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Introduction

The environmental impact of international trade is a concerning issue in the fight against climate change. Trade liberalization—combined with globally fragmented environmental policies—is often associated with the formation of pollution havens. This is because trade enables emissions leakages, which is defined as the outsourcing of emissions-intensive production to countries with weaker environmental regulations. Therefore, literature on this subject has suggested that a globally coordinated policy response is necessary to mitigate the impact of trade on climate change (Aichele & Felbermayr, 2012; Ben-David et al., 2020; Felbmermayr & Peterson, 2020). However, some studies have found that unilateral policy actions have no tangible effect on the volume of emissions associated with trade and, in some cases, the reduction of emissions volume associated with trade (Baylis et al., 2014; Kumar & Prabkahar, 2016; Hoekstra et al., 2016). This policy brief aims to provide insights on unilateral or multilateral actions countries can take to mitigate the impact of embodied emissions associated with the production of traded goods.

Policy Recommendations

Governments and multilateral bodies may implement a variety of policies to reduce the environmental impact of trade, ranging from (a) a unilateral strengthening of environmental regulations, (b) increasing adoption of low-carbon technologies (LCTs), and (c) implementing environmental provisions in regional trading agreements (RTAs). These three policy recommendations are explained in greater detail below.

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1. Unilateral Strengthening of Environmental Regulations

In the absence of a multilaterally coordinated strengthening of environmental regulations, countries can unilaterally strengthen their own environmental regulations to mitigate their impact on climate change without fear of emissions leakages. These policies may include ending fossil fuel subsidies, implementing carbon taxes, or implementing stronger environmental standards.

2. Increase Adoption and Rate of Technical Diffusion of Low-Carbon Technologies

Adopting greener technologies reduces the volume of emissions associated with the production of exports and reduces the need to import pollutive inputs. The adoption of LCTs should be emphasized in the export sectors of developing countries because the Greenhouse Gas (GHG) intensities of developing countries are generally larger than that of developed countries. This policy recommendation can be actualized by increasing domestic adoption and increasing rates of technological diffusion of LCTs across developed and developing countries. These LCTs include products such as electric vehicles, solar photovoltaics, and wind turbines.

3. Adopting Environmental Provisions in RTAs

Regional trade agreements are shown to have a significant effect on increasing GHG emissions embodied in trade. These environmental provisions can come in many forms, such as (a) improvements in environmental protection, (b) adoption of environmental laws, (c) harmonization of environmental laws, and (d) promotion of trade in LCTs (Monteiro, 2016).

Estimation Method

The policy brief analyzed trends on the flow of emissions of Kyoto GHGs associated with the trade of an exporting country to an importing country. The samples include data across 144 economies arranged into 19,980 unique pairs from 2007 to 2015, except for the years 2010, 2011, and 2014 due to missing data. Several factors were identified as determinants of GHG flows from an exporting country to an importing country, as shown in Table 1.

Table 1
Summary of Variables Used in This Study

Variable	Label
Embodied Kyoto GHG emissions in Kt CO2 equivalent from exporter (i) to importer (j).	GHGij
Difference in stringency and enforcement of environmental regulations index between importer (j) and exporter (i).	SEERdiffji
Natural logarithm of GHG intensity, measured in Kt CO2 equivalent over billion GDP in current prices	lnGHGPerGDP
GDP per capita	lnGDPC
Both importer and exporter are Annex I parties	BothAnnex
Only exporter is Annex I party	OnlyAnnexOrig
Only importer is Annex I party	OnlyAnnexDest
Common RTA	RTA
Population	lnPop
Distance	ldist
Common language	Comlang
Colonial history	Colony
Interaction between colonial history and distance	Colony * lnDist

To determine the impacts of these determinants, this study utilized a gravity model estimated via Poisson pseudo maximum likelihood (PPML). The model utilized in this study is shown in Equation 1 and is applied to all observations in this study.

$$\begin{aligned} GHG_{ij} = {} & \beta_1 + \beta_2(SEERdiff_{ji}) + \beta_3(lnGHGPerGDP_i) \\ & + \beta_4(lnGHGPerGDP_j) + \beta_5(lnGDPC_i) + \beta_6(lnGDPC_j) \\ & + \beta_7(BothAnnex) + \beta_8(OnlyAnnexOrig) \\ & + \beta_9(OnlyAnnexDest) + \beta_{10}(RTA) + \beta_{11}(lnDist) \\ & + \beta_{12}(lnPop_i) + \beta_{13}(lnPop_j) + \beta_{14}(Comlang) \\ & + \beta_{15}(Colony) + \beta_{16}(Colony * lnDist) + \epsilon \end{aligned} \quad (1)$$

Furthermore, the samples were divided into four groups to provide more insights into the differing trends between developing economies (non-Annex I parties to UNFCCC) and developed economies (Annex I parties to UNFCCC). These groups are (a) trade between developed countries, (b) trade between developing countries, (c) trading relationships where the developing country is the exporter, and (d) trading relationships where the developed country is the exporter. Equation 2 is utilized in the groupwise analysis, which is a modification of Equation 1 that excludes the Annex I variables due to the nature of the dis-aggregation.

