =	900
	between		0.4472136	0	1	n =	45
	within		0	0.2666667	0.2666667	T =	20
fdi	overall	0.3301587	0.4705191	0	1	N =	900
	between		0.3310684	0	0.952381	n =	45
	within		0.337793	0.6222222	1.187302	T =	20
hist	overall	0.8444444	0.3626254	0	1	N =	900
	between		0.3665289	0	1	n =	45
	within		0	0.8444444	0.8444444	T =	20
crisis	overall	0.1428571	0.3501124	0	1	N =	900
	between		0	0.1428571	0.1428571	n =	45
	within		0.3501124	0	1	T =	20

4. Findings and Discussion

4.1 Regression results of the augmented gravity model with Fixed Effects

Table 4.1 Regression results under fixed effects

<i>Intrade</i>	<i>Coef.</i>	<i>Std. Err.</i>	<i>t</i>	<i>P>t</i>	<i>[95%Conf.</i>	<i>Interval]</i>
<i>lnGDPj</i>	0.658155	0.075283	8.74	0.000	0.510402	0.805907
<i>lnGDPI</i>	0.433699	0.124794	3.48	0.001	0.188775	0.678623
<i>lnPOPj</i>	-0.09002	0.365914	-0.25	0.806	-0.80818	0.628126
<i>lnPOPI</i>	18.1312	3.172429	5.72	0.000	11.90491	24.35748
<i>Indist</i>	-2341.2	1118.542	-2.09	0.037	-4536.48	-145.92
<i>llkd</i>	0	(omitted)				
<i>fdi</i>	0.111585	0.060011	1.86	0.063	-0.00619	0.229363
<i>hist</i>	0	(omitted)				
<i>crisis</i>	0.186865	0.059141	3.16	0.002	0.070795	0.302936
<i>_cons</i>	21289.06	10344.49	2.06	0.040	986.7087	41591.41
<i>sigma_u</i>	339.8821					
<i>sigma_e</i>	0.597792					
<i>rho</i>	0.99999691(fraction of variance due to u_i)					
	Number of obs = 900					
	Number of groups = 45					
	Obs per group: 20					
	R-sq: within = 0.8475 between = 0.0033 overall = 0.0021					

Note: llkd & hist omitted because of collinearity

$$\text{Corr}(u_i, Xb) = -1.0000 \quad F(7,893) = 708.99 \quad \text{Prob} > F = 0.0000$$

F test that all $u_i=0$: $F(44, 893) = 65.04$

The results from Table 4.1 suggest that with fixed effects, most of the selected factors are significant, except the population of China's trade partner in Africa, which does not significantly affect trade. A 1% increase in the GDP of China's trade partner in Africa leads to a 0.66% increase in trade, while a similar increase in the GDP of China leads to a 0.43% increase in trade. However, a 1% increase in the population of China will lead to an 18% increase in trade. Distance has a very negative effect on trade. The trade increased by 0.11% as a result of foreign direct investment; during the financial crisis, the trade increased by 0.19% as compared to the period not affected by the financial crisis.

4.2 Regression results of the augmented gravity model with Random Effects

Table 4.2 Regression results under random effects

<i>Lntrade</i>	<i>Coef.</i>	<i>Std. Err.</i>	<i>z</i>	<i>P>z</i>	[95% <i>Conf. Interval</i>]
<i>lnGDPj</i>	0.672192	0.068623	9.80	0.000	0.537693 0.806691
<i>lnGDPi</i>	0.446081	0.122319	3.65	0.000	0.206341 0.685822
<i>lnPOPj</i>	0.128175	0.123835	1.04	0.301	-0.11454 0.370888
<i>lnPOPi</i>	16.21092	2.988834	5.42	0.000	10.35291 22.06892
<i>Lndist</i>	0.879928	1.085641	0.81	0.418	-1.24789 3.007745
<i>Llkd</i>	-1.48458	0.35842	-4.14	0.000	-2.18708 -0.78209
<i>Fdi</i>	0.140553	0.058463	2.40	0.016	0.025969 0.255137
<i>hist</i>	0.622922	0.503099	1.24	0.216	-0.36313 1.608978
<i>crisis</i>	0.200389	0.058215	3.44	0.001	0.086289 0.314489
<i>_cons</i>	-359.612	60.14525	-5.98	0.000	-477.495 -241.73
<i>sigma_u</i>	0.986323				
<i>sigma_e</i>	0.597792				
<i>rho</i>	0.73135012(fraction of variance due to u_i)				
	Number of obs = 900				
	Number of groups = 45				
	Obs per group: 20				
	R-sq: within = 0.8466 between = 0.7248 overall = 0.7754				

corr (u_i, X) = 0 (assumed) Wald chi2(9) = 5049.97 Prob > chi2 = 0.0000

The results from Table 4.2 suggest that with random effects, all of the selected factors are significant. A 1% increase in the GDP of China's trade partner in Africa leads to a 0.67% increase in trade, while a similar increase in the GDP of China leads to a 0.44% increase in trade. Furthermore, a 1% increase in the population of China's trade partner in Africa leads to a 0.13% increase in trade, while a similar increase in the population of China leads to a 16.2% increase in trade. Distance has a very positive effect on trade. The volume of trade with landlocked countries is 1.48% less than that with coastal and island countries. The volume of trade increased by 0.14% as a result of foreign direct investment; the volume of trade for the countries with trade history with China is 0.62% more than the country without trade history. During the financial crisis, trade increased by 0.2% as compared to the period not affected by the crisis.

