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OBORO Emmanuel David
 Department of Economics,
 Edwin Clark University
 Kiagbodo, Delta State, Nigeria

Green economy and green trade: Evidence from WAMZ countries

OBORO Emmanuel David

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Abstract

The aim of this study is to investigate the ways in which green trade, green energy production, and green innovation support green economic growth in the West African Monetary Zone (WAMZ) member countries. Information on WAMZ economies for the years 2000–2023 is derived from a number of sources, including the Organization for Economic Co-operation and Development (OECD), International Energy Statistics (IES), and World Development Indicators (WDI). The cointegration test by Wasteland (2007) is used to examine the long-term relationships between the modeled variables, and the second-generation unit root test by Pesaran (2007) is used to evaluate the stationarity of the data. The long-term relationships between the modeled variables—which eventually reach a stationary state—are validated by the study. The study confirmed the modeled variables' long-term correlation, which become stationary at the first differences. To estimate the empirical results, the study also employed fully modified least squares (FMOLS) and dynamic least squares (DOLS). The results of the study show that green energy, green innovation, and green trade are driving growth in the green economy of the West African Monetary Zone (WAMZ).

Keywords: Green trade, green energy, green innovation, green economic growth, WAMZ

1. Introduction

Global trade trends indicate that although many emerging nations are increasingly participating more actively in trade, many others—especially the least developed nations, which make up less than 1% of total trade—remain on the edge of commerce. These nations, which still mostly rely on goods and raw materials derived from natural resources, are extremely susceptible to shocks to the economy and environment. The shift to a green economy that is inclusive offers several, ample opportunities. Utilizing the growing consumer demand for more sustainable products and environmental goods and services, countries can diversify their economy, become less dependent on commodities, and become more competitive. As a result, communities support long-term, sustainable growth while simultaneously enhancing their ability to address the numerous environmental issues that lie ahead (UNCTAD, 2023).

Issues related to green trade are attracting a lot of interest from both public and private entities. We need to reconsider our networks of production and consumption since environmental issues are becoming more pressing. The circular economy needs to be implemented across value chains, supply chain sustainability is becoming more and more popular, and trade and climate issues are coming together more frequently. But there are environmental drawbacks to trade as well. If nothing is done, the total amount of emissions from international merchandise shipping might rise by as much as 160% by the year 2050. Companies that decide to shift production to regions with laxer regulations risk "environmental leakage." On the other hand, strict requirements that exporters cannot meet could keep them out of certain markets. Despite having little upstream visibility, businesses may wish to increase the impacts of their suppliers (WEFORUM, 2024).

Greening trade is not just a chance, but a necessity in today's world of ever-increasing connectivity, where trillions of dollars' worth of goods and services are exchanged annually. International trade needs to change for the better in order to stop land degradation, stop the loss of biodiversity worldwide, reduce greenhouse gas emissions, and safeguard our oceans. At the June 2012 Rio+20 conference, this is exactly what world leaders envisioned. The green economy was cited as "an important tool for achieving sustainable development" and

Corresponding Author:
OBORO Emmanuel David
 Department of Economics,
 Edwin Clark University
 Kiagbodo, Delta State, Nigeria

"international trade [as] an engine for development and sustained economic growth" was reiterated. Green economy policies that increase sustainable trade and lessen climate-related disasters are likely to be beneficial for developing nations in particular (Atkinson, 2020; United Nations, 2013) [6]. The goal of the study is to familiarize interested parties in business, government, and civil society with the several approaches that might be employed to address this challenge by utilizing green trade prospects. It is projected that as more nations adopt economic stimulus plans that include increased prices for climate-friendly measures, the demand for environmental goods and services would increase globally. Ensuring that governments are cognizant of these opportunities and has the abilities to leverage them is a pragmatic task.

2. Literature review

2.1. Conceptual Issues

The Green Economy

The UN Environment Programme defines a green economy as one that enhances human well-being and social equity while reducing environmental risks and ecological scarcities. It aligns with the three pillars of sustainable development: social, economic, and environmental. The Rio+20 Conference endorsed the green economy approach for sustainable development and poverty eradication. An inclusive green economy builds social equity and reduces environmental risks.

2.1.2. West African Monetary Zone

The West African Monetary Zone (WAMZ) is a group of six countries within ECOWAS formed in 2000. Member countries are: The Gambia, Ghana, Guinea, Liberia, Nigeria and Sierra Leone. The group has plan of introducing a common currency, the Eco, by the year 2015. The WAMZ is largely dominated by Nigeria, reflecting its status as Africa's largest oil producer and most populous country. All the members of group are English-speaking countries, except Guinea, which is Francophone. Along with Mauritania, Guinea opted out of the CFA franc currency shared by all other former French colonies in West and Central Africa.

The organs of WAMZ are: Technical Committee supported by cross-cutting expert committees, Committee of Governors, Convergence Council of Ministers and the Summit of Heads of State and Government. The work of the Zone is handled by the West African Monetary Institute from its office in Accra, Ghana.

