Greening Trade through Global Value Chains in Africa

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Bringing Rigour and Evidence to Economic Policy Making in Africa

Greening Trade through Global Value Chains in Africa

By

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Abstract

The global response to climate change necessitates that less developed economies adapt and maximize new potential export opportunities in global trade, and access green technology through imports for their own green transformation. Using detailed firm-level data for Malawi and Kenya (2013-2020), this paper tests whether firms in global value chains (GVCs) participate more in green trade relative to non-GVC firms. Second, we test whether importing green goods leads to exporting green goods. Green goods are heterogeneous and are divided into 19 different categories, depending on their usage in climate mitigation and adaptation. We find that imports of green goods far exceed exports, signaling that trade currently serves more as an access to green technologies with limited exports of these products. Second, being a GVC firm is associated with a higher probability of importing than exporting green goods. Also, the increase in trade value after a firm becomes a GVC is much larger for imports than exports. Third, higher imports of green goods are associated with higher exports of green goods, especially for GVC firms. Therefore, GVCs can play a key role in Africa's green transition and trade competitiveness. As such, it is imperative for African governments to attract foreign direct investment in the green sector, potentially targeting sectors where they can gradually acquire comparative advantage and start exporting green goods in the future.

JEL Classification: F18, D22, Q56

Keywords: Green Goods; Environmental goods; Malawi; Kenya; Climate Change

1. Introduction

Climate change and the green transition globally continue to alter the patterns of external demand for materials and products. The global response to climate change necessitates that less developed economies, dependent on carbon-intensive global value chains (GVCs), quickly adapt and maximize new potential opportunities in global trade (Brenton et al., 2022). Research has shown that while the interdependence of the current global system makes countries that are more integrated more vulnerable, these inter-linkages make them more resilient (Brenton et al., 2022). While these findings are mainly in the context of the 2019 Coronavirus (COVID-19), climate change policies could alter GVCs to a greater extent than transitory shocks such as the COVID-19 pandemic. Firms in low-income countries will be affected by emerging policy responses to climate change, since these policies prompt a shift in demand from carbon-intensive products in major markets. Reducing emissions may also facilitate future access to export markets if countries begin to penalize emissions-intensive trade.

New export opportunities may arise in the greening of GVCs as countries innovate with cleaner production techniques and greener products (World Bank, 2020). At the same time, access to foreign markets may entail access to green goods and technologies that can play a role in the diversification of green production in various sectors. As Africa intensifies efforts to better integrate into global and regional value chains, this can be coupled with addressing the increasing importance of export diversification to GVCs that are less carbon-intensive. Countries may need to support the use of more efficient and cleaner technologies, which would facilitate a green transition. The transition to a low-carbon economy depends on, among other things, the development, adoption and diffusion of environmental goods, services and technologies (World Trade Organization, 2022).

This paper assesses the readiness and opportunities for Africa to participate in green trade through GVCs using Customs data for Kenya and Malawi. While both are developing countries, Malawi is also a least developing country (LDC), as are over 30 other countries in Africa (UNCTAD, 2022). Therefore, the results of this analysis may allow for some generalization to other African countries at varying levels of development. Data from the Green Transition Navigator ranks Kenya among the top 10 exporters and importers of green goods in Africa while Malawi is among the top 30 for exports and the top 40 for imports (out of 54 countries). This suggests that our results are also insightful to countries at different levels of green trade.

The analysis is done in two ways. First, we test whether GVC firms trade more in green trade for which, *apriori*, the expected result is ambiguous[1]. On the one hand, globalizing of value chains, which traditionally involves relocating operations to lower-cost destinations such as Africa or Asia, may not lead to greener trade (Li and Zhou, 2017). For example, de Melo and Solleder (2022) argue that environmental impacts are higher in upstream industries where most African countries are located. Several studies tried to investigate if the Pollution Haven Effect is present when firms set up new plants[2]. The results are largely inconclusive (see Duan et al., 2021; Shi et al., 2022 and Wu et al., 2024 for examples).

On the other hand, GVC firms are more exposed to foreign markets and may have access to new and greener technologies, leading to greener trade. Imports generally allow for better and/or cheaper access to technology (including green technology), which are all necessary for green structural transformation (UNCTAD, 2022). Moreover, the increased importance of sustainability for consumers, investors and country governments has started to motivate multinational corporations to address environmental issues within their global supply chains (Ponte, 2020). This leaves African GVC-participating firms to comply with strong environmental quality controls from their trade partners, which could incentivize them to adopt better technologies and gravitate towards green-good production and export. An empirical test could tell us about the correlation between GVC participation and trade in green goods.

Second, we test whether importing green goods leads to exporting green goods. Imports of green goods can boost a country's green competitiveness by reducing the cost of inputs for production processes and innovation of green goods (Chen et al., 2024) that form part of regional and global value chains. Alternatively, given that green goods tend to be more knowledge-intensive and demand more investment in research and development, green imports can lead to technology dependence and crowding-out effects as the technological gap between developing and developed countries locks developing countries into low-end manufacturing with high energy consumption and pollution, in turn producing fewer green goods for export (Chen et al., 2024).

The green goods referred to in this paper are based on the list of green products defined by the Green Transition Navigator (GTN). This is a compilation of the Organization for Economic Co-operation and Development (OECD), Asia-Pacific

[1] The World Development Report 2020 (World Bank, 2020) states that perhaps the biggest contributions of GVCs to the environment may be the many new and innovative environmental products they make possible. However, the" Scale effects", which refer to the rapid growth of GVC economic activity, are bad for the environment, whereas composition effects, which refer to how tasks are distributed across the globe, have ambiguous effects on the environment.

[2] The Pollution Haven Effect postulates that countries with weak environmental regulations will have comparative advantages in attracting pollution-intensive industries.

Economic Co-operation (APEC), and the World Trade Organization (WTO) green goods classifications, which are listed into a single, comprehensive dataset (Andres et al., 2023). These products are divided into 19 different categories, depending on their use in climate mitigation and adaptation.[3][4]

We find that green goods trade is generally low, accounting for less than 10% of imports and around 3% of exports for Kenya and Malawi. This shows that imports of green goods far exceed exports, signaling that trade currently serves more as an access to green technologies with limited exports of these products. The types of green goods exported differ between GVC and non-GVC firms, while the types of green goods imported are relatively the same. Econometric analysis shows that being a GVC firm increases the probability of starting to import rather than exporting green goods. We also find that firms that switch from non-GVCs to GVCs are not associated with increased green exports. Instead, there is evidence that becoming a GVC firm is associated with a high green-good import performance in Kenya and Malawi. The increase in green imports is much larger in Kenya than in Malawi in terms of the number of increased green-good categories. Finally, higher imports of green goods are associated with higher exports of green goods, especially for GVC firms.

Studies on GVCs and trade in green/environmentally friendly goods are few. Zhong et al. (2021) and Lu et al. (2024) find GVCs as a conduit for transferring carbon and sulphur dioxide emissions across countries, respectively. On the other hand, Wang et al. (2021), Wu et al. (2024), Li et al. (2024) and Gao et al. (2024) find that above-threshold GVC embeddedness reduces environmental pollution in Russia, Mexico, India, China and Brazil. As for green/environmentally-friendly goods,

Qu et al. (2020) find that above-threshold GVC embeddedness fosters green growth. Equally, Can et al. (2021) find that trade openness in environment-friendly goods, and environmentally preferable goods, stimulates environmental sustainability for OECD countries. Chen et al. (2024) find that the importation of green products stifles green technology innovation in China. Chen et al. (2024) finds that importation from China boosts Africa's green growth.

Firm-level evidence on the subject of GVCs and green goods shows that GVC firms, in comparison to non-GVCs, are more likely to adopt environmentally friendly production technologies, comply with more demanding standards and regulations and, in the case of manufacturing firms, monitor CO_2 emissions along their supply chains (Siewers et al., 2024; Paschoaleto and Martínez-Zarzoso, 2024). Furthermore, the success of green trade is championed by leading firms in specific sectors (Ponte, 2022).

[3] The terms green goods and environmental goods are used interchangeably throughout the paper.

[4] The Pollution Heaven Effect postulates that countries with weak environmental regulations will have comparative advantages in attracting pollution-intensive industries.

These firms operate at the upstream level and are expected to transfer green production-related knowledge to downstream firms (majorly their partners) that are not necessarily green (De Marchi et al., 2013).

Overall, just as data and research on global value chains in Africa is still relatively low compared to other regions (Alhassan et al., 2021), even less is known on trade in these "greener products" and what role GVCs have to play in enabling this shift in global trade. Nevertheless, these are important academic and policy discussions in a changing world, and this paper attempts to fill this knowledge gap and provide some policy messages from the results. To the best of our knowledge, this is the first study that investigates the relationship between GVC participation and trading in green goods using firm-level data trade in an African context.

The rest of the paper is organized as follows. Section 2 describes the data. Section 3 describes the methodology and discusses their respective results. Section 4 concludes the study.

2. Data

Data Description and Sources

The study relies on customs transactions data at the firm level from Kenya and Malawi, covering the period between 2013 and 2020. Kenya's data is obtained from the Exporter Dynamics Database (EDD) by the World Bank (Fernandes et al., 2016)[5] while Malawi's data is from the Malawi National Statistics Office (NSO). The Malawi data by NSO is majorly sourced from the Malawi Revenue Authority (MRA) through Customs declaration forms. MRA captures data electronically using Automated System for Customs Data (ASYCUDA World) format from the ports that are automated, and this is shared with the National Statistical Office (NSO). NSO also collects hard copies from all the small ports that are not automated.

