IBN HALDUN UNIVERSITY
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF MANAGEMENT

PH.D. THESIS

THE IMPACT OF THE TRADE WAR BETWEEN THE US AND CHINA ON THE SUB-SAHARAN AFRICAN COUNTRIES: A CGE GTAP MODEL APPROACH

FATUMA ABDALLAH NANTEMBELELE

THESIS SUPERVISOR
PROF. MUSTAFA KEMAL YILMAZ

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by
FATUMA ABDALLAH NANTEMBELELE

A thesis submitted to the School of Graduate Studies in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Management

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PROF. MUSTAFA KEMAL YILMAZ

ISTANBUL, 2023

APPROVAL PAGE

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Doctor of Philosophy in Management.

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ÖZ

ABD VE ÇİN ARASINDAKİ TİCARET SAVAŞININ SAHRA ALTI AFRİKA ÜLKELERİ ÜZERİNDEKİ ETKİSİ: CGE GTAP MODELİ YAKLAŞIMI

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Haziran 2023, 104 sayfa

ABD ve Çin dünyanın en büyük ekonomileri olup güçlü ticaret ortaklarıdır. Bu iki ülke arasındaki ticaret savaşı, Sahra Altı Afrika (SAA) ülkeleri de dahil olmak üzere diğer ülkeleri etkilemektedir. Bu çalışma, ABD ve Çin arasındaki ticaret savaşının SAA ülkelerinin dış ticaret ve ekonomilerine etkilerini incelemektedir. Çalışmada Hesaplamalı Genel Denge ve GTAP modeli kullanılmıştır. Çalışma sonuçları, ABD ile Çin arasındaki ticaret savaşının ticaret yaratma ve SAA'ya yönlendirme etkisiyle fırsatlar yarattığını göstermektedir. SAA bölgeleri tarife savaşından olumlu etkilenmiştir. Doğu Afrika ve Diğer Doğu Afrika bölgesi diğer bölgelere göre daha fazla fayda temin etmiştir. Nijerya ve Güney Afrika ticaret savaşından en fazla yararlanan ülkelerdir. Sektörel sonuçlar tarife önlemlerinin SAA ülkelerinde olumlu etkileri olduğunu göstermektedir. SAA ülkelerinin ticaret savaşındaki konumlarını bilmelerinin onların ekonomik refahını arttırmasına ve küresel pazarlık güçlerini kuvvetlendirecek stratejik kararlar almalarına yardımcı olması beklenmektedir.

Anahtar Kelimeler: ABD, Çin, Hesaplanabilir Genel Denge Modeli (CGE), Küresel Ticaret Analiz Projesi (GTAP), Sahra Altı Afrika, Ticaret Savaşı.

ABSTRACT

THE IMPACT OF THE TRADE WAR BETWEEN THE US AND CHINA ON THE SUB-SAHARAN AFRICAN COUNTRIES: A CGE GTAP MODEL APPROACH

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This study examines the impact of the trade war between the US and China on the trade and economies of the SSA countries. Using social accounting matrix data from the GTAP database, the study employs a Computable General Equilibrium model (CGE), specifically the GTAP model, to run the simulations on the effects of the tariff changes between the US and China on the SSA regions. The results show that the trade war negatively affects both the US and China, creating opportunities through trade creation and diversion effects to the SSA countries. SSA is positively affected by the trade war in all tariff scenarios. East Africa and ROEA regions gain more than the other SSA regions. The sectorial results show that all sectors in the SSA encounter positive effects except the minerals and metal sector in East Africa and ROEA. The findings provide valuable insights for companies, consumers, and policymakers in the SSA countries. The trade war increased the ability of the companies to produce efficiently and meet the needs of consumers while maximizing their profit through the welfare allocative effects. The trade diversion from the US and China increased imports in the SSA regions, raising the availability of goods to meet customer needs. Policymakers may take measures to empower firms in the SSA to take more advantage of international trade-related activities.

Key Words: China, Computable General Equilibrium Model (CGE), Global Trade Analysis Project (GTAP), Sub-Saharan Africa, Trade war, United States.

DEDICATION

I dedicate my work to my beloved son, and my parents, whose magnificent devotion and motivation encouraged me to achieve this successful result. I love you all so much.

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My sincere appreciation and gratitude go to The Almighty God who has created faith in me and provided me with spiritual guidance throughout my life.

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I would love to thank my whole family, especially my mother, Mama Rukia Hassani Semkiwa, who has always been with me and has always given me the assurances that whatever you work hard for is possible to achieve. Thank you, mama you are my roadmap and have made it possible for me to see this through, from the beginning to the end.

My newborn son, Alieu Amani, whose existence gave me the courage, motivation, and strength to work even harder. His existence has pushed me in difficult times, sleepless, and exhausting days, and nights.

Last but not least I would like to thank my beloved husband for his ongoing support. He has been my mentor, stress absorber, PhD mate, advisor, a point of encouragement and more. Thank you for being with me every time.

Fatuma Abdallah Nantembelele

ISTANBUL, 2023

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LIST OF SYMBOLS AND ABBREVIATIONS

ACFTA	African Continental Free Trade Area
AGE	Applied General Equilibrium
AGOA	African Growth and Opportunity Act
ASEAN	Association of Southeast Asian Nations
BITs	Bilateral Investment Treaty(s)
CCA	Capital Consumption Allowance
CD	Cobb Douglas
CDE	Constant Difference of Elasticity
CES	Constant Elasticity of Substitution
CET	Constant Elasticity of Transformation
CGE	Computable General Equilibrium
CIF	Cost, Insurance, Freight
COMESA	Common Market for Eastern and Southern Africa
CPC	Cooperative Patent Classification
CPI	Consumer Price Index
CTOT	Commodity Terms of Trade
EAC	East African Community
ECOWAS	Economic Community of West African States
EPA	Economic Partnership Agreement
ETRAE	Elasticity of Transformation
EU	European Union
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FOCAC	Forum on China–Africa Cooperation
FTA	Free Trade Agreement
G20	Group of Twenty
GAMS	General Algebraic Modeling System
GDP	Gross Domestic Product
GE	General Equilibrium
GEMPACK	General Equilibrium Modelling PACKage

GII	Global Innovation Index
GTAP	Global Trade Analysis Project
GTAPAgg	GTAP Aggregation Software
GVAR	Global Vector Autoregression
HS6	Six Digit Harmonized System
IBT	Indirect Business Taxes
IMF	International Monetary Fund
IP	Intellectual Property
ISIC	International Standard Industrial Classification
MIRAGE	Modelling International Relationships in Applied General Equilibrium
MOFCOM	Ministry of Commerce of the People's Republic of China
NX	Country's Net Exports
RCEP	Regional Comprehensive Economic Partnership
ROA	Rest of Africa
ROEA	Rest of East Africa
ROSA	Rest of South Africa
ROTW	Rest of the World
ROWA	Rest of West Africa
RunGTAP	GTAP Simulation Software
SAFTA	South Asian Free Trade Area
SAM	Social Accounting Matrix
SMART	Software for Market Analysis and Restrictions on Trade
SOEs	State Owned Enterprises
SSA	Sub-Sahara Africa
TIFA	Trade and Investment Framework Agreement
TRAINS	Trade Analysis and Information System
UK	United Kingdom
UN	United Nations
UN Comtrade	United Nations Commodity Trade
UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organization
US	United States of America

USD	United States Dollar
USTR	United States Trade Representative
WAEMU	West African Economic and Monetary Union
WB	World Bank
WDI	World Development Indicator
WEF	World Economic Forum
WEO	World Economic Outlook
WIPO	World Intellectual Property Organization
WITS	World Integrated Trade Solution
WTO	World Trade Organization

CHAPTER I

INTRODUCTION

1.1. Background of the Study

International trade creates markets for goods, services, and factors of production as well as increases productivity, and improves innovations and capital accumulation that affect economic growth. It also increases consumers' choices due to the availability of different goods and services and promotes competition, leading to high efficiency. All these benefits positively influence the economic growth of nations.

Many studies argue that international trade significantly affects countries' economic growth and productivity (Alcala & Ciccone, 2004; Vamvakidis, 1999). These effects include the reduction of the income gap, provision of intermediate inputs (Grossman & Helpman, 1991), facilitation of technological diffusion (Eaton & Kortum, 1996; Adeleye et al., 2015), increase in employment, productivity, and technological advancement and improvement in social welfare (Sun & Heshmati, 2010), among many others. Connolly (1999) argued that importing high-technology products positively affects domestic innovation and raises Gross Domestic Product (GDP). Further, improving technology and international trade activities increases the quality of productive factors and leads to physical capital accumulation (Afonso, 2001). Englander and Gurney (1994) and Azeez et al. (2014) claimed that international trade, together with other factors, i.e., physical and human capital accumulation, research and development, and technical knowledge, acts as the primary source and catalysis of economic growth. Furthermore, the relationship between international trade and economic growth is subject to other macroeconomic policies like trade barriers, as there is a co-integration between these dynamics (Caleb et al., 2014).

International trade activities are conducted in different conditions; while some partner states practice it in a trade liberalization/free trade manner, some involve tariff or non-tariff measures. Non-tariff measures involve matters like the protection of the

environment, animals, and human life, while tariff measures are in the form of taxes and other duties. The literature on the effect of trade barriers provides mixed results. Some authors argue that trade barriers reduce trade, while others claim that they increase trade flows (Dal Bianco et al., 2016; Heien & Sims, 2000). Non-trade barriers complement tariff measures, which are more trade-restrictive than tariffs. Looi-Kee et al. (2009) found that, on average non-trade barriers contribute more than tariffs to trade protection. When there is a tariff reduction, importers are likely to increase their trade, and the abolition of non-trade barriers increases new imports (Imbruno, 2016). Hence, the reductions of tariff and non-tariff barriers increase world trade (Ghodsi et al., 2017; Hayakawa & Kimura, 2014).

In the discussion of international trade, two giant countries, i.e., China and the United States of America (US), should be analyzed separately as they dominate the world economy. Besides being close partners, they unofficially manage the marketplace with their power in terms of population and economic size. However, there has been an ongoing trade war between these two countries in recent years. The US has initiated trade lawsuits against other trading partners in the world more than 131 times and more than 23 times against China, as reported by the World Trade Organization (WTO) (WTO, 2019). Chi and Qiao (2019) indicated that China is the main target of these trade lawsuits due to its increasing economic and technological power. On the other hand, the US imposed tariffs in 2017 on 12,007 goods and services imported from different countries, particularly from China and its neighboring countries, i.e., Vietnam, Taiwan, and Malaysia. The total value of the tariff was USD 303 billion. This is the most extensive protectionist measure taken by the US in trade policy history since the 1929 Smoot-Hawley Act (Fajgelbaum et al., 2019).

The trade war between the US and China became more severe in 2018 when Donald Trump came into power. Trump administration claimed that China is doing illegal dumping, manipulating the currency, and stealing intellectual rights (Capie et al., 2020; Chi & Qiao, 2019; Teimouri & Raeissadat, 2019; Xia et al., 2019). In April 2017, the US started an investigation into steel and aluminum imports. In January 2018, it imposed new tariffs on solar panels and washing machines imported from China (Bekkers, 2019). In March 2018, it put tariffs on aluminum for 10% and on steel for more than 25%. In April 2018, the Chinese government took a counteraction

measure by imposing tariffs on 128 goods, including agricultural products, that cost USD 2.4 billion to the US (Capie et al., 2020; Karaganov, 2018; Wong & Koty, 2020; Zhang, 2020). The US reacted by releasing a list of 1,300 Chinese goods that were taxed over 25% and worth USD 50 billion. This list targeted the technology and pharmaceutical industries in China. The Chinese government released another list of 106 goods that included cars, airplanes, and other products. The war continued up to a stage where the tax imposed on Chinese goods by the US reached USD 505 billion, affecting almost all Chinese products (Chi & Qiao, 2019; Dollar, 2018; Karaganov, 2018; Manish & Sanjay Krishnan, 2018; Xinhua, 2018). Before 2017, the tariff was 6.6%, but after 2017 the rate increased to 23.0%, which was worth USD 96 billion for 2,931 Chinese exporting goods (Fatma & Bharti, 2019). The increases in tariffs have affected the markets in both countries, particularly producers, consumers, and companies that make foreign investments (Capie et al., 2020).

Teimouri and Raeissadat (2019) argued that the trade war between China and the US is different from others because these countries have a GDP of over 40% and a population of over 30% of the world. China was the largest energy consumer in 2017, accounting for 23.2% of the total world consumption, followed by the US with 16.5% (Xia et al., 2019). Chinese markets depend on US consumers. China imports USD 187.5 and exports USD 522.9 billion to the US. In 2017, the US trade deficit reached 47%, i.e., USD 275.8 billion, by trading with China. Statistics show the US trade deficit from the import of Chinese goods from 2007 to 2018 (WDI, 2019). This deficit is one of the reasons why the US has increased the tariffs on imported goods from China (Xia et al., 2019).

Fajgelbaum et al. (2019) mentioned that the trade war is influenced by two factors: tariffs and changes in prices. Another reason is the theft of intellectual property (IP) as claimed by the US government (MOFCOM, 2018, 2019; White House, 2017). There is also a strong market distortion caused by Chinese State-Owned Enterprises (SOEs). Last but not least, the US government claims that China has been manipulating currency to generate trading gains (US Department of the Treasury, 2019).

Panagariya (2018) argued that the trade war between the US and China has affected both producers and consumers in the US, China, and the rest of the world. After the

rise of tariffs, the trade war decreased the US welfare by 0.04% of GDP, which is worth USD 78.0 billion in the short run. Trade gains of domestic producers due to high production prices were 0.12% of GDP, which is worth USD 21.0 billion, while consumer and producer loss was 0.37% of the GDP in the US. During the trade war, the Chinese GDP declined from 6.6% in 2018 to 6.3% in 2019, and it is expected to be below 6% by 2022 (Carataș & Spătariu, 2019).

Using deadweight loss and Harberger's triangle Evans (2019) found that the trade war between the US and China has several effects: (1) the prices of items that directly affect consumers' welfare will rise; (2) firms will face extra costs for exports; (3) investors will become nervous; (4) some investors will diversify into Bitcoin and other cryptocurrencies; (5) the trade war may turn into a currency war; (6) developed countries could be hit seriously, and (7) tariffs applied on developing countries' exports would rise steeply. In this respect, the trade war has created opportunities and threats for other countries. For example, Russia gained from the trade war because it supplied agricultural products to China. On the other hand, the Japanese GDP was reduced by 19% due to the reduction of its export to the US and China (Carataș & Spătariu, 2019).

The trade war also affects African countries. There are relatively few studies held on the effects of the trade war between the US and China on African countries, and they reveal mixed results. Using the data from 1970 to 2017, Olayungbo (2019) employed the global vector autoregression (GVAR) model to forecast the possible effects of the trade war on the selected oil-exporting African countries, i.e., Algeria, Angola, Egypt, Gabon, Nigeria, and Tunisia. The findings show that the foreign trade output shock has a positive effect in Gabon, Egypt, Angola, and Algeria and adverse effects on Tunisia and Nigeria in the long run. In another study held by Nyongesa (2019) on the trade war, the author discussed the reason for the rise of the relationship between Asian countries, particularly China, with Africa and whether this relationship between China imports energy and raw materials from Africa has been influenced more by the trade war between China and the US. He concluded that the trade war should not be ignored because the tariffs imposed between these countries have stimulated the interest of Asian countries in African resources.

1.2. Problem Statement

The trade war between the US and China has changed the direction of foreign trade in the world in such a way that it does not only affect international trade but also affects companies (Hass & Denmark, 2020). It creates uncertainties for managers that are responsible for international trade activities, supply chain operations, and marketing. Cyrill (2019) argued that the trade war creates boundaries for firms in different countries. The tariffs, in turn, affect the markets since the cost of supply chain operations, production, and retail business are adversely influenced. Marte (2019) claimed that the trade war has real-life implications for managers, employees, and consumers, savings levels, employment opportunities, and financial decisions. Macdavid (2019) mentioned that the trade war affects small firms due to incremental cost increases and sales decreases. All these challenges lead to uncertainty in the world economy (UNCTAD, 2019; WTO, 2019). This destabilization started in early 2018 when the US applied the Trade Expansion Act of 1962, section 232, which talks about a national security threat. Apart from this section, the US also applied Section 301 of unfair trade with the trading partners. The applications of these sections involved many US trading partners, but China was the primary target. China reacted to it by increasing the tariff on goods and services (Li et al., 2018). 90% of the HS6 (six-digit Harmonized System)[1] Products were affected by the tariffs in the US and China in mid-2019 (Li et al., 2020). In 2020, the US and China had a Phase One Trade Agreement to slow down the war. Brown (2021) and Hsu (2021) claimed that the tariffs are still high even after the Phase One Trade Agreement. The Phase One deal covered penal responsibility issues, intellectual property rights, and trade secret protection, whereby the tariff agreement was ineffective (Polatay, 2020). Furthermore, the Chinese government did not purchase the products that amounted to USD 200 billion as part of the Phase One Agreement.

The US and China are also trading partners of the Sub-Saharan African (SSA) countries. According to World Integrated Trade Solution (WITS) data for 2019, the total value of SSA exports (FOB) is USD 241,362 million, while the total value of imports is USD 253,395 million. The main exported products are petroleum oil,

[1] HS is a standardized numerical method of classifying traded products that are used by customs authorities around the world.

minerals like gold, diamonds, and agricultural products. The SSA exports to China and the US reach USD 25.9 billion (10.8%) and 12.4 billion (5.1%), respectively. The SSA imports from China and the US are worth USD 45.5 billion (17.9%) and USD 16.4 billion (6.4%), respectively. Hence, a change in trade policy between these two countries may have implications for the SSA region.

Prior studies reveal that the trade war affects China more than any other country (Innocent, 2019; Li et al., 2018; Ndzendze, 2020; Xia et al., 2019). Thus, if Chinese goods are affected by the trade war, then there may be a direct or indirect impact on African countries. The US tariffs on China also indirectly affect China's need for raw materials from the SSA. This effect is estimated to decrease Chinese demand for raw materials amounting to USD 75.26 billion. African Development Bank warned that in 2021 the trade war decreased the GDP by 1.9% and 2.5% in resource-intensive and oil-exporting African countries, respectively. The IMF reported that the GDP growth of Africa may drop to 1.5% by 2021 due to the trade war (WEF, 2019). China gets the supply of raw materials from African countries due to the trade war. The main concern, however, is whether this trade adds value to African countries. Another question is whether Africa can still maintain trade with the US as the US has reduced its dependence on some raw materials from Africa, including oil and gas. This import of oil and gas from Africa to the US dropped from USD 99.5 billion in 2008 to USD 17.6 billion in 2018. Furthermore, when African countries import from the US, the relative cost of these goods is high, and many African people cannot afford the prices. The literature shows that other countries like Mexico, Taiwan, India, Vietnam, Canada, and Korea gained from the trade war (Fabricius, 2018; Nicita, 2019). Blessed with raw materials and population, what is the position of the African continent in this trade war? To what extent are the African economies affected? The few trade war studies done on Africa (Ndzendze, 2020; Nyongesa, 2019; Olayungbo, 2019) only describe the situation with mixed results. This is the only study that examines the impact of the trade war on the SSA countries by employing the GTAP model.

Moreover, China experienced a decrease in farm export, including soybeans, to the US, which fell to USD 25 billion during the Obama administration and USD 13 billion after the trade war. China sold these products to Brazil (Ndzendze, 2020). What was the situation in the SSA countries? Could the US create a new supply chain for African

countries by importing soybeans and other raw materials from African countries as a result of trade diversion and creation effect? What about the excess supply of products that have been created during and after the trade war? Is there a possibility for African countries to be another significant market for these products? What is the position of the SSA countries in meeting the demand for goods and services in the US?

There are few studies held on the impact of the trade war in Africa, usually discussing the perception of the trade war's effect on African countries (Fabricius, 2018; Ndzendze, 2020; Nyongesa, 2019; Olayungbo, 2019). To the best of our knowledge, none of the prior studies carried out a detailed analysis on the following issues: (1) how the trade war affects the trade volume of African countries, (2) which economic indicators are affected by the trade war in African countries? (3) Which industries have been affected the most after the trade war? (4) Whether there is a gap in the SSA regions due to the trade war. This study makes significant contributions to these matters.

1.3. Research Objectives

This study aims to analyze the impact of the trade war between the US and China on the trade and economy of the SSA countries by using a multi-regional and multi-sectoral Computable General Equilibrium (CGE) model, i.e., Global Trade Analysis Project (GTAP) and GTAP 10 database. GTAP database uses SAM data that combine datasets for each region and aggregate trade bilateral data from different sources, i.e., UNCTAD, WTO, UNIDO, IMF, and WB. The trade protection data are in 6-digit Harmonized System (HS6) level, which is aggregated in trade weight obtained from the MacMap database and COMTRADE. The database covers 121 countries, an aggregate of 20 regions, and a total of 65 industries that represent 98% of the world's GDP and 92% of the world's population.

To make this analysis, we set up a series of research objectives:

1. To analyze whether there are any changes in the trade volume and trade balance in the SSA regions before and after the trade war.
2. To examine the economic indicators that have been affected in the SSA countries by the trade war.

3. To investigate whether the trade war created trade diversion and trade creation in the SSA regions.
4. To analyze other effects of the trade war, including economic welfare.
5. To identify which sectors have been affected the most by the trade war.

1.4. Scope and Limitations of the Study

This study focuses on the selected SSA countries that are the leading trading partners of the US and China and analyzes the data at the regional, country, and sectorial levels. The SSA countries are categorized according to the trade volume with these two countries. The SSA countries are also analyzed on regions by aggregating them into different categories, i.e., the Rest of East Africa, the Rest of West Africa, the Rest of South Africa, and the Rest of the World as per data availability. Finally, the work conducts country analysis based on the SSA countries with the highest GDP. This analysis allows us to identify the contribution of each country to the total effect of the trade war in the region. In terms of industries, this study mainly focuses on four categories, i.e., food and agricultural products, oil and gas, minerals and metals, and other industries.

According to the literature, there are many factors that may cause the trade war between the US and China, including the trade deficit, tariff, and intellectual property right, among many others. This study only focuses on the effects of the tariff measures as the primary cause of the trade war, and it uses it as a shock variable in the simulation of the results.

1.5. About Sub-Sahara Africa

The African continent has 54 countries and five regions. These regions are Southern Africa (10 countries), East Africa (14 countries), West Africa (15 countries), Central Africa (9 countries), and North Africa (7 countries). SSA has 46 countries; it has a population of 1,078,306,520, a GDP of USD 1,770,043 million, and a trade balance of USD -66,114 million (WDI, 2019). It is characterized by abundant resources like timber, oil, gas, gold, and diamond. Due to these rich resources, the region has gone through colonialism in its history. The region has also been doing trade with other

countries, including China and the US. The trading activities between SSA and the US, and China have been structured through trade Acts and Forums. The Forum of China-Africa Cooperation (FOCAC) is one of them. Another example is the Africa Growth and Opportunity Act (AGOA) established between Africa and the US.

SSA has a population of 1,078,306,520, a GDP of USD 1,770,043 million, and a trade balance of USD-66,114 million (WDI, 2019). According to World Integrated Trade Solution (WITS) data for 2019, the total value of SSA exports (FOB) is USD 241,362 million, while its total import is USD 253,395 million. The region exports about 4,535 products to 228 countries and imports 4,627 products from 236 countries. These products include raw materials, intermediate goods, consumer goods, and capital goods. The main exported products are petroleum oil, minerals like gold, diamonds, and agricultural products like cocoa beans. The main export partners and their shares are as follows: China USD-25,987 million (10.77%), India USD -18,494 million (7.66%), the US USD -12,460 million (5.16%), and Netherlands USD -11,338 million. The main importers to the SSA are China USD-45,548 million (17.98%), India USD -17,087 million (6.74%), the US USD -16,407 million (6.47%), and Germany USD -12,397 million (4.89%). The fact that both the US and China are among the top trade partners of the SSA, any dispute that arises between these two countries would have implications for the SSA countries.

