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Assessing the Achievements of the Copenhagen Accord: Trade, Climate Commitments, and Global Sustainability Impacts

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Abstract:

Nations worldwide are concerned about climate change and the urgency of taking appropriate actions to control it. Due to the uncoordinated efforts being put in by different countries to tackle the crisis, there is an inefficiency in the actual results being achieved. One of the biggest problems involved is that of carbon leakage where unilateral emission reductions by a single nation can be offset by increasing emissions in other countries by shifting production activities. This paper stresses carbon tariffs as a tool to achieve sustainable development goals (SDGs) effectively. It explores the impacts of carbon tariffs proposed by the EU, across sectors by deriving a multi-sector gravity model and obtaining a decomposition of emission changes into various effects based on the source of the change. The authors also examined the influences of the commitments made by the nations who pledged under the Copenhagen Accord (2009) by comparing the committed and actual reductions in emissions. Carbon tariffs will make carbon-intensive production more expensive, and as the law of demand follows, polluters emitting less will benefit from it, thus opening the doors for sustainable production. The implementation of carbon tariffs may pose challenges, such as trade tensions, compliance with World Trade Organization (WTO) rules, and so on. Despite these concerns, carbon tariffs are increasingly seen as a necessary tool to promote sustainable trade and combat climate change by incentivizing cleaner production methods globally.

Keywords: *Carbon tariff