The customs datasets record transactions for each exporter and importer by product (at 8-digit Harmonized System (HS) level), destination/origin, date of export/import and value of export/import.[6] Firms have anonymous IDs. The data cleaning process entailed three steps. First, trade flows were aggregated to establish the annual value a firm trades a product with a partner. Second, trade flows were aggregated to the 6-digit level and concorded to the 2012 version of HS to form a list of HS 6-digit categories that are comparable internationally. Lastly, the trade value was converted from Kenyan shillings/Malawian Kwacha to US dollars using annual exchange rate values from the International Monetary Fund (IMF).

The green goods referred to in this paper are based on a list of green products defined by the Green Transition Navigator (GTN). This is a compilation of the Organization for Economic Co-operation and Development (OECD), Asia-Pacific Economic Co-operation (APEC), and the World Trade Organization (WTO) green goods classifications, which are listed into a single, comprehensive dataset (Mealy and Teytelboym, 2022; Andres et al., 2023). The GTN list has 543 products classified at the six-digit level of the HS 1992 version.[7] These products are divided into 19 categories, depending on their use in climate mitigation or adaptation. The products are then concorded to the 2012 version of HS to merge with the Customs data. Nonetheless, we are aware of existing challenges regarding the identification of an inclusive list of green goods. First, De Melo and Solleder (2020) notes that the existing lists of green goods are not representative as they are largely based on the

[5] The data used in this paper is updated and currently not available to the public.
[6] We compared aggregate exports and imports from our Customs data with official government statistics for Kenya and Malawi for the period of our study and the ratio was one, indicating the reliability of Customs data.
[7] There are 337 products at the six-digit level of the HS 2012 version.

definitions of a few developed countries. In addition, the process of defining green goods favours high-income countries and the entire discussion seems unfair to developing countries given that their developed counterparts followed a 'grow-first-clean-up later' approach (De Melo and Solleder, 2020). Lastly, there are sharp and deep differences regarding the definition of environmental goods (Mao et al., 2023).

The list we use has the advantage of comprising the popular lists (OECD, APEC and WTO), which individually have between 54 and 248 products at the 6-digit level. In addition, the list includes products that have either been endorsed by a large number of WTO or APEC member countries or their environmental benefits have been determined by the (rather selective) OECD (Mealy and Teytelboym, 2022).[8] However, the lack of most agricultural products, in which a majority of developing countries possess a comparative advantage (De Melo and Solleder, 2020), might be a shortcoming of our list.

GVC Firms and Green Goods

In this paper, GVC firms are defined as those that participate in both export and import (of intermediate goods) activities. This is in line with the broad offshoring measure used in the literature, though ours is at firm-level (Feenstra and Hanson, 1999).[9]

Data for Kenya includes information from an average of 6,731 exporting firms for the sample period[10], of which 32% are GVCs. Importers are 37,528 on average with 11.5% being GVC firms (Appendix Table A1). Malawi has an average of 954 exporters[11], of which 41% are GVCs. The average number of importers in Malawi over the study period is 15,859 firms, out of which 7% are GVC firms (Appendix Table A2). Between 2013 and 2020, 26% and 32% of green goods exporters in Kenya and Malawi, respectively, were GVCs. The share of GVC firms exporting green goods in Kenya has been declining, while for Malawi, the share has increased substantially to a level where exports of green goods are almost exclusively done by GVC firms. The average share of GVCs in the population of green goods importers in Kenya and Malawi between 2013 and 2020 is 11% and 7%, respectively (see Appendix Table A1 and Table A2). This suggests that most GVCs that trade in green goods export rather than import them.

The share of green goods in total import and export value is shown in Table 1. Green goods account for a higher share in import value than export value in both Kenya

[8] We find that 28% of products in our list appear in the list of products used in decarbonization technologies by Rosenow and Mealy (2024).
[9] This approach only captures direct trade and backward GVC engagement of firms due to data limitations (Montfaucon et al., 2023).
[10] This is close to what Turkcan et al. (2022) found.
[11] [1]This is close to what Cadot et al. (2013) found.

and Malawi. These goods accounted for 9.5% of Kenya's imports and 8% of Malawi's imports, on average, over the period of study. The export share is between 2% and 3%, on average, in the two countries. Green goods are mainly imported from non-African countries but are exported to African countries; seven out of ten top export destinations for Kenya's and Malawi's green-good exports are in Africa. China, India, the US, Germany, Japan, the United Kingdom and South Africa featured among the top ten importers of green goods for the two countries.

Table 1: Share of green goods in total imports and exports of Kenya and Malawi (%)

	Kenya		Malawi	
Year	**Imports**	**Exports**	**Imports**	**Exports**
2013	7.86	3.38	7.34	1.09
2014	8.04	3.04	8.72	2.47
2015	9.34	3.03	10.66	4.17
2016	11.17	2.20	6.35	2.77
2017	9.57	2.30	9.48	1.06
2018	9.49	2.53	7.83	0.65
2019	9.63	2.75	7.99	1.16
2020	10.69	2.53	7.58	1.24

Source: Author estimations

Specific Green Good Categories

Green goods are divided into 19 categories. Table 2 shows the shares of exports and imports by these categories of green goods for GVC and non-GVC firms in Kenya between 2013 and 2020. The results reveal that renewable energy green goods were the most exported by firms in Kenya in 2013. However, their share declined from 32.5% in 2013 to around 11.4% in 2020. They have been overtaken by environmentally preferable products based on end-use or disposal characteristics of green goods whose percentage has more than doubled from 22.9% in 2013 to 50.8% in 2020. Natural resource protection is another green good whose export share has skyrocketed from below 1.0% in 2013 to 7.1% in 2020. The share of wastewater management and potable water treatment goods in total green-good exports declined from 23.6% in 2016 to around 6.0% and 10.0% in 2019 and 2020, respectively. Except for cleaner or more resource efficient technologies and products, whose share has declined from 8.2% in 2013 to 5.2% in 2020, other categories of green goods account for less than 2.5% of green-good exports by GVC firms in Kenya.

Waste water management and potable water treatment goods dominate the exports of green goods by non-GVC firms in Kenya. Their share was about 33% in 2013, 52% in 2016 and has since remained at around 40%. The share of renewable energy green goods is also high among non-GVC firms in Kenya. It has risen from around 20% in 2013 to 25% and 22% in 2019 and 2020, respectively. The share of cleaner or more resource efficient technologies and products in green-good exports of non-GVC firms has doubled from 5.5% in 2013 to around 11.3% in 2020.

A fifth of green-good export value by non-GVC firms in Kenya in 2013 was in the management of solid and hazardous waste and recycling systems products. The share has declined to approximately 17% in 2020.

Three-quarters of the value of green-good imports by GVC firms in Kenya in 2013 was in renewable energy and waste management, recycling and remediation, as shown by the lower section of Table 2. The two commodities accounted for 69% of the total import value of green goods in 2014, of which 40% was from renewable energy products. However, the share of wastewater management and potable water treatment has since overtaken that of renewable energy. For instance, 41% versus 32% for renewable energy in 2020. The share of management of solid and hazardous waste and recycling systems in the total import value of green goods has stagnated at around 9% while that of heat and energy management goods has increased from 5.9% in 2013 to 9.7% in 2020.

Renewable energy and waste management, recycling and remediation green goods have also dominated the import value of non-GVC firms in Kenya. The two accounted for about 71% of the import value of green goods in 2013. The share declined to around 63% in 2020. The share of cleaner or more resource efficient technologies and products in the total import value of non-GVC firms has quadrupled, from 4.4% in 2013 to 17.9% in 2020. The share of management of solid and hazardous waste and recycling systems' goods in the total import value of non-GVC firms in Kenya has stagnated at around 8% except for 2019 when it was almost 14%.

The share of export and import value by green-good category between 2013 and 2020 in Malawi for GVC and non-GVC firms is shown in Table 3. Noise and vibration abatement goods accounted for half of the export value of green goods by GVC firms in Malawi in 2013. Noise and vibration abatement goods have since dominated Malawi's GVC exports; the share was about 82% in 2016, 70% in 2019 and 65% in 2020. The share of waste management, recycling and remediation in the export value of green goods by GVC firms in Malawi was the second highest in 2013 but has diminished to around 1% in 2020. The share of heat and energy management in the

export value of green goods by GVC firms in Malawi has hovered around 20.0% except for 2016 when it was 1.7%. Exports of clean up or remediation of soil and water goods by GVC firms in Malawi have fluctuated with their share in the export value of green goods ranging from 0.3% to 12.7%.

No green product has consistently dominated the export share of the total export value of green goods by non-GVC firms in Malawi. Wastewater management and potable water treatment accounted for almost half of this share, but it declined to 23% in 2020. The share of management of solid and hazardous waste and recycling systems goods in the total export value of green goods by non-GVC firms increased by about 27% between 2016 and 2013 but has since declined to 6.9% in 2020. Cleaner or more resource efficient technologies and products accounted for 36% of the export share in 2016 while renewable energy was the highest exported green good in 2019 and 2020; the share was 71% and 54%, respectively. Renewable energy and wastewater management and potable water treatment have dominated Malawi's green-good imports by GVC firms as per the lower part of Table 3. The two commodities accounted for 60% of the total value of green-good imports by GVC firms 2013. The share rose to 77% and 70% in 2019 and 2020. The share of management of solid and hazardous waste and recycling systems goods in Malawi's green-good import value by GVC firms has also increased tremendously, from 6% in 2013 to 13% in 2020. Conversely, the share of cleaner or more resource efficient technologies and products has declined by over two and a half times over the study period.