4.3 Hausman test results of the augmented gravity model

Table 4.3 Hausman Test Results for all the countries

---- Coefficients ----				
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fixed	random	Difference	
	S.E.			
<i>lnGDPj</i>	.6581545	.6721921	-.0140376	.0309577
<i>lnGDPi</i>	.4336992	.4460813	-.0123821	.0247328
<i>lnPOPj</i>	-.0900247	.1281753	-.2182	.3443221
<i>lnPOPi</i>	18.1312	16.21092	1.920279	1.06357
<i>Indist</i>	-2341.199	.8799275	-2342.079	1118.542
<i>fdi</i>	.1115845	.1405531	-.0289686	.0135428
<i>crisis</i>	.1868653	.2003893	-.013524	.0104197
<i>b =</i>	consistent under Ho and Ha; obtained from xtreg			
<i>B =</i>	inconsistent under Ha, efficient under Ho; obtained from xtreg			
<i>Test: Ho:</i>	difference in coefficients not systematic			
	$\chi^2(2) = (b-B)'[(V_b-V_B)^{-1}](b-B)$			
	5			
	Prob>chi2 = 0.0820			
	(V_b-V_B is not positive definite)			

The results from table 4.3 of the Hausman test used to examine whether the null hypothesis that the coefficients of the random effects are the same with the consistent fixed estimator suggests that the random-effects model will be the most appropriate; therefore, the random effects model will be considered in evaluating the determinants of trade between China and African countries.

5. Recommendation

Our results reveal that China's trade with African countries is positively affected by economic size and population. In most of the cases, the population of the African country has a positive effect, but in one of the cases, it harms the trade. Trade is affected positively in all but one of the cases by distance.

In the case of total trade with all the countries, the results from the random effect GLS showed that the economic effects on GDP are consistent, and the increase in the population of either of the trade partners leads to an increase in trade because of the increase in the target market. The positive impact that distance has on trade is inconsistent with previous research but can be explained by the development of logistics and transportation systems. The negative effect of the landlocked criteria may suggest geographical features in coastal areas are favorable to the flow of goods. Foreign direct investment appears to be an incentive to trade, as trade is more important with the countries that received the investments. Trade history in this case also appears to have a positive impact, as familiarity between the trading partners can only lead to clearer trade patterns, which most definitely lead to higher trade volumes. Trade volumes increased during the financial crisis, and this can be explained by the decrease in the price of certain commodities, namely natural resources, which are Africa's main export product.

The impact of Africa's GDP in this area implies that dealing with African nations is different from trading with the rest of the globe. Only fair policies that boost GDP, boost domestic production of goods where these nations have a competitive edge, and prudent exchange rate management can allow Africa to gain from the trading relationship. Additionally, we suggested that African nations implement tariff scaling, imposing a larger duty on processed goods than on primary goods. There should also be market pricing support for African producers and consumers. If African governments can afford it, deficit payments can be used to supplement price support. At the very least, African countries should assert the reparation principle, which states that the conqueror should compensate the underdog through commerce.

5.1 Areas for further research

More research is needed to determine the level of production specialization necessary in this trade. Another topic of research would be to examine high-end product trade rather than typical ways of calculating aggregated trade flow without disaggregating high- and low-end products.

5.2 Recommendations

Africa has a chance to cause change, and these changes are dependent on well-outlined and structured policies. Policies that can hold and keep standards and expectations. However, there is a lot of threat that stands in the way of growth if it is not addressed.

Although China-Africa trade is growing drastically and either party is benefiting, many more opportunities have not been utilized. To fully take advantage of these opportunities, China should intend to assist Africa in its development process, in contrast to assisting African countries in exploiting their resources. Progress on this scale can only be attained when the partnership is free from trade and non-trade barriers.

Having a well-defined framework of operation that will ensure that African goods are competitive in the Chinese market will be of great help. In addition, African countries should not depend on grants, aid,

and foreign direct investments to boost and develop their manufacturing industries but must focus more on developing innovative schemes and policies for the production of fully manufactured goods.

Conclusion

In this theoretical work, we have applied the Gravity Model to analyse the factors influencing trade between China and African countries using panel data regression technique. We can conclude from the analysis that the factors affecting trade between China and the sampled African countries are, namely, the size of the population of the trade partners, the economic sizes of the trade partners represented by their respective GDP, and the distance between the countries. The findings in this analysis will assist stakeholders in making a fair and balanced assessment of trade relations between China and African countries.

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