The WAMZ is making effort to establish a strong stable currency on the side of the CFA franc, whose exchange rate is tied to the Euro and guaranteed by the French Treasury. The ultimate goal is for the CFA franc and Eco to merge, giving all of West Africa a single, stable currency. The launch of the new currency is being developed by the West African Monetary Institute based in Accra, Ghana. However, several of the WAMZ's countries are facing challenges of weak currencies and budget deficits, including inflation (CBN, 2023).

2.1.3. Trade-Related Measures and Multilateral Environmental Agreements (MEAs)

The WTO recognizes the interconnectedness of economic activity with the environment, emphasizing trade's role in

protecting and preserving it. Sustainable development requires mutual support for an open, equitable, and non-discriminatory multilateral trading system. Trade presents both challenges and opportunities for environmental protection, with some Multilateral Environmental Agreements (MEA) trade-related measures serving similar functions. These include;

- **Regulating trade in environmentally hazardous products or goods:** The Basel Convention and Rotterdam Convention regulate trade in environmentally hazardous products, implementing measures like prior informed consent, trade restrictions, and labeling requirements to mitigate health and environmental risks from transboundary movements of hazardous wastes.

- **Supporting the phase-out of certain substances:** The Montreal Protocol and Stockholm Convention both support the phase-out of certain substances through trade restrictions, aiming to eliminate and restrict the production and use of covered chemicals.

- **Enhancing informed decision-making:** Trade-related measures in MEAs like Rotterdam Convention, Basel Convention, and Biosafety Protocol enhance informed decision-making by providing necessary information, such as notification and consent requirements, and addressing information deficiencies in hazardous waste labeling and movement documentation.

- **Encouraging standardized information systems:** Standardized information systems, such as CITES, Resolution Conf. 12.3, Biosafety Protocol, and Basel Convention, help prevent the proliferation of different standards, facilitating environmental protection and harmonizing waste codes through the World Customs Organization.

- **Avoiding "free-riding" and promoting a level playing field:** The Montreal Protocol promotes a level playing field for environmental agreements, preventing non-Parties from exploiting environmental gains without similar efforts. Trade-related measures can incentivize countries to join MEAs, increasing coverage and effectiveness.

- **Assisting in compliance and enforcement:** MEAs typically promote compliance rather than penalize non-compliance, with some MEAs including trade-related measures to address non-compliance. However, the use of these measures has been limited. The new resolution on CITES compliance procedures allows temporary suspension of commercial or all trade in specimens of CITES listed species, similar to the Montreal Protocol.

2.1.4. International Trade Law

The international trade regime, established in 1947, through the GATT, is part of the Bretton-Woods system designed to manage global economic governance and development through five functions: administering trade agreements, acting as a forum for negotiations, settling disputes, reviewing national trade policies, and assisting developing countries.

Objectives of the WTO

The goals of the WTO, outlined in the Marrakesh Agreement, include enhancing living standards, ensuring full employment, fostering large real incomes and demand for goods and services.

The preamble outlines goals for sustainable development, resource optimization, environmental protection, and aiding

developing countries in securing international trade, especially for the least developed nations.

1. The relationship between trade laws and environmental trade measures, as those found in MEAs.
2. The relationship between trade laws that impact trade and environmental policy.
3. a) The relationship between trade laws, taxes, and environmental fees.
b) The relationship between environmental norms and rules pertaining to product packaging, recycling, and labeling and trade laws.
4. Trade laws addressing trade measures used to achieve environmental goals and environmental policies that impact trade's transparency (i.e., full and timely disclosure).
5. How the MEAs and WTO dispute settlement processes are related.
6. The potential for environmental restrictions to make it more difficult for exports from developing countries to reach markets, as well as the potential environmental benefits of removing trade barriers and inefficiencies.
7. The issue of exporting goods that are prohibited in the country.
 1. The relationship between the environment and the TRIPS Agreement.
 8. The relationship between environment and service commerce.
 9. Relations between the World Trade Organization and non-governmental and intergovernmental groups.

2.2. Sustainable Consumption and Development Nexus

When we talk about weak sustainable consumption, we mean improving the efficiency of consumption by developments in technology or design. Examples of this include switching from gas-guzzling cars to more fuel-efficient versions, hybrids, or fully electric cars. These techniques reduce the amount of resources used, but they don't address problems or help the environment. Although fuel is still needed for these changes, weak usage still provides benefits. While individuals can attain weak sustainable consumption; strong sustainable consumption need changes at the national and international levels. Whenever possible, it is advisable to make informed choices about sustainable consumption (United Nations, 2023)

2.2.1. Weak and Strong Sustainable Consumption

Weak sustainable consumption involves improving consumption efficiency through technological or design improvements, such as switching from petrol-guzzling to efficient cars or hybrids or fully electric cars. While these practices reduce resource consumption, they do not solve problems or help the environment. While fuel is still needed for these changes, weak consumption still has benefits. Strong sustainable consumption requires change at national and global levels, while weak sustainable consumption is achievable for individuals. It is advisable to make strong sustainable consumption choices whenever possible.