Table 2: Share of exports and imports by green-good category for GVC and non-GVC firms in Kenya

Export Analysis (%)								
	GVC				Non-GVC			
Product category	**2013**	**2016**	**2019**	**2020**	**2013**	**2016**	**2019**	**2020**
Air Pollution Control	-	-	-	-	0.4	0.1	0.3	0.1
Clean Up or Remediation of Soil and Water	-	-	-	-	0.0	0.0	0.0	0.0
Cleaner or More Resource Efficient Technologies and Products	8.2	4.4	4.1	5.2	5.5	1.7	10.4	11.3
Efficient Consumption of Energy Technologies and Carbon Capture and Storage	0.0	0.0	0.0	-	0.3	0.3	0.0	0.1
Environmental Monitoring, Analysis and Assessment Equipment	0.1	0.2	4.5	0.9	5.0	6.9	1.8	1.9
Environmentally Preferable Products based on End-Use or Disposal	22.9	51.6	52.3	50.8	0.0	0.6	0.1	0.7

Characteristics								
Gas Flaring Emission Reduction	0.1	0.2	0.1	0.1	0.8	0.5	0.4	0.1
Heat and Energy Management	2.1	2.0	3.5	2.1	1.9	1.0	3.1	3.4
Management of Solid and Hazardous Waste and Recycling Systems	11.1	10.3	14.6	10.3	20.4	12.9	16.1	16.7
Natural Resource Protection	0.7	0.1	4.7	7.1	0.5	0.5	1.3	1.0
Natural Risk Management	4.1	2.1	0.5	0.7	12.2	5.3	0.7	0.3
Noise and Vibration Abatement	0.2	0.1	0.8	0.2	0.0	0.0	0.2	0.3
Renewable Energy	32.5	4.9	8.4	11.4	19.6	16.8	25.4	22.3
Resources and Pollution Management	-	-	-	-	0.0	0.3	0.0	0.0
Waste Management, Recycling and Remediation	0.2	0.1	0.0	0.2	0.4	0.8	0.4	0.3
Waste Water Management and Potable Water Treatment	17.4	23.6	6.0	9.5	32.8	52.1	38.7	40.2
Water Supply	0.4	0.4	0.6	1.3	0.1	0.2	1.0	1.3
Import analysis (%)								
	GVC				**Non-GVC**			
Product category	**2013**	**2016**	**2019**	**2020**	**2013**	**2016**	**2019**	**2020**
Air Pollution Control	-	-	-	-	0.5	0.5	0.7	0.4
Clean Up or Remediation of Soil and Water	-	-	-	-	0.1	0.1	0.1	0.0
Cleaner or More Resource Efficient Technologies and Products	2.7	10.7	7.8	3.1	4.4	8.2	12.8	17.9
Efficient Consumption of Energy Technologies and Carbon Capture and Storage	0.0	0.1	0.0	0.0	5.5	0.2	0.5	0.5
Environmental Monitoring, Analysis and Assessment Equipment	0.4	0.4	0.6	0.3	4.7	5.2	4.6	3.8
Environmentally Preferable Products based on End-Use or Disposal Characteristics	0.4	0.3	0.3	0.5	0.0	0.1	0.1	0.0
Gas Flairing Emission Reduction	0.5	1.5	0.3	0.3	1.1	1.0	1.1	0.8
Heat and Energy Management	5.9	7.0	9.3	9.7	3.5	8.8	2.5	3.6
Management of Solid and Hazardous Waste and	9.1	6.9	9.1	10.2	7.7	7.1	13.7	8.3

Recycling Systems								
Natural Resource Protection	0.2	0.1	0.2	0.2	0.0	0.0	0.1	0.1
Natural Risk Management	0.7	0.8	0.3	0.0	1.4	1.2	0.5	0.2
Noise and Vibration Abatement	4.1	2.9	3.0	2.5	0.4	0.4	0.4	0.5
Renewable Energy	39.4	40.4	32.6	31.7	36.2	34.4	35.7	32.6
Resources and Pollution Management	-	-	-	-	0.0	0.0	0.0	0.1
Waste Management, Recycling and Remediation	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.9
Waste Water Management and Potable Water Treatment	36.5	28.6	36.3	41.2	34.3	32.7	27.1	30.1
Water Supply	0.2	0.1	0.2	0.2	0.0	0.0	0.0	0.0

Note: Share is the portion of firms (GVC or non-GVC) that trade in a specific green good out of the total value of green-good exports or imports by GVCs or non-GVC firms.
Source: Author estimations

Table 3: Share of exports and imports by green-good category for GVC and non-GVC firms in Malawi

Export analysis (%)								
	GVC				Non-GVC			
Product category	2013	2016	2019	2020	2013	2016	2019	2020
Air Pollution Control	-	-	-	-	0.0	0.0	0.0	0.0
Clean Up or Remediation of Soil and Water	0.4	6.1	0.3	12.7	0.0	0.0	0.8	0.0
Cleaner or More Resource Efficient Technologies and Products	-	-	-	-	4.0	36.0	0.5	6.7
Efficient Consumption of Energy Technologies and Carbon Capture and Storage	0.0	0.0	1.1	0.0	0.0	0.1	0.4	0.1
Environmental Monitoring, Analysis and Assessment Equipment	0.1	1.1	0.0	1.3	0.8	0.6	3.0	3.8
Environmentally Preferable Products based on End-Use or Disposal Characteristics	0.3	0.0	0.2	-	-	-	0.3	-
Gas Flaring Emission Reduction	4.8	2.9	1.8	0.4	0.0	0.0	0.7	0.0
Heat and Energy Management	19.9	1.7	21.6	19.5	0.3	0.1	0.5	1.6
Management of Solid and Hazardous Waste and Recycling Systems	0.0	0.0	0.1	-	34.5	61.2	8.2	6.9
Natural Resource Protection	-	1.1	0.0	-	0.0	-	-	-
Natural Risk Management	0.2	0.2	0.1	0.2	0.2	0.1	3.2	3.0
Noise and Vibration Abatement	50.0	81.8	70.0	64.7	0.0	0.0	-	0.6
Renewable Energy	0.2	-	0.2	-	11.6	0.7	70.9	54.2
Resources and Pollution	-	-	-	-	-	0.0	-	-

Management								
Waste Management, Recycling and Remediation	24.1	5.0	4.5	1.2	-	-	0.0	-
Waste Water Management and Potable Water Treatment	0.0	-	-	-	48.6	1.2	11.7	23.0
Water Supply	-	-	-	-	0.0	0.0	0.0	0.0
Import analysis (%)								
	GVC				Non-GVC			
Product category	2013	2016	2019	2020	2013	2016	2019	2020
Air Pollution Control	-	-	-	-	0.5	0.4	0.4	0.3
Clean Up or Remediation of Soil and Water	-	-	-	-	0.0	0.0	0.0	0.0
Cleaner or More Resource Efficient Technologies and Products	22.7	11.5	8.6	8.9	22.3	16.6	8.3	6.3
Efficient Consumption of Energy Technologies and Carbon Capture and Storage	0.1	0.0	0.0	0.1	0.4	0.2	0.1	0.1
Environmental Monitoring, Analysis and Assessment Equipment	0.0	0.2	0.1	0.1	4.2	4.2	3.9	5.6
Environmentally Preferable Products based on End-Use or Disposal Characteristics	1.2	0.7	0.6	0.6	0.2	0.2	0.6	0.1
Gas Flairing Emission Reduction	0.2	0.1	0.3	0.2	0.6	0.4	1.2	1.6
Heat and Energy Management	4.6	4.7	3.5	6.1	3.6	7.2	5.5	6.1
Management of Solid and Hazardous Waste and Recycling Systems	6.0	10.2	7.9	13.0	6.5	6.6	6.4	11.0
Natural Resource Protection	0.0	0.2	0.1	0.0	0.1	0.2	0.2	0.2
Natural Risk Management	0.1	0.1	0.0	0.0	1.1	0.8	0.5	0.5
Noise and Vibration Abatement	1.1	0.7	0.8	1.1	0.1	0.2	0.3	0.3
Renewable Energy	30.1	35.1	40.0	20.2	27.1	29.4	40.8	33.4
Resources and Pollution Management	-	-	-	-	0.0	0.0	0.0	0.0
Waste Management, Recycling and Remediation	0.3	0.4	0.4	0.3	0.0	0.0	0.0	0.0
Waste Water Management and Potable Water Treatment	29.4	36.0	37.4	49.3	33.3	33.4	31.7	34.3
Water Supply	4.2	0.1	0.1	0.3	0.1	0.2	0.1	0.2

Note: Share is the portion of firms (GVC or non-GVC) that trade in a specific green good out of the total value of green-good exports or imports by GVCs or non-GVC firms.
Source: Author estimations

Malawi's non-GVC firms mimic the import patterns of GVC firms for most green goods. Both renewable energy and wastewater management and potable water treatment goods dominate the import value of green goods by non-GVCs; their share ranges from 60% in 2013 to about 68% in 2020. The share of management of

solid and hazardous waste and recycling systems in the total green-good import value grew over the study period by 4.5%, while the share of cleaner or more resource efficient technologies and products declined by over three and a half times over the period of study. The import shares of environmental monitoring, analysis and assessment equipment, and heat and energy management have grown substantially over the study period.