$$\begin{aligned} GHG_{ij} = {} & \beta_1 + \beta_2(SEERdiff_{ji}) + \beta_3(lnGHGPerGDP_i) \\ & + \beta_4(lnGHGPerGDP_j) + \beta_5(lnGDPC_i) + \beta_6(lnGDPC_j) \\ & + \beta_7(RTA) + \beta_8(lnDist) + \beta_9(lnPop_i) + \beta_{10}(lnPop_j) \\ & + \beta_{11}(Comlang) + \beta_{12}(Colony) + \beta_{13}(Colony * lnDist) + \epsilon \end{aligned} \quad (2)$$

Estimation Results

1. Evidence for the Pollution Haven Hypothesis and Emissions Leakage

The regression analyses show little evidence that importers are offshoring emissions-intensive production when they unilaterally strengthen their own environmental regulations. On the contrary, a unilateral strengthening of environmental regulations can reduce the volume of GHG flows by 8.66%. However, there appears to be evidence that developing nations—or non-Annex I countries—are specializing in emissions-intensive exports. Meanwhile, developed nations—or Annex I parties to the UNFCCC—are specializing in relatively cleaner exports. This is shown from the findings that trading relationships where Annex I countries are exporters tend to be associated with lesser GHG emissions, relative to trading relationships where non-Annex I countries are exporters.

In the disaggregated analysis, a unilateral strengthening of an importer's environmental regulations has no statistically significant impact on the GHG emissions embodied within a non-Annex I country's exports. This could indicate that, in the worst-case scenario, a unilateral strengthening of environmental regulations does not promote emissions leakages. This is because producers may be passing on higher costs associated with more stringent environmental regulations onto domestic consumers (Sato & Dechezleprêtre, 2015).

To summarize, these estimates show that environmental regulations can reduce GHG emissions embodied in imports. However, this trend may differ among developed and developing countries. Particularly, a unilateral strengthening of environmental regulations shows no effect on the volume of embodied emissions on imports from developing countries. However, a unilateral strengthening of environmental regulations may reduce the volume of embodied emissions on imports from developed countries.

2. The Impact of Technology

The impact of technology, as proxied by a country's GHG intensity, appears to be substantial. On average, a 1% increase in an exporter's GHG intensity is associated with a 1.3% increase in the volume of GHG emissions embodied in the country's exports. In the dis-aggregated analysis, the GHG intensities of Annex I importers tend to have a statistically significant positive impact on GHG emissions embodied on their imports. Although no literature has explained this effect, one may infer that developed countries utilizing emissions-intensive techniques of production are likely to import pollutive inputs from emissions-intensive sectors. On the other hand, the GHG intensity in trade between non-Annex I countries is negatively correlated. This may indicate that non-Annex I countries exploit their partners' comparative environmental advantage by offshoring pollutive activities to more efficient partners. The groupwise analyses also show that the magnitude of the impact of GHG intensities in a non-Annex I exporter's embodied emissions is generally larger than that of Annex I exporters.

These results imply that increasing the adoption of low-carbon technologies can mitigate the environmental impact of trade. In line with this, Pigato et al. (2020) cited potential avenues by which countries can unilaterally and multilaterally increase the adoption of LCTs. Firstly, national governments can introduce demand-pull policies to foster the market for LCTs through policies like subsidies and green public procurement programs. Secondly, national governments can increase their country's ability to absorb and adopt LCTs by strengthening their human capital, physical infrastructure, and financial markets. Thirdly, countries may multilaterally pursue processes by which international institutions can make LCT patents available to developing countries. Lastly, countries can reduce barriers that hinder trade and foreign direct investments on LCTs through trade and investment agreements.

3. The Impact of Gravity Variables

Estimates on the impact of gravity variables appear to be in line with much of the trade gravity literature. The results show that larger GHG flows are expected when nations are wealthier and more populous, as nations are more likely to trade with one another the greater their income and population (Shepherd, 2016). Additionally, the distance appears to be associated with lesser GHG flows as this implies greater trade costs between two trading partners. Trade-facilitating factors, such as sharing a common official language, colonial linkages, and common membership in a regional trading agreement, appear to have a positive impact on GHG flows. Though, as a policy variable, extra attention is needed towards the formation of RTAs. This is because when both importing and exporting countries are members in at least one RTA, the volume of GHG emissions is—on average—expected to be 78.32% higher compared to trading relationships where both nations are not signatories of at least one RTA.

The estimate for the impact of RTA suggests that enacting environmental provisions may dent the environmental impact of these agreements. Indeed, there are already several instances of environmental provisions being adopted worldwide (Monteiro, 2016). Parties to the East African Community's common market agreed upon developing common environmental regulations, incentives, and standards. Additionally, the RTA signed between the EU, Colombia, and Peru explicitly called for the removal of trade and investment barriers that hindered innovation, development, and deployment of technologies that can contribute to climate change mitigation and adaptation

Empirical evidence also shows that environmental provisions can reduce GHG emissions. In a study by Baghdadi et al. (2013), emissions per capita of trading pairs covered by environmental provisions are lower by 18% relative to countries part of RTAs without environmental provisions. Brandi et al. (2020) also showed that adopting environmental provisions in RTAs is likely to reduce the volume of pollutive exports from developing countries and shift their export production towards cleaner goods.

Conclusion

Trade has undoubtedly benefited much of the world. However, the environmental impact of trade could potentially erase the gains made from trade, especially amidst the ongoing climate crisis. Mitigating the emissions associated with the production of traded goods will evidently help global mitigation efforts, considering that nearly a quarter of all CO2 emissions are associated with the production of traded goods (Peters et al., 2011). As such, mitigating the volume of emissions released in the production of traded goods and services is an essential component in the fight against climate change.

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