2.2.2. Strong Sustainable Consumption

Strong sustainable consumption necessitates adjustments to choices, habits, and infrastructure because it has a significant environmental impact. It pertains to institutions, companies, and governments, necessitating modifications to infrastructure and lowering dependency on natural

resources. Strong sustainable consumption is rarely discussed in political discussions, despite the focus given to weak sustainable consumption. Strong sustainable consumption is hampered by overconsumption, which comprises utilizing resources that are not sourced sustainably and consuming when it is not necessary. Societies based on capitalism, where prosperity is equated with economic expansion, are inimical to robust sustainable consumption, which opines that "less is more" and "smaller is better." Given that both capitalism and sustainable consumption depend on the use of natural resources, socialism, which opposes capitalism, is unlikely to be the answer. Circularity, which prioritizes stability and economic success, is the greatest option.

Societies based on capitalism, where prosperity is equated with economic expansion, are inimical to robust sustainable consumption, which opines that "less is more" and "smaller is better." Given that both capitalism and sustainable consumption depend on the use of natural resources, socialism, which opposes capitalism, is unlikely to be the answer. The ideal approach is circularity, which places more emphasis on resource reuse and stability for economic gain than on exploiting virgin resources that are disposed of in landfills. (Mont, Lehner and Dalhammar, 2022)

2.3. Green Products for a Sustainable Earth

The past fifty years have seen a rise in environmental issues due to resource usage by humans.

Humans have used up more resources in the last 50 years than they did in the entire past. Together with other environmental realities, such as the fact that 9 out of 10 people on the planet breathe contaminated air and that between 500 billion and 1 trillion plastic bags are disposed of in landfills annually, the decomposition of a single plastic bag can take up to 1,000 years. The green generation, who prioritize environmentally friendly decisions and sustainable products, is increasingly interested in green products. A 2015 study found that 73% of consumers across 60 countries are willing to pay more for sustainable products. This growing market requires entrepreneurs to understand green products, their benefits and challenges, and how to build them (Deena, 2024 and Das, 2023; Eco Friendly Habits, 2021)).

Eco-friendly products are available to help reduce waste and impact the environment. We can reduce our environmental footprint by making conscious choices and researching the production process. These products are made from organic and natural ingredients and come in recyclable, compostable, or biodegradable packaging. Start using eco-friendly products today to save the environment (Eco Friendly Habits, 2021; Jamezshame, 2022).

- **Reusable Snack Bags:** Reduce the amount of plastic in your home by replacing plastic Ziploc bags with reusable products such as reusable snack bags. One good brand is the Stasher Snack Bags. These bags are Lead-free, PVC free, BPA free, phthalates free, and vinyl free.
- **Biodegradable trash bags:** Trash bags are another huge culprit to pollution. Every trash bag you use is a hazard to the environment. Biodegradable trash bags are normally easy to compost and hence safe for the environment. They are 100% compostable and are BPI certified.