For both Kenya and Malawi, GVC trade mainly takes place with countries outside of Africa for both imports and exports (Appendix Figure A1 and Figure A2). On average, 59% and 73% of GVC exports from Kenya and Malawi (by trade value), respectively, was to non-African countries over the study period. China, the United States, Germany, the Netherlands and Belgium were among the top ten GVC destinations for both countries. As for the import value of GVCs, on average, over 85% and 62% of the trade value of Kenya and Malawi, respectively, was from countries outside Africa during the period of study. China, South Africa, Saudi Arabia, United Arab Emirates and Germany were among the top ten sources of GVC trade for both countries.

3. Econometric Specification and Results

Firm Entry into Green Goods Trade

First, we check whether GVC firms are more likely to enter green goods trade compared with non-GVC firms by exploring the determinants of entry into green goods trade. That is, for firms that are already GVC firms, are they likely to also become green good traders compared to firms that are not yet GVC firms? To analyze the factors that determine entry into green goods trading, we adopt a binary regression, specifically the probit model considering that we have a limited dependent variable (0 for exit and 1 for entry into green products trading). The model is specified as follows:

$$Pr(y_{it} = 1|GVC_{it}, \gamma_i, \gamma_t) = \Phi(\beta_0 + \beta_1 GVC_{it} + \gamma_i + \gamma_t + \varepsilon_{it}) \quad (1)$$

Where y_{it} is the probability that the *ith* firm will enter or exit the export (or import) of a green good at time *t*. Φ denotes the standard normal cumulative distribution function.

GVC_{it} is a binary variable identifying whether a firm is a GVC or not at time *t*. As earlier stated, these are firms that simultaneously export and import intermediate products. Ideally, the foreign market entry of a firm is determined by several firm-level characteristics such as size and profitability (Greenaway and Kneller, 2007; Broocks and Van Biesebroeck, 2017). However, given the data limitations and the potential of these characteristics causing endogeneity when ignored in the equation, we control them by including the firm-fixed effects (γ_i). Fluctuations that occur over time are also controlled through the time-fixed effects (γ_t). ε_{it} is the error term.

This analysis is done for overall green goods and the 19 categories of green goods for both Kenya and Malawi to understand if specific types of green goods are more attractive to GVC firms. The final analyses are presented as marginal effects to reveal the magnitude of change GVCs on entry into the export/import of green goods.

The results from Equation 1 (which are marginal effects), which are presented in Table 4 show that being a GVC firm decreases the odds of entry into green-goods trade in both Kenya and Malawi. Being a GVC reduces the probability of exporting green goods by roughly 14% in Kenya. Being a GVC also reduces the chances of exporting green goods in Malawi, albeit the effect is not statistically significant. The probability of GVC firms reducing green-good imports is 13.5% in Kenya and 12.0% in Malawi. These results imply that firms that are already GVCs may find it less lucrative to enter the green-goods trade, suggesting that these firms may not be drivers of green transition in Africa.

Whereas these initial results are important, they lump together imports and exports as well as all green goods. For policy and economic relevance, specific green goods need to be analyzed. Green goods are heterogeneous in nature and use and understanding which categories of firms are more likely to trade in, especially GVC firms, is crucial (see discussion in Section 2). This highlights the importance of a more in-depth analysis.

Table 4: Probit model marginal effects for the effect of GVCs on green goods trade entry for Kenya and Malawi

	Kenya		Malawi	
	Exports firms	**Imports firms**	**Exports firms**	**Imports firms**
GVC	-0.141***	-0.135***	-0.00525	-0.118***
	(0.00596)	(0.00212)	(0.0154)	(0.00390)
Observations	53,845	300,223	7,631	126,872
Time Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1.

Source: Author estimations

There are 19 categories of green goods used in the data, based on the GTN list. Entry into exports of green goods may indicate production and supply potential for a country. It may indicate that a country is likely to tap into increasing global demand for such products. On the other hand, imports signal access to foreign inputs and technologies, which may be for production purposes or end-use. Entry into import product markets may suggest that there is demand for such products locally and that there may be spillovers in green technologies. Figure 1 present results of the effect of GVCs on the probability of entry into specific green-good exports for Kenya. We find that being a GVC significantly affects a firm's entry into most green-goods categories, except natural risk management, whose coefficient is statistically insignificant. Of the remaining categories, we find that GVC firms have a low probability of entry into most of the green-good categories apart from environmentally preferable products based on end-use or disposal characteristics. Ideally, being a GVC firm raises the likelihood of exporting environmentally

preferable products based on end-use or disposal characteristics by 2%. This shows that GVC firms have an export opportunity in commodities such as assembled flooring panels for mosaic floors of wood (HS 441871), assembled flooring panel for multilayer of wood (HS 441872), and binder/baler twine of sisal/other textile fibres of genus agave (HS 560721). We also find that GVC firms have the least likelihood of starting to export efficient consumption of energy technologies and carbon capture and storage, wastewater management and potable water treatment, and management of solid and hazardous waste and recycling systems green goods by 32%, 26% and 23%, respectively.

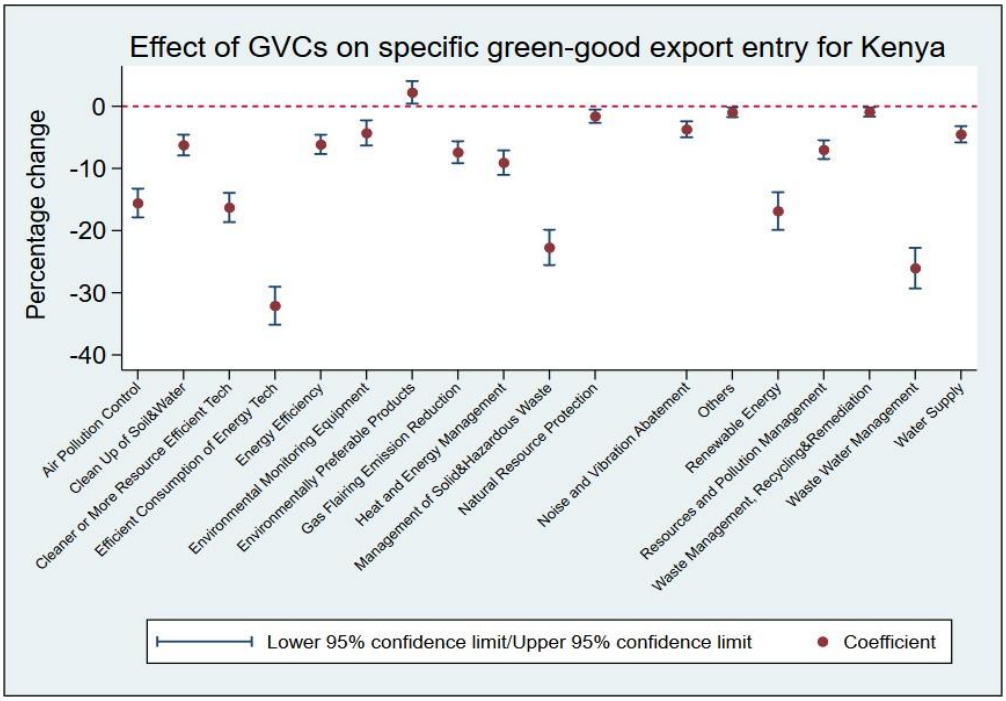
Figure 2 shows the probability of GVCs importing specific green goods in Kenya. Unlike exports (Figure 1), GVCs have a probability of increasing imports of more green-good imports in Kenya. Imports of clean up or remediation of soil and water; environmental monitoring, analysis and assessment equipment; gas flaring emission reduction; natural risk management; and water supply increase when a firm is a GVC in Kenya. This suggests that these sectors provide the required green technology in Kenya. The probability of importing the remaining green goods drops when a firm is a GVC. This is the worst for cleaner or more resource-efficient technologies and products, energy efficiency renewable energy, and heat and energy management, whose probabilities drop by between 16% and 23%.

The results for Malawi are presented in Table 5. We find that GVC firms have a 3% likelihood of exporting green goods from the environmentally preferable products based on end-use or disposal characteristics sector than non-GVCs. We find that the likelihood of GVCs exporting the remaining green-good categories in Malawi is either low or non- existent. In this regard, the probability of exporting air pollution control; cleaner or more resource efficient technologies and products; efficient consumption of energy technologies and carbon capture and storage; energy efficiency; environmental monitoring, analysis and assessment equipment; and management of solid and hazardous waste and recycling systems is low when a firm is a GVC compared to a non-GVC in Malawi.

The lower segment of Table 5 shows results for imports. We find that GVC firms are more likely to import green goods in the areas of air pollution control; environmental monitoring, analysis and assessment equipment; gas flairing emission reduction; and natural risk management. This indicates that commodities from these sectors are perceived to be vital for the development of Malawi's green industries. Conversely, GVCs have a low likelihood of importing green goods from sectors such as clean up or remediation of soil and water; cleaner or more resource efficient technologies and products; efficient consumption of energy technologies and carbon capture and storage; energy efficiency; environmentally preferable products based on end-use or disposal characteristics; heat and energy management; management of solid and hazardous waste and recycling systems;

natural resource protection; renewable energy; resources and pollution management; and waste water management and potable water treatment.