Additionally, the export-import statistics of SSA individual countries show that both China and the US are among the top five main trading partners. For instance, Nigeria's exports value to China accounts for USD 1,766 Million (5.06%), while the country's imports value from China is USD 15,947Million (28.76%), followed by the imports from the US worth USD 5,024Million (9.06%).

Furthermore, China is the number one trading partner of South Africa; the export value from South Africa to China and import value from China to South Africa account for USD 9,749 Million (11.49%) and USD 14,309 million (20.76%), respectively. South Africa's second export partner is the US, whose export value is USD 7,131 million (8.37%). Likewise, the US exports to South Africa account for USD 4,436 Million (6.43%).

Similarly, China is the number one import partner of both Kenya and Ethiopia. China's import value to Kenya is USD 3,394 Million (22.03%), while its import value to Ethiopia is USD 4,157 million (29.50%). When it comes to exports to the US, Kenya's export value to the US is USD464 (7.7%), while Ethiopia's export value to the US is USD 259 million (10.24%), and Ethiopia's imports from the US are worth USD718 million (5.1%).

In Tanzania, the export value to China and import value from China are USD 239 Million (3.93%) and USD2,156 million (25.31%), respectively. Last but not least, the value of export from Ghana to China accounts for USD2,809 million (16.75%), and the import value from China to Ghana is USD 1,896 Million. This is followed by imports from the US to Ghana which accounts for USD 976 million (9.35%). The fact that both the US and China are among the top trade partners of the SSA, any dispute that arises between these two countries would have implications for the SSA countries (WITS, 2023)

Figure 1.1. Map of Sub-Sahara Africa Region

1.6. Organization of the Study

This study is organized into five chapters.

Chapter One discusses the background of the study, the problem statement, the research questions, and the scope of the study. It gives a general outlook on the relevance of the trade war in the context of the SSA and its potential consequences. Chapter Two reviews the literature and discusses the theoretical and empirical background. Chapter Three presents the data, the research methodology, and the

model, i.e., the Computable General Equilibrium Model CGE (GTAP), in detail. It also introduces the scenarios elaborated in this study. Chapter Four provides the empirical findings of the study, interprets them, and discusses the results. Chapter Five concludes and discusses the implications of the study and directions for future research.

CHAPTER II

LITERATURE REVIEW

This Chapter reviews the literature, provides the conceptual framework, and defines the variables. In this Chapter, we developed a systematic literature review, as shown in Tables 2.1 and 2.5. Table 2.1 specifically summarizes the CGE-GTAP model studies, covering the tariff scenario implemented during the trade war between the US and China, while Table 2.5 summarizes other US-China trade war studies that have employed other models.

2.1. Overview of the Trade War

A trade war occurs when two or more countries impose trade barriers on each other in an extremely protective way. Trade barriers can be in the form of tariffs and non-tariff measures. Tariffs protect local industries by reducing competition from abroad. It also increases the cost of imports for protected industries. Lee and Swagel (1997) found that trade barriers debilitate trade. Haveman and Thurby (1999) revealed that tariff measures affect trade reduction and diversion effects more than compression effects, while non-tariff measures affect trade reduction more than the tariff itself, concluding that non-tariff measures cause a huge reduction in trade than tariff measures. Hence, imposing trade protection may result in positive and negative consequences.

Academicians have different approaches to explaining the causes and consequences of trade wars. Some authors believe that a trade war is likely to decrease trading volume and lead to new trade arrangements between countries, decreasing the welfare of people even though some industries may gain from it (Bagwell & Staiger, 2001). It may also cause high costs, reduce the profitability of exporters, harm importers (Elms, 2004), and may negatively affect consumer behavior, investment, and global allocation of resources (Xia et al., 2019).

2.2. The Global Impact of the Trade War

The trade war between the US and China does not only affect international trade but also affects companies (Hass & Denmark, 2020). The war creates uncertainty for managers that are responsible for international trade activities, supply chain operations, and international marketing. The IMF states that the trade war affects the performance of companies from manufacturing to the supply chain. To manage these challenges, managers conduct contingency plans and make scenario analyses to come up with alternative strategies (Colback, 2020). For instance, Burma and Vietnam try to attract firms that are reluctant to use China as a strategic manufacturing location (Colback, 2020; Mary, 2019). Cyrill (2019) argued that the trade war creates boundaries for firms in both the US and China. The tariffs can, in turn, affect the markets since the cost of supply chain and operations, production, and retail business may be affected. The outcome is that firms either incur losses or stop production in the US and China. They look for other destinations where they can invest, and the SSA countries are one viable option.

There are many studies discussing how the trade war affects the welfare of people (Amiti et al., 2019; Cavallo et al., 2019; Fajgelbaum et al., 2019). Almost all these studies show that the trade war reduces consumer welfare by the increase in the prices of goods. Jang (2019) argued that the trade war does not only affect the marketplace but also influences the purchasing behavior of consumers. Berstein (2020) highlighted that the trade war affects companies through global supply chain operations and high production costs. Marte (2019) argued that the trade war has real-life implications for managers, employees, and consumers, savings levels, and employment opportunities. Davis (2019) interviewed small firms that were affected by the trade war and indicated that small firms should decide whether they shift their supply chain to other countries. Macdavid (2019) mentioned that the trade war affects small firms due to incremental cost increases and sales decreases. Some firms already shifted the production and supply chain from China to other countries, but it takes time to find a good partner (Colback, 2020; Davis, 2019).

China and the US are the largest economies in the world. Therefore, any trade war between these countries creates a spillover effect on the economies of other countries,

including African ones (Andrews & Witheridge, 2018; Robinson & Thierfelder, 2019). Thus, countries that supply raw materials and provide markets for goods and services of the US and China look for opportunities out of this trade war. It is estimated that 63% of the USD 21 billion export losses of China to the US have been diverted to other countries, including Mexico, whose export to the US increased by USD 3.5 billion, Vietnam, whose export to the US increased by USD 2.6 billion, EU whose export to the US increased by USD 2.7 billion, Taiwan and India (USD 4.2 billion), and Canada and Korea whose export increased from USD 0.9 to USD 1.5 billion (Fabricius, 2018; Nicita, 2019). This study examines the impact of the trade war on the SSA, blessed with valuable raw materials and intensively populated markets.

The US and China had the Phase One Agreement in January 2020 to solve the dispute between them. In this agreement, the Chinese government agreed to raise the import of goods from the US by USD 200 billion to minimize the US trade deficit. China also agreed to tighten intellectual property guidelines, discontinue currency manipulation, and stop technology transfers from the US. On the other side, the US agreed to reduce the tariff by half on USD 120 billion worth of Chinese goods (Capie et al., 2020). In terms of technology, the US increased the restrictions on artificial intelligence, biotech, computers, marine technologies, and others (Johnson, 2020). The US also plans to cancel Chinese citizens from getting student visas for technology research.

2.3. Trade War Between the US and China

The international trade relationship between the US and China is composed of cooperation and war (Polatay, 2020). From 2008 to 2019, the bilateral trade volume between the US and China increased and created a trade deficit in the US. Among many countries that are subject to the US tariff sanctions, China is the only country that has a trade surplus out of its trade relationship with the US (Iqbal et al., 2019). Even after raising the tariffs, the US still has a high trade deficit with China.

Moreover, the US lost its comparative advantage over China and other Eastern Asian countries since these countries have labor-intensive economies. The Global Innovation Index (GII) issued by the World Intellectual Property Organization (WIPO) shows that China is among the best-performing countries in innovation. China took the fifth

position in 2018 in terms of technology, while the US was ranked as the sixth country (Polatay, 2020). All these factors contribute to the ongoing trade war between these two economies. Thus, the retaliatory effects of the US trading partner would further harm employment opportunities, income, and economic output in the US. The statistics show that in the long run, the GDP and wages in the US are estimated to go down by 0.23% and 0.15%, respectively, and full-time jobs of 179,800 are expected to disappear.

Huang and Smith (2020) argue that an incremental increase in the US tariff towards China and other countries aims to create a trade balance. For instance, the imports from China to the US fell by USD 87.3 billion due to tariffs. This decrease was recorded as the largest one when compared to other trading partners of the US. Even though Chinese exports to the US decreased, China still has a trade surplus due to reductions in imports from Taiwan, South Korea, and Japan. This reduction balanced the trade of China by more than USD 60 billion. China also diversifies its market to South Asia, exporting USD 38.5 billion from the EU and SSA. Further, supply chain activities in China focus on comparative advantages, i.e., producing highly technological products from developed countries and labor-intensive products from low wages countries (Huang & Smith, 2020).

2.3.1. The US-China Trade Relations

According to WDI (2019), China has a positive trade balance of USD 164,986 million. The export and import in China are USD 2,498,570 million and USD 2,068,950 million for 215 partners and 4,423 products. The US is its first import partner, with an import value of USD 418,584 million and a share of 16.75%. Other major import partners are Hong Kong (11.19%), Japan (5.73%), Korean Republic (4.44%), and Vietnam (3.92%). The US is also China's major export partner, accounting for USD 123,236 million and a share of 5.96%. Other main export partners are Korean Republic, Asia, and Japan.

In the US, the value of total export and import is USD 1,644,276 million and 2,567,492 million with 223 partners and 4,529 products. The trade balance of the US is USD -610,470 million. Hence, there is trade deficit. China is the first export partner of the

US with an export volume of USD 472,465 million (18.40%), followed by Mexico (14.07%), Canada (12.72%), Japan (6.72%), and Germany (5.06%), while it is the third import partner of the US with an import volume of USD 106,627 million (6.48%). Canada, Mexico, Japan, and the UK are the first, second, fourth, and fifth import partners, respectively. When comparing the trade volume between the US and Africa vs. China and Africa, statistics show that the total trade volume between China and Africa has always been higher than the trade volume between the US and Africa, as shown in Figure 2.1.

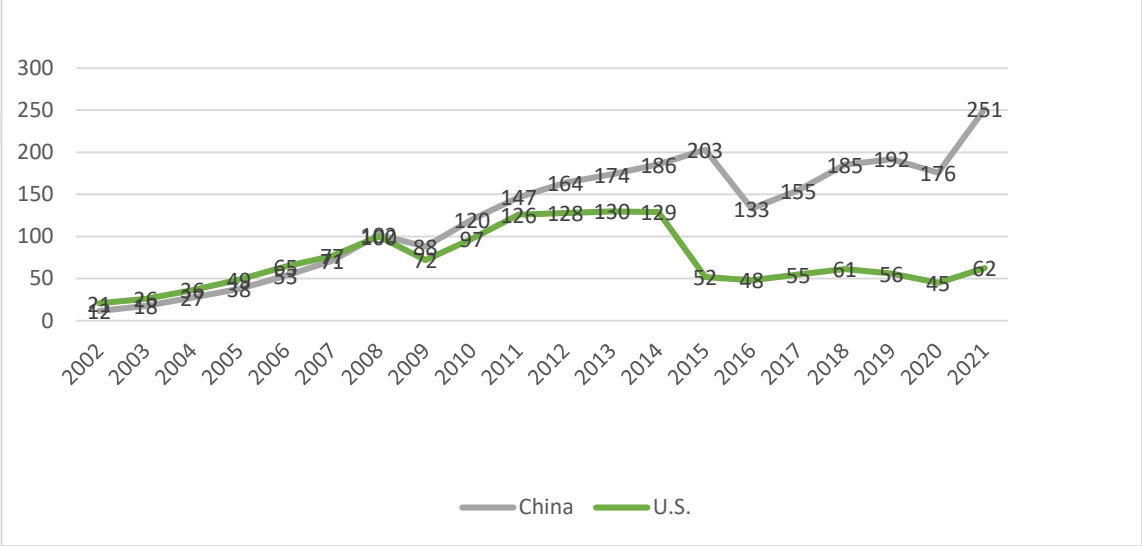

Figure 2.1. US-Africa Trade vs. China-Africa Trade (USD bn)

Source: UN Comtrade, 2023

2.4. China-Africa Trade Relations

China and Africa cooperate on the trade and investment relationship under FOCAC. FOCAC is the Forum on China-Africa Cooperation and has objectives of equal consultation, enhancing understanding, expanding consensus, strengthening friendship, and promoting cooperation between African countries and China (FOCAC, 2021). Since the mid-2010s, trade has increased between Africa and Asia, particularly in China (Nyongesa, 2019). According to Broadman (2007), the trade relationship has flourished, particularly in raw materials. Omuroyi (2015) inferred that over the past decade, the trade link between Africa and China has doubled and benefited African

economies while it has provided advantages to China's industrialization (Albert, 2017; Nyongesa, 2019). UNCTAD (2014) reported that the SSA export one-third of China's energy. Figure 2.2 shows the trade relationship between Africa and China from 2002 to 2021.

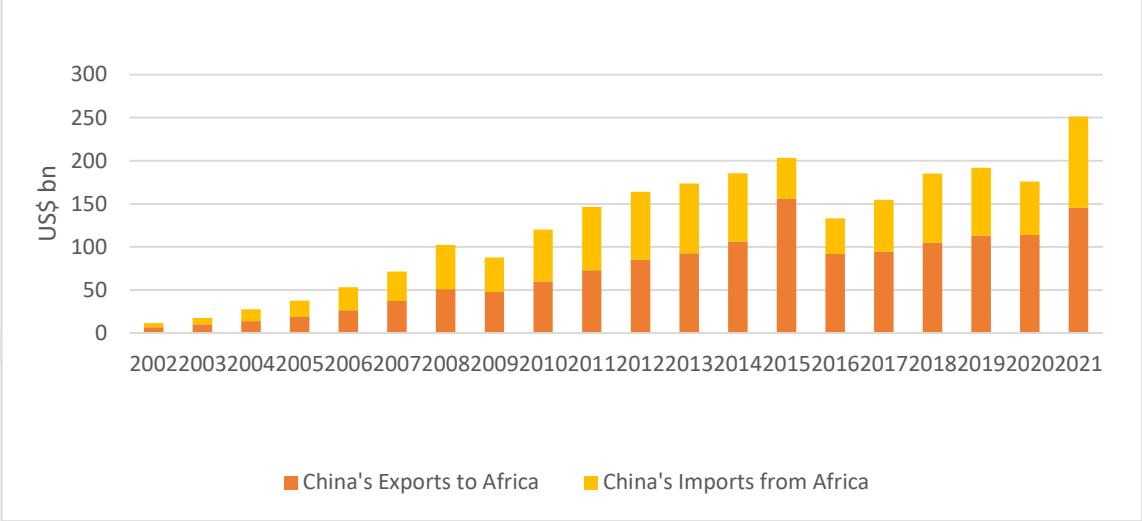

Figure 2.2. China-Africa Trade Relationship

Source: UN Comtrade, 2023

2.5. The US-Africa Trade Relations

The trade relationship between the US and Africa can be explained by the African Growth and Opportunity Act (AGOA) enacted in 2000. AGOA aims to enhance market accessibility of SSA-qualified countries to the US. The Act provided tariff-free access to about 6,500 products (AGOA, 2021). The main goods that are exported from the US to the SSA include electrical machinery (USD 864 million), mineral fuels (USD 1.4 billion), vehicles (USD 1.6 billion), and aircraft (USD 1.5 billion). On the other hand, the SSA exports to the US oil, precious metals (USD11.2 billion), cocoa (USD 4.1 billion), vehicles (USD 1.2 billion), and iron and steel (USD 1.2 billion, and 950 million). In total, the two-way trade between the SSA and the US has increased from USD 36.9 billion to USD 39 billion from 2015 to 2017. The main SSA countries that supplied to the US were Botswana (USD 772 million), South Africa (USD 7.8 billion),

Nigeria (USD 7.1 billion), Angola (USD 2.6 billion), and Cote d'Ivoire (USD 1.2 billion) (AGOA, 2021).

On the other hand, the US investment in the SSA countries has dropped by 23% from USD 37.5 billion in 2014 to USD 29 billion in 2016. The main countries that the US invested in are Nigeria (USD 3.8 billion), South Africa (USD 5.1 billion), and Mauritius (USD 6.7 billion). The US imported USD 99.5 billion of oil from Africa in 2008 compared to USD 17.6 billion of oil and gas in 2018. This reduction occurred because the US started to produce its power/energy and hence, have less dependency on the oil and gas from Africa. Another reason for the trade variation is the relatively high cost of the US export in comparison to the income level of African countries (USTR, 2022).

There is also a Bilateral Investment Treaty (BITs) agreement that the US entered in some African countries, i.e., Cameroon, the Democratic Republic of Congo, Congo, Rwanda, and Mozambique. The BITs aim to encourage market-oriented domestic policies that treat investments in a transparent and non-discriminatory way and to support the development of international standards that are consistent with these objectives. The US also entered another agreement, i.e., Trade and Investment Framework Agreement (TIFA), with some African countries (Nigeria, Angola, Ghana, Liberia, Mauritius, Rwanda, South Africa, and Mozambique) and African communities, i.e., West African Economic and Monetary Union (WAEMU), East African Community (EAC), and Common Market for Eastern and Southern Africa (COMESA) to strengthen trade and investment activities between the US and African countries (USTR, 2022). Figure 2.3 shows the trade relationship between the US and Africa from 2002 to 2021.

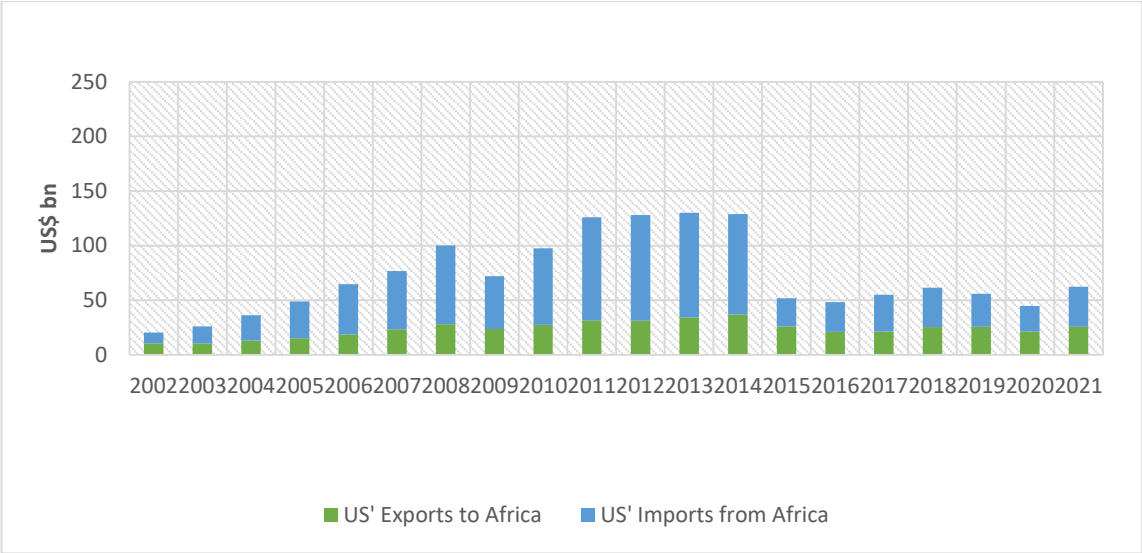

Figure 2.3. US-Africa Trade Relationship

Source: UN Comtrade, 2023

2.6. International Trade Studies and Models

Prior studies that have analyzed the trade war between the US and China due to policy changes, particularly tariffs, used different approaches. Many of these studies employed general equilibrium models, particularly the Global Trade Analysis Project (GTAP) model (Carvalho et al., 2019; Li et al., 2016; Li et al., 2020; Mahadevan & Nugroho, 2019; Rosyadi & Widodo, 2018; Siriwardana & Yang, 2008; Siriwardana, 2001; Sulamaa & Widgrén, 2005; Анненков, 2019). Other studies used different Computable General Equilibrium Models (CGE) apart from the GTAP model, multi-country global general equilibrium model - GE (Balistreri et al., 2018; Carvalho et al., 2019; Fusacchia, 2019; Itakura, 2020; Li et al., 2018; Li et al., 2020; Mahadevan & Nugroho, 2019; Xia et al., 2019), gravity model (Kalendienė & Loda, 2019), deadweight loss method, (Evans, 2019), scenario analysis (Chong & Li, 2019), and bibliometric research-content analysis (Huang, 2019; Sousa et al., 2019). Other studies that used equilibrium models discussed the costs and benefits of protectionist measures as well as trade liberalization (Ahmed, 2010, 2011; Brockmeier, 2001; Carvalho et al., 2019; Hosoe et al., 2010; Jammes & Olarreaga, 2005; Karing et al., 2005; Karing et al., 2006; Li et al., 2016; Li et al., 2020; Mahadevan & Nugroho, 2019; Marchand, 2013; Raihan, 2009: Rosyadi and Widodo, 2018; Siriwardana & Yang, 2008; Siriwardana, 2001; Sulamaa & Widgrén, 2005).

Sousa et al. (2019) employed content analysis and performed bibliometric research to examine the strategic tools that companies can use in a competitive market amid the trade war between the US and China. He showed that international trade is affected by physical, political-legal, technological, socioeconomic, and economic factors. Huang (2019) used content analysis to compare the news reported by the New York Times and People's Daily on the trade war. The results show significant positive and negative differences in how the news reports the US and China trade war.

The use of the CGE Model to analyze the effects of trade wars has been emerging in recent years. Some authors, like Carvalho et al. (2019), analyzed the outcomes of tariffs on the welfare of the US and China by using the GTAP model and showed that the US and China welfare would decrease from USD 23.6 billion to USD 19.3 and from USD 43.1 billion to USD 39.7 billion, respectively. Giesecke et al. (2019) employed a dynamic GTAP model, i.e., GTAP-MVH, and showed that the trade war would affect real consumption, employment, and GDP in the US and China. Bellora and Fontagné (2020) used MIRAGE-e dynamic model and revealed that both the US and China's real wages and GDP will go down in the year 2030, and there will be more negative impacts on China compared to the US. Similar results were identified by Guo et al. (2018) by employing GTAP in GAMS (General et al.). They found that the welfare of China and the US decreased while the welfare of the Asian countries increased. The results also show that there is a decrease in imports and exports in the US and China and trade diversion to countries like Mexico, Canada, the EU, and South Korea.

In 2014, Ossa used four databases, i.e., GTAP database, UNCTAD, TRAINS, and UN Comtrade, to analyze the effects of tariffs on 33 industries for seven countries/regions, i.e., Brazil, China, US, EU, India, Japan, the Rest of the World, by using CGE model. The results showed that the tariff would cause a welfare loss of 2.9% to all regions/countries. Noland et al. (2016) used Moody's Analytics to analyze the impact of the trade policies on the US economy and indicated that the tariffs would cause a disruption of the import and export of China and creates a trade diversion. Li and Lin (2018) used the multi-country global general equilibrium model (GE) to analyze the economic impacts of the China-US trade war to simulate possible outcomes by applying tariff and non-tariff measures. They showed that China will lose more than

the US. These findings are in line with the findings of Mahadevan and Nugroho (2019), but the latter claims that the US will also lose if China retaliates. Balistreri et al. (2018) used regional and global CGE models to explore the effects of the trade war and found that while China and the US experienced welfare loss of -1.7% and -1.02%, respectively, other countries gained due to trade diversion.

Walmsley and Minor (2018) studied the trade war between the US and China, covering Korea, Russia, India, Canada, EU, and Mexico, by employing a dynamic CGE model and found that the US GDP will decrease by -1.25% by 2030. A similar study that employed CGE was conducted by Devarajan et al. (2018) covering the US, China, Japan, Canada, Mexico, and the EU, and the results showed that the GDP of China and the US are affected by -0.1% and -0.3% respectively. Kalendienė and Loda (2019) used the gravity model to analyze the trade war between the US and China and indicated that, out of the largest Lithuania trade partners, only the Netherlands and Denmark gained in terms of export volume. Jain and Saraswat (2019) used time series analysis to analyze the US-China trade war and claimed that no country gains from the trade war, and high prices make consumers suffer. Carvalho et al. (2019) used the GTAP model to examine the trade war between the US and China and identified that the US welfare dropped from USD 23.6 billion to USD 19.3 billion, while the welfare of China decreased from USD 43.1 billion to USD 39.7 billion. Li et al. (2020) used GTAP in the GAMS model and found that the welfare of the US and China dropped by 0.2% and 1.7%, respectively. The trade war also caused welfare gain in the form of trade diversion to many Asian countries. Mahadevan and Nugroho (2019) mentioned that the trade war is estimated to cause USD 17.7 billion loss globally.