- **Reusable Water Bottles:** Take around right now and you're likely to see a water bottle laying around. Instead of buying water every time you need to quench your thirst, buy a reusable water bottle and reduce the use of plastic around the world. There are so many brands of eco-friendly water bottles but Camelbak is one of the best ones. This water bottle is BPA, BPS, and BPF free. The bottles come in multiple sizes and colors in both BPA-free plastic and insulated stainless steel,
- **Eco friendly cloths:** Replace all your synthetic sponges with natural cleaning cloths and scrubbers. Most natural cleaning cloths don't come in any plastic packaging because they don't need to be kept moist. Skoy cloths are a great choice for eco-friendly cleaning cloths. They are made from cotton and cellulose. They clean so well and one cloth can do the job of 15 rolls of paper towels.
- **Eco friendly laundry detergent:** A lot of environmental pollution from our homes comes from the detergents that we use. Most of these contain a lot of chemicals that end up in water bodies. Start using natural detergents such as Method's eco-friendly products for the homemade from naturally derived, plant-based ingredients and contain a hypoallergenic formula. The detergents are also packaged in a recyclable bottle made from 100% PCR (post-consumer recycled) materials.
- **LED light bulbs:** LED light bulbs are one of the most eco-friendly products you'll find around. They convert 95% of the energy used into light and only 5% is wasted as heat. This makes them way more energy efficient than traditional lighting options. LEDs also use much less power saving you money.
- **Water-Saving Showerhead:** Conserve water around your home by installing water-saving showerheads. Normal shower heads have a high flow wasting so much water as you shower. Water-saving showerheads, however, have a low flow delivering just enough water to rinse shampoo and conditioner without wasting unnecessary amounts.
- **Timer for your water heater:** How many times have you forgotten to turn off your water heater? Countless I imagine. Thank god for timers! Get a timer that will automatically turn off your heater when you are not at home or at night.
- **Energy Saving Power Switch:** Did you know that your electronic devices continue to use energy even when not in use? As long as they are connected to a power source they will continue to use energy. Save energy by using an energy-saving power switch that shuts off all power to electronics and appliances via a flip of a switch.
- **Eco friendly shower curtain:** Minimize the use of plastic in your house by using an organic hemp shower curtain instead of a plastic one. This eco-friendly product is plastic-free and produces zero toxins and chemicals while you enjoy a hot shower.
- **Eco Friendly bath towels:** Another great green product addition to your home is eco-friendly Chakir Turkish Linens bath towels. These towels are made from 35% bamboo fiber, are chemical-free and contain only natural dyes. In addition, they are affordable and feel great on your skin.
- **Eco friendly clothes:** How many times a year do you shop for new clothes? Do you find yourself not wearing near new clothes just because they are out of style? Fast fashion, where you buy clothes to fit the current style, leads to so much waste. One of the biggest brands fighting fast fashion is Everlane. This ethical clothing brand offers sustainable fashion and affordable clothes that you can wear for any season. You can easily turn Everlane's basics into bold fashion statements.
- **Eco-friendly bags (chic made consciously):** Plastic bags are the worst thing that happened to our environment. The amount of pollution caused by plastic bags is ridiculous. You don't need plastic bags anymore. Go for Chic Made Consciously bags that are made from recycled materials. These green products are not only environmentally friendly but also reusable.
- **Eco friendly shoes:** If you're shopping for new shoes, grab a pair of sustainable Allbirds. These shoes are made from wool and tree fiber. The company is committed to sustainability and source their materials from farms that use very little fertilizer and rely on rainfall instead of irrigation. The production of these shoes thus does very minimal harm to the environment.
- **Eco friendly sunglasses:** Looking for eco-friendly sunglasses, try Shwood. Their handcrafted sunglasses are made from premium wood which is very sustainable.
- **Eco friendly underwear:** Tired of buying poor quality underwear? Try PACT super long-lasting basics. This brand has a line of basics that includes leggings, underwear, tees, and hoodies. Their basics are great for everyone in the family, toddler and baby included. PACT supports Fair Trade which contributes to sustainable development by offering better trading conditions and fair wages to all employees especially the marginalized ones.
- **Non-toxic makeup:** A lot of makeup in the market today contain synthetic chemicals that are harmful to our skin. Fortunately, there has been a rise in non-toxic makeup. These don't contain chemicals, parabens, phthalates or genetically modified ingredients. 100% Pure is one of the best all-natural makeup brands in the US. The brand creates vegan cosmetics using natural ingredients such as high-performing antioxidants, naturally occurring vitamins, and essential oils.
- **Not-toxic lipsticks:** If you're looking for an eco-friendly lipstick, go for Bite Beauty. Their lipsticks, made from organic butter, are creamy, hydrating and long-wearing.
- **Eco friendly toothbrush:** Consider using a recyclable bamboo toothbrush. Wowe manufactures the best eco-friendly toothbrush on the market. Made from bamboo, these toothbrushes are stronger and cheaper than plastic toothbrushes. The bristles are BPA free so you won't be putting any toxins in your mouth.
- **Bamboo Safety Razor:** Ditch the disposable razors and start using bamboo safety razors. They will give you a much closer shave while keeping the environment safe at the same time. Bamboo razors have aluminum blades that are much easier to recycle, and last longer than other types of blades so you won't be throwing away a plastic razor every three days or so!
- **Eco Friendly Cotton Buds:** Cotton buds have been described as bad for you and most people recommend

doing away with them completely. However, if you are yet to give up your Q tips then go for eco-friendly Q tips instead of the plastic one. Organic Q-tips are a good choice for environmentally friendly products. They are disposable, biodegradable, organic, and contain all-natural bamboo. They are also sturdier and better quality than the plastic ones.