Figure 1: Probit model marginal effects for the effect of GVCs on specific green- good export entry for Kenya

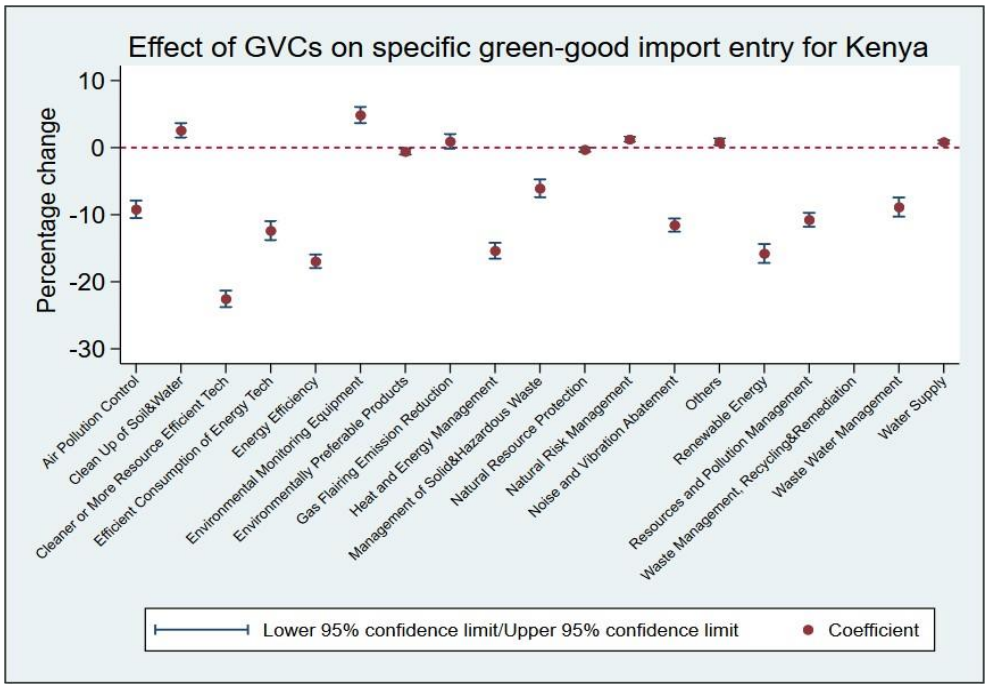


Note: Only significant coefficients are plotted

Source: Author compilation using customs data

In general, GVC firms are more likely to import than export most green goods in Kenya and Malawi, going by the results in Figure 1, Figure 2 and Table 5. The broad implication of these results is that LDC and other developing countries, especially in Africa, are more likely to rely on GVCs for access to green technologies to boost the local capacity of green industries. Sectors of green goods whose exports and imports are likely to rise when they are traded by GVC firms are largely similar in Kenya and Malawi, suggesting that the heterogeneity in green trade across African countries is small. In this regard, green goods classified as environmentally preferable products based on end-use or disposal characteristics have a positive and significant coefficient for Kenya and Malawi's exports, suggesting that African countries can pursue trade opportunities in products in this sector. Imports of green goods under the categories of environmental monitoring, analysis and assessment equipment; gas flairing emission reduction; and natural risk management increase when a firm is a GVC in both Kenya and Malawi.

Figure 2: Probit model marginal effects for the effect of GVCs on specific green- good import entry for Kenya



Note: Only significant coefficients are plotted.

Source: Author compilation using customs data

Table 5: Probit model marginal effects for the effect of GVCs on specific green-good export and import entry for Malawi

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Exports																		
GVC	-0.117***	-0.0191	-0.184***	-0.0948*	-0.0477*	-0.120***	0.0267**	-0.00535	-0.00569	-0.113***	-0.00823	-0.0184	0.00314	-0.00576	0.0399	-0.00341	-0.0670	0.00526
	(0.0427)	(0.0217)	(0.0489)	(0.0536)	(0.0263)	(0.0434)	(0.0133)	(0.0250)	(0.0337)	(0.0410)	(0.0101)	(0.0190)	(0.0186)	(0.0518)	(0.0244)	(0.0109)	(0.0523)	(0.0116)
Observations	1,467	1,467	1,467	1,467	1,467	1,467	1,467	1,467	1,467	1,467	966	1,467	1,467	1,467	1,467	955	1,467	1,467
Time-Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Imports																		
GVC	0.188***	-0.0258***	-0.0735***	-0.185***	-0.147***	0.0159**	-0.0499***	0.0225***	-0.143***	-0.0759***	-0.0184***	0.00755***	0.00327	-0.0460***	-0.105***	0.000428	-0.210***	0.00183
	(0.0122)	(0.00688)	(0.0130)	(0.0112)	(0.00796)	(0.00770)	(0.00528)	(0.00654)	(0.00891)	(0.00965)	(0.00326)	(0.00248)	(0.00564)	(0.0132)	(0.00751)	(0.00226)	(0.0119)	(0.00291)
Observations	23,326	23,326	23,326	23,326	23,326	23,326	23,326	23,326	23,326	23,326	23,326	23,326	23,326	23,326	23,326	23,326	23,326	23,326
Time-Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1. (1) = Air Pollution Control; (2) = Clean Up or Remediation of Soil and Water ; (3) = Cleaner or More Resource Efficient Technologies and Products; (4) = Efficient Consumption of Energy Technologies and Carbon Capture and Storage; (5) = Energy Efficiency; (6) = Environmental Monitoring, Analysis and Assessment Equipment; (7) = Environmentally Preferable Products based on End-Use or Disposal Characteristics; (8) = Gas Flairing Emission Reduction; (9) = Heat and Energy Management; (10) = Management of Solid and Hazardous Waste and Recycling Systems; (11) = Natural Resource Protection; (12) = Natural Risk Management; (13) = Noise and Vibration Abatement; (14) = Renewable Energy; (15) = Resources and Pollution Management(16) = Waste Management, Recycling and Remediation; (17) = Waste Water Management and Potable Water Treatment; (18) = Water Supply

Source: Author estimations

Whether Becoming a GVC Firm Leads to Higher Green Good Trade

The second but related question relates to firms that are not yet GVC firms and whether becoming a GVC firm leads to more volumes of green trade relative to non-GVC firms. GVC firms dominate trade and their role in green goods trade would be significant in this shift in the world economy. Therefore, the results of this section will help us understand the effect of becoming a GVC firm on imports and exports of green goods. To enable this analysis, we use a difference-in-difference (DiD) model with multiple time periods (csdid in Stata), which accommodates panel data to evaluate the impact of being a GVC firm on green trade. Using the DiD model controls for additional firm effects and their interactions with time as follows:

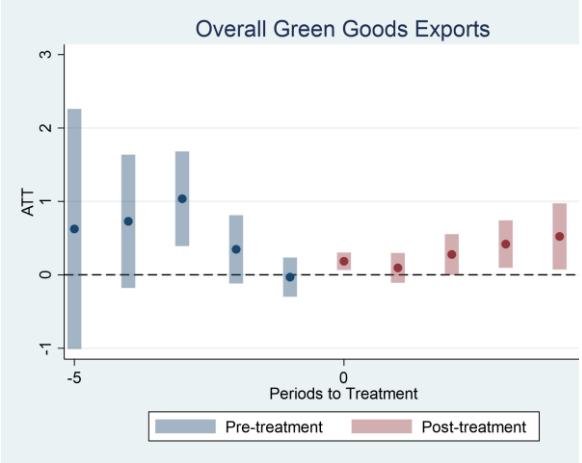
$$Imports_{ijt}\ or\ Exports_{ijt} = \beta_0 + \sum_{k=T_0}^{-2} \delta_k Xtreat_{it} + \sum_{k=0}^{T_1} \gamma_k Xtreat_{it} + \gamma_i + \gamma_j + \gamma_t + \varepsilon_{ijt} \quad (2)$$

Where $Imports_{ijt}$ *or* $Exports_{ijt}$ is the natural logarithm of the export or import value of a green good by firm *i* with partner country *j* at time *t*. $treat_{it}$ is a dummy variable, which corresponds to 1 if the observation's time relative to the group's first treated period is the same value as k; otherwise, 0 (control/ the never treated group). T_0 and T_1 are the lowest and highest number of leads and lags to consider neighboring the treatment period, respectively. γ_i, γ_j and γ_t represents firm, partner-country and time fixed-effects. ε_{ijt} is the error term.

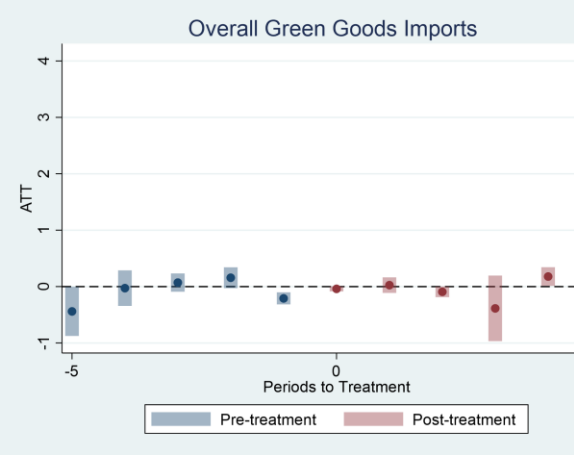
This analysis is done for the top 10 of the 19 categories of green goods (in terms of observations) for both Kenya and Malawi, to understand if specific types of green goods are more attractive to firms.