Evans (2019) used allocative inefficiency/excess burden, also known as a deadweight loss method, to check the effect of the trade war. The results showed that the trade war is likely to affect companies that transfer the tariff loads to final consumers by raising the prices of goods and services, affecting the welfare of consumers. On the manufacturing side, the trade war is likely to affect the jobs of people because the effects of tariff can increase the cost of operation and hence causes job losses. Using scenario analysis, Chong and Li (2019) claimed that in the worst-case scenario, China will incur a loss of 1% in GDP, and its employment will decrease by 1.1% due to the trade war. Many studies use GTAP to examine the effects of trade policy changes.

Анненков (2019) employed the GTAP model to analyze the effects of Brexit on trade in the UK. The study used two trade policy instruments, i.e., trade-weighted most favored rates tariffs and ad-valorem equivalents. The results showed that there is a trade diversion problem.

Ahmed (2011) estimated four tariff liberalization scenarios and employed the computable general equilibrium GTAP model and partial equilibrium model (SMART) to investigate the economic impact of the Australia-India FTA and indicated that both countries have welfare gains and trade creation. Ahmed (2010) examined the impact of the India-Japan FTA by using GTAP and SMART models. The results of the SMART models showed that both countries gain in terms of consumer surplus, suggesting that trade policies create competition that favors consumers. The results of the GTAP model indicated a rise in bilateral exports and welfare gains in Japan, while there was a welfare loss and trade diversion in India. The effects on GDP and employment were present in both countries.

Karing et al. (2006) evaluated the economic repercussion of trade between the Common Market for Eastern and Southern Africa (COMESA) and EU member states with the Economic Partnership Agreement (EPA) by employing GTAP and SMART models. The findings showed that these types of multilateral agreements have effects on the production, prices, trade, and supply and demand of goods and factors of production. Further, these agreements have impacts on the value of imported and locally produced markets. Karing et al. (2005) explored the impact of the EPAs on African countries, particularly the Economic Community of West African States (ECOWAS), and indicated that the EPAs mostly affect the GDP, welfare, and improvement of market access for ECOWAS trading partners states.

Siriwardana and Yang (2008) explored the effect of the proposed Australian-China FTA by employing the GTAP model and indicated that there were positive welfare effects for both countries, while sectorial effects were diversified. Rosyadi and Widodo (2018) analyzed the potential global impact of the US plans to impose tariffs against China by using the GTAP model and detected that the new policy change might result in trade diversion, shrinking bilateral trade between the two countries, and increasing trade with the third trading partners. Using a partial equilibrium WITS-

SMART model, Raihan (2009) analyzed the impact of preferential trading agreement (SAFTA) in India by focusing on net trade effects, trade diversion, and trade creation. The findings showed that the Indian welfare was positive and trade creation was more than trade diversion, creating a positive effect. Marchand (2013) explored the trade liberalization between Canada and India by using the partial equilibrium model SMART to predict the effect of free trade on export and imports, welfare, trade creation, and trade diversion. The results showed that FTAs increase the volume of trade and affect other countries, including the US, China, and Russia.

Table 2.1 summarizes the findings of the studies that employed the CGE-GTAP model with the tariff scenarios that were implemented during the trade war between the US and China

Table 2.1. A Summary of the CGE-GTAP Model Studies on the Effects of the Trade War Between the US and China

Author(s)	Model/Methods	Tariff Scenario	Findings
Balistreri et al. (2018)	GTAP Model	"The escalated tariff rates as proposed for January 1, 2018". Page 13-14.	Other countries gain due to trade diversion created by the trade war. Trade war causes China and the US to experience welfare loss of -1.7% and -1.02%, respectively.
Bellora and Fontagné (2020)	MIRAGE-e, GTAP Database	"Scenario 1: Trade value and protection: Most impacted bilateral flows Scenario 2: Sanctions on automobiles and retaliations Scenario 3: Phasing out of industrial tariffs between the EU and the US". Page11, 13-14.	The US and China's real wages and GDP will go down by 2030. The US and China can experience a loss of 0.41% and 0.59% of the GDP, respectively.
Carvalho et al. (2019)	GTAP Model GTAP 9	"Scenario 1: It corresponds to the unilateral imposition of US tariffs on: (a) US additional 25% import duty on steel from China, India, Russia, EU, and other countries; (b) Additional 10% US import tariff on aluminum from China, India, Russia, EU, and other countries. (c) An additional 25% charge on Chinese products listed by the US. Scenario 2: Chinese retaliation with the imposition of: (a) Additional 25% tariff on the US products by China". Page 6.	The welfare of the US and China will decrease from USD 23.6 billion to USD 19.3 and from USD 43.1 billion to USD 39.7 billion, respectively, due to the trade war.
Devarajan et al. (2019)	Static GLOBE CGE model, GTAP 9 Database	"Scenario 1: Join the trade war and retaliate against increases in the US tariffs. Scenario 2: Do nothing. Scenario 3: Pursue trade agreements with non-US regions. Scenario 4: Pursue trade agreements with non-US regions and unilaterally liberalize tariffs on imports from the US (in effect, 'turning the other cheek' in response to higher US tariffs)". Page 6	China and US GDP will go down by -0.1% and -0.3%, respectively.

Table 2.1. (cont.)

Author(s)	Model/Methods	Tariff Scenario	Findings
Guo et al. (2018)	A multiple-country and multiple-sector model The OECD Inter-Country Input-Output Database (ICIO)	"Scenario 1: Unilateral US tariffs with balanced trade Scenario 2: US-China retaliatory tariff war with balanced trade Scenario 3: US–China retaliatory tariff war with ongoing trade imbalance". Page 13, 15-17	The war decreased imports and exports of the US and China. Further, the welfare of China and the US decreased by 1.7% and 0.2%, respectively, while the welfare of the Asian countries increased. There is also a trade diversion effect on other countries, i.e., Mexico, Canada, the EU, and South Korea.
Itakura (2020)	Dynamic GTAP model (GDyn)	"Scenario 1: Raising import tariffs in 2018-2019. Scenario 2: In addition to Scenario 1, the trade war is assumed to deter FDI in the US and China. Scenario 3: Lowering productivity - In addition to Scenario 2, the trade war is assumed to worsen productivity in the US and China". Page 7	Trade war reduces almost all sectorial imports and output. It also reduces the GDP of China and the US by -1.41% and -1.35%, respectively, due to lower productivity.
Li et al. (2020).	Canonical GTAP in the GAMS model GTAP 10	"Scenario 1: Steel-aluminum tariff increases due to the US steel and aluminum tariffs and retaliatory tariffs from China, EU, India, and Turkey. Scenario 2: March 2020 tariff increases in scenario one and additional tariff increases between the US and China, including USD 50 billion rounds, USD 200 billion/60 billion rounds, and the first wave of the USD 300/75 billion round tariff increases (reduced by half). Scenario 3: Full tariffs cumulative tariff increases in scenarios 1 and 2, and scheduled tariff increases on USD 250 billion Chinese products from 25% to 30%, and the full first wave and the second wave of the USD 300/75 billion round tariffs". Page .4	The welfare of the US and China dropped by 0.2% and 1.7%, respectively. Additionally, it caused welfare gain in the form of trade diversion to the trading partners.
Mahadevan and Nugroho (2019)	Dynamic computable general equilibrium (CGE) model- GTAP	"Scenario 1: The RCEP concluded in 2019. Scenario 2: The US–China trade war in 2018. Scenario 3: It combines Simulation 1 + Simulation 2. Scenario 4: The conclusion of the RCEP without India" Page 7.	There is a trade diversion to the RCEP member countries due to the trade war.
Rosyadi and Widodo, (2018)	GTAP Version 6.2 GTAP Database 9	"Scenario 1: Full trade protection scenario 45% Scenario 2: Manufacturing trade protection scenario 45%". Page 16	A trade war can shrink bilateral trade between the US and China and may increase trade with third partners due to trade diversion.

2.6.1. Different Approaches to the Trade and Tariff Relationship

Trade policy analysis employs different models and theories. Equilibrium models and theories are one of them. General equilibrium models, such as the GTAP model, analyze both direct and indirect effects of trade policy, while partial equilibrium models only focus on direct effects and ignore the effects in other industries. This study discusses and employs the general equilibrium model (GTAP-Global Trade Analysis Project).

Equilibrium models are used to identify and analyze multilateral and bilateral trade policy implications in economies. The models were initially used by UNCTAD and other international organizations, i.e., World Bank (WB) and United Nations Industrial Development Organization (UNIDO), to check the effects of the trade liberalization scenarios. The models can also identify the effects of trade modifications on specific commodities, helping to figure out future trade negotiations. Further, countries can evaluate the direct effects of preferences under the Generalized System of Preferences and stimulate solutions that can favor them. The general equilibrium model (GTAP model) validates the results of direct effects and gives indirect effects. The UNCTAD used these models to evaluate and forecast the effects of policy changes on commercial activities that involve tariff rates and non-tariff incidences. The results include trade creation, trade diversion, total trade, price, revenue, welfare, employment, GDP, and trade balance. This study covers the following variables.

Trade volume (export and import): Import means the value of imports of commodities from supplier to destination at CIF (cost, insurance, and freight) prices. Export means the value of exports of the commodity from supplier to destination at FOB (free on board) prices.

Trade balance: It is the difference between exports and imports. A trade surplus means exports are more than imports. A trade deficit means imports are more than exports.

Economic indicator: It is the GDP in the region and measures the size of the economy.

Trade creation: It is the increase of demand for commodity A (e.g., coffee) in country B (e.g., Tanzania). This occurs when there is a decrease in the price of that commodity due to changes in tariff or non-tariff measures of similar commodities in another country (e.g., Kenya). Likewise, the trade creation (loss) can be the changes in the price level of domestic demand (Kenya) in comparison to the import price level of trading partner (Tanzania), which is caused by tariff or non-tariff changes.

Trade diversion: It happens when an importer (Tanzania) substitutes commodities from Kenya to Uganda when there is a price increase in Kenya caused by tariff changes. Thus, Tanzania will tend to buy more goods from Uganda than Kenya and create trade diversion.

Total trade effect: It is the net effect in each market for every trading partner. It is obtained by summing the trade diversion and trade creation effects.

Welfare effects: They are the advantages that consumers in importing nations/regions get from a decrease in domestic prices. Lower prices are led by the removal or reduction of tariff and non-tariff barriers and hence, provide welfare gains to consumers.

Tariff (An ad valorem tariff): It is the tax charged on imports that is usually in the form of a fixed percentage value.

2.7. Objectives of the Study and Expected Outcomes

Table 2.2. summarizes the objectives of the study and the expected outcomes.

Table 2.2. Objectives and Expected Outcomes

Objectives	**Expected outcomes**
To analyze whether there are any changes in the trade volume and trade balance in the SSA regions before and after the trade war	+
To examine the economic indicators that have been affected in the SSA countries by the trade war.	+
To investigate whether the trade war created trade diversion and trade creation in the SSA regions.	+
To analyze other effects of the trade war, including economic welfare.	+
To identify which sectors have been affected the most by the trade war.	+

Table 2.3. A Summary of the US-China Trade War Studies Held with Different Methodologies

Author(s)	Countries	Research Objectives	Methodology	Variables	Findings
Alim Rosyadi & Widodo (2018)	US-China	Analyzing the effect of the US and China trade war on the global economy.	GTAP model and database	Tariff, welfare, GDP, trade balance, terms of trade	The trade war creates diversion effects and reduces the unilateral relationship between the US and China.
Bown (2019)	US-China	The assessment of what happened between the US and China in 2018	Secondary data (1980-2018) Time series analysis Descriptive statistics	Tariff, import, export, FDI	The US started a trade war to fix the old rules and strategies. The aim was to fix future international cooperation.
Carvalho et al. (2019)	US-China, emerging countries	Examining the effects of the US-China trade war on emerging countries.	GTAP model and database	Tariff, production, exports, imports, trade, balance, welfare	The war increases the US domestic production and reduces the US trade deficit. The tariff burden is shared by consumers and producers. Some emerging countries experience positive effects caused by the trade diversion and creation effect in sectors in that they have comparative advantages.
Chong & Li (2019).	US-China, EU, ASEAN countries South Korea, Japan, Taiwan	Studying the historical point of view of the trade war between the US and China	Secondary data Scenario analysis	Tariff, import, export	The trade war does not cause catastrophic effects in China. China will lose 1% of its GDP and 1.1% of its jobs in the worst-case scenario.
Ernst et al. (2019).	G20 + China-US	Discussion of the evolution of trade barriers over the past decade.	Survey of recent publications on trade war	Tariff, Import, Export, employment	The trade war between the US and China does not solve trade imbalances and employment problems. The negative direct effects on the labor markets still exist. The war is likely to have negative consequences on the labor market.

Table 2.3. (cont.)

Author(s)	Countries	Research Objectives	Methodology	Variables	Findings
Evans (2019)	US-China	To examine how trade war affects the US and China and the global economy.	Secondary data. A deadweight loss, Herberger's triangle	Tariffs, consumers, producers, investors, businesses	The trade war causes welfare loss due to increases in prices, and export costs for firms, causing panic in investors.
Fabricius (2018)	US-China, South Africa	The effect of tariffs imposed by the US on China on the job market in the steel and aluminum sectors in South Africa	Opinion paper	Tariff, Import, export, employment	The tariffs introduced by the US could cause a loss of thousands of jobs in the steel and aluminum sectors in South Africa.
Fofack (2018)	Africa	The assessment of Africa's growth prospects in the short and medium term.	Secondary data, time series analysis. Descriptive statistics	Tariff, GDP, import, export	The African Continental Free Trade Area shows a better future. There seems to be an acceleration of structural transformation, economic integration, and diversification of exports of African economies
Furceri et al. (2018)	151 countries, including 34 advanced and 117 developing ones.	Analysis of the effects of tariffs on GDP, productivity, unemployment, inequality, and trade balance.	Annual data, 151 countries (1963-2014) Local projection method and Vector Auto regression model	Tariff, GDP, productivity, unemployment, inequality, trade balance	Tariff increases do not improve the trade balance. In the medium term, the rise in tariffs reduces output and productivity. It also increases unemployment and inequality.
Fusacchia (2019)	US-China, Germany, France, Italy	Assessment of the effects of the tariffs implemented by the US and China on global value chains, with a focus on the major EU economies.	GTAP database, Computable general equilibrium model	Tariff export, import, domestic prices, supply, demand	The trade war between the US and China strengthens the relationship between EU countries and the US.
Goulard (2020)	US-China, EU	Studying the outcome of the US and China trade war on the EU market.	Literature paper	-	The war does not only affect the US and China but also causes a major disruption in global trade. Other countries gain due to trade diversion.

Table 2.3. (cont.)

Author(s)	Countries	Research Objectives	Methodology	Variables	Findings
Itakura (2020)	US-China, Japan, Hong Kong, Korea, Taiwan, Singapore, Indonesia, Philippines, Malaysia, Thailand, Vietnam, Australia, New Zealand, India	Evaluation of the economic effects of the US-China trade war.	GTAP model and database	Tariff, Import, GDP, investment, productivity.	The negative effects of the trade war are experienced by the US and China trade partners. It reduced the world GDP by USD 450 billion.
Kalendienė & Loda (2019)	Russia, Latvia, Poland, Germany, US, Netherlands, Estonia, Italy, Sweden, Belarus, France, UK, Belgium, Ukraine, Norway, China, Denmark, Kazakhstan, Finland	Assessment of the effect of China and the US trade war on the export of the largest trade partners of Lithuania.	Secondary data (2014-2019) Gravity model	Tariff, import, export, consumer price index, commodity Terms of Trade	Out of Lithuania's largest trade partners, only Netherlands and Denmark are positively affected by the US and China trade war.
Kempa & Khan (2019).	The US and 25 countries	Analysis of international spillover effects of US trade restrictions, modeled as a reduction of US imports.	Quarterly secondary data from1992Q1 to 2017Q4 GVAR model	Real exports and imports, GDP, real exchange rate, and the Brent crude oil price	The trade restrictions deteriorate the US trade balance in the long run while the rest of the world trade balance improves. The opposite is true in the short run.
Kraciuk (2019)	US-China, Canada, Mexico, Japan, UK	Evaluation of the potential effects of tariff conflict on mutual trade	Secondary data (1980-2017) Descriptive statistics	Tariff, import, export	The increase of 25% tariff by the US to China will reduce Chinese exports to the US and hence reduce the US trade deficit. China can minimize its trade loss by taking retaliatory action toward the US.

Table 2.3. (cont.)

Author(s)	Countries	Research Objectives	Methodology	Variables	Findings
Li et al. (2018)	Australia, Bahrain, Brazil, Brunei, Canada, Chile, China, EU, India, Indonesia, Japan, Korea, Kuwait, Malaysia, Mexico, New Zealand, Oman, Papua New Guinea, Peru, Qatar, Philippines, Russia, Saudi Arabia, Thailand, Singapore, the united arab Emirates, the US, Vietnam, and the rest of the world	Who is the winner of the trade war between the US and China?	Input-output/social accounting matrices data, CGE modeling	Tariff and non-tariff import, export, GDP, exchange rate, employment, welfare, trade	The US wins the trade war under the condition of unilateral sanctions; however, losses when China retaliate. When there is a mutual trade agreement, China losses more than the US. Other countries gain in terms of trade and welfare, but at the same time, it costs their manufacturing employment and a reduction in GDP.
Li et al. (2020).	US-China, Asian countries	To assess the impacts of the trade war on Asian countries.	Input-output/ social accounting matrices data, CGE model	Tariff, export, import	The increase in tariff decreases the welfare of the US and China by 0.2% and 1.7%, respectively. The exports and imports of China with the US are reduced by 52.3% and 49.3%, respectively. The tariff changes also cause a diversion effect to Asia and other countries.
Liu & Woo (2018).	US-China	Analysis of the causes of the trade war in early August 2018 between China and the US	Secondary data (a) purchasing power parity, and (b) price elasticity approaches	Exchange rate, import, export, GDP	China's trade and investment with the advanced economies should be based on reciprocity. The US should differentiate economic and strategic competition on trade matters.

Table 2.3. (cont.)

Author(s)	Countries	Research Objectives	Methodology	Variables	Findings
Lyman (2014)	US-China, Africa	The discussion of whether China and the US's relationship in Africa creates an opportunity for cooperation.	Literature paper	-	China has political and commercial challenges for the US, but it is not considered a threat by the US in Africa.
Mahadevan & Nugroho (2019)	US-China, RCEP ASEAN and non-ASEAN members	Examine the effects of the Regional Comprehensive Economic Partnership (RCEP) in the presence of a trade war between the US and China.	CGE-GTAP database	Tariff, import, export, GDP, welfare	The trade war between the US and China creates trade diversion to the RCEP member states. Globally, the war causes negative effects.
Mao & Görg (2020).	US-China	Investigating the indirect effects of tariff increments on China and the US trade partners.	Secondary data A cumulative tariff	Tariff, Import	The US and China trade partners are affected by the trade war and can economically help in solving the ongoing war.
Ndzendze (2020)	The US-China and African countries	Assessment of the trade dynamics between the African continent and China since the outbreak of the trade war	Secondary data from Trade Map database (2017–2019) Descriptive statistics	GDP growth, export, import	There was a decline in the pattern of growth in the African region in 2018 and 2019. During the same time, Asia, Latin America, and the Caribbean had continuous growth.
Nicita (2019)	China and US	Examining the impact of the US tariffs on China's imports.	Dichotomous logistic regression	Tariff, Import, export	The tariff war caused a reduction in imports by 25% in the US. The Chinese exports to the US diverted to other countries, including Taiwan, Mexico, Vietnam, EU. Both China and the US are negatively affected. The US effects are more on the rise of consumer prices, while in China, the losses are associated with import reduction.

Table 2.3. (cont.)

Author(s)	Countries	Research Objectives	Methodology	Variables	Findings
Olayungbo (2019)	US-China, Algeria, Angola, Egypt, Gabon, Nigeria, Tunisia.	The examination of the effects of the trade war between the US and China on oil exporting African countries.	Secondary data (1970-2017) GVAR (Dickey fuller unit root test, Johansen co-integration test, Granger causality)	Tariff, exchange rate, GDP, export, import, foreign output	The trade dispute between the US and China has positive and negative consequences for different nations. In the long run, it has positive effects on the export of oil for Algeria, Gabon, Egypt, and Angola and negative effects on Tunisia and Nigeria.
Pencea (2019)	US, China, South-East Asia, EU	To look at the evolution of the US-China economic relations from the multi-dimensional perspective	Secondary data, Descriptive statistics	Tariff, export, import,production, consumption	In the long run, there are no winners from the trade war between the US and China.
Scheipl et al. (2020)	US-China, Australia	Analysis of the outcome of the trade war between the US and China on steel sector companies in Australia.	Expert interviews, secondary data, regression analysis	Tariff, imports	The trade war does not only affect the US and China but other parties like the EU. Firms can use strategies that involve their products and competitors to minimize the negative effects of the trade war.
Semin et al. (2019).	US-China, Russia, Poland, Turkey, Taiwan, Thailand, and South Africa.	Assessment of the impact of China- the US trade war on Russia, Poland, Turkey, Taiwan, Thailand, and South Africa	Expert evaluation method, Descriptive statistics, regression analysis	Trade duties, import, export, GDP growth, Industrial Production Index, FDI, Stock Index, and national currency growth rate	The trade war between the US and China has negative effects on import growth and positive effects on the growth rates of exports, industrial production, and foreign investment of Russia, Taiwan, Turkey, and Poland.
Siriwardana & Yang (2008)	Australia-China	Analysis of the proposed Australian-China Free Trade Agreement.	GTAP model and database	Tariff, GDP, import, export, trade balance, terms of trade, real consumption	The agreement increases bilateral trade; however, Australia gains more. The agreement positively affects GDP, welfare, and consumption. The sectorial results do not have a clear direction.

Table 2.3. (cont.)

Author(s)	Countries	Research Objectives	Methodology	Variables	Findings
Sousa et al. (2019)	US-China	The dimensions of a model to potentiate the US-China firms	Bibliometric research (2015-2019)	-	The US and China firms have physical, sociocultural, political-legal, economic, and technological challenges to overcome.
Steinbock (2018)	US-China	Understanding the global effect of the US and China trade war.	Secondary data Descriptive statistics	Tariff, import, export, GDP	The trade war is a reflection of the post-cold war. The global economic scenarios of the war are now feasible.
Teimouri & Raeissadat (2019)	US-China, ASEAN countries	Evaluation of the impact of China and the US trade war on ASEAN countries.	Secondary data Descriptive statistics	Tariff, import, export	The US tariff does not significantly affect the ASEAN economies. However, different ASEAN sectors are affected, especially those that have the highest trade volume with both the US and China.
Xia et al. (2019)	US-China	To what extent does the dispute between China and the US affect energy markets?	Input-output/social accounting matrices, Multi-country input-output model	Tariff, import, export, GDP, Consumer Price Index, productivity.	The trade war affects both the US and China even though China suffers more. There is a major reduction in the demand for energy in the US and China. In the short run, the global economy faces negative effects.
Анненков (2019)	Brexit-Countries	Estimation of the Brexit economic outcome on the trade and economy of the UK.	GTAP model and database	Tariff, GDP, welfare, import, export	The UK lost and must use other trade partners to subsidize the loss. The effects are shared by the UK, EU, and world trade partners.

CHAPTER III

DATA AND RESEARCH METHODOLOGY

3.1. Introduction

This study adopts a positivist philosophy, applies quantitative tools, and uses a deductive approach. This approach fits in this study because we simulate the impact of tariffs on trade wars by using different tariff scenarios. The deductive approach also enables to present of the facts quantitatively and uses the GTAP model to generalize the findings. We adopt a standard Computable General Equilibrium Model (CGE- GTAP) to simulate the scenarios.

3.2. Conceptual Framework

The conceptual framework of this study is adapted from the structure of CGE models developed by Lofgren et al. (2002), as shown in Figure 3.1. The study focuses on the impacts of tariff changes on imports, exports, trade balance, GDP, trade diversion, trade creation, and welfare in SSA countries. The model can be divided into three stages.