- **Reusable Makeup Remover Pads:** Reusable makeup remover pads are biodegradable reusable. They are made out of organic bamboo fibers and come with a high-quality small laundry bag to wash them for your next use.
- **Eco friendly sunscreen:** Sunscreen is a great product that protects us from sunburn and in the long term skin cancer/skin aging. Unfortunately, most sunscreens contain harmful chemicals that are left behind in oceans and ruin the coral and marine. To enjoy the beach responsibly, get an eco-friendly sun cream without harmful chemicals such as The Bare Republic. This sunscreen is mineral-based and actually quite affordable.
- **Reusable menstrual cup:** The DivaCup has got to be one of the best menstrual cup products that you will totally love. It's made from 100% silicone hence, it's reusable. Imagine all the tampons or pads you will save from using just a single cup! The DivaCup is odor-free, comfortable, and offers 12 hours of protection.
- **Eco friendly hairdryer:** Eco Tool's air hairdryer acts as a diffuser, thus drying hair 40% faster and causes less heat damage as it uses less heat than a traditional blow dryer. The Eco Tools dryer is made from bamboo, and recycled aluminum and plastic. The packaging is made of 100% Tree-Free paper.
- **Eco friendly toothpaste:** Cali white toothpaste is powerful but gentle vegan toothpaste made from food-grade activated charcoal, certified organic coconut oil, and baking soda. This combination will leave your teeth sparkling white without leaving any toxins in your mouth and does not cause tooth sensitivity. It is also safe for kids.
- **Organic natural deodorant:** That irritation you feel every time you wear deodorant is caused by chemicals used to make it. Organic natural deodorants are now a common feature in the personal care industry. A favorite is the Stick Up Organic Natural Deodorant which has no fragrances, no toxins, no aluminum, and is free of BPA. It also comes in a biodegradable cardboard container.
- **Organic body wash:** Looking for a body wash that is free of chemicals but still keeps you clean and fresh all day? Check out Puracy Natural Body Wash. The body wash contains ingredients that are plant-based, non-toxic, hypoallergenic and free of harsh chemicals.
- **Eco-friendly jewelry:** Raven & Lily has a wide range of stylish eco-friendly jewelry to choose from. Their products are made with the environment in mind. The jewelry is crafted from recycled brass, copper, silver, and bullet casings. The company upholds sustainable, fair-wage employment and endeavors to empower marginalized women artisans in countries such as Ethiopia.
- **Eco friendly watches:** Original Grain manufactures gorgeous watches handmade from premium sustainable wood and 100% stainless steel. In addition to selling

eco-friendly products, Original Grain one tree for every watch purchased.

- **Eco friendly engagement rings:** Looking for an eco-friendly engagement? Go to Brilliant Earth. This brand is popular for its coveted engagement rings made from sustainably mined, conflict-free diamonds.
- **Solar charger for cell phone/Ipad:** Save energy while traveling by charging your devices using a solar charger. The portable Nekteck 21W Solar Charger has a compact design making it lightweight at just 18 ounces. It is high-performing and reasonably priced.
- **Wooden cutlery travel set:** BewBew offers a reusable set of wooden cutlery that you can take with you wherever you go. This set is made with 100% durable untreated fiber bamboo. Your utensils will last you years of use without warping or getting stained.
- **E-reader:** Are you a diehard paperback fan? Your reading habits may be damaging the environment. It may be difficult to give up paperback but you'll be doing the environment a favor by getting an E-reader especially if you buy new books frequently. One of the best E-readers in the market is definitely the Kindle. You can now take all your books with you and buy as many as you want without harming trees.
- **Reusable notebooks:** About 69 million tons of notebook paper is lost in the US every year. Cut down on your paper waste by getting a Rocket book Everlast Reusable Smart Notebook. You can write and wipe clean the notebook and reuse it as many times as you want.

2.4. Empirical Review

A large number of scholars conducted empirical investigations into the connection between trade, economic growth, and environmental quality. For instance, Copeland and Taylor (1997) ^[15] investigated the relationship between global trade, national income, and environmental pollution and created a static model of North-South trade for the first time. The study demonstrated the beneficial effects of free trade in reducing environmental pollution based on the scale, technique, and composition effects.

Copeland and Taylor (2001) ^[16] indicated that trade would result from pollution-constrained production in nations having poor environmental regulations and limited resources. The result of the study suggested that, unlike the developed countries, developing nations shared different environmental burdens in free trade because of poor environmental regulation policies. Aklin (2016) ^[2] specified that international trade shifts the pollution from one country to another. Udeagha and Ngepah (2019) worked on the relationship between trade openness and environment quality. In this regard, the study utilized the data of South African Economies and showed the positive association between trade openness and environmental quality in the short run, while negative association in long run.

Udeagha and Ngepah (2019) investigated the connection between environmental quality and trade openness. Using data from South African economies, the study demonstrated that trade openness and environmental quality have a positive short-term correlation but a negative long-term correlation. Previous research has also emphasized how trading with other countries improves the state of the environment.

For example, Al-Mulali and Ozturk (2015)^[3] discussed how trade helps importing nations' environmental pollution levels decrease. However, it may not be good news for developing countries to benefit from trade in the long run in terms of the environment. The relationship between the rise in urban population, global trade, and environmental deterioration was investigated by Mensah *et al.* (2018) using data from China between 1980 and 2014. A causal relationship between imports and the urban population was also found in the study, highlighting the beneficial impacts of trade on China's environmental damage. Based on the study's hypotheses, China's environmental degradation can be attributed mostly to imports, urbanization, and energy consumption. Boamah (2018)^[9]

In their 2017 study, Duan and Jiang used the updated pollution term of trade indicator to look at the increasing shift in China's environmental pollution costs relative to its economic gains from international trade. The study's findings demonstrated that the various shifts in trade-related pollution by income categories are mostly driven by changes in the global trade pattern. This paper first examines the substantial impact of global commerce on environmental pollution and economic growth before focusing on the function of green trade in green economic growth. For example, Ali *et al.* (2020) looked into how GHG emissions were affected by green and nongreen trade. According to the study's findings, green trade considerably lowers greenhouse gas emissions.