We find that becoming a GVC firm is not associated with increased green exports. Instead, there is evidence that becoming a GVC firm is associated with a high green-good import performance in Kenya and Malawi. Parts a and c of Figure 3 show that firms had higher export values of green goods when they were non-GVCs than when they became GVCs. On the contrary, parts b and d show that the import value increased when firms switched from non-GVCs to GVCs. Appendix Table A3 shows that the value of green imports increased by 33% and 23% on average in Kenya and Malawi, respectively, after firms became GVCs. The superior performance of imports over exports, when firms become GVCs, echoes the results of Table 1 where imports have a larger share of green goods than exports and subsection 3.1 where GVC firms are more likely to start importing green goods than exporting them.

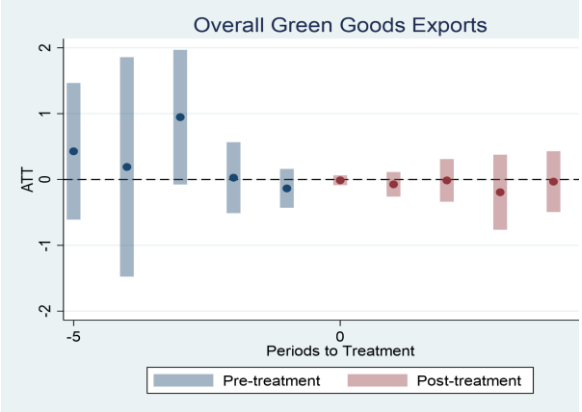
Figure 3: DiDs with multiple time periods-green goods - Kenya and Malawi



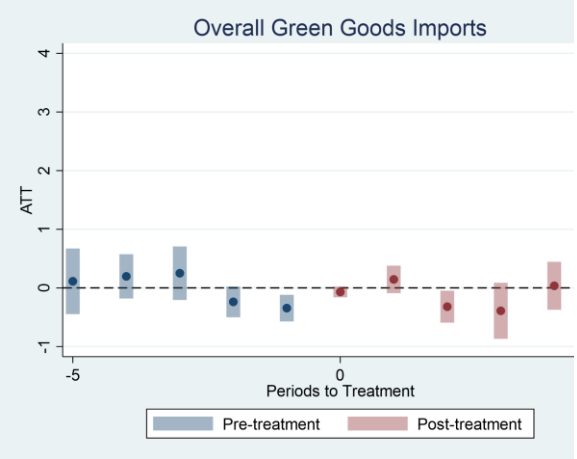
Exports - Kenya



(b) Imports - Kenya



(c) Exports - Malawi



(d) Imports - Malawi

Notes: Analysis is at firm-product level.

Source: Author's compilation using Customs data

Specific green Goods

We also assess the effect of GVCs on the import and export values of specific green goods. We find that exports of three (efficient consumption of energy technologies and carbon capture and storage; waste water management and potable water treatment; and gas flaring emission reduction) of the top ten specific green good categories increased after firms became GVCs (Table 6). The increase in imports is much larger than exports as half of the top 10 green-good categories

increased their imports when firms became GVCs.[12] This affirms the aggregate result where imports become better than exports when firms switch from being non-GVCs to GVCs. The results for Malawi are not as strong, given that the country is smaller and the share of trade and GVC firms is also relatively small. Only imports and exports of Air Pollution Control of the 10 top categories increase after firms become GVCs (Table 7).

Table 6: Effect of becoming a GVC firm on imports and exports of green goods firms in Kenya

	Exports		Imports	
	Pre_avg	**Post_avg**	**Pre_avg**	**Post_avg**
Efficient Consumption of Energy Technologies and Carbon Capture and Storage	0.477*	0.245*	-0.0168	0.0894
	(0.290)	(0.130)	(0.0953)	(0.0692)
Waste Water Management and Potable Water Treatment	0.379	0.329***	0.00604	0.238
	(0.295)	(0.123)	(0.0949)	(0.170)
Renewable Energy	0.451	0.212	-0.0242	0.165**
	(0.670)	(0.240)	(0.122)	(0.0780)
Environmental Monitoring, Analysis and Assessment Equipment	0.102	0.659	-0.290	0.364**
	(0.775)	(0.534)	(0.275)	(0.162)
Air Pollution Control	0.0158	0.308	0.154	0.350**
	(0.412)	(0.197)	(0.0993)	(0.144)
Management of Solid and Hazardous Waste and Recycling Systems	0.0713	0.267	-0.503***	-0.209
	(0.571)	(0.335)	(0.119)	(0.173)
Gas Flairing Emission Reduction	0.642	2.408***	-0.0103	0.426***
	(0.463)	(0.221)	(0.248)	(0.160)
Resources and Pollution Management	0.212	-0.492	-0.129	0.424
	(0.534)	(0.374)	(0.132)	(0.275)
Heat and Energy Management	1.616	0.118	-0.0548	0.736***
	(1.002)	(0.303)	(0.240)	(0.168)
Cleaner or More Resource Efficient Technologies and Products	0.188	0.273	-0.464**	-0.266
	(0.294)	(0.301)	(0.222)	(0.195)

Note: Standard errors in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1. Time, partner-country and firm-fixed effects are included.

[12] These are Renewable Energy; Environmental Monitoring, Analysis and Assessment Equipment; Air Pollution Control; Gas Flairing Emission Reduction; and Heat and Energy Management.

Table 7: Effect of being a GVC firm on Imports and Exports of Green Goods Firms in Malawi

	Exports		Imports	
	Pre_avg	Post_avg	Pre_avg	Post_avg
Efficient Consumption of Energy Technologies and Carbon Capture and Storage	0.306	-0.124*	0.218**	0.0968
	(0.280)	(0.0751)	(0.106)	(0.128)
Waste Water Management and Potable Water Treatment	0.690*	-0.000368	0.0853	0.197
	(0.410)	(0.0923)	(0.115)	(0.151)
Renewable Energy	-0.263	0.0936	0.0341	0.119
	(0.229)	(0.178)	(0.233)	(0.116)
Environmental Monitoring, Analysis and Assessment Equipment	0	0.578	-0.308	0.905
	(0)	(1.307)	(0.264)	(1.256)
Air Pollution Control	-0.182	0.385**	0.145	0.756***
	(0.153)	(0.189)	(0.106)	(0.207)
Management of Solid and Hazardous Waste and Recycling Systems	0.423	-0.409***	0.0285	-1.432***
	(0.373)	(0.150)	(0.172)	(0.544)
Resources and Pollution Management	0	-2.391	-0.190	-1.130***
	(0)	(1.684)	(0.284)	(0.277)
Heat and Energy Management	0.000425***	-0.417	0.866***	0.340
	(0)	(0.787)	(0.191)	(0.290)
Cleaner or More Resource Efficient Technologies and Products	0.735*	-0.454	-0.151	0.132
	(0.432)	(0.344)	(0.159)	(0.169)

Note: Standard errors in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1. Time, partner-country and firm-fixed effects are included.

Whether importing green goods leads to exporting green goods

We further investigate if importing more green goods leads to exporting more green goods. This is done by estimating the following equation:

$$Export_{ijt} = \beta_0 + \beta_1 Import_{ijt} + \gamma_i + \gamma_j + \gamma_t + \varepsilon_{ijt} \quad (3)$$

β_1 measures the effect of importing a green good (in value terms) on the export value of green goods by firm i with partner-country j at time t[12]. γ_i, γ_j and γ_t are the firm, partner-country and time fixed-effects respectively. ε_{ijt} is the error term.

Estimating equation 3 through Ordinary Least Squares (OLS) could suffer from endogeneity problems as a firm's decision to import and export could be decided jointly in the production process (Kasahara and Lapham, 2013). For example, firm-level demand shock could affect both import and export concurrently. To address such endogeneity concerns, we use firm-level instrumental variables first suggested by Hummels et al. (2014). Assume firm i imports product k from country j at time t.[13] The import of firms i will be instrumented by World Export Supply (WES)

[13] Export and import values are in natural logarithms.

of product *k* by country *j* at year *t*. The import of product *k* by firm *i* in Kenya/Malawi is correlated with country *j's* world export supply, as it captures productivity changes of the exporter country. However, as a small player, firm *i* in Kenya/Malawi has a minimal role in influencing the global export of the commodity by country *j*, which makes WES a credible instrument to eliminate the bias.

Given the stable nature of supply chain relationships, changes in the productivity of country *j* will affect firms differently depending on their prior trade relationship with them. That relationship is set in the initial year of our data, and it is captured by the share product *k* import from country *j* to the total material imports for firm *i* in the pre-sample year (2013) or first year of entry for newer firms. Finally, to calculate the firm-level WES, the pre-sample weight shares will be multiplied with the WES at the product-country level and aggregated at the firm level. In summary, the firm-level import instrument is a weighted average of world export supply at product and origin levels presented in equation 4.[14]

Equation 3 is analyzed to establish the effect of importing green goods on exporting green goods by firms in Kenya and Malawi. The preliminary results (see Appendix Table A4), using OLS, show that importing green goods improves the export of green goods, whether a firm is a GVC or not. However, as discussed in section 3.3, this approach suffers the problem of endogeneity. This is addressed by running an instrumental variables model where the firm-level instrument is a weighted average of world export supply at product and origin levels presented in Equation 4.