- The first stage is the *production stage*. It involves domestic and exported products.
- The second stage is the *distribution* of products to different markets**.**
- The last stage is the *consumption* of the products.
- The connection from one stage to another is explained by the arrows that use different assumptions and functions. They are *CD, CES, or fixed function* for the production stage and *CET function* from the production stage to the markets/distribution stage. Finally, there is *an imperfect substitutability Armington function* from the distribution stage to the consumer stage.

- *Stage One - Production Stage:* According to Figure 3.1, this stage involves *factors and intermediate inputs of production.* To produce, firms need resources, i.e., *factors of production* (labor, land, and capital) and *intermediate inputs* (raw materials). These resources determine the quality and quantity of outputs. Hence, they are combined by the *CD* (Cobb-Douglas), i.e., the inputs describe the outputs, *CES* (Constant Elasticity of Substitution), i.e., changes in the inputs results in the constant change in the output, or *fixed function* (fixed inputs that are used to produce a fixed quantity of output).
- *Stage Two – Market/Distribution Stage:* Once the goods are produced at stage one, they are distributed to the *domestic and foreign* markets through a *CET* (Constant Elasticity of Transformation) function, which assumes that the goods consumed at the domestic market and the goods exported are not the same. Thus, producers need to upgrade the products before they export.
- *Stage Three – Consumption of Goods:* The goods at *the domestic* market are usually combined with *imports*, making total domestic *consumption*. This combination is executed through the assumption of *imperfect substitutability (Armington function).* This function shows that the goods that are imported cannot be substituted with the goods produced and consumed at the domestic market since they have different features. The goods are also differentiated due to their country of origin. The total consumption is held by *households*, *government*, *investment*, or *intermediate use* for production. Finally, the model shows the *trade balance*.

In summary, the structure of the CGE model shows how policy changes affect everything in the economy. According to the model, when the government changes tariffs, exports, imports, prices, producers, consumption, employment opportunities, production capacity, households, investors, and people's welfare are affected.

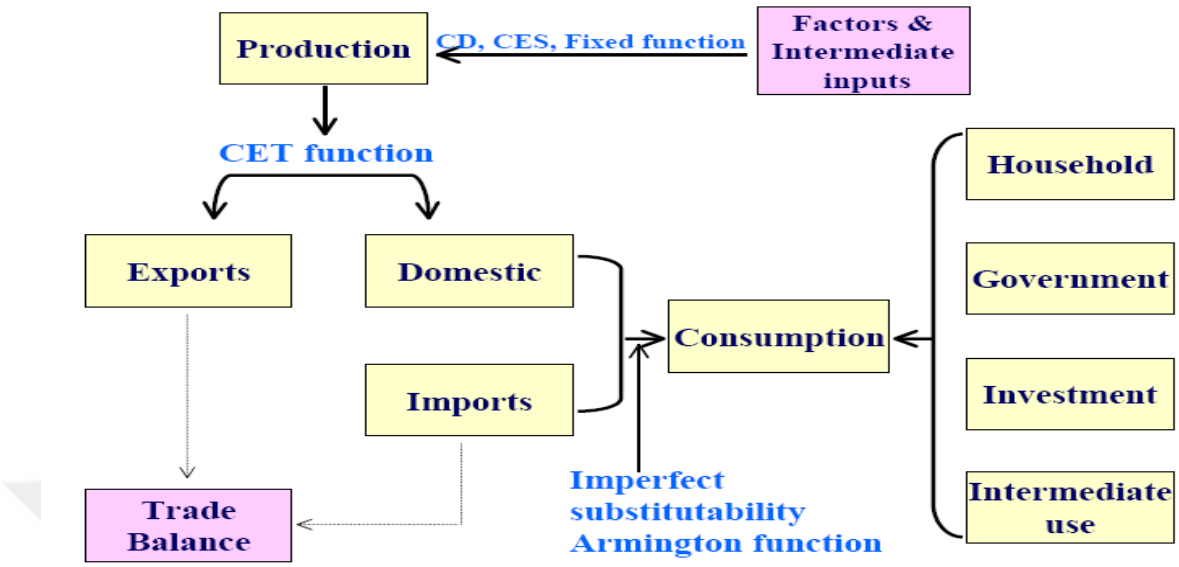

Figure 3.1. Conceptual Framework

Source: Lofgren et al. (2002)

A standard computable general equilibrium (CGE) model in GAMS

Computable general equilibrium models produce output for many variables. Based on the research objectives, researchers only focus on the variables that are relevant to their studies. Table 3.1 presents the definition and measurement of the variables in this study.

Table 3.1. Definitions and Measurement of the Variables

Variable	Code	Definition of the variable	Measurement of variable	Source
Tariff rate	TMS	(Ad valorem) Tax paid on exported or imported goods and services	Percentage increase/decrease in taxes	GTAP Website
Import	VCIF/VMSB	Value of imports from supplier to the destination at CIF prices	USD Million	GTAP Website
Export	VXW/VFOB	Value of exports from supplier to the destination at FOB prices	USD Million	GTAP Website
Gross Domestic Product	GDP	Gross domestic product in the region	USD Million	GTAP Website

Table 3.1. (cont.)

Trade diversion and creation	TC/TD	Trade creation is the replacement of expensive domestic production by cheaper imports from partner countries. Trade diversion is the decrease in trade following the formation of a trading bloc as trade with low-cost non-trading bloc members is replaced by trade with relatively high-cost trading bloc members.	USD Million gained/lost by traded countries	GTAP Website
Trade balance	TBAL	The balance between exports and imports	USD Million	GTAP Website
Consumer welfare	EV	Individual benefits are derived from the consumption of goods and services.	Equivalent variation in USD Million	OECD Website

3.3. Computable General Equilibrium CGE - GTAP Model

Tariffs have direct and indirect effects on trade and the costs of goods and services. Thus, the analysis of tariff changes helps to examine the effects of possible scenarios on industries, producers, and consumers (Karing et al., 2005, 2006). The analysis of trade policy changes using the CGE model encompasses different industries and countries/regions. It examines the effects of the policy instrument on the factors of production and the relative prices at the national and international levels (Karing et al., 2005).

GTAP model is an input-output, multi-regional, multi-sectorial CGE model that deals with comparative analyses related to the changes in the factors of production and inter-sectorial production (Adams et al., 1998). It focuses on resource reallocation between industries after the trade policy modifications (Karing et al., 2006). General equilibrium models are primarily known for their features in dealing with multiple industries. The GTAP model is based on the neoclassical theory developed by Hertel (1997) and later modified by Corong et al. (2017) and Aguiar et al. (2019) a. It involves multi-regional and multi-sectoral dimensions related to trade policies such as quantitative restrictions, ad valorem

taxes, and tariffs (Adams et al., 1998; Ahmed, 2011; Karing et al., 2006). The GTAP model analyses the variables that are affected by trade policy changes. Some of these variables are welfare distribution, trade, prices, and factors of production, output, and unemployment. The model can explore trade creation and trade diversion.

GTAP model is composed of the Leontief function and nested constant elasticity of substitution (CES) that represent the production technology in levels (Ahmed, 2011; Sulamaa & Widgrén, 2005). First, at the highest level, there is a fixed proportion of primary factor and intermediate input bundles as required by the Leontief function. Second, at the middle nest, there is a combination of primary factors, domestic goods, and imported goods bundles, that creates intermediate input bundles in the form of CES. The model assumes that technology is separable between the intermediate and primary factors, enabling the firm to choose and mix the factors that maximize Profit. It also allows equal elasticity substitution of factor inputs. Hence, each sector and region may select the factors that maximize inputs and minimize costs. The regional income in GTAP includes the constant share of national savings, private consumption, and government spending. The constant difference elasticity demand represents the utility and brings constraints that optimize the behavior of consumers. Further, the Cobb-Douglas distribution represents total government spending that is distributed across goods (Ahmed, 2010, 2011; Анненков, 2019; Siriwardana & Yang, 2008; Sulamaa & Widgrén, 2005).

The factors of production in the GTAP model have international perfect capital mobility that has the same income despite their location (Ahmed, 2011; Siriwardana, 2001). The model assumes that markets are perfectly competitive. The prices are equal to marginal costs. Consumers differentiate the products that are domestic and imported (Siriwardana & Yang, 2008). The factors of production in the GTAP model are natural resources, land, labor, and capital goods. The land is assumed to be for the agricultural sector only, while capital can be traded globally. Land and labor are immobile throughout countries. These assumptions of the model give users a chance to select independent variables (Sulamaa & Widgrén, 2005). The model also differentiates the factors that are sluggish in adjusting

and perfectly mobile[2]. The supply of capital is mobile, while the supply of land and labor is immobile (Ahmed, 2010). However, the assumption of capital mobility between countries and the flexibility and fixed characteristics feature of real wages for the labor market limits the uses of the GTAP model for the short-run analysis of trade policy impacts since policy modifications can lead to poor application of labor and capital (Dixon et al., 2019).

3.4. GTAP Model and Database

The GTAP model is simplified by using graphics, as shown in Figure 3.2. (Brockmeier, 2001). Ahmed (2010) argued that each region in the GTAP model originated from the ORAN model, which is an Applied General Equilibrium (AGE) model. ORAN model was developed to check regional single general equilibrium (Dixon & Parmenter, 1996). Hence, it lays the foundation of behavioral equations that captures the GTAP model. The equations involve international trade (imports and export equations) and consumer behavior equations. GTAP model also captures accounting relationship equations that ensure consistency between macroeconomic variables (GDP, unemployment, international trade) and behavioral equations. The accounting relationship equations create balance and consistency in terms of expenditures and receipts.[3] (Ahmed, 2010). The behavioral and accounting equations and their derivation by the GTAP model are covered by Hertel (1997). In the GTAP model, the behavioral sub-models of production, government spending, consumption, and trade activities are incorporated into the general equilibrium. The incorporation of these sub-models involves some assumptions, i.e., demand, global service, production, and trade assumptions (Li et al., 2016).

[2] "A sluggish factor is partially mobile across sectors and is modeled according to a CET function with a degree of mobility governed by the elasticity of transformation ETRAE. The factor returns also vary by endowment type. Perfectly mobile factors receive uniform returns across activities (i.e., an economy-wide price), while returns to sector-specific factors vary by activity. The returns to sluggish factors depend on their mobility (i.e., sector-specific returns if immobile or an economy-wide return if perfectly mobile)" Aguiar et al. (2019, p.12) b.

[3]The receipt is the record that gives proof of financial transaction.

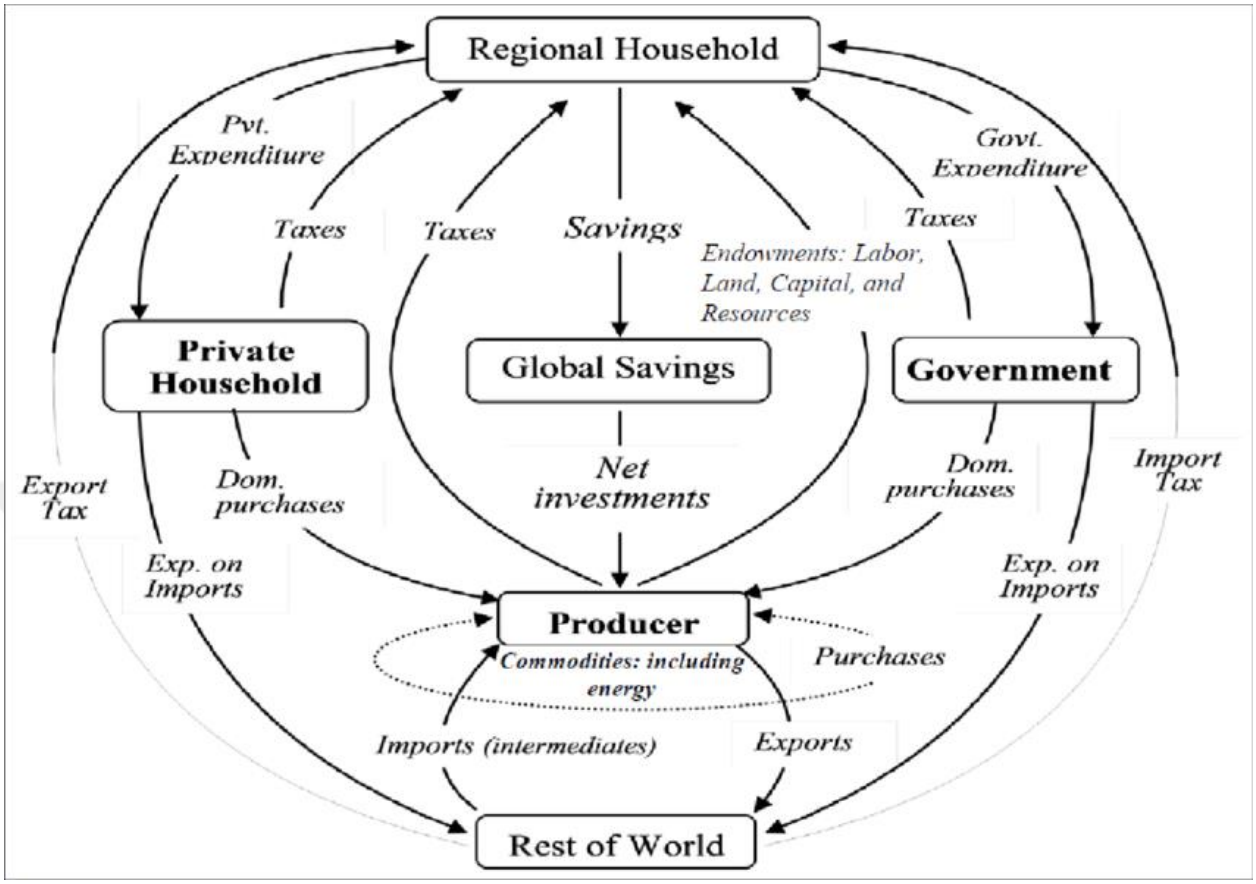

Figure 3.2. Structure of the GTAP Model

Source: Hertel and Tsigas (1997)

3.4.1. Assumptions of the GTAP Model

The GTAP model has some assumptions. *Demand assumption* includes deposit, government spending, and private consumption behaviors, whereby the utility function determines the citizen consumption distribution. The Cobb-Douglass response function is used to ensure a constant share of the consumption budget for regional residents. *Trade assumption* follows the assumption of Armington, who assumes that there is no substitutability element for goods produced in different countries. *The production assumption* is about the behavior of producers. It follows the Leontief production function whereby for a manufacturer to produce goods, the intermediate products and initial factor endowments are irreplaceable. The export and domestic products create intermediate

investment through CES (constant elasticity of substitution equation). Additionally, all factors of production are incorporated into the initial investment through CES. By Cobb-Douglas utility function, the GTAP model assumes that consumers spend their income (Brockmeier, 2001**).** Government spending, demands for imports, and domestic consumption are presented in the model by CES and Constant Difference of Elasticity (CDE). The last assumption is about *global services* comprising international transportation and global banking sectors. It assumes that the deposit of all countries makes the total global deposit, and this is equal to global aggregate investment (Li et al., 2016). This study adopts equations from the standard GTAP model 7 (GTAP V7).

3.4.2. Why GTAP Model?

This study employs the GTAP model that gives a comprehensive and accurate assessment of the trade war outcomes on national economies. The model uses the Armington elasticity that shows the degree of substitution of demand in different countries for similar products. We get the data from the GTAP 10. This database is rich due to the composition of trade transaction data from different industries (Gehlhar et al., 1997). Trade transactions in the database differentiate the regions of origins and destination of commodities and the source of agent, which includes government, investment, household, and intermediate demand (McDougall & Dimaranan, 2002). It is also associated with the GTAP model that incorporates behavioral and accounting-related equations, which enable it to be compatible with the data, hence making the simulation/analysis processes easy and straightforward.

According to the GTAP model, a home or local agent (importer) is responsible for the payment of import duties, while the buyers of commodities are subject to sales tax. Hence, the tariff expenses are charged through the import duties, and later, the buyers contribute to the tariff taxes by paying sales tax. The local supply from the production of commodities involves the exported products and the products that are used domestically.

The production of domestic and exported products needs intermediate inputs. These inputs involve five factors: skilled and unskilled labor, land, natural resources, and capital. These factors incur indirect taxes. The income from these factors is considered as household income that is then divided into government income, savings, and private household. The database divides tax into five categories; factors taxes, commodity (sales) taxes, production taxes, and import and export duties. Figure 3.1. shows how the GTAP model works, as explained by Hertel (1997) and simplified by Brockmeier (2001).

GTAP 10 is a global economic database that covers 121 countries, an aggregate of 20 regions, and a total of 65 industries that represent 98% of the world's GDP and 92% of the world's population. The database has four reference years: 2004, 2007, 2011, and 2014. The database includes tariffs, energy, emission, and macroeconomic data, bilateral trade data, and International Standard Industrial Classification (ISIC) and Cooperative Patent Classification (CPC). In this study, we use CGE - GTAP model and database to analyze whether the trade war between the US and China has created a trade diversion or creation has affected trade, GDP, trade balance, and consumer welfare of the SSA countries.

The GTAP model does not work like econometric models. In econometric analysis, the interpretations of the results are based on the estimations of the significance or non-significance of the variables. However, in the CGE models (GTAP model), the results provide the actual Value that shows the magnitude of the impact on the economy. It provides accurate results that can be used by policymakers to make reliable decisions since the results show to what extent a shock, i.e., a tariff shock, affects the economy. Scholars use this model to argue on trade wars, taxes, and many other issues. The GTAP model and its database use General Equilibrium Modelling Software (GEMPACK software) to calibrate the simulation of the scenarios. Even though the software involves many steps to come up with the solution, these steps ensure that the solution is accurate and precise. The calibration/analysis process of the CGE model is shown in Figure 3.3.

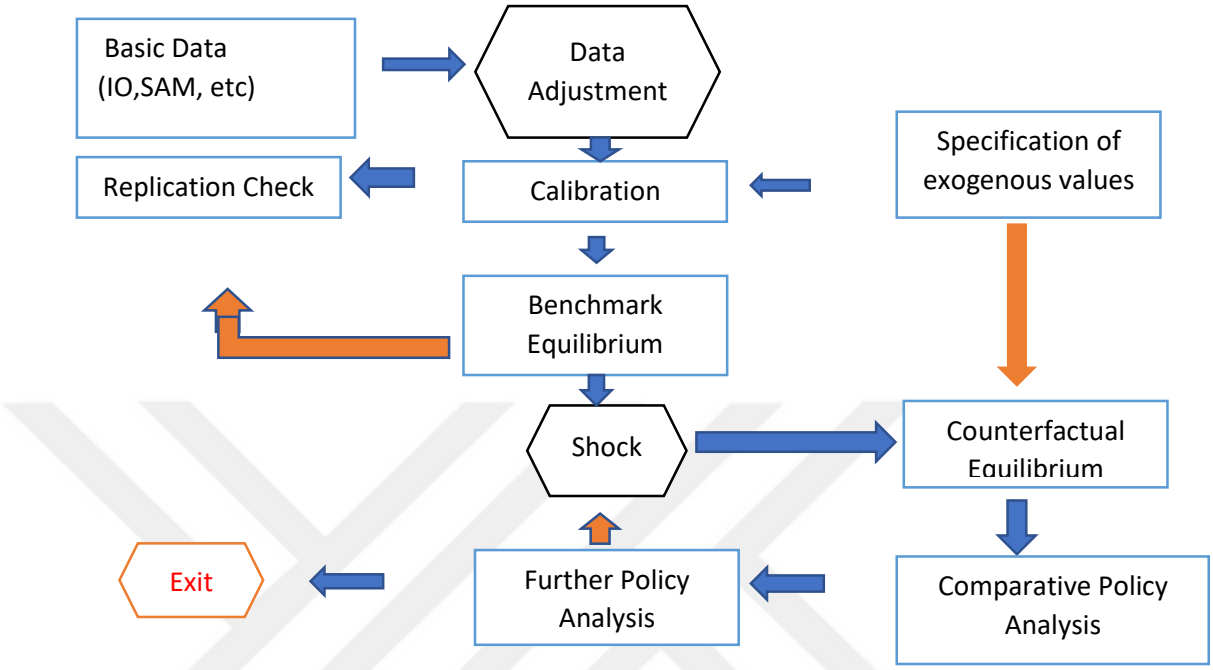

Figure 3.3. The Working Process of the CGE Model

Source: Shoven, J.B. and J. Whalley. "Applying general equilibrium" Surveys of Economic Literature, p. 104, 1998

Figure 3.3 shows how the CGE-GTAP model works. The model starts with the input-output data or Social Accounting Matrices data. The data are then adjusted. The adjustment involves the aggregation (Combining) of data according to country/countries/region as well as the industries/sectors. The aggregation process depends on which sectors or countries a researcher is working on. Then, the specification of exogenous variables is made clear, and the calibration/analysis process starts.

The results obtained gives initial results or benchmark equilibrium, which are later going to be compared with the new equilibrium after adding the shock (for example, a tariff shock). After the benchmark equilibrium, the tariff shock or any other shock is added, and then the new equilibrium is obtained. The comparative analysis can now be held by comparing the benchmark equilibrium and counterfactual equilibrium. After that, the sensitivity analysis could be done with respect to parameters or to shock.

3.4.3. Data

The study uses input-output or Social Accounting Matrix (SAM) data[4]. This type of data is comprehensive, gives the records of the whole economy, and captures the interdependence that exists between sectors. GTAP database uses SAM data that combine datasets for each region and aggregate trade bilateral data from different sources, i.e., UNCTAD, WTO, UNIDO, IMF, and WB. The trade protection data are in 6-digit Harmonised System (HS6) level, which is aggregated in trade weight obtained from the MacMap database and COMTRADE. The data include export, tariff revenue, bilateral data, and prices, among many others.

To analyze the data, we employ GEMPACK software and other related software that is incorporated into the GTAP model. The software includes RunGTAP for simulation purposes, GTAPAgg for aggregating the region/country, sectors, and factors of production, TABmate for viewing the model details and the equations, ViewHAR for viewing the data and the simulation results, and the charter for visualization purposes (Harrison & Pearson, 1996). The simulation/analysis involves stages shown in Figure 3.3. To make the calibration process possible, we aggregate the countries and sectors as shown in Tables A.6 and A.7. Figure 3.3 shows how the CGE-GTAP model works. The model starts with the input-output data. The data are then adjusted by aggregating them according to countries/regions and industries. We then define exogenous variables and start the calibration/analysis process.

The initial results are later compared with the new equilibrium results after adding the shock, i.e., tariff. After the initial equilibrium, the tariff shock is added, and then the new equilibrium results are obtained. Then, the comparative analysis is held by comparing the benchmark/initial equilibrium and counterfactual equilibrium. All stages are executed by using the software. In this study, we employ GEMPACK-related software (ViewHAR, TABmate, RunGTAP, GTAPAgg2). In the study, we aggregate 65 industries into four

[4] SAM is a broad database that includes economy-wide data, recording all transactions and interrelationships between sectors (economic agents) in a specific economy for a certain period.

categories, and the 121 countries and 20 regions are aggregated into 10 regions. The factors of production are aggregated into natural resources, land, capital, unskilled labor, and skilled labor. Natural resources, land, labor, and capital are set to have limited mobility in line with the assumption of Burfisher (2021) and Adams (2005).

3.5. Study Shock "Import Tariff (tms)"

GTAP model examines the trade flow effects of goods, industries, countries, and regions. The model treats private households using CDE assumption and involves international trade, transport margins, and the global banking sector that integrates world consumption and saving (Hertel, 1997). This study applies "a shock on import tariff (tms) of industry," which is implemented on the export of country r by country s. This shock directly affects import prices (pim) shown in Equation 1 and the import amount shown in Equation 3. This shock indirectly affects other variables, including factors of production (labor, capital, land, and natural resources), prices, consumer welfare, GDP, employment, and trade.