Additional research, including that conducted in the United Arab Emirates (UAE) by Sbia *et al.* (2014), Brazil by Pao and Fu (2013), the United States (USA) by Yildirim *et al.* (2012), and the Eurasian nations (Apergis and Payne (2011))^[5], also demonstrated the beneficial impacts of renewable energy consumption on economic growth. In other words, when renewable energy consumption rises, economic growth will generally rise as well.

Using data from the European Union from 1990 to 2009, Alper and Oguz (2016)^[4] investigated the impact of renewable energy on economic growth. The study's findings demonstrated the beneficial relationship between renewable energy and economic growth in Poland, Slovenia, Bulgaria, and Estonia. Numerous other studies have also demonstrated the beneficial effects of renewable energy consumption on economic growth. These studies include Sbia *et al.* (2014) in the United Arab Emirates; Pao and Fu (2013) in Brazil; Yildirim *et al.* (2012) in the United States; and Apergis and Payne (2011)^[5] in Eurasian nations. These findings imply that, on average, economic growth will increase in response to increases in renewable energy consumption.

Sohag *et al.* (2015) examined the impact of green energy on green economic growth by using the data of turkey from 1980 through 2017. The findings of the study revealed the positive Influence of green energy on green economic growth. Dai *et al.* (2016)^[18] applied a dynamic computable general equilibrium model for investigating the economic effects and environmental benefits of the large-scale development of renewable energy in China. The findings of the study revealed the significant green economic growth effects of renewable energy. The study concluded that renewable energy tends to increase economic growth through environmental protection.

According to Muhammad and Khan (2019), using renewable energy does not considerably worsen the environment. Majeed and Luni (2019)^[30] outlined how using renewable energy can enhance the condition of the environment. The panel of 166 countries for the years 1990–2017 served as the basis for the study's conclusions. According to Bhattacharya, Paramati, Ozturk, and Bhattacharya *et al.* (2016)^[7], the relationship between EG and renewable energy use depends on the economic development stage.

According to Klewitz and Hansen (2014), technological advancements are the best means of ensuring the most efficient, fine, and clean use of resources, which raises living standards and fosters social sustainability while also improving the quality of the environment. Wong *et al.* (2005) used cross-sectional data from 37 GEM 2002 participating countries to study how technical innovation affects economic growth. The study's conclusions demonstrated how technical innovation contributes to economic prosperity.

To the extent of the author's best knowledge, the relationship between green trade and green economic growth is still not discussed by the researchers. Therefore, the present study contributes to the existing debate of green economic growth by empirically examining the role of green trade in green economic growth.

2.5. Theoretical framework of the study

The study investigates the connections among green trade, green innovation, green energy, and green growth. It argues that green economic growth is essential for addressing environmental problems and fostering economic growth. Core-macro economic theory suggests that renewable energy production and consumption reduce dependency on resources and negative externalities. Green innovations also contribute to green economic growth. Tech-related innovation is critical to long-term economic growth, according to the theory of comparative advantage. Technological innovations, such as green technologies, can alleviate environmental issues and promote economic growth. The useful contributions of green technologies to sustainable economic growth are further supported by Porter's hypothesis and modern growth theories.

The study also supports the H-O model, which emphasizes the importance of environmental endowments and competitiveness. It suggests that countries should export and import environmentally friendly goods, with the composition effect indicating specialization in international trade (Farhan Ahmed *et al.*, 2021)^[24].

3. Data and methodology

The specific goal of this study is to clarify, within the framework of the West African Monetary Zone, how green trade, green energy, and green innovation contribute to green economic growth. Data on clean energy production was gathered from International Energy Statistics (IES), data on green trade and innovation came from the OECD, and data on the remaining variables was gathered from World Development Indicators (WDI). A synopsis of the variables is provided in Table 1. In order to obtain more exact results, the author transformed each variable into its natural logarithm.

Table 1: Description of variables

Variable	Notation	Measurement	Data Source
Dependent Variable			
Green economic Growth	GG	Green economic growth = GDP + EE – NRP – NFD–CO ₂ Where: “GDP is Gross domestic product growth (Annual %); EE is education expenditure (% of GDP); NRP is fossil fuel consumption (% of total), CO ₂ is carbon emissions (% of fuel)”	WDI
Independent Variables			
Green Trade	GT	“Share of export of environmental goods to total export”	OECD
Green Innovation	GI	“Environmental-related technologies”	OECD
Cleaner Energy Production	GE	“Share of electricity generated by renewable power plants in total electricity generated by all types of plants”	IES

Econometric techniques

Cross-sectional dependence

Because of mutual shocks, unidentified causes, and financial and economic absorption, researchers have discovered that panel data frequently suffers from cross-sectional dependency. Pesaran's cross-sectional dependence test, which employs pair-wise correlation coefficients for panels with small N and large T, is used in the study to address this issue.