Table 8 presents the Instrumental Variables results. We find that importing green goods boosts the exports of green goods in Malawi and Kenya. The magnitude of the coefficient is larger for GVC firms compared to nōn-GVCs. Therefore, two-way traders (firms that simultaneously import and export) are likely to export green goods once they import them. Since this inference could vary by type of green good, Table A5 presents results by category of green-good. We find that importing green goods boosts exports of 14 out of 19 green-good categories in Kenya among GVC firms. The number of categories whose exports increase in Malawi is a bit higher, 15 out of 19 green-good categories.

Table 8: Effect of being a GVC firm on Imports and Exports of Green Goods Firms in Malawi

	Kenya		Malawi	
	GVCs	Non-GVCs	GVCs	Non-GVCs
Green imports	1.664***	1.048***	2.079***	1.593***
	(0.075)	(0.038)	(0.095)	(0.075)
Constant	-0.795	0.211	-20.691***	-15.649***
	(1.503)	(1.299)	(1.059)	(4.335)
Observations	87,502	112,992	19,015	22,537
Number of id pair	58,407	80,674	10,052	13,124
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1.

[14] Refer to Hummels et al. (2014) for details.

4. Conclusions

This paper assesses the readiness and opportunities for Africa to participate in green trade through GVCs. First, we test whether GVC firms trade more in green imports (access) and exports (opportunities). This is done by assessing the entry of GVC and non-GVC firms into green-good markets. Then, we test whether becoming a GVC firm is associated with increased green-goods trade. Finally, we test whether importing green goods leads to exporting green goods.

In general, trade in green goods remains relatively low in Africa. Imports of green goods far exceed exports, signaling that trade currently serves more of an access to green technologies, with limited export opportunities for these products. The types of green goods exported differ between GVC and non-GVC firms, while the type of green goods imported are relatively the same.

Econometric analysis shows that being a GVC firm increases the probability of starting to import rather than export green goods. Exports of green goods under the category of environmentally preferable products based on end-use or disposal characteristics grow when a firm is a GVC in both Kenya and Malawi. On the other hand, imports of green goods under the categories of Environmental Monitoring, Analysis and Assessment Equipment; Gas Flairing Emission Reduction; and Natural Risk Management increase when a firm is a GVC in both Kenya and Malawi. We further find that firms that switch from non-GVCs to GVCs are not associated with increased green exports. Instead, there is evidence that becoming a GVC firm is associated with a high green-good import performance in Kenya and Malawi. The increase in green imports is much larger in Kenya than in Malawi in terms of the number of increased green-good categories. Finally, higher imports of green goods are associated with higher green goods exports, especially for GVC firms.

These results suggest that the interconnection of global value chains plays a key role in Africa's green transition, especially in attracting green technology. Therefore, policies should be geared towards attracting foreign direct investment in the green sector. This could be done by targeting sectors such as Environmental Monitoring, Analysis, and Assessment Equipment, whose propensity for importing is high for firms that participate in global value chain trade. It could also be done by having a targeted industrial policy that lures lead firms in green-good GVCs, thereby creating domestic linkages and investing in new activity areas in which countries can acquire comparative advantage gradually and start exporting green goods in the future (Chang, 2015). These strategies should be complemented with increased investment in green innovation, research and development, and collaboration among countries and firms.

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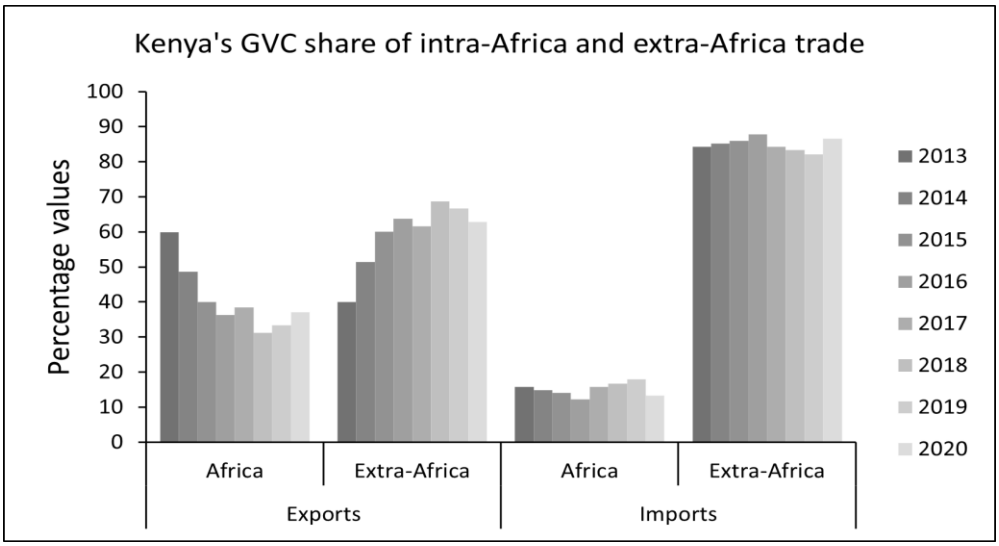
Appendix

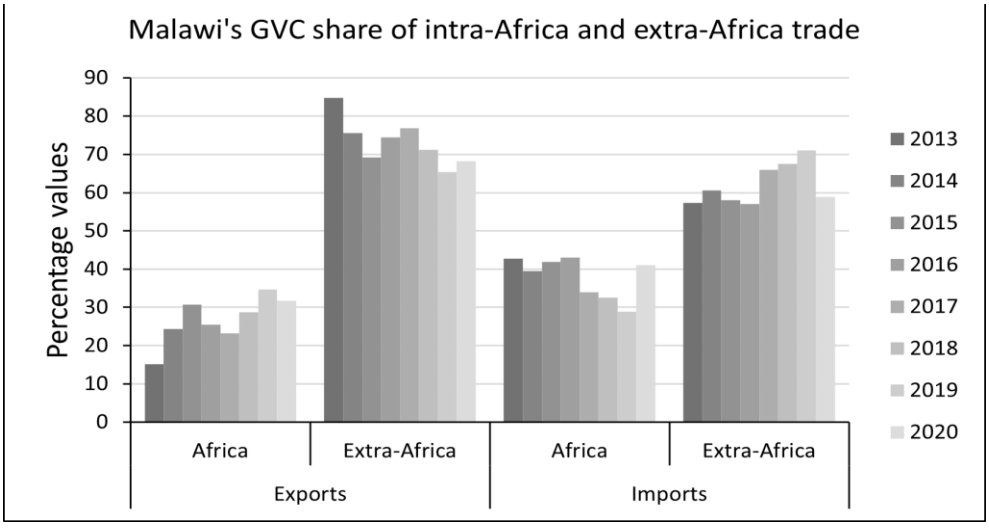
Figure A1: Share of Kenya's intra-Africa and extra-Africa GVC trade



Note: A GVC firm is one that simultaneously exports and imports

Source: Author's compilation using customs data

Figure A2: Share of Malawi's intra-Africa and extra-Africa GVC trade



Note: A GVC firm is one that simultaneously exports and imports

Source: Author's compilation using customs data

Table A1: Kenya descriptive statistics for exports and imports of GVCs and Green Goods

Overall GVC Firm Statistics Kenya						
Export analysis						
Year	Firms	Share Firms	Prod	Dest.	Prod. per firm	**Dest. per firm**
2013	1,960	37	1,680	26	8.8	**2.3**
2014	1,731	26	1,565	37	8.1	**2.4**
2015	1,554	20	1,432	26	7.5	**2.5**
2016	1,368	32	1,250	41	7.1	**2.3**
2017	1,279	18	1,496	28	7.3	**2.4**
2018	1,323	18	1,205	36	6.2	**2.3**
2019	1,273	17	1,168	37	6.3	**2.4**
2020	1,223	16	1,139	34	5.7	**2.3**
Import analysis						
Year	Firms	Share Firms	Prod	Dest.	Prod. per firm	**Dest. per firm**
2013	3,201	8	1,311	55	14.8	**3.7**
2014	2,849	11	1,467	41	13.7	**3.6**
2015	3,139	7	1,402	51	15.1	**3.9**
2016	2,662	10	1,378	41	14.7	**3.9**
2017	2,714	7	1,410	23	15.1	**4.0**
2018	2,688	7	1,302	22	15.4	**4.1**
2019	2,825	6	1,346	30	16.5	**4.3**
2020	2,732	6	1,255	15	16.8	**4.5**
GVC Firms Trading in Green Goods Kenya						
Export analysis						
Year	Firms	Share Firms	Prod	Dest.	Prod. per firm	**Dest. per firm**
2013	179	44	122	1	3.1	**1.6**
2014	134	24	111	4	2.9	**1.6**
2015	132	23	102	1	2.9	**1.7**
2016	114	41	91	5	2.8	**1.7**
2017	108	19	120	2	2.8	**1.6**
2018	130	19	92	3	2.6	**1.6**
2019	116	17	101	3	2.8	**1.6**
2020	121	18	99	2	2.6	**1.6**
Import analysis						
Year	Firms	Share Firms	Prod	Dest.	Prod. per firm	**Dest. per firm**
2013	239	15	60	3	4.2	**1.6**
2014	201	13	67	3	4.1	**1.6**
2015	201	11	66	4	4.4	**1.6**
2016	167	11	62	5	4.4	**1.6**
2017	189	12	53	0	4.4	**1.6**
2018	183	10	50	0	4.4	**1.6**
2019	206	8	56	3	4.7	**1.6**
2020	**229**	**7**	**43**	**5**	**4.7**	**1.6**

Note: Share Firms is the ratio of GVC firms that trade in green goods over the total number of firms that trade in green goods. All per-firm stats are the average numbers per firm.