Equations (1) to (4) represents how this shock (import tariff shock) work[5]. The shock links the tariff on the imports of sector *i* in country *s*, which is imposed on the exports from country *r*. The changes in tariff shock *tms*, change the prices of the imported products given by country *r* to region *s*, which is *pms* (*i r s*). Thus, *tms* and the CIF, *pcif* make *pms* as shown in Equation 1.

$$tms(i,r,s) + pcif(i,r,s) = pms(i,r,s) \quad (1)$$

There are two direct outcomes due to the changes in the prices of domestic products for the imports of sector *i*. First, the effects on the total prices of imports of sector *i*, which affects the prices of imported products pim(i,s). The participation of each region in the imports of sector *i* (MSHRS) create pim as shown in Equation 2.

[5] The equations are written by Mark Horridge. They are available in RunGTAP software, and they can be viewed by using TABmate (GEMPACK-related software).

$$\sum MSHRS(i,r,s)x\ pms(i,r,s)pim(i,r,s) = pim(i,s) \quad (2)$$

Another effect caused by the changes in the prices of domestic products for the import sector is the change in the imports of the region/country that are affected by the changes in tariff. If there is a reduction in imports in the regions that are subject to the tariff, it creates an opportunity for the regions that are not affected by the tariff, known as qxs(i,r,s). qxs is the product of total imports of sector i in country s, the elasticity of the substitution between domestic and imported products i in country s, called esubm, and the difference between pms(i,r,s) and pms(i,s).

$$qim(i,s) - esubm(i)x\ \big(pms(i,r,s) - pim(i,s)\big) = qxs(i,r,s) \quad (3)$$

As a result, there will be a change in the production in the region which is caused by the demand directed toward domestic production. Thus, the effect of tms, i.e., tariff shock, is observed in the endogenous variables, i.e., pim, qds, qxs, qo, and pms. The changes in the values of these variables are compared to the baseline equilibrium and new equilibrium.

$$SHRDM(i,s)x\ qds(i,r,s) + SHRST(i,s)x\ qst(i,s) + \sum SHRXMD(i,r,s)x\ qxs(i,r,s) = qo(s) \quad (4)$$

The direct effects on import amount (qxs (i,r,s)) is shown in Equation 3, where the effects of reduced imports are experienced by the country that faces the tariff measures. The import amount (qim) is the accumulation of imports from s and sector i. This variable differs from domestic products by the assumption of elasticity of substitution (esubm).[6]

[6] tms- is the tax change on the imported product i from country r to country/region s, pms - domestic price for good i supplied from r to region/country s, pcif - CIF world price of commodity i supplied from r to s, pim - market price of composite import i in region s MSHRS- share of imports from r in import bill of s at market prices, qxs - export sales of commodity i from r to region s, esubm -elasticity of substitution between the imports and domestic products, SHRXMD is the share of export sales of product *i* provided by country *r* to region *s*, SHRDM is the share of domestic sales of sector *i* in the country *s*, SHRST is the share of sales of *i* to global transportation services in *s*, qxs are the exports of *i* from country r to region *s* (% variation), qo- is the output of sector *i* in country *s* (% change), qds is the domestic sales of *i* in region *s*, and qst is the sales of sector *i* to the international transport sector.

3.5.1. The Selection of the Study Tariff Changes Scenarios

In this study, the selected tariff scenarios are based on the following facts. In September 2018, the US increased tariffs on products by 10% which was equivalent to USD 200 billion. The Chinese government responded to that increase by raising the tariff of goods imported from the US by 5%-10%, which was equivalent to USD 60 billion. The 10% tariff increase was later followed by a 25% increase. Similar measures were taken by the Chinese government by imposing a 5% to 25% tariff. From June to August 2019, the US imposed a 25% tariff on USD 50 billion worth of Chinese exports. This tariff targeted the "Made in China 2025" products. The Chinese government imposed the same tariff, i.e., 25%, on the same products covered by the US (Zhang, 2020). In September 2019, the US imposed another tariff of 15% on Chinese products that were worth USD 75 billion. The Chinese government hit back with the same amount. The tariff imposed by the US and China keeps on-going from 2018 to 2021, ranging from 5% to 30%.

Brown and Kolb (2022) argued that even after the Phase One Trade Agreement, the US still increased tariffs by 5% on Chinese goods that are worth USD 250 billion. The tariffs after this agreement are more than six times as compared to the tariff before the trade war, indicating that the trade war is still ongoing. This six times accounts for 19.3% tariff equivalent to 66.4% of products exported to the US, while from China to the US, the average tariffs are 20.7% covering 58.3% of Chinese imports to the US (Brown, 2021). During the agreement, the Chinese government committed to buying more products amounting to USD 200 billion. However, as of February 2021, China bought only 59% of the agreed amount by purchasing only USD 94 billion worth of goods. Hence, the trade flow in China and the US is expected to divert to other trading partners.

Building on these arguments, the following tariff simulations are calibrated to answer the research questions:

i. The 10% tariff on Chinese products from the US and retaliatory measures from the Chinese government to the US.

ii. The 25% tariff on Chinese products from the US and retaliatory measures from the Chinese government to the US.

iii. 19.3% tariff on products exported from China to the US and 20.7% tariff on China imports to the US.

This study uses a baseline scenario assuming that there will be free trade in the global economy to compare the effects of the trade war before and after the tariff changes and differentiate this scenario from the aforesaid three scenarios. Table 3.2 is a summary of tariff changes between the US and China since the beginning of the trade war. This study only uses three scenarios out of all listed scenarios in Table 3.2.

Table 3.2. A Summary of the Tariff Scenarios Between the US, China, and Other Trading Partners

Tariff Description	**Imposing Country**	**Targeted Country**	**Import Tariff (Ad valorem)**
Current tariff	China	US	19.30%
Current tariff	US	China	20.70%
List of Chinese products worth USD 50 billion	US	China	25%
List of US products worth USD 50 billion	China	US	25%
Iron and steel	US	China, EU, India, and others	25%
Aluminum	US	China, EU, India, and others	10%
List of Chinese products worth USD 200 billion	US	China	10% later, 25%
List of the US products worth USD 60 billion	China	US	5%-10%, later 25%

CHAPTER IV

FINDINGS AND DISCUSSIONS

4.1. Introduction

This Chapter presents the effects of the trade war on the trade balance, export, import, trade diversion, trade creation, GDP, and welfare. It gives the results about the tariff changes, i.e., tariff simulation, by using three scenarios, i.e., 10%, 25%, and 19.2% / 20.7%. It also provides the findings for the export and import by region and commodity/sector.

4.1.1. Effects of the Trade War on Imports, Exports, and Trade Balance

The study findings show that in the SSA, the trade war improves the exports of all regions in all scenarios. However, the simulation results on a country basis show that Tanzania's exports are still the same before and after the trade war, meaning that the trade war has not affected the country's export volume. The most favorable scenario for the SSA is the second one. East Africa and ROEA regions perform better than the rest of the other regions. The export of the East African region increased by 0.013%, 0.025%, and 0.019% for scenarios 1, 2, and 3, respectively, and the export of the ROEA region increased by 0.010%, 0.025%, and 0.020% for scenario 1, 2, and 3 respectively.[7]. These results indicate a trade creation for the SSA. The country findings show that Ethiopia is ahead of other countries, followed by Kenya, Tanzania, Ghana, Nigeria, and South Africa.

In scenario 1, the findings show that the exports of the West Africa and ROSA regions are positively affected by a similar percentage (0.009%), followed by ROWA (0.008%).

[7] The percentage values are calculated based on the 2014 data in GTAP 10 database.

Further, the export of the South Africa region increased by 0.007%, hence being the least beneficiary region in terms of exports. The issue of South Africa having small gains in terms of exports due to the trade war is because the US tariff sanctions directly affected this region. Scenario 2 is the best scenario for the SSA. In this scenario, ROWA, East Africa, and ROEA have a higher percentage of exports (0.025%) over all regions. This is followed by West Africa with a 0.021% increase in export and South Africa and ROSA with a 0.020% increase. The findings for scenario 3 show that the exports of ROWA, ROEA, East Africa, West Africa, ROSA, and South Africa increase by 0.021%, 0.02%, 0.019%, 0.017%, 0.016%, and 0.015%, respectively. Nigeria records higher exports in country analysis with an increase in export by 0.009%, 0.023%, and 0.017% in scenarios 1, 2, and 3, respectively.

The trade war also increased the imports of the SSA regions. Similar to the export results, the most favorable scenario is the second one. The imports of all regions are positively affected by the trade war. The findings reveal mixed findings as the import percentage of some regions is more in specific scenarios, while in other scenarios, they perform lower. The percentage increase in the imports of the SSA shows that the imports of West Africa increased by 0.021%, 0.052%, 0.041%; ROWA by 0.017%, 0.042%, 0.034%; East Africa by 0.022%, 0.050%, 0.042%; ROEA by 0.020%, 0.050%, 0.041%; South Africa by 0.020%, 0.051%, 0.041%; and ROSA 0.017%, 0.043%, 0.035% for scenario 1, 2 and 3. Ethiopia, Nigeria, and Kenya record a high percentage of import values.

Although the increase in the imports of the SSA is a good indicator of consumer welfare, it slightly deteriorates the trade balance. One may notice that the increase in exports due to the trade war has given a chance to the companies in the SSA to produce more goods for export. Likewise, the increase in the imports of the SSA due to the diversion effect has provided an opportunity for the importing firms to increase the supply of goods in the domestic market, leading to an increase in consumer welfare.

The results are presented in Tables 4.1, 4.2, and 4.3. and Figure 4.1. Table A4 in the Appendix provides the results for the baseline values, while Tables A1, A2, and A3 present country results.

Table 4.1. The Effects of the Trade War on GDP Decomposed (Income and Expenditure), Export, Import, and Trade Balance by Region in Percentage Change for Scenario 1[8,9,10]

Scenario 1	China	US	West Africa	ROWA	East Africa	ROEA	South Africa	ROSA	ROA	ROTW	Total
Land	0.002	-0.058	0.011	0.000	0.031	0.020	0.000	0.000	0.010	0.014	0.006
Capital	-0.042	-0.020	0.011	0.012	0.016	0.015	0.013	0.012	0.013	0.016	0.003
Natural Resources	-0.018	0.034	0.007	0.000	0.000	0.000	0.018	0.011	0.005	-0.001	0.001
Labor (Skilled/Unskilled)	-0.041	-0.020	0.013	0.014	0.015	0.016	0.014	0.013	0.013	0.016	-0.001
Indirect Taxes	0.002	0.075	0.023	0.019	0.025	0.024	0.018	0.023	0.022	0.018	0.024
Household	-0.035	-0.014	0.013	0.016	0.017	0.017	0.015	0.013	0.014	0.017	0.004
Investment	-0.050	-0.044	0.023	0.023	0.023	0.025	0.032	0.031	0.020	0.032	-0.001
Government	-0.038	-0.014	0.012	0.019	0.013	0.014	0.014	0.012	0.014	0.017	0.005
Exports	-0.100	-0.123	0.009	0.008	0.013	0.010	0.007	0.009	0.009	0.012	-0.014
International Margins	-0.020	-0.021	-0.177	0.000	0.000	0.000	0.000	0.000	-0.026	-0.020	-0.020
Imports	-0.153	-0.142	0.021	0.017	0.022	0.020	0.020	0.017	0.016	0.023	-0.015
Total GDP	-0.034	-0.013	0.013	0.015	0.016	0.016	0.014	0.013	0.014	0.016	0.003
Total GDP (Absolute Value)	-3,513	-2,198	76	10	17	42	51	24	118	7,796	2423
Total GDP (Abs. Inflated Value)	4,457	2,789	96	13	22	53	65	30	150	9,892	3,074
Total Export	-0.098	-0.121	0.008	0.008	0.006	0.010	0.008	0.007	0.009	0.011	-0.015
Total Export (Absolute Value)	-2,485	-2,416	9	2	1	6	10	6	22	1,736	-3,107
Total Export (Abs. Inflated Value)	3,153	3,065	11	3	1.3	8	13	8	28	2,203	3,942
Total Imports (Percentage Change)	-0.153	-0.142	0.021	0.017	0.022	0.020	0.020	0.017	0.016	0.023	-0.015
Total Import (Absolute Value)	-3,185	-3,706	19	7	8	16	25	12	50	3,650	-3,106
Total Import (Abs. inflated Value)	-4,045	-4,707	24	9	10	20	32	15	64	4,636	-3,945
Trade Balance (Percentage Change)	0.053	0.019	-0.013	-0.009	-0.010	-0.010	-0.013	-0.008	-0.007	-0.011	0.000

[8] For all tables, the negative (minus) sign is a mathematical representation of a reduction in a particular variable. For instance, there is no negative export but a reduction in export by a certain amount (percentage or USD million). The opposite is true for the rest. That is, there is an increase due to the trade war.

[9] The absolute values are all in USD million, and all values (absolute and percentage values) are calculated based on the 2014 data in GTAP 10 database. See Appendix Table A4 for the baseline data.

[10] The absolute inflated values (USD Million) have a total inflation rate of 23.32% between January 2014-December 2022, and the average inflation rate is 1.27% per year (The calculations use the mean yearly CPI data of the US available at https://www.bls.gov/cpi/). The inflated values calculations use the formula/calculator available at https://www.bls.gov/data/inflation_calculator.htm

Table 4.2. The Effects of the Trade War on GDP Decomposed (Income and Expenditure), Exports, Imports, Trade Balance, and Welfare Decomposition in Percentage Change for Scenario 2

Scenario 2	China	US	West Africa	ROWA	East Africa	ROEA	South Africa	ROSA	ROA	ROTW	Total
Land	0.005	-0.141	0.033	0.000	0.062	0.040	0.102	0.060	0.030	0.034	0.016
Capital	-0.105	-0.048	0.028	0.031	0.036	0.037	0.032	0.030	0.032	0.040	0.007
Natural Resources	-0.045	0.083	0.014	0.000	0.000	0.015	0.018	0.028	0.010	-0.002	0.003
Labor (Skilled/Unskilled)	-0.102	-0.048	0.032	0.036	0.038	0.039	0.034	0.032	0.033	0.041	-0.003
Indirect Taxes	0.001	0.184	0.057	0.052	0.075	0.059	0.048	0.053	0.059	0.045	0.057
Household	-0.089	-0.034	0.032	0.040	0.041	0.040	0.036	0.033	0.034	0.041	0.010
Investment	-0.124	-0.108	0.058	0.059	0.056	0.061	0.078	0.078	0.051	0.079	-0.002
Government	-0.094	-0.034	0.032	0.038	0.038	0.037	0.035	0.033	0.034	0.042	0.012
Exports	-0.246	-0.301	0.021	0.025	0.025	0.025	0.020	0.020	0.023	0.029	-0.035
International Margins	-0.049	-0.051	-0.177	0.000	-0.092	0.000	0.000	0.000	-0.052	-0.050	-0.049
Imports	-0.377	-0.349	0.052	0.042	0.050	0.050	0.051	0.043	0.039	0.057	-0.036
Total GDP	-0.085	-0.031	0.031	0.038	0.039	0.039	0.034	0.032	0.033	0.040	0.008
Total GDP (Absolute Value)	-8,771	-5,368	188	25	43	103	125	58	290	19,216	5,909
Total GDP (Absol. Inflated Value)	-11,139	-6,817	239	32	55	131	159	74	368	24,404	7,504
Total Export	-0.242	-0.297	0.021	0.025	0.024	0.024	0.020	0.020	0.022	0.027	-0.036
Total Export (Absolute Value)	-6,108	-5,924	22	6	4	15	24	16	53	4,289	-7,602
Total Export (Absol. Inflated Value)	-7,757	-7,523	28	8	5	19	30	20	67	5,447	-9,655
Total Import	-0.377	-0.349	0.052	0.042	0.050	0.050	0.051	0.043	0.039	0.057	-0.036
Total Import (Absolute Value)	-7,823	-9,112	46	17	18	40	63	31	123	8,996	-7,602
Total Import (Absol. Inflated Value)	-9,935	-11,572	58	22	23	51	80	39	156	11,425	-9,655
Trade Balance	0.131	0.048	-0.031	-0.016	-0.025	-0.025	-0.031	-0.024	-0.016	-0.028	0.000
Welfare Allocative Efficiency	-1,658	-627	8	6	6	10	10	4	23	934	-1283
Welfare Allocat. Eff. Inflated Value	-2,106	-796	10	8	8	13	13	5	29	1,186	-1629
Welfare Terms of Trade (TOT)	-2,184	-904	20	4	6	11	18	8	22	2,998	-1
Welfare TOT Abs. Inflated Value	-2,774	-1,148	25	5	8	14	23	10	28	3,807	-1
Welfare Investment Saving (I-S)	254	-180	-2	0	2	2	0	-1	6	-81	0
Welfare I-S Abs. Inflated Value	323	-229	-3	0	3	3	0	-1.27	8	-103	0

Table 4.3. The Effects of the Trade War on GDP Decomposed (Income and Expenditure), Exports, Imports, Trade Balance, and Welfare Decomposition in Percentage Change for Scenario 3

Scenario 3	China	US	West Africa	ROWA	East Africa	ROEA	South Africa	ROSA	ROA	ROTW	Total
Land	0.009	-0.119	0.026	0.000	0.062	0.040	0.102	0.060	0.020	0.027	0.014
Capital	-0.080	-0.042	0.023	0.023	0.029	0.031	0.026	0.024	0.026	0.032	0.006
Natural Resources	-0.035	0.070	0.011	0.000	0.000	0.015	0.018	0.022	0.008	-0.002	0.002
Labor (Skilled/Unskilled)	-0.078	-0.042	0.026	0.032	0.030	0.031	0.027	0.025	0.027	0.033	-0.003
Indirect Taxes	0.009	0.140	0.045	0.039	0.050	0.047	0.036	0.038	0.047	0.036	0.046
Household	-0.067	-0.030	0.026	0.033	0.033	0.033	0.029	0.026	0.027	0.033	0.008
Investment	-0.096	-0.089	0.047	0.047	0.046	0.051	0.063	0.062	0.041	0.064	-0.001
Government	-0.071	-0.030	0.026	0.029	0.032	0.031	0.029	0.027	0.028	0.034	0.010
Exports	-0.196	-0.242	0.017	0.021	0.019	0.020	0.015	0.016	0.019	0.023	-0.028
International Margins	-0.039	-0.039	-0.177	0.000	0.000	0.000	0.000	0.000	-0.026	-0.039	-0.039
Imports	-0.302	-0.281	0.041	0.034	0.042	0.041	0.041	0.035	0.032	0.046	-0.028
Total GDP	-0.064	-0.028	0.025	0.032	0.032	0.032	0.028	0.026	0.027	0.032	0.006
Total GDP (Absolute Value)	-6,594	-4886	152	21	35	84	102	47	233	15,544	4,738
Total GDP (Abs. Inflated Value)	-8,374	-6205	193	27	44	107	130	60	296	19,741	6,017
Total Export (Percentage Change)	-0.193	-0.238	0.017	0.017	0.018	0.019	0.015	0.016	0.018	0.021	-0.028
Total Export (Absolute Value)	-4,865	-4753	18	4	3	12	19	13	43	3,460	-6,044
Total Export (Abs. Inflated Value)	-6,179	6,036	23	5	4	15	24	17	55	4,394	-7,676
Total Import (Percentage Change)	-0.302	-0.281	0.041	0.034	0.042	0.041	0.041	0.035	0.032	0.046	-0.028
Total Import (Absolute Value)	-6,265	-7,318	37	14	15	33	51	25	99	7,266	-6,044
Total Import (Abs. Inflated Value)	-7,957	-9,294	47	18	19	42	65	32	126	9,228	-7,676
Trade Balance (Percentage Change)	0.106	0.039	-0.024	-0.013	-0.023	-0.022	-0.025	-0.019	-0.013	-0.022	0.000
Welfare Allocative Efficiency	-1,322	-487	6	5	5	7	8	3	18	740	-1,017
Welfare Alloc. Eff. Infla. Value	-1,679	618	8	6	6	9	10	4	23	940	-1,292
Welfare Terms of Trade (TOT)	-1,667	-799	15	3	5	9	14	6	17	2,396	-1
Welfare Terms of Trade Infl. Value	-2,117	-1,015	19	4	6	11	18	8	22	3,043	-1.27
Welfare Investment Saving (I-S)	202	-162	-1	0	1	2	0	-1	5	-47	0
Welfare I-S Inflated Value	257	-206	-1.27	0	1.27	3	0	-1.27	6	-60	0

Source: ROWA-Rest of West Africa, ROEA-Rest of East Africa, ROSA-Rest of South Africa, ROA-Rest of Africa, ROTW-Rest of the World

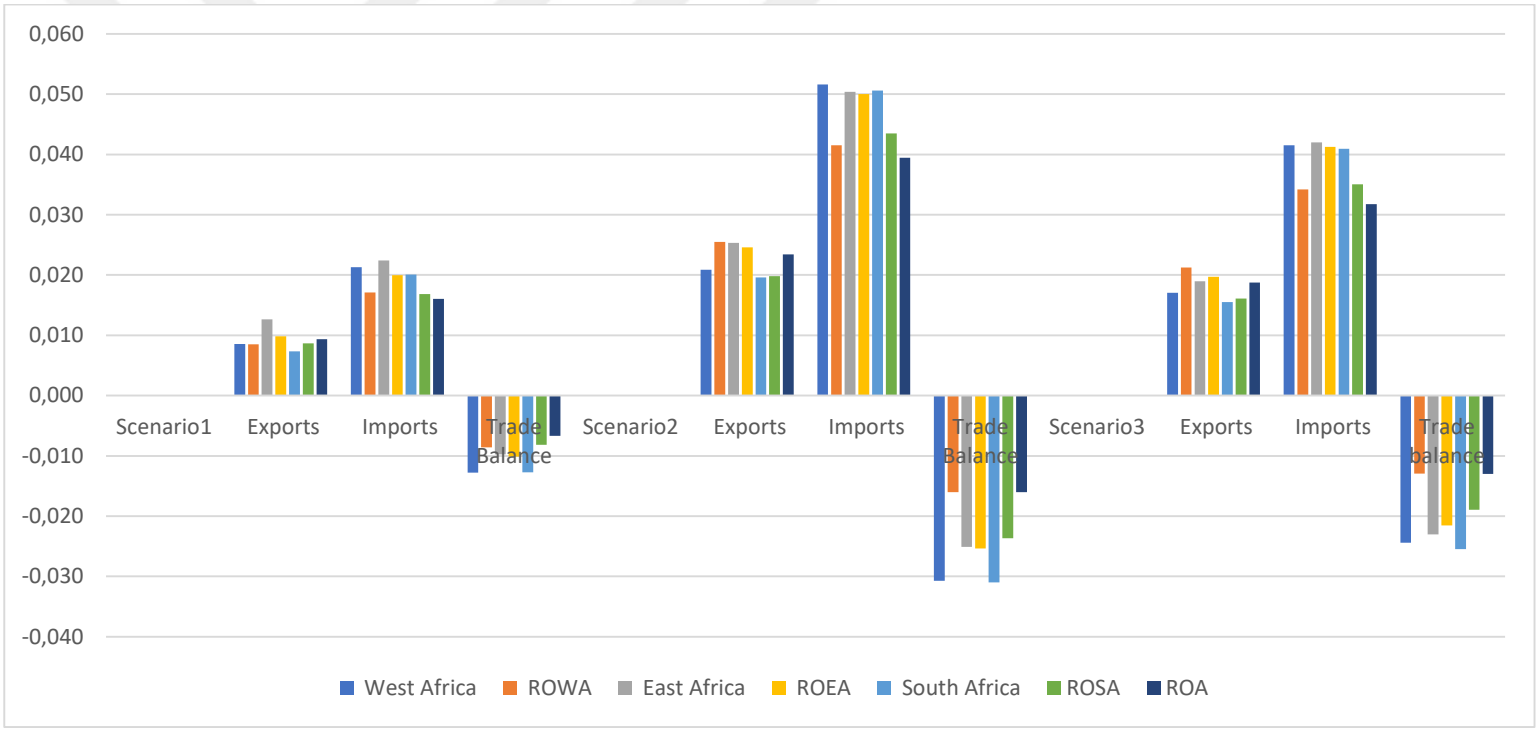

Figure 4.1. Export, Import, and Trade Balance in the SSA in Percentage Change for Scenarios 1, 2, and 3

4.1.2. Export and Import Volume by Regions and Sectors

This section presents the export and import sectorial results. We cover three sectors, i.e., food and agriculture, minerals and metals, and oil and gas, for each region and scenario. The sectorial results for exports reveal mixed findings.