Panel unit root test in the presence of cross-sectional dependency

Panel data frequently has cross-section dependency, and first-generation unit-root tests may be deceptive. Second-generation unit-root tests, like CIPS, are created to remedy this. These tests verify data stationarity and take cross-section dependency into account. The cross-sectional lagged average of people is calculated using cross-sectional augmented dickey fuller (CADF) regression, the foundation of CIPS, in order to track common factors.

Panel cointegration tests

Green economic growth, green trade, green innovation, and clean energy output are tested over the long run using the bootstrap test of cointegration in this study. Due to its capacity to manage cross-sectional dependencies, structural breaks, and small sample numbers, this method is recommended. Moreover, it evaluates cointegration under the null hypothesis of "no-error correction" and eschews common factor restrictions. Long-term relationship or cointegration between the variables is evident when the null hypothesis is rejected.

Estimation techniques

The study estimates the long-run coefficients of cointegrating vectors using dynamic least square (DOLS) and fully modified least square (FMOLS) models. Cross-sectional dependency, endogeneity, and heterogeneity are addressed by FMOLS, whilst parametric adjustments and past and future predictor values are incorporated by DOLS to produce unbiased and consistent estimators.

4. Empirical results

Descriptive statistic

The analysis starts with the variables' descriptive statistics from the sample of chosen WAMZ countries. The green economic growth (GG) mean value, as indicated by the table

2, is -1.7854, with a range of -2.0302 to -1.3005. With a mean value of 3.0098, green energy (GE) ranges from a low of -2.67577 to a maximum of 4.6069. Green innovation (GI) has a mean value of 2.2303 and a minimum and maximum value of 0.0392 and 3.8747, respectively. Green trade (GT) ranges from -2.3748 to 2.0932, with a mean value of 3.16E-07. The normalcy of residuals is tested using the Jarque-Bera method. "Residuals are normally distributed" is the null hypothesis for the test. Given that the Jarque-Bera probability values are significant, the result demonstrates that the residuals are not normally distributed.

Table 2: Descriptive statistics

	GG	GT	GE	GI
Mean	-1.7852	3.16E-07	3.0098	2.2303
Median	-1.8095	-0.1447	3.4341	2.1927
Maximum	-1.3005	2.0932	4.6069	3.8747
Minimum	-2.0302	-2.3748	-2.6757	0.0392
Std. Dev.	0.1916	1.0000	1.4689	0.7643
Skewness	0.9244	0.5816	-1.3260	-0.0701
Kurtosis	3.0164	3.1297	4.7723	2.8061
Jarque-Bera	13.533	5.4234	40.273	3.8266
P-value	0.0011	0.0364	0.0000	0.0728

To identify the problem of cross-sectional dependency in the data, the study uses the Pesaran CD test. The null hypothesis of "cross-sectional dependency" is rejected at the 1% level (p-value<0.01), according to Table 3's results, suggesting that a shock in one of the chosen countries tends to spread to other countries.

Table 3: Cross-sectional dependence

Variables	CD statistics	p-value	Decision
GG	7.1815	0.000	“Cross-Sectional dependence”
GE	6.8490	0.000	“Cross-Sectional dependence”
GI	9.3572	0.000	“Cross-Sectional dependence”
GT	4.7828	0.000	“Cross-Sectional dependence”

Panel unit root

To verify whether data is stationarity, Table 4 presents the findings of the CIPS test. The null hypothesis for the test is "nonstationary series." The findings show that all of the series, both with and without a trend, are nonstationary at a level. However, by rejecting the null hypothesis of "nonstationary series" at the 1% (p-value<0.01) level, the series become stationary at the first difference. This means that all of the series are integrated of order 1, or I (1).

Table 4: CIPS second-generation unit-root test

Variables	Level		First-Difference		Order of integration
	Constant	Constant and trend	Constant	Constant and trend	
GG	-0.5463	-0.5534	-2.5471**	-3.5774***	I (1)
GE	-1.7525	-1.6742	-2.6534**	-3.2352***	I (1)
GI	-1.2821	-1.9644	-2.8476***	-3.5475***	I (1)
GT	-1.2227	-1.7843	-2.8491***	-3.5285***	I (1)

Panel Cointegration

To determine whether there is a long-term relationship between variables, Westerlund (2007) tested for cointegration, and the results are shown in Table 5. The probability values of Gt, Ga, Pt, and Pa are less than 0.01 in the result, indicating a long-term association between green economic growth, GE, GI, and GT, and rejecting the null hypothesis of "nocointegration" at the 1% level.