Source: Author estimations

Table A2: Malawi descriptive statistics for exports and imports of GVCs and Green Goods

Overall GVC Firm Statistics Malawi						
Export analysis						
Year	Firms	Share Firms	Prod	Dest.	Prod. per firm	**Dest. per firm**
2013	273	22	479	72	2.9	**2.1**
2014	253	23	474	83	2.9	**2.1**
2015	291	28	483	72	2.8	**2.0**
2016	288	30	495	74	2.8	**2.1**
2017	284	33	499	79	3.0	**2.1**
2018	260	34	538	73	3.4	**2.2**
2019	278	32	533	82	3.1	**2.1**
2020	252	33	424	75	2.6	**2.0**
Import analysis						
Year	Firms	Share Firms	Prod	Dest.	Prod. per firm	**Dest. per firm**
2013	657	5	1,627	53	17.4	**2.9**
2014	642	4	1,634	45	16.9	**2.9**
2015	477	11	1,333	40	13.7	**2.6**
2016	709	5	1,576	62	16.7	**3.2**
2017	700	4	1,645	65	17.5	**3.3**
2018	679	3	1,671	73	18.9	**3.4**
2019	679	3	1,654	62	18.8	**3.4**
2020	638	3	1,575	54	17.9	**3.5**
GVC Firms Trading in Green Goods Malawi						
Export analysis						
Year	Firms	Share Firms	Prod	Dest.	Prod. per firm	**Dest. per firm**
2013	17	29	52	1	1.8	**1.1**
2014	17	24	60	1	1.8	**1.2**
2015	16	28	65	0	2.1	**1.0**
2016	16	29	66	2	1.8	**1.1**
2017	15	27	59	1	1.7	**1.2**
2018	24	37	60	2	1.9	**1.2**
2019	20	38	65	1	2.0	**1.2**
2020	22	42	51	1	1.9	**1.2**
Import analysis						
Year	Firms	Share Firms	Prod	Dest.	Prod. per firm	**Dest. per firm**
2013	39	6	133	4	4.3	**1.5**
2014	29	4	131	4	4.3	**1.4**
2015	36	13	115	3	3.3	**1.4**
2016	39	6	121	7	4.1	**1.5**
2017	63	7	127	7	4.5	**1.5**
2018	59	6	130	14	4.9	**1.5**
2019	53	6	122	13	4.9	**1.6**
2020	**39**	**5**	**122**	**9**	**4.6**	**1.5**

Note: Share Firms is the ratio of GVC firms that trade in green goods over the total number of firms that trade in green goods.
All per-firm stats are the average numbers per firm.
Source: Author estimations

Table A3: DID with multiple time periods-event study for green goods (ATT for GVC vs Non-GVC) - Kenya and Malawi

	Kenya		Malawi	
	Exports	Imports	Exports	Imports
Pre avg	0.541***	-0.0893	0.317	-0.00550
	(0.207)	(0.0652)	(0.221)	(0.0900)
Post avg	0.241***	0.331**	0.0147	0.226***
	(0.0821)	(0.141)	(0.134)	(0.0849)
Tm5	0.625	-0.440**	0.360	0.0913
	(0.835)	(0.222)	(0.596)	(0.214)
Tm4	0.729	-0.0271	0.806	0.229
	(0.464)	(0.161)	(0.702)	(0.145)
Tm3	1.036***	0.0713	0.382	-0.0311
	(0.329)	(0.0829)	(0.404)	(0.271)
Tm2	0.348	0.158*	0.203	-0.0991
	(0.237)	(0.0943)	(0.187)	(0.104)
Tm1	-0.0312	-0.209***	-0.167	-0.217**
	(0.136)	(0.0548)	(0.139)	(0.108)
Tp0	0.185***	-0.0395*	-0.0432	0.0292
	(0.0610)	(0.0230)	(0.0631)	(0.0839)
Tp1	0.0951	0.0263	-0.0626	0.105
	(0.104)	(0.0706)	(0.118)	(0.126)
Tp2	0.277**	-0.0918*	-0.0731	-0.153
	(0.141)	(0.0485)	(0.266)	(0.127)
Tp3	0.419**	-0.386	-0.132	-0.238
	(0.165)	(0.296)	(0.256)	(0.215)
Tp4	0.523**	0.179**	-0.115	-0.200
	(0.230)	(0.0845)	(0.403)	(0.156)
Tp5	-0.0515	2.297**	0.514	1.814***
	(0.326)	(0.935)	(0.708)	(0.527)
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Partner-country FE	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1.

Table A4: OLS results for the effect of green imports on green exports in Kenya and Malawi

	Kenya		Malawi	
	GVCs	Non-GVCs	GVCs	Non-GVCs
Green imports	0.023***	-0.279***	0.557***	0.281***
	(0.008)	(0.004)	(0.022)	(0.008)
Constant	6.787***	7.985***	-3.019***	-1.307***
	(0.137)	(0.060)	(0.254)	(0.069)
Observations	87,502	213,880	19,015	66,073
Number of pair_id	58,407	165,576	10,052	46,810
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Partner-country FE	Yes	Yes	Yes	Yes

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

Table A5: Instrumental variables results for the effect of specific green-good imports on green exports in Kenya and Malawi by GVC firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
									Kenya									
Green imports	1.612***	-2.512	2.839***	1.370***	1.236***	1.288***	2.000**	1.024***	1.143***	1.700***	1.880	0.520	1.691***	1.843***	1.188***	1.598*	1.453***	1.666
	(0.214)	(1.814)	(0.708)	(0.104)	(0.272)	(0.311)	(0.896)	(0.197)	(0.162)	(0.200)	(1.286)	(0.637)	(0.272)	(0.158)	(0.148)	(0.959)	(0.118)	(2.506)
Constant	-11.681	62.638*	-41.889**	-6.424	-8.703	-4.310	9.390*	12.382*	-7.875*	-21.128***	-15.454	-6.683	19.739***	-9.646**	-6.140	-18.239	-10.573***	-20.963
	(7.941)	(35.580)	(18.726)	(4.033)	(6.174)	(5.689)	(4.824)	(6.489)	(4.565)	(6.275)	(23.848)	(13.985)	(6.570)	(4.509)	(6.763)	(19.406)	(3.596)	(44.008)
Observations	9,365	399	3,464	33,215	3,530	3,781	1,106	6,966	8,736	10,183	373	279	4,361	21,751	15,351	236	35,100	390
Number of pair id	6,065	279	2,358	22,350	2,479	2,901	800	4,939	6,177	6,689	267	210	2,695	14,679	9,799	170	22,796	235
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Partner-country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
									Malawi									
Green imports	2.193***	2.316**	2.343***	2.200***	1.443***	2.047***	1.948***	2.234***	2.144***	2.075***	1.011	2.648	1.934***	1.999***	2.068***	2.792**	2.034***	2.532
	(0.339)	(0.981)	(0.296)	(0.166)	(0.466)	(0.508)	(0.488)	(0.376)	(0.300)	(0.251)	(0.758)	(2.046)	(0.335)	(0.190)	(0.280)	(1.262)	(0.165)	(1.624)
Constant	-22.353***	-25.234**	-23.990***	-22.012***	-13.931***	-19.048***	-18.840***	-22.974***	-21.788***	-21.245***	-7.303	-23.373	-17.965***	-19.737***	-20.587***	-32.156**	-20.238***	-27.090
	(3.832)	(11.207)	(3.420)	(1.892)	(4.881)	(6.131)	(5.121)	(4.432)	(3.377)	(2.820)	(9.016)	(25.228)	(3.625)	(2.135)	(3.119)	(15.439)	(1.846)	(20.275)
Observations	1,828	81	1,462	6,675	896	615	366	1,159	2,005	2,435	107	59	891	4,671	2,584	134	6,778	105
Number of pair id	885	53	730	3,433	484	392	218	678	1,201	1,279	73	35	419	2,599	1,187	58	3,329	62
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Partner-country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1. (1) = Air Pollution Control; (2) = Clean Up or Remediation of Soil and Water ; (3) = Cleaner or More Resource Efficient Technologies and Products; (4) = Efficient Consumption of Energy Technologies and Carbon Capture and Storage; (5) = Energy Efficiency; (6) = Environmental Monitoring, Analysis and Assessment Equipment; (7) = Environmentally Preferable Products based on End-Use or Disposal Characteristics; (8) = Gas Flairing Emission Reduction; (9) = Heat and Energy Management; (10) = Management of Solid and Hazardous Waste and Recycling Systems; (11) = Natural Resource Protection; (12) = Natural Risk Management; (13) = Noise and Vibration Abatement; (14) = Renewable Energy; (15) = Resources and Pollution Management; (16) = Waste Management, Recycling and Remediation; (17) = Waste Water Management and Potable Water Treatment; (18) = Water Supply

Source: Author estimation

Mission

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