4.1.2.1. Food and Agriculture Sector

The findings for the food and agriculture sector show that in all scenarios, all SSA regions experience an increase in exports. Only in scenario 1 the exports of East Africa and West Africa regions exports are not affected by the tariff war. In the ROSA region, the increase in exports is higher than in the other SSA regions (0.111%). ROWA (0.031%), ROEA (0.023%), and South Africa (0.017%) follow ROSA. When it comes to imports, the findings show that in scenario 1, East Africa followed by ROEA records, increased its imports in the food and agricultural sectors by 0.027% and 0.025%, respectively. West Africa (0.020%) follows them. South Africa and ROSA increase their imports by the same percentage (0.013%).

Similar to scenario 1, the findings for scenario 2 show that East Africa and ROEA have a higher percentage increase in imports than the other SSA regions by 0.055% and 0.050%, respectively. ROWA (0.044%) and West Africa (0.040%) follow them. ROSA and South Africa have a similar increase (0.026%) in the imports of food and agricultural goods. In scenario 3, East Africa (0.055%), South Africa, and ROSA (0.026%) have similar performances to scenario 2. The imports of West Africa and ROWA increased by a similar percentage of 0.03%.

4.1.2.2. Mineral and Metals Sector

Unlike the food and agriculture sector, the findings for exports in the minerals and metals sector have mixed results. Some regions were not affected by the tariff war, while other regions recorded a positive or negative change. In scenario 1, the exports of West Africa,

ROWA, South Africa, and ROSA have not changed, while East Africa and ROEA have a decrease in exports by -0.031% and -0.007%, respectively. In scenario 2, the exports of West Africa, ROWA, and South Africa were not affected by the trade war, while other regions experienced a decline in the exports of minerals and metals, East Africa by -0.031%, ROEA by -0.021%, ROSA by -0.013%. In scenario 3, the findings are similar to those in scenario 2 for West Africa and ROWA. Other regions have a decline in exports, East Africa by -0.031%, ROEA by -0.014%, and ROSA by -0.007%. However, in this scenario, South Africa has an increase in the exports of minerals and metals by 0.002%.

The findings for the imports show that in scenario 1, the trade war did not affect the imports of West Africa and ROWA. ROSA records a higher percentage of increase in imports by 0.021%, followed by East Africa at 0.019%, South Africa at 0.014%, and ROEA at 0.008%. In scenario 2, both South Africa and ROSA record similar results, a 0.041% increase in imports. East Africa (0.037%), ROEA (0.025%), and ROWA (0.023%) follow them. West Africa is the least beneficiary country, with an increase in imports by 0.018%. In scenario 3, the findings indicate that East Africa, South Africa, and ROSA record high percentage increases in imports by 0.037%, 0.034%, and 0.031%, respectively. West Africa performs lower (0.009%).

4.1.2.3. Oil and Gas Sector

The findings for the exports in the oil and gas sector show that the trade war has either increased the exports in some regions or has not affected some other regions. In scenario 1, the results show that the trade war has not affected ROWA, East Africa, and South Africa. Other regions have been positively affected. The exports of ROSA, West Africa, and ROEA in the oil and gas sector increased by 0.01%, 0.008%, and 0.007%, respectively. In scenario 2, the exports of East Africa and South Africa were not affected, although other regions experienced positive effects. ROWA and ROSA had an increase in exports by 0.024%, followed by West Africa (0.021%) and ROEA (0.02%). In scenario 3, similar to scenario 1, the exports of ROWA, East Africa, and South Africa were not affected. West Africa, ROEA, and ROSA record an increase in exports by 0.017%, 0.013%, and 0.019%.

When it comes to the imports in the oil and gas sector, the findings show that the trade war has positively affected the sector in the SSA except the ROWA region in scenarios 1 and 3 and ROSA in scenario 1, whose imports have not been changed. In scenario 1, the imports of East Africa and ROEA increased by 0.019% and 0.021%, respectively, followed by South Africa (0.013%) and West Africa (0.011%). Scenario 2 is the best scenario, particularly for East Africa and ROEA, as their imports increased by 0.037% and 0.031%, respectively. South Africa (0.026%), ROWA (0.025%), and West Africa (0.022%) follow them. For scenario 3, the imports of West Africa, East Africa, ROEA, and ROSA are precisely similar to scenario 2.

The country's sectorial findings show that the trade war creates an opportunity for some sectors. The mineral and metals sector in South Africa and the service sector in Ethiopia and Kenya encounter adverse effects on exports and imports due to the trade war. The adverse effects in the minerals and metals sector in South Africa are evident because South Africa was among the countries that were directly targeted by the US tariffs in the steel and aluminum sector. Nigeria is among the top producers of oil and gas in the SSA. Hence, it enjoys benefits before and after the trade war. South Africa also incurs positive effects in the food and agriculture sector in terms of export and import. The trade war affects more West and South African countries, while East African countries are affected less. Table 4.4 and Figure 4.2. show the sectorial results.

Table 4.4. Percentage Change in Sectorial Exports and Imports by Region

Scenario 1										
	Exports					Imports				
Country/Region/Sector	Food & Agri.	Mineral& Metal	Oil& Gas	Other Sectors	Total	Food & Agri.	Mineral& Metal	Oil& Gas	Other Sectors	Total
China	0.003	-0.090	0.106	-0.106	-0.098	-0.281	-0.125	-0.007	-0.177	-0.153
US	-0.222	-0.085	0.039	-0.132	-0.121	-0.082	-0.178	-0.005	-0.167	-0.142
West Africa	0.000	0.000	0.008	0.019	0.008	0.020	0.000	0.011	0.025	0.021
ROWA	0.031	0.000	0.000	0.018	0.008	0.015	0.000	0.000	0.019	0.017
East Africa	0.000	-0.031	0.000	0.013	0.006	0.027	0.019	0.019	0.028	0.022
ROEA	0.023	-0.007	0.007	0.020	0.010	0.025	0.008	0.021	0.024	0.020
South Africa	0.017	0.000	0.000	0.014	0.008	0.013	0.014	0.013	0.025	0.020
ROSA	0.111	0.000	0.010	0.017	0.007	0.013	0.021	0.000	0.019	0.017
ROA	0.009	-0.005	0.007	0.014	0.009	0.014	0.012	0.012	0.018	0.016
ROTW	0.011	-0.001	0.002	0.015	0.011	0.019	0.017	0.010	0.027	0.023
Total	-0.014	-0.017	0.006	-0.018	-0.015	-0.014	-0.017	0.006	-0.018	-0.015
Scenario 2										
China	0.010	-0.220	0.267	-0.262	-0.242	-0.690	-0.309	-0.016	-0.434	-0.377
US	-0.547	-0.212	0.097	-0.323	-0.297	-0.202	-0.437	-0.011	-0.410	-0.349
West Africa	0.019	0.000	0.021	0.056	0.021	0.040	0.018	0.022	0.063	0.052
ROWA	0.063	0.000	0.024	0.053	0.021	0.044	0.023	0.025	0.050	0.042
East Africa	0.034	-0.031	0.000	0.039	0.024	0.055	0.037	0.037	0.066	0.050
ROEA	0.054	-0.021	0.020	0.046	0.024	0.050	0.025	0.031	0.058	0.050
South Africa	0.050	0.000	0.000	0.035	0.020	0.026	0.041	0.026	0.060	0.051
ROSA	0.111	-0.013	0.024	0.050	0.020	0.026	0.041	0.018	0.048	0.043
ROA	0.028	-0.005	0.016	0.035	0.022	0.034	0.032	0.029	0.045	0.039
ROTW	0.027	-0.002	0.004	0.036	0.027	0.048	0.043	0.024	0.067	0.057
Total	-0.033	-0.042	0.016	-0.044	-0.036	-0.034	-0.043	0.016	-0.044	-0.036
Scenario3										
China	0.002	-0.176	0.202	-0.208	-0.193	-0.561	-0.243	-0.012	-0.349	-0.302
US	-0.449	-0.165	0.084	-0.260	-0.238	-0.168	-0.350	-0.010	-0.329	-0.281
West Africa	0.019	0.000	0.017	0.038	0.017	0.030	0.009	0.022	0.049	0.041
ROWA	0.063	0.000	0.000	0.035	0.017	0.030	0.023	0.000	0.043	0.034
East Africa	0.017	-0.031	0.000	0.026	0.018	0.055	0.037	0.037	0.052	0.042
ROEA	0.047	-0.014	0.013	0.036	0.019	0.041	0.025	0.031	0.048	0.041
South Africa	0.042	0.002	0.000	0.027	0.015	0.026	0.034	0.022	0.049	0.041
ROSA	0.111	-0.007	0.019	0.034	0.016	0.026	0.031	0.018	0.039	0.035

Table 4.4. (cont.)

	Exports					Imports				
Country/Region/Sector	Food & Agri.	Mineral& Metal	Oil& Gas	Other Sectors	Total	Food & Agri.	Mineral& Metal	Oil& Gas	Other Sectors	Total
ROA	0.018	-0.005	0.013	0.028	0.018	0.028	0.025	0.023	0.036	0.032
ROTW	0.023	-0.001	0.003	0.029	0.021	0.039	0.035	0.019	0.054	0.046
Total	-0.027	-0.033	0.013	-0.035	-0.028	-0.028	-0.034	0.013	-0.035	-0.028

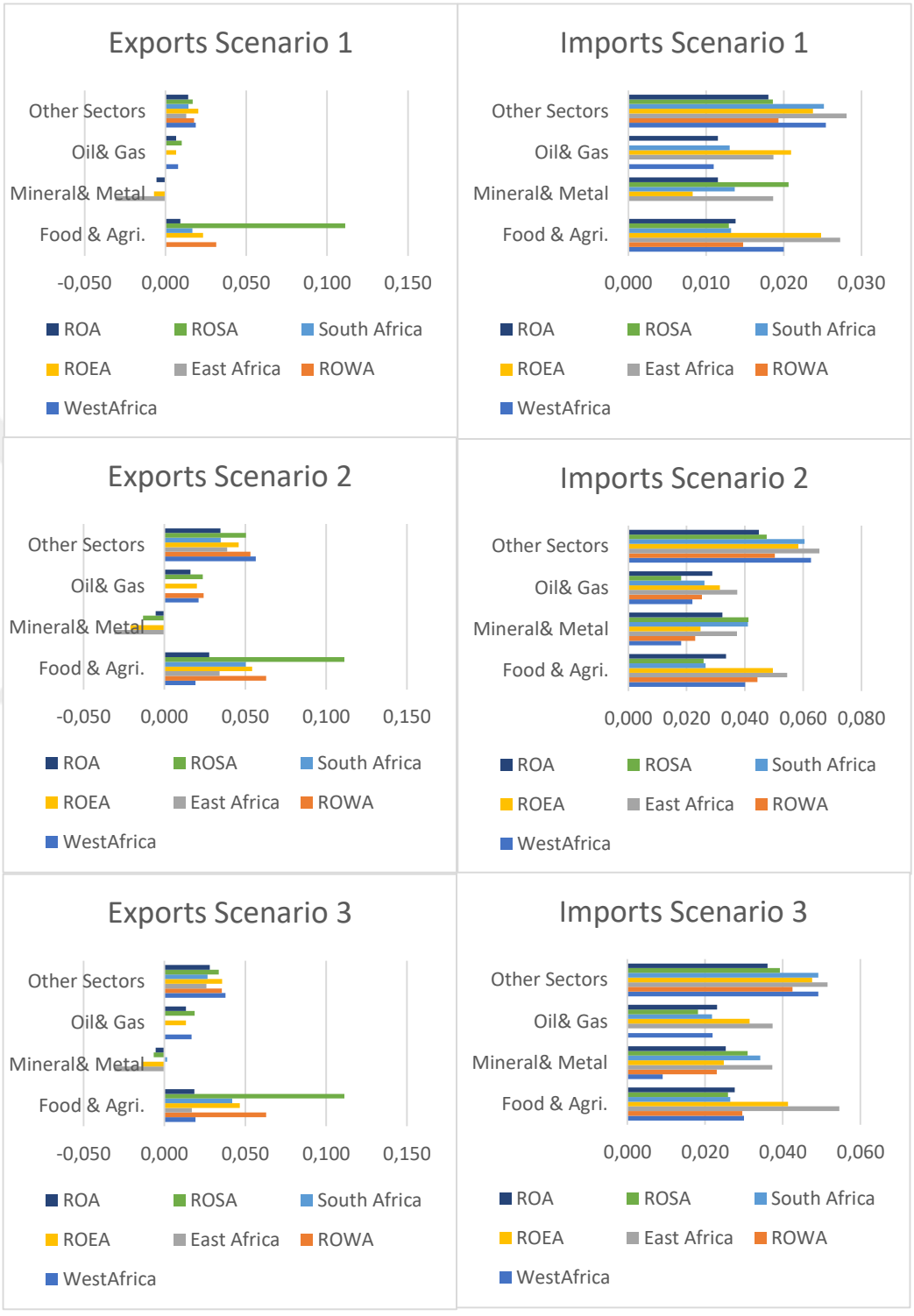

Figure 4.2. Effects of the Trade War on the SSA Sectorial Exports and Imports for Scenarios 1, 2, and 3 (Percentage Change)

4.1.3. Trade Diversion and Trade Creation

One may expect that the trade war will push both the US and China to look for new markets for their products. They are also expected to seek more supply from other trade partners. The findings show that both the exports and import volume of the SSA have increased due to the trade war. This result may imply that there is a trade creation and diversion effect due to the trade war to other regions, including the SSA ones. The increase in the export volume of the SSA may be the outcome of the creation effect, as many markets demand the supply of goods from the SSA. On the angle of trade diversion, the results may refer to more imports to the SSA, affecting the supply side and offering more choices for consumers.

Even though all regions in the SSA benefited from the diversion effects, some regions recorded an enormous percentage increase in their trade volume, which are East Africa and ROEA. Our findings are in line with the findings of other studies (Balistreri et al., 2018; Goulard, 2020; Guo et al., 2018; Li et al., 2020; Mahadevan & Nugroho, 2019; Nicita, 2019; Noland et al., 2016; Rosyadi & Widodo, 2018). Guo et al. (2018) argued that the trade war caused a diversion effect on other countries, i.e., Mexico, Canada, the EU, and South Korea. Other studies concluded that countries like Mexico, Taiwan, India, Vietnam, Canada, and Korea gained from the trade war diversion effect (Fabricius, 2018; Nicita, 2019). Furthermore, Balistreri et al. (2018) argued that countries gain due to trade diversion created by the trade war. This result is also similar to the findings of Rosyadi and Widodo (2018), who inferred that the new policy change (tariff change) could result in trade diversion. Mahadevan and Nugroho (2019) claimed that there is a trade diversion to the RCEP member countries due to the trade war. Last but not least, Goulard (2020) concluded that the trade war is not limited to the US and China only, but some emerging markets can benefit from it due to the diversion.

4.2. Effects of the Trade War on Economic Indicators

Economic indicators are also affected by the trade war, and one of these indicators is GDP. It is a composition of many factors, including export and import. This study focuses on the GDP by using the expenditure approach and income approach. The GDP by income approach gives the output for all factors of production, land, labor, capital, and natural resources, while the GDP by expenditure approach focuses on the consumption capacity by households, investment capacity by investors, government expenditure, and net exports. The mathematical formula for GDP by expenditure and income approach is given in the following equations:

$$Expenditure\ Approach\ for\ GDP = C + I + G + NX$$

$$Income\ Approach\ for\ GDP\ = W\ +\ I\ +\ R\ +\ P\ +\ IBT\ +\ CCA$$

Where by:

C = Consumer spending on the consumption of goods and services,
I = Spending on the investment by the private sector,
G = Government expenditures on activities that boost the economy,
NX = Country's net exports
W = Wages,
I = Interest,
R = Rent,
P = Profit,
IBT = Indirect Business Taxes,
CCA = Capital Consumption Allowance

Tables 4.1, 4.2, and 4.3 present the results of the GDP decomposed for expenditure and income approach, while Figure 4.3 shows the effect of the trade war on total GDP. The findings indicate that after the trade war, the GDP of the US records low performance by -0.01%, -0.03%, and -0.03% for scenarios 1, 2, and 3, respectively. The GDP of China is

also affected negatively in all scenarios after the trade war by -0.03% for scenario 1, -0.08% for scenario 2, and -0.06% for scenario 3. These results are in line with the findings of Panagariya (2018). He argues that the trade war decreased US welfare by 0.04% of GDP. The simulation results of Itakura (2020) also indicate that the trade war decreases the total output volume in the US and China by -1.4% and -1.7%, respectively, due to lower productivity. Prior studies support these results (Bellora & Fontagné, 2020; Giesecke et al., 2019). Walmsley and Minor (2018) claimed that by 2030, the GDP of the US will decrease by -1.25%. Devarajan et al. (2018) argued that the GDP of China and the US will go down by -0.1% and -0.3%. Prior studies show similar directions for the effects of the trade war but have different percentage results compared to this study. Even though these studies use the CGE-GTAP model, the versions of the models, types of scenarios, and base data are different, as shown in Tables 2.3 and 2.1.

In the SSA, the trade war affected the GDP of the SSA regions positively. East Africa region performs better with an increase of 0.016%, 0.039%, and 0.032% for scenarios 1, 2, and 3, respectively. ROEA follow this region with an increase in GDP of 0.016%, 0.039%, and 0.028% for scenario 1, 2, and 3, respectively. The GDP of the other regions was also positively affected by the trade war. The GDP of West Africa increased by 0.013%, 0.031%, and 0.021%, ROWA by 0.015%, 0.038%, and 0.021%, South Africa by 0.014%, 0.034%, and 0.026%, and ROSA by 0.012%, 0.032% and 0.027% for scenario 1, 2 and 3, respectively.

4.2.1. GDP Decomposed (Income and Expenditure Approaches)

Although the previous section discusses the results of the effects of the trade war on GDP, the results can be further presented and elaborated on a GDP decomposed format for expenditure and income approach, as shown in Tables 4.1, 4.2, and 4.3.

The results for the GDP by income approach cover income earned by land, capital, natural resources, and labor. The findings in the previous section show that the GDP of the SSA was positively affected. These results are reflected in the GDP decomposed variables,

revealing that these variables of both GDP by income and expenditure approach were also positively affected. The trade war increased the capital element of the GDP in all scenarios, particularly in scenario 2. ROEA and East Africa regions have higher percentages by 0.015%, 0.037%, 0.031%, and 0.016%, 0.036%, and 0.029%, respectively, for scenarios 1, 2, and 3. The income gained by the skilled and unskilled labor also increased in all scenarios, particularly in the second. For scenarios 1, 2, and 3, the increase in income by labor is as follows; in East Africa, 0.015%, 0.038%, and 0.030%; in ROEA, 0.016%, 0.039%, and 0.031%; in ROWA, 0.013%, 0.032%, and 0.032%, in South Africa 0.014%, 0.034%, and 0.027%, in West Africa 0.013%, 0.032%, and 0.026%, in ROSA 0.013%, 0.032%, and 0.025%.

The results of the GDP by expenditure approach focuses on the spending capacity/power of the household, investment activities, governments, export, and imports. In all scenarios, the findings reveal that the elements of GDP expenditure in their SSA were not affected positively. For scenarios 1, 2, and 3, the government spending records 0.019%, 0.038%, 0.029% increase in ROWA, 0.014%, 0.037%, 0.031% increase in ROEA, and 0.014%, 0.035%, 0.029% increase in South Africa. The spending on investment activities increased by 0.031%, 0.078%, 0.062% in ROSA, 0.032%, 0.078%, 0.063% in South Africa, and 0.025%, 0.061%, 0.051% in ROEA. Other regions also experience a positive effect, as shown in Tables 4.1, 4.2, and 4.3 and Figure 4.3.

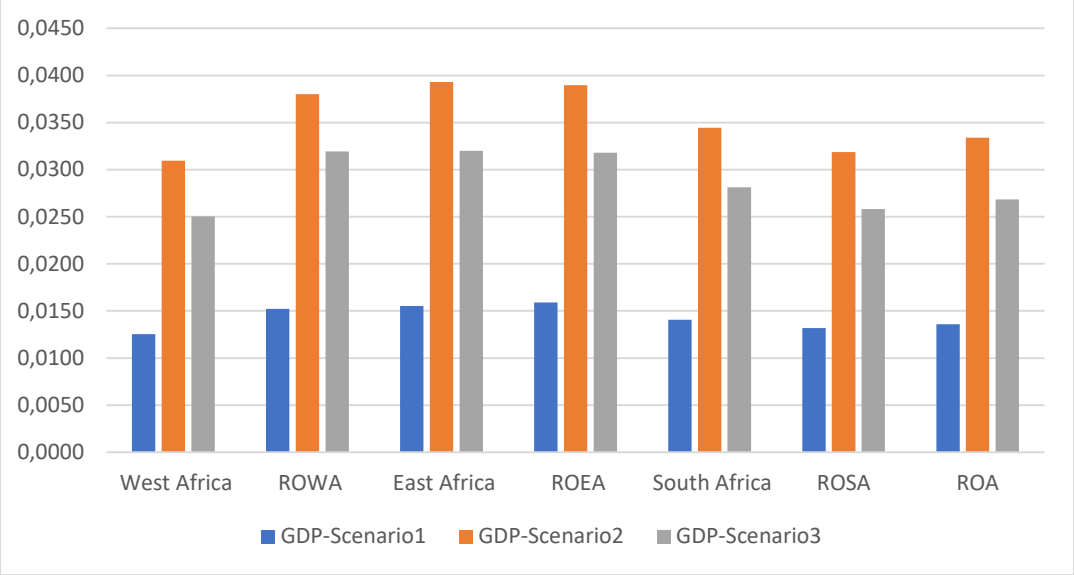

Figure 4.3. The Effects of the Trade War

on the GDP of the SSA in Percentage Change

4.3. Effect of the Trade War on Welfare

The welfare effects results are decomposed into three categories: welfare allocative efficiency.[11], welfare terms of trade[12] and welfare investment savings. The results show that in all scenarios, China experiences a deterioration in its welfare (both the welfare allocative efficiency and welfare terms of trade) more than the US. However, the welfare investment saving for China is positive for all scenarios, while it is negative for the US.

In the SSA, the results are positive for welfare allocative efficiency, where South Africa and East Africa, followed by West Africa, have a high welfare allocative efficiency and welfare terms of trade. However, there is a mixed result for the welfare investment saving. West Africa and the ROWA have negative welfare in terms of investment saving. The investment savings of South Africa and the ROWA were not affected by the trade war, while East Africa and the ROEA were slightly positively affected.

[11] Allocative efficiency is a crucial element of the total welfare analysis of trade. Countries improve the outcomes of consumers and suppliers when they operate in an allocative efficient way. Companies increase the output of GDP and meet the demand of consumers when they operate in an allocative efficient way.

[12]The welfare of the people (consumption) increases when there is an improvement in terms of trade. However, the total GDP remains unchanged.

A positive welfare allocative efficiency is a good measure in a region/country as it shows that people consume the most desired combination of goods that maximizes welfare. On the firm side, allocative efficiency means the production of a mixture of goods at a minimum cost with the maximum utilization of inputs and fulfilling the needs of customers efficiently. The findings for welfare indicate that the trade war led to higher benefits for consumers and companies in terms of low production costs and maximum satisfaction. The results are presented in Tables 4.2 and 4.3. The findings are in line with the previous studies (Amiti et al., 2019; Bagwell & Staiger, 2001; Balistreri et al., 2018; Carvalho et al., 2019; Fajgelbaum et al., 2019; Evans, 2019; Guo et al., 2018; Li et al., 2020; Ossa, 2014; Panagariya, 2018). Even though there are some differences in percentage results, these differences might be due to various factors, including the tariff scenario used, the model version, and solution methods. According to Guo et al. (2018) and Li et al. (2020), the welfare of China and the US decreased by 1.7% and 0.2%, respectively, while the welfare of the Asian countries increased, indicating that the trade war caused welfare gain in the form of trade diversion. Li et al. (2020) also inferred that the trade war caused welfare gain in the form of trade diversion, as well as in terms of trade and GDP for both China and the US.