Table 5: Westerlund (2007) panel cointegration test

	Test statistics	Robust p value	Decision
Gt	-5.02701***	0.020	Cointegration exists
Ga	-21.0430***	0.000	Cointegration exists
Pt	-7.1720***	0.002	Cointegration exists
Pa	-15.3522***	0.000	Cointegration exists

Hypothesis testing

Table 6: Hypothesis testing

Variables	FMOLS		DOLS		Decision
	DV: green economic growth		DV: green economic growth		
	Coefficient	p-value	Coefficient	p-Value	
GE	0.0281***	0.0341	0.0502***	0.0312	H1 Supported
GI	0.0125***	0.0241	0.0623***	0.0221	H2 Supported
GT	0.0304***	0.0003	0.0212***	0.0002	H3 Supported
R ²	0.952		0.975		
Adjusted R ²	0.935		0.952		

The outcomes of FMOLS and DOLS are fairly similar. The DOLS results indicate that the GE coefficient (0.0502) is significant at the 5% level because the p-value is less than 0.05, or 0.0312<0.05. The outcome suggests that GE has a beneficial impact on the expansion of the green economy. As an illustration, a 1% rise in GE typically results in 5.02% more growth in the green economy. As the p-value is less than 0.05, or 0.0221<0.05), the coefficient of GI (0.0623) is positive and significant at the 5% level, suggesting a positive correlation between GI and green economic growth. This suggests that there is a 6.23% tendency for green economic growth to improve with every 1% increase in GT. Given that the p-value is less than 0.01, or (0.0002<0.05), the coefficient of GT (0.0212) is likewise positive and significant at the 1% level, demonstrating the beneficial contributions of GT to the expansion of the green economy. The results show that green economic growth tends to improve by 2.12% with every 1% increase in GT. According to the value of Adjusted R2, GE, GI, and GT took together account for 96.2% of the variability in green economic development.

5. Conclusion and Recommendations

Within the framework of the West African Monetary Zone, this study examined the roles that GE, GI, and GT play in the growth of green economies. The investigation discovered some intriguing results. First, the study shows that green energy has a beneficial impact on green economic

Table 5 illustrates the use of FMOLS and DOLS in this investigation. The FMOLS results show that the GE coefficient (0.0281) is positive and significant at the 5% level because the p-value is less than 0.05, or (0.0341<0.05). This suggests that there is a 2.81% tendency for green economic growth to improve with every 1% increase in GE. Given that the p-value is smaller than 0.05, or 0.0241<0.05, the coefficient of green innovation (GI) (0.0125) is likewise positive and significant at the 5% level. According to the findings, there is a 1.25% tendency for green economic growth to increase with every 1% increase in GI. With a p-value of less than 0.05 (0.0003<0.05), the GT coefficient (0.0304) is also positive and significant at the 1% level. This means that a 1% increase in GT tends to enhance green economic growth by 3.04%. Table 6's Adjusted R2 value indicates that GE, GI, and GT account for 93.5% of the variances in green economic development.

growth by promoting environmental sustainability by reducing reliance on finite resources like fuel, coal, and gas (Alper and Oguz 2016) [4]. Furthermore, GDP is sustainable since it is not reliant on the depletion of natural resources when it is generated by green energy sources (Owusu and Asumadu-Sarkodie 2016). Core-macro economic theory also validates the results. Second, the study's findings demonstrate the important and because green innovation fosters the use of reasonably priced, ecologically friendly technologies that lessen pollution in the environment, make modern technologies accessible, and advance sustainable economic growth (Popp 2002). The study's conclusions are corroborated by the Porter Hypothesis, economic theory, ecological modernization theory, and comparative advantage theory. Finally, the research indicates that a rise in green trade is advantageous for the green economic growth of WAMZ countries. This is because GT contributes to the growth of the green economy by lowering greenhouse gas emissions, increasing energy efficiency, boosting industrial development, and fostering economic advancement. The findings are corroborated by Siebert and Larrick's (1992) expanded H-O model and the composition.

5.1. Recommendations

This study makes the following policy recommendations based on empirical findings. First, according to the study, new initiatives and investments in renewable energy sources are needed to boost the generation of green energy in

WAMZ economies. By providing subsidies, WAMZ Economies' government ought to incentivize private industry players to enhance their use of renewable energy. In order to facilitate investor participation at the installation and production stages, tax incentives should be made available. In order to shift the production of energy from conventional energy sources to renewable/cleaner sources, a carbon price should be imposed on the use of conventional energy. The second finding of the study is that upgrading the financial markets is necessary to encourage green innovation. Finally, the report recommends that low taxation policies and the encouragement of the manufacturing of eco-friendly products be used by the government to foster green trade. All of the recommended policy implications support the attainment of SDG7 (affordable and clean energy), SDG13 (environmental sustainability), SDG8 (decent work and economic growth), SDG12 (responsible production and consumption), and SDG6 (clean water and sanitation), in addition to aiding the government of WAMZ Economies in promoting green economic growth.

5.2. Limitations and Future Research

The study provides a preliminary understanding of green economic growth in WAMZ Nations, but has limitations. Future research should replicate the study in different developing nations and compare results cross-nationally. Additionally, the study only explored three factors contributing to green economic growth.

6. Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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