4.4. Effects of the Trade War on Supply of Commodity, Level of Net Income, Total Revenue from Import Tax

This study explores the effects of the trade war on the Supply of commodities, Level of Net Income, and Total Revenue from Import Tax. The effects of these variables are directly connected to the welfare results of consumers, producers, and the government. Tables 4.5, 4.6, and 4.7 show the results. For consumers, the findings capture VPP- Private household expenditure on commodities (sum of VDPP- Private household expenditure on domestic commodities and VMPP- Private household expenditure on imported commodities), PRIVEXP- Aggregate private consumption/expenditure. And INCOME – Level of expenditure on net income. For producers, the findings capture the VCB- Supply of commodity by producers. TAXRIMP- Total revenue from the import tax payment.

The findings for private consumption – PRIVEXP, Net income or expenditure – INCOME, and private household expenditure on commodity -VPP in SSA are similar and have been positively affected by the trade war.

Tables 4.5 and 4.6 show that in the SSA, all regions show positive results for the VPP, PRIVEXP, and INCOME. The VPP results that are presented on a sectorial basis have mixed findings in the food and agriculture sector in all scenarios, as well as the mineral and metal sectors and oil and gas. This is because some regions record meager gains while others exhibit no changes. In total, the VPP, PRIVEXP, and INCOME findings show that East Africa followed by ROEA, recorded high private expenditure/income due to the trade war. East Africa private expenditure increased by 0.017%, 0.041%, 0.033%; ROEA private expenditure increased by 0.017%, 0.040%, 0.033% for scenarios 1, 2, and 3, respectively. The results on private expenditures for the other regions for scenarios 1, 2, and 3 are as follows: ROWA (0.016%, 0.040%, 0.033); South Africa (0.015%, 0.036%, 0.029%); ROSA (0.013%, 0.033%, 0.026%); West Africa (0.013%, 0.032%, 0.026%).

In the SSA, East Africa, and ROEA, revenues from import taxes have high records compared to the other SSA regions with the increase of 0.055%, 0.110%, and 0.110%, and in ROEA, 0.057%, 0.134%, 0.096% for scenario 1, 2 and 3, respectively. Other SSA regions also have positive effects on the revenue from imports, as presented in Table 4.5. In the SSA, the trade war has increased the Value of all factors of production, with labor having more Value, followed by capital and land. West Africa is ahead of all regions, while the Rest of West Africa is the least performing.

In the SSA, the Value added for sectors shows different results. The trade war neither increased nor decreased the Value, particularly in the mineral and metals and oil and gas sectors, for some regions (West Africa, Rest of West Africa, East Africa, and Rest of East Africa in the mineral and metal sector and South Africa in the oil and gas sector). In the food and agriculture sector, the trade war positively affected all SSA region's value-added, with West Africa being ahead of other regions in all scenarios. For the mineral and metals sector, the Value added of West Africa and the Rest of East Africa shows a negative result,

while the Rest of West Africa, East Africa, and the Rest of South Africa are not affected. In the oil and gas, West Africa is ahead of other SSA regions. The Rest of West Africa, East Africa, and South Africa have not been affected by the trade war in all scenarios.

Table 4.5 show the level of expenditure (net income), the total revenue from import tax payment, and regional cross-investment by region. The effects of the trade war on these outputs are almost similar. China is ahead of the US. Both the US and China's expenditure (net income), import tax revenue, and regional cross-investment decrease as the trade war continues. In the SSA, West Africa, followed by South Africa, and the Rest of East Africa, have more net income after the trade war, more revenue from import taxes, and higher cross investment.

Table 4.5. The Effects of the Trade War on Private Consumption, Net Income, Revenue from Import Tax, Investment, and Saving by Region in Percentage Change

	China	US	West Africa	ROWA	East Africa	ROEA	South Africa	ROSA	ROA	ROTW	Total
Scenario 1											
PRIVEXP- Private consumption	-0.035	-0.014	0.013	0.016	0.017	0.017	0.015	0.013	0.014	0.017	0.004
INCOME- Net income/expenditure	-0.037	-0.014	0.013	0.015	0.017	0.016	0.015	0.013	0.014	0.017	0.003
TAXRIMP-Revenue from import tax	1.056	3.955	0.039	0.025	0.055	0.057	0.059	0.051	0.043	0.052	0.446
REGINV-Cross investment region	-0.050	-0.044	0.023	0.023	0.023	0.025	0.032	0.031	0.020	0.032	-0.001
NETINV- Net investment region	-0.068	-0.110	0.036	0.038	0.030	0.033	0.077	0.094	0.026	0.058	-0.005
SAVE -Net savings in the region	-0.038	-0.014	0.013	0.015	0.000	0.014	0.017	0.011	0.014	0.017	-0.005
Scenario 2											
PRIVEXP- Private consumption	-0.089	-0.034	0.032	0.040	0.041	0.040	0.036	0.033	0.034	0.041	0.010
INCOME- Net income/expenditure	-0.092	-0.034	0.032	0.040	0.042	0.040	0.036	0.033	0.034	0.041	0.007
TAXRIMP-Revenue from import tax	2.530	9.679	0.091	0.074	0.110	0.134	0.137	0.102	0.112	0.129	1.085
REGINV- Cross-investment region	-0.124	-0.108	0.058	0.059	0.056	0.061	0.078	0.078	0.051	0.079	-0.002
NETINV- Net investment region	-0.167	-0.272	0.089	0.085	0.075	0.083	0.185	0.236	0.063	0.144	-0.014
SAVE-Net saving in the region	-0.057	-0.020	0.018	0.030	0.000	0.023	0.021	0.017	0.020	0.025	-0.008
Scenario 3											
PRIVEXP- Private consumption	-0.067	-0.030	0.026	0.033	0.033	0.033	0.029	0.026	0.027	0.033	0.008
INCOME- Net income/expenditure	-0.069	-0.030	0.026	0.032	0.034	0.033	0.029	0.027	0.027	0.033	0.006
TAXRIMP-Revenue from import tax	2.133	7.521	0.078	0.049	0.110	0.096	0.118	0.076	0.085	0.102	0.868
REGINV- Cross-investment region	-0.096	-0.089	0.047	0.047	0.046	0.051	0.063	0.062	0.041	0.064	-0.001
NETINV- Net investment region	-0.130	-0.221	0.072	0.066	0.060	0.068	0.150	0.189	0.051	0.116	-0.010
SAVE-Net saving in the region	-0.071	-0.003	0.025	0.030	0.000	0.033	0.029	0.022	0.028	0.034	-0.010

Table 4.6. Private Household Expenditure on Commodity (VPP) and Supply of Commodity by Region (VCB)

Scenario 1											
VPP	**China**	**US**	**West Africa**	**ROWA**	**East Africa**	**ROEA**	**South Africa**	**ROSA**	**ROA**	**ROTW**	**Total**
Food and Agriculture	-0.025	-0.013	0.013	0.017	0.019	0.016	0.014	0.014	0.013	0.016	0.006
Minerals and Metal	-0.036	-0.011	0.000	0.000	0.000	0.000	0.032	0.045	0.008	0.016	0.006
Oil and Gas	-0.025	-0.013	0.000	0.000	0.058	0.031	0.011	0.042	0.012	0.016	0.007
Other Sectors	-0.039	-0.014	0.013	0.014	0.019	0.016	0.015	0.013	0.014	0.017	0.004
Total	-0.035	-0.014	0.013	0.016	0.017	0.017	0.015	0.013	0.014	0.017	0.004
VCB											
Food and Agriculture	0.001	-0.037	0.013	0.016	0.016	0.017	0.014	0.014	0.012	0.012	0.004
Minerals and Metal	-0.014	0.017	-0.010	0.000	0.000	-0.007	0.003	0.000	0.005	0.004	-0.001
Oil and Gas	0.024	0.017	0.008	0.000	0.000	0.005	0.013	0.010	0.007	0.005	0.009
Other Sectors	-0.030	-0.014	0.012	0.011	0.012	0.014	0.013	0.012	0.012	0.015	0.001
Total	-0.023	-0.013	0.012	0.010	0.013	0.013	0.012	0.011	0.011	0.013	0.002
Scenario 2											
VPP	**China**	**US**	**West Africa**	**ROWA**	**East Africa**	**ROEA**	**South Africa**	**ROSA**	**ROA**	**ROTW**	**Total**
Food and Agriculture	-0.062	-0.033	0.032	0.046	0.045	0.041	0.035	0.032	0.033	0.039	0.015
Mineral and Metal	-0.092	-0.028	0.017	0.000	0.000	0.028	0.032	0.045	0.032	0.040	0.016
Oil and Gas	-0.063	-0.030	0.024	0.076	0.058	0.031	0.032	0.042	0.033	0.039	0.017
Other Sectors	-0.099	-0.034	0.031	0.038	0.042	0.040	0.037	0.034	0.034	0.042	0.009
Total	-0.089	-0.034	0.032	0.040	0.041	0.040	0.036	0.033	0.034	0.041	0.010
VCB											
Food and Agriculture	0.002	-0.091	0.031	0.044	0.040	0.042	0.036	0.033	0.031	0.031	0.010
Mineral and Metal	-0.035	0.043	-0.021	-0.008	-0.024	-0.017	0.008	0.000	0.012	0.009	-0.003
Oil and Gas	0.059	0.041	0.019	0.016	0.000	0.018	0.026	0.024	0.018	0.013	0.023
Other Sectors	-0.075	-0.035	0.030	0.025	0.028	0.033	0.032	0.031	0.031	0.037	0.003
Total	-0.058	-0.031	0.029	0.025	0.031	0.031	0.029	0.027	0.028	0.033	0.004
VPP	**China**	**US**	**West Africa**	**ROWA**	**East Africa**	**ROEA**	**South Africa**	**ROSA**	**ROA**	**ROTW**	**Total**
Scenario 3											
Food and Agriculture	-0.046	-0.029	0.026	0.038	0.036	0.034	0.029	0.028	0.027	0.031	0.012
Mineral and Metal	-0.067	-0.025	0.017	0.000	0.000	0.028	0.032	0.045	0.024	0.032	0.013
Oil and Gas	-0.048	-0.027	0.024	0.000	0.058	0.031	0.032	0.042	0.025	0.031	0.014
Other Sectors	-0.075	-0.030	0.025	0.031	0.035	0.033	0.030	0.027	0.028	0.034	0.007
Total	-0.067	-0.030	0.026	0.033	0.033	0.033	0.029	0.026	0.027	0.033	0.008
VCB											
Food and Agriculture	0.006	-0.076	0.025	0.036	0.033	0.034	0.029	0.027	0.025	0.025	0.009
Minerals and Metal	-0.026	0.033	-0.010	0.000	-0.012	-0.010	0.008	0.003	0.011	0.007	-0.002

Table 4.6. (cont.)

Oil and Gas	0.046	0.034	0.015	0.016	0.000	0.014	0.021	0.019	0.014	0.011	0.018
Other Sectors	-0.056	-0.031	0.024	0.020	0.023	0.027	0.026	0.025	0.025	0.030	0.003
Total	-0.043	-0.027	0.023	0.021	0.025	0.025	0.024	0.022	0.023	0.027	0.003

Table 4.7. Value Added in the Sector (VVA) and Value of Factors of Production by Region (VENDWMS)

Scenario 1											
VVA	**China**	**US**	**West Africa**	**ROWA**	**East Africa**	**ROEA**	**South Africa**	**ROSA**	**ROA**	**ROTW**	**Total**
Food and Agriculture	-0.010	-0.046	0.013	0.015	0.016	0.018	0.018	0.015	0.013	0.014	0.003
Mineral and Metal	-0.033	0.007	-0.020	0.000	0.000	-0.015	0.005	0.000	0.008	0.006	-0.004
Oil and Gas	0.015	0.013	0.008	0.000	0.000	0.007	0.000	0.013	0.007	0.005	0.007
Other Sectors	-0.046	-0.020	0.013	0.013	0.015	0.015	0.014	0.014	0.014	0.017	0.000
Total	-0.041	-0.019	0.012	0.014	0.015	0.015	0.014	0.012	0.013	0.016	0.001
VENDWMS											
Capital	-0.042	-0.020	0.012	0.016	0.016	0.014	0.013	0.012	0.013	0.016	0.003
Labor	-0.041	-0.020	0.013	0.019	0.015	0.015	0.014	0.012	0.013	0.016	-0.003
Land	0.003	-0.060	0.015	0.000	0.031	0.020	0.000	0.000	0.010	0.014	0.006
Total	-0.041	-0.020	0.013	0.013	0.015	0.015	0.013	0.012	0.013	0.016	0.000
Scenario 2											
VVA	**China**	**US**	**West Africa**	**ROWA**	**East Africa**	**ROEA**	**South Africa**	**ROSA**	**ROA**	**ROTW**	**Total**
Food and Agriculture	-0.025	-0.113	0.033	0.046	0.044	0.046	0.041	0.035	0.033	0.035	0.008
Mineral and Metal	-0.082	0.017	-0.020	0.000	0.000	-0.015	0.011	0.000	0.018	0.016	-0.010
Oil and Gas	0.037	0.033	0.020	0.047	0.000	0.014	0.000	0.028	0.017	0.013	0.017
Other Sectors	-0.115	-0.050	0.032	0.033	0.035	0.038	0.036	0.035	0.035	0.042	0.001
Total	-0.101	-0.048	0.030	0.036	0.037	0.037	0.033	0.030	0.032	0.039	0.002
VENDWMS											
Capital	-0.105	-0.048	0.029	0.032	0.036	0.037	0.032	0.030	0.032	0.040	0.007
Labor	-0.102	-0.048	0.032	0.038	0.038	0.038	0.033	0.031	0.033	0.040	-0.007
Land	0.006	-0.143	0.034	0.000	0.062	0.040	0.104	0.061	0.031	0.033	0.015
Total	-0.101	-0.049	0.031	0.034	0.037	0.038	0.033	0.031	0.033	0.040	0.000
Scenario 3											
VVA	**China**	**US**	**West Africa**	**ROWA**	**East Africa**	**ROEA**	**South Africa**	**ROSA**	**ROA**	**ROTW**	**Total**
Food and Agriculture	-0.016	-0.095	0.027	0.038	0.035	0.036	0.035	0.030	0.027	0.029	0.007

Table 4.7. (cont.)

Mineral and Metal	-0.063	0.012	-0.020	0.000	0.000	-0.015	0.009	0.000	0.015	0.013	-0.008
Oil and Gas	0.029	0.028	0.016	0.047	0.000	0.014	0.000	0.023	0.013	0.010	0.014
Other Sectors	-0.088	-0.043	0.026	0.026	0.029	0.031	0.029	0.027	0.028	0.034	0.001
Total	-0.077	-0.041	0.024	0.028	0.030	0.031	0.027	0.025	0.026	0.032	0.001
VENDWMS											
Capital	-0.080	-0.042	0.024	0.028	0.029	0.030	0.026	0.024	0.026	0.032	0.006
Labor	-0.078	-0.042	0.026	0.033	0.031	0.031	0.027	0.026	0.026	0.033	-0.006
Land	0.009	-0.120	0.027	0.000	0.062	0.040	0.104	0.000	0.031	0.027	0.013
Total	-0.078	-0.042	0.025	0.027	0.030	0.031	0.027	0.026	0.026	0.032	0.000

Table 4.8. Study Objectives, Expected Outcomes, and Actual Outcomes

Objective	Objective Statement	Expected Outcome	Actual Outcome
One	Tariff changes between the US and China positively affect the export and import volume of the SSA. The trade war between the US and China improves the trade balance of the SSA regions.	+	+
Two	The tariff changes by the US and China positively affect the economic indicators (GDP) of the SSA regions.	+	+
Three	The trade war between the US and China lead to trade creation and trade diversion in the SSA regions.	+	+
Four	The trade war between the US and China positively affects consumer welfare in the SSA countries.	+	+
Five	The food and agriculture, oil and gas, and minerals and metal sectors in the SSA are positively affected by the trade war between the US and China.	+	+

CHAPTER V

CONCLUSION

International trade has shown remarkable growth in the world economy, leading to diverse impacts on firms, consumers, and other related parties. While international trade improves economic growth, increases productivity, and enhances resource allocation, it may also cause trade imbalance and severe competition. In this respect, the trade war that began in 2017 between the US and China has considerably affected international trade. The trade war through tariff changes affects Chinese and US products worth USD 550 billion and USD 185 billion, respectively. Both countries take retaliatory actions against each other regarding tariffs, and these measures impact the trading partners.

The trade war between the US and China has affected the two countries and their trade partners. The trade war has affected the trade volume (exports, imports), trade balance, welfare, employment, and many other indicators, leading to opportunities for some regions and threats for others. Even though trade wars are considered to distract economies and trade partners as well as unhealthy, this war has created several opportunities for SSA as the US and China are among their most important trading partners. Trade statistics show that China imports USD 25,987 million (10.77%) from the SSA and exports USD 45,548 million (17.98%) to the SSA, while the US imports USD 12,460 million (5.16%) from the SSA and exports USD 16,407 Million (6.47%) to SSA. Thus, any trade war between them is expected to affect the SSA regions.

This study analyses the impact of the trade war between the US and China on the trade and economy of the Sub-Saharan African countries by employing the Computable General Equilibrium (CGE)- Global Trade Analysis Project (GTAP) model. GTAP model is a multi-regional, multi-sectoral computable general equilibrium model. It employs systems of equations that use quantitative analysis and show equilibrium, direct and indirect effects for all markets. It is known for using actual economic data in the form of social accounting matrix to estimate the effects of specific policy changes (shocks) on the economy. In this

study, we use actual tariff shocks that have been imposed and still exist in the US and China and analyze how these shocks affect the SSA regions. We use three scenarios/tariff shocks that have taken place since the beginning of the trade war to date: (i) The 10% tariff on Chinese products from the US, and retaliatory measures from the Chinese government to the US, (ii) the 25% tariff of Chinese product from the US, and retaliatory measures from the Chinese government to the US and (iii) 19.3% tariff of products exported from China to the US and 20.7% tariff of China imports to the US.

5.1. Summary of the Findings

The findings show that the US has slightly improved its trade balance as a result of the tariff impositions; however, both the US and China lost in terms of trade volume, GDP, and welfare as the war decreased their exports and imports. On the other side, the trade war leads to trade creation and diversion effects to other trading partners; the SSA is one of them. These effects offer opportunities for the SSA regions, directly affecting their exports and imports. They also have indirect effects on other variables, including GDP, welfare, trade balance, revenue, and import taxes. The results indicate that even though the trade war positively affects the SSA regions in all three scenarios, some regions record a higher percentage than others.

East Africa and ROEA enjoy the benefits of the trade war more than other SSA regions, as these regions record higher percentages in export, import, and GDP. Nigeria, South Africa, and some East African countries, i.e., Tanzania, Kenya, and Ethiopia, are more affected. The sectorial results show that in all regions, the percentage of imports in the food and agriculture, minerals and metals, and oil and gas sectors are positively influenced by the trade war. In terms of exports, the findings show mixed results, particularly for the minerals and metals sectors. In some regions, i.e., East Africa and ROEA, the minerals and metals sectors record a negative export, while in some other regions, i.e., West Africa, ROWA, and South Africa, the sector is not affected, particularly for scenarios 1 and 2.

In the SSA, the trade war offers opportunities for trade volume and economic growth. The GDP of the SSA increased by 0.01%, 0.03%, and 0.02% for scenarios 1, 2, and 3, respectively. In terms of trade volume, the exports of the SSA increased by 0.01%, 0.04%, and 0.03%, while the imports of the SSA raised by 0.03%, 0.1%, and 0.1% for scenarios 1, 2, and 3, respectively. These findings are in line with the findings of the prior studies (Bellora & Fontagné, 2020; Devarajan et al., 2018; Guo et al., 2018; Itakura, 2020; Walmsley & Minor, 2018) that argue that the trade war between the US and China causes diversion effects and hence, positively affects the trade volume of the third partners. Our findings are also supported by Nyongesa (2019), who concluded that the trade war between the US and China had stimulated the interest of Asian countries, including China, in the need for African resources. In our findings, we observe an increase in both exports and imports on a sectorial basis. However, the findings of Ndzendze (2020) are different from our results, as he observed that the trade war between the US and China caused a declining pattern in agricultural products in Africa. Additionally, the study done by Olayungbo (2019) on the trade war effect on the selected oil producers' countries in Africa found that Nigeria incurs a negative effect. Likewise, in our findings where we observed Nigeria as among the top producers of oil and gas in the SSA, and it enjoys the benefits of the trade war in terms of both exports and imports.

The findings also show that the trade war raised the welfare of the consumers, producers, and government in household expenditure on commodities, private consumption expenditure, the value of the factors of production, the value added in the sectors, expenditure level/net income, and even the revenue from imports taxes in the SSA regions. All SSA regions were positively affected by the trade war, and there was an increase in exports, imports, welfare, economic growth, and sectoral gains.

5.2. Implications of the Study

The study has several practical implications for companies (producers, exporters, and importers), consumers, governments, and policymakers in Sub-Sahara Africa. For companies, the trade war has increased their ability to produce efficiently and meet the

needs of consumers while maximizing their profit through the welfare allocative effects. Additionally, the trade diversion from the US and China has increased imports in the SSA regions, raising the availability of various goods to satisfy customer needs. Finally, these trade activities create more revenue in the respective economies.

For consumers and households in the SSA, the trade war has increased their welfare. The positive welfare allocative efficiency shows that the consumers maximize their consumption with the available goods at affordable prices.

For the governments in the SSA countries, the trade war affects the GDP growth. The trade war increased the import taxes for the SSA regions. These taxes could be used by the government to develop new economic activities in these countries. Furthermore, the trade creation may lead to market expansion for the domestic market companies, increasing their visibility and competitive power in foreign markets. Likewise, the trade diversion may increase the availability of goods that could not be produced in the domestic market, increasing the welfare of people. The positive welfare investment saving results are also crucial as the SSA can use these savings to offset its trade deficit. More investment will also lead to more production and a booming economy. Aside from the benefits gained from the trade war, the SSA government should be nonaligned and not choose parties when it comes to the trade war between the US and China.

For policymakers, the tariff shocks are likely to have long-run effects on different economic agents, including companies, consumers, and the government. Thus, they should come up with policies that make the best use of the benefits and opportunities by facilitating international trade activities for SSA companies. For instance, they may take policy measures to empower companies in the SSA regions to take advantage of international trade-related activities and to ensure people, i.e., workers, and consumers, benefit from the trade war. In this respect, policymakers may remove barriers and establish stable political relations with the trading partners. The SSA countries may also sign regional trade agreements with the US and China to strengthen their positions in

international trade and to reduce economic inequalities among the SSA countries and hence, strengthen the prosperity of the whole region.

The opportunities offered by the trade war should also create some challenges for the SSA regions to improve the quality of products that will meet international standards and continue enjoying this ongoing dispute between the US and China. The SSA governments should ensure a smooth operation of the trade process from the raw materials to final products at a certain quality and cost structure. They should also provide a well-functioning business/trade environment, infrastructure, and logistic services. Finally, the SSA countries should empower companies in international trade by supporting trade activities by creating smooth, efficient, and fast supply chain procedures at the ports.

5.3. Limitations of the Study and Future Research

We acknowledge that this study has some limitations. This research covers only Sub-Saharan Africa regions to discuss the effects of the trade war between the US and China. Future work may include the whole of Africa and analyze all countries individually to generalize the results. We also aggregate sectors into three segments, focusing on the most important ones in discussing the effects of the trade war. Future studies may deepen the analysis by enlarging the sector coverage and exploring product-specific factors.

The study employs the CGE-GTAP model and database that may be considered a black box (disclosed) in nature in terms of its data and a lack of theoretical support to explain the results. Future research may use other models to support our findings. The sectorial results may be expanded to target the sectors affecting each SSA country without aggregating them. This study also concentrates on the regional/country level, analyzing aggregate data with a focus on significant macroeconomic variables like trade volume and economic growth. Future research may focus on firm-level analysis by running a survey and conducting in-depth interviews with the company managers to provide managerial insights.

Many factors may cause the trade war between the US and China. The coverage of this study is limited to only tariffs. Future studies may explore other factors affecting the trade war. The trade war between the US and China is not only limited to foreign trade but also includes the war in territorial terms, technological and other areas. These areas that are not directly related to trade could be further explored by other researchers to understand their genesis and possible repercussions in other economies.

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APPENDIXES

APPENDIX A

Table A.1. The Country Effects of the Trade War on GDP (Decomposed), Exports, Imports, and Trade Balance (Percentage Change) - Scenario 1

Scenario 1	US	China	Nigeria	South Africa	Kenya	Ethiopia	Tanzania	Ghana	Rest of SSA	Rest of the World	Total
Household	-0.017	-0.040	0.014	0.013	0.018	0.022	0.016	0.015	0.015	0.019	0.004
Investment	-0.051	-0.055	0.025	0.032	0.021	0.025	0.025	0.029	0.027	0.035	-0.001
Government	-0.018	-0.043	0.014	0.013	0.022	0.021	0.029	0.014	0.014	0.019	0.005
Exports	-0.132	-0.109	0.010	0.006	0.000	0.016	0.000	0.008	0.008	0.012	-0.016
International Margins	-0.021	-0.020	0.000	0.000	0.000	0.000	-0.204	0.000	0.000	-0.019	-0.019
Imports	-0.156	-0.162	0.022	0.018	0.019	0.024	0.020	0.017	0.017	0.024	-0.016
Land	-0.121	0.037	0.015	0.000	0.066	0.047	0.000	0.000	0.012	0.011	0.009
Capital	-0.023	-0.047	0.013	0.012	0.020	0.017	0.014	0.010	0.014	0.018	0.003
Natural Resources	0.039	-0.005	0.007	0.000	0.000	0.000	0.000	0.000	0.009	-0.004	0.001
Labor	-0.023	-0.046	0.015	0.012	0.018	0.020	0.016	0.013	0.014	0.019	-0.002
Indirect Taxes	0.072	-0.007	0.024	0.019	0.046	0.022	0.017	0.019	0.019	0.020	0.023
Total GDP (percentage change)	-0.016	-0.039	0.014	0.013	0.020	0.020	0.017	0.016	0.014	0.018	0.003
Exports (percentage change)	-0.130	-0.107	0.009	0.006	0.011	0.015	0.000	0.008	0.008	0.011	-0.016
Imports (percentage change)	-0.156	-0.162	0.022	0.018	0.019	0.024	0.020	0.017	0.017	0.024	-0.016
Trade balance (percentage change)	0.239	0.151	-0.033	-0.740	0.033	0.050	0.030	0.065	0.094	-1.039	-100.000

Table A.2. The Country Effects of the Trade War on GDP (Decomposed), Exports, Imports, and Trade Balance (Percentage Change) - Scenario 2

Scenario 2	US	China	Nigeria	South Africa	Kenya	Ethiopia	Tanzania	Ghana	Rest of SSA	Rest of the World	Total
Household	-0.044	-0.099	0.036	0.033	0.048	0.052	0.041	0.038	0.037	0.047	0.010
Investment	-0.127	-0.137	0.062	0.077	0.063	0.065	0.056	0.078	0.067	0.089	-0.002
Government	-0.044	-0.107	0.035	0.033	0.056	0.062	0.044	0.043	0.037	0.048	0.013
Exports	-0.331	-0.271	0.023	0.014	0.012	0.031	0.000	0.015	0.020	0.030	-0.041
International Margins	-0.048	-0.047	0.000	0.000	0.000	0.000	-0.204	0.000	-0.051	-0.047	-0.047
Imports	-0.390	-0.405	0.056	0.045	0.052	0.071	0.048	0.045	0.043	0.060	-0.041
Total	-0.040	-0.096	0.035	0.032	0.047	0.050	0.040	0.036	0.035	0.046	0.008
Land	-0.303	0.093	0.038	0.000	0.066	0.094	0.058	0.105	0.049	0.027	0.022
Capital	-0.057	-0.118	0.032	0.030	0.046	0.046	0.034	0.031	0.034	0.046	0.008
Natural Resources	0.096	-0.011	0.018	0.000	0.000	0.000	0.000	0.000	0.024	-0.009	0.003
Labor	-0.058	-0.115	0.038	0.031	0.048	0.049	0.039	0.036	0.035	0.047	-0.004
Indirect Taxes	0.179	-0.016	0.057	0.047	0.093	0.065	0.052	0.056	0.049	0.050	0.056
Total	-0.040	-0.096	0.035	0.032	0.047	0.050	0.040	0.036	0.035	0.046	0.008
Total GDP (percentage change)	-0.040	-0.096	0.035	0.032	0.047	0.050	0.040	0.036	0.035	0.046	0.008
Exports (percentage change)	-0.326	-0.267	0.023	0.014	0.011	0.015	0.000	0.015	0.019	0.027	-0.041
Imports (percentage change)	-0.390	-0.405	0.056	0.045	0.052	0.071	0.048	0.045	0.043	0.060	-0.041
Trade balance (percentage change)	0.597	0.378	-0.084	-1.850	0.082	0.116	0.091	0.151	0.233	-2.598	-100.000

Table A.3. The Country Effects of the Trade War on GDP (Decomposed), Exports, Imports, and Trade Balance (Percentage Change) - Scenario 3

Scenario 3	US	China	Nigeria	South Africa	Kenya	Ethiopia	Tanzania	Ghana	Rest of SSA	Rest of the World	Total
Household	-0.039	-0.075	0.029	0.027	0.038	0.043	0.035	0.031	0.030	0.038	0.008
Investment	-0.105	-0.105	0.050	0.063	0.049	0.050	0.050	0.068	0.055	0.072	-0.001
Government	-0.039	-0.081	0.028	0.027	0.045	0.041	0.044	0.029	0.029	0.038	0.011
Exports	-0.264	-0.215	0.018	0.012	0.012	0.016	0.000	0.015	0.016	0.024	-0.032
International Margins	-0.039	-0.037	0.000	0.000	0.000	0.000	-0.204	0.000	-0.051	-0.037	-0.037
Imports	-0.312	-0.323	0.045	0.036	0.043	0.055	0.034	0.034	0.035	0.048	-0.032
Land	-0.247	0.079	0.031	0.000	0.066	0.047	0.058	0.000	0.037	0.023	0.018
Capital	-0.049	-0.090	0.026	0.025	0.036	0.038	0.027	0.021	0.027	0.037	0.007
Natural Resources	0.081	-0.009	0.014	0.000	0.000	0.000	0.000	0.000	0.018	-0.007	0.003
Labor	-0.050	-0.088	0.030	0.025	0.037	0.041	0.031	0.027	0.028	0.038	-0.003
Indirect Taxes	0.062	0.001	0.024	0.019	0.046	0.043	0.017	0.019	0.019	0.020	0.023
Total GDP (percentage change)	-0.036	-0.073	0.028	0.026	0.037	0.041	0.033	0.028	0.029	0.037	0.006
Exports (percentage change)	-0.260	-0.212	0.017	0.012	0.011	0.015	0.000	0.015	0.016	0.022	-0.032
Imports (percentage change)	-0.312	-0.323	0.045	0.036	0.043	0.055	0.034	0.034	0.035	0.048	-0.032
Trade balance (percentage change)	0.005	0.003	-0.001	-0.015	0.001	0.001	0.001	0.001	0.002	-0.021	-2.000

Table A.4. The Baseline Values of Different Variables

Region/Variable	China	US	West Africa	ROWA	East Africa	ROEA	South Africa	ROSA	ROA
PRIVEXP	3,937,565	11,984,588	441,506	55,359	82,079	186,478	216,834	107,218	558,096
INCOME	8,719,358	15,194,169	558,868	59,273	98,938	237,327	314,486	158,478	793,666
TAXRIMP	64,101	28,215	7,678	4,052	3,626	5,232	5,093	3,928	18,787
REGINV	4,565,018	3,402,731	98,581	17,092	30,461	66,732	74,214	32,033	226,720
NETINV	2,933,271	1,248,791	50,339	10,616	19,978	39,778	25,990	8,479	152,148
SAVE	3,379,358	635,141	67,201	(6,557)	1,137	21,498	24,132	18,021	79,034
VKB	40,793,684	53,848,504	1,206,057	161,895	262,056	673,871	1,205,581	588,853	1,864,288
INCOME	8,719,358	15,194,169	558,868	59,273	98,938	237,327	314,486	158,478	793,666
TAXROUT	(32,607)	720,059	4,169	1,299	(3,242)	1,561	6,859	1,142	4,793
TAXREXP	55,651	3,872	48	532	508	269	1,685	177	1,680
Land	136,148	39,662	26,996	1,082	3,249	4,990	977	1,678	9,893
Capital	4,257,242	4,456,944	182,881	25,789	44,829	107,861	160,100	86,290	380,527
Natural Resources	140,968	106,303	28,202	1,482	520	6,496	5,496	18,059	39,193
Skilled Unskilled	4,182,307	11,504,132	351,352	21,942	52,839	119,403	151,934	62,794	380,565
Indirect Taxes	1,634,444	1,241,065	17,679	15,454	7,983	25,531	44,202	13,211	58,060
Total	10,351,107	17,348,106	607,110	65,748	109,421	264,282	362,709	182,032	868,237
Household	3,937,565	11,984,588	441,506	55,359	82,079	186,478	216,834	107,218	558,096
Investment	4,565,018	3,402,731	98,581	17,092	30,461	66,732	74,214	32,033	226,720
Government	1,402,436	2,574,440	50,161	10,471	15,723	29,352	73,520	33,240	156,535
Exports	2,472,417	1,960,815	105,455	23,552	15,808	60,970	122,600	80,787	234,941
International Margins	50,929	33,506	565	230	1,084	771	112	88	3,853
Imports	(2,077,259)	(2,607,972)	(89,157)	(40,955)	(35,733)	(80,021)	(124,570)	(71,333)	(311,908)
Total	10,351,105	17,348,107	607,110	65,748	109,421	264,282	362,709	182,032	868,237
GOVEXP	1,402,436	2,574,440	50,161	10,471	15,723	29,352	73,520	33,240	156,535
Region/Variable	China	US	West Africa	ROWA	East Africa	ROEA	South Africa	ROSA	ROA
VXWREGION	2,523,346	1,994,321	106,019	23,782	16,892	61,741	122,712	80,875	238,794
VMWREGION	2,077,259	2,607,972	89,157	40,955	35,733	80,021	124,570	71,333	311,908
GDP	10,351,105	17,348,108	607,110	65,748	109,421	264,282	362,709	182,032	868,237
TBAL	446,086	(613,652)	16,862	(17,173)	(18,842)	(18,280)	(1,858)	9,542	(73,114)

NOTE: The baseline values are in the GTAP 10 database for the base year 2014.

Table A.5. The Codes and Explanations of the Variables According to GTAP Model and Database

BVCIF	Imports of commodity from region to supplier valued CIF (tradeable only)
BVDPP	Private household expenditure on domestic commodities
BVMPP	Private household expenditure on imported commodity
GDPINC	GDPINC income-side GDP
GDP	GDP gross domestic product in region
GDPEXP	GDP expenditure side summary
INCOME	Level of expenditure, NET income in the region
INCOMEEV	Regional income, for Equivalent Variation calculations
NETINV	Regional Net Investment in region
PRIVEXP	Aggregate private consumption expenditure in region
REGINV	Regional cross investment in region
SAVE	NET saving in region valued at producer prices
SAVEEV	Saving in region for Equivalent Variation calculation
TAXRIMP	Total revenue from import tax payment in region
TBAL	Trade balance for region
VCB	Supply of commodity in region
VCIF	Value of imports of commodity from supply to destination at CIF prices (tradeable only)
VDGB	Government expenditure on domestic commodity in region at basic price
VDGP	Government expenditure on domestic commodity in region at producer price
VDPB	Private household expenditure on domestic commodity in region at basic
VDPP	Private household expenditure on domestic commodities in region
VENDWMS	Value of factors of production
VFOB	Value of export of commodity from supply to destination at FOB prices (tradeable only)
VMCIF	Value of commodity imports by destination at CIF prices
VMFB	Expenditure on imported commodity by activity in region at basic price
VMGB	Government expenditure on imported commodity in region at basic price
VMGP	Government expenditure on imported. commodity in region at producer price
VMPB	Private household expenditure on imported commodities in region at basic
VMPP	Private household expenditure on imported commodities in region
VMSB	Value of imports of commodities from supply to destination at domestic (basic)
VMWREGION	Value of commodity imports by region at CIF prices
VPP	Private household expenditure on commodity
VST	Value of exports of margin from region for international transport
VVA	Value added in activity (Sector) in a region
VXDFOB	FOB value of commodities exports to all destination. (Tradeable only)
VXSB	Supply of commodities from supply to destination at basic prices (tradeable only)
VXW	Value of exports by commodity and region at FOB prices
VXWCOMMOD	Value of world exports by commodity at FOB prices
VXWREGION	Value of exports by region at FOB prices

Table A.6. Country or Region Aggregation

Code	Description Country/Region
CHN	China
US	United States of America
West Africa	Nigeria and Ghana
Rest of West Africa -ROWA	Guinea, Senegal, Togo, Cape Verde, Gambia, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Saint Helena, Sierra Leone
East Africa	Tanzania, Kenya
Rest of East Africa -ROEA	Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Uganda, Zambia, Zimbabwe, Burundi, Comoros, Djibouti, Eritrea, Mayotte, Seychelles, Somalia, Sudan, Ethiopia
South Africa	Namibia, South Africa
Rest of South Africa-ROSA	Eswatini, Botswana, Lesotho
Rest of Africa -ROA	Egypt, Morocco, Tunisia, Algeria, Libya, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Central African Republic Chad, Congo, Equatorial Guinea, Gabon, Sao Tome and Principe, Angola, Congo.
Rest of the World	Australia, Christmas Island, Cocos (Keeling) Islands, Heard Island and McDonald Islands, Norfolk Island, New Zealand, American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia, Federated States of Nauru, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, United States Minor Outlying Islands, Vanuatu, Wallis and Futuna Islands, Hong Kong, Special Administrative Region of China, Japan, Korea, Republic of, Mongolia, Taiwan, Korea, Democratic People's Republic of, Macao, Special Administrative Region of China, Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Philippines, Singapore, Thailand, Viet Nam, Myanmar, Timor-Leste, Bangladesh, India, Nepal, Pakistan, Sri Lanka, Afghanistan, Bhutan, Maldives, Canada, Mexico, Bermuda, Greenland, Saint Pierre and Miquelon, Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela (Bolivarian Republic of), Falkland Islands (Malvinas), French Guiana, Guyana, South Georgia and the South Sandwich Islands, Suriname, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, Belize, Dominican Republic P, Jamaica, Puerto Rico, Trinidad and Tobago P, Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, British Virgin Islands, Cayman Islands, Cuba, Dominica, Grenada, Haiti, Montserrat, Netherlands Antilles, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and Grenadines, Turks and Caicos Islands, Virgin Islands, US, Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland , Aland Islands, Finland, France, Guadeloupe, Martinique, Réunion, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom, Switzerland, Norway, Svalbard and Jan Mayen Islands, Iceland, Liechtenstein, Albania, Bulgaria, Belarus, Croatia, Romania, Russian Federation, Ukraine, Moldova, Andorra, Bosnia and Herzegovina, Faroe Islands, Gibraltar, Guernsey, Holy See (Vatican City State), Isle of Man, Jersey, Monaco, Montenegro, North Macedonia, San Marino, Serbia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Armenia, Azerbaijan, Georgia, Bahrain, Iran, Islamic Republic of, Israel, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, Turkey, United Arab Emirates, Iraq, Lebanon, Palestinian Territory, Occupied, Syrian Arab Republic (Syria),Yemen, Rest of the World Antarctica, Bouvet Island, British Indian Ocean Territory, French Southern Territories

Source: GTAP 10 Database

Table A.7. Sectorial Aggregation

Sector	Description
Food and Agriculture	Paddy rice, Wheat, Cereal grains, Vegetables, Fruit, Nuts, Oil seeds, Sugar cane, Sugar beet, Plant-based fibers, Food products, Crops, Bovine meat products, Meat products, Vegetable oils and fats, Dairy products, processed rice, Sugar, Beverages and tobacco products, Bovine cattle, sheep and goats, horses, Animal products, Raw milk.
Minerals and Metal	Mineral products, Ferrous metals, Metals, Metal products, Other Extraction (formerly Minerals), Coal
Oil and Gas	Oil, Petroleum, Coal products, Gas, Gas manufacture- distribution
Other Sectors	Textiles, Wearing apparel, Leather products, Wood products, Paper products, publishing, Chemical products, Basic pharmaceutical products, Rubber and plastic products, Wool, silk-worm cocoons, Forestry, Fishing, Computer, electronic and optical products, Electrical equipment, Machinery and equipment, Motor vehicles and parts, Transport equipment , Manufactures , Electricity, Water, Construction, Trade, Accommodation, Food and service activities, Transport , Water transport, Air transport, Warehousing and support activities, Communication, Financial services, Insurance (formerly isr), Real estate activities, Business services, Recreational and other services, Public Administration and defense, Education, Human health and social work activities, Dwellings.

Source: GTAP 10 Database

Table A.8. A Summary of the Findings and Discussion by Objectives

Objective	Results	Similar Results in the Literature	Supported
AIM OF THE STUDY: To analyze the impact of the trade war between the US and China on the trade and economy of Sub-Saharan African countries by using the Computable General Equilibrium (CGE) model, i.e., the Global Trade Analysis Project (GTAP).	The US exports have reduced by 0.12%, 0.4%, and 0.3%, while its imports have also reduced by 0.1%, 0.4%, and 0.3% for scenarios 1, 2, and 3, respectively. The percentage of GDP lost from the total GDP due to the trade war is 0.01%,0.03%, and 0.02% for scenarios 1, 2, and 3, respectively. In China, the percentage loss of exports due to the trade war is 0.1%, 0.2%, and 0.2%, while its imports loss from the imports is 0.2%, 0.4%, and 0.3% for scenarios 1,2 and 3, respectively. The GDP loss from the total GDP of China is 0.02%, 0.06%, and 0.05% for scenarios 1, 2, and 3, respectively. In the SSA, the trade war is an opportunity for the trade volume and the economy. The GDP of the SSA increased by 0.01%, 0.03%, and 0.02% for scenarios 1, 2, and 3, respectively. In terms of trade volume, the SSA exports increased by 0.01%, 0.04%, and 0.03%, while their imports increased by 0.03%, 0.1%, and 0.1% for scenarios 1, 2, and 3, respectively.	-Guo et al. (2018), Itakura (2020), Bellora and Fontagné (2020), Walmsley and Minor (2018), Devarajan et al. (2018)	YES
OBJECTIVE ONE: To analyze whether there are any changes in the trade volume and trade balance before and after the trade war in the SSA region.	The trade war has decreased the imports and exports of the US and China. The trade war has increased the imports and exports of SSA.	- Decreased imports and exports from the US and China – Guo et al. (2018) -Trade war reduces almost all sectoral imports and output Itakura (2020) - The war can shrink bilateral trade between the US and China and increase trade with the third partners - Rosyadi and Widodo (2018) -Trade barriers like tariffs generally affect the exports and imports of trade partners - Lee and Swagel (1997), Haveman and Thurby (1999), Heien and Sims (2000)	YES

Table A.8 (cont.)

Objective	Results	Similar Results in the Literature	Supported
OBJECTIVE TWO: To examine the economic indicators that are affected in the SSA countries by the trade war.	The US GDP decreased by -0.03% for scenario 2, -0.03% for scenario 2, and -0.01% for scenario 1. China's GDP decreased by -0.06% for Scenario 3, -0.08% for Scenario 2, and -0.03% for Scenario 1. The GDP of SSA has increased for all regions in all scenarios, where West Africa, followed by South Africa, gained more than the other regions.	- The trade war reduces the GDP of China and the US by -1.41% and -1.35%, respectively, due to lower productivity – Itakura (2020). - Trade war decreased the US welfare by 0.04% - The US and China's real wages and GDP will go down by the year 2030- Bellora and Fontagné (2020). - By 2030, the US GDP will decrease by -1.25% - Walmsley and Minor (2018). - China and US GDP will go down by -0.1% and -0.3%, respectively – Devarajan et al. (2018) - Other studies include Englander and Gurney (1994), Connolly (1999), Vamvakidis (1999), Alcala and Ciccone (2004), Sun and Heshmati (2010)	YES
OBJECTIVE THREE: To analyze whether the trade war created trade diversion and trade creation in the SSA.	There are both trade creation and trade diversion effects in the SSA due to the trade war	- Trade diversion effects on other countries, i.e., Mexico, Canada, EU, and South Korea – Guo et al. (2018). - Countries like Mexico, Taiwan, India, Vietnam, Canada, and Korea gained from the trade war diversion effect- Fabricius (2018), Nicita (2019) - Other countries gain due to trade diversion Balistreri et al. (2018), Li et al. (2020), Rosyadi and Widodo (2018). - There is trade diversion to the RCEP member countries due to the trade war – Mahadevan and Nugroho (2019). - Some emerging countries benefit from the trade war because of the diversion effect - Goulard (2020).	YES

Table A.8. (cont.)

Objective	Results	Similar Results in the Literature	Supported
OBJECTIVE FOUR: To analyze other effects of the trade war, including welfare in the SSA.	The trade war has raised the welfare of consumers, producers, and government in terms of household expenditure on commodities, private consumption expenditure, the value that the factors of production have, the value added in the commodities/sectors, expenditure level/NET income, and even the revenue from imports tax payment.	- The welfare of China and the US decreased by 1.7% and 0.2%, respectively, while the welfare of the Asian countries increased – Guo et al. (2018), Balistreri et al. (2018) - The trade war caused welfare gain in the form of trade diversion and decreased welfare in terms of trade and GDP for China and the US - Li et al. (2020) - The US and China's welfare will decrease from USD 23.6 billion to USD 19.3 and from USD 43.1 billion to USD 39.7 billion due to the trade war Carvalho et al. (2019). - After the rise of tariffs, the trade war decreased the US welfare by 0.04% of GDP- Panagariya (2018) - The trade war between the US and China has had several effects worldwide, including the rise of consumer welfare - Evans (2019). - The trade war reduces consumer welfare through the increase in the prices of goods - Amiti et al. (2019), Fajgelbaum et al. (2019)	YES
OBJECTIVE FIVE: To describe which industries are affected the most by the trade war.	All selected sectors are affected by the trade war, i.e., the food and agriculture sector, the oil and gas sector, and the mineral and metal sector.	There is no literature to support the objective	NIL

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Education:

2018-2023 PhD in Management. Ibn Haldun University, Turkey

2015-2017 MA in Business Administration, Binary University, Malaysia

2011-2014 BA in Economics, Mzumbe University, Tanzania

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Experience:

October 2021 – June, 2023, Senior Research Fellow at the Center of Ethical Studies, Ibn Haldun University

September 2018 – June, 2023, Teaching Assistant and Research Assistant at Ibn Haldun University

March 2018, Assistant Lecturer at Kampala International University

July 2014 - October 2015, Economist and data analyst at Dynamic Engineering Consultancy Limited (Part time)

July 2014 – October 2015, Intern at National Social Security Fund (NSSF) Tanzania

October 2013 - February 2014, Ministry of East African Cooperation, Department of Policy, and Planning

Academic Awards:

June 2021 - The best presentation award in the 4th Graduate Conference on Social Sciences, Humanities, and Management, Ibn Haldun University Conference Participation:

June 2021 - Ibn Haldun University, Graduate Conference on Social Sciences, Humanities, and Management (IHU GradCon 2021), Istanbul, Turkey

June 2018 - International Conference on Emerging Issues in Economics, Social Sciences and Business Management, The Federal Kuala Lumpur, Malaysia

March 2018 - Asia Human Capital Development Conference, Kuala Lumpur Malaysia

November 2017 - 26th International Conference on Social Science and Humanities, Kuala Lumpur Malaysia.

November 2017 - 27th International Conference on Teaching, Education and Learning, the Federal Kuala Lumpur.

October 2017 - CFO Dialogue, Hilton Kuala Lumpur, Malaysia.

September 2017 - ASIC International Conference in Higher Education, International Marketing and working with agents, Kuala Lumpur, Malaysia

Publications:

"The effects of a US -China trade war on Sub-Saharan Africa: pro-active domestic policies make the difference". *Journal of Policy Modeling*, June 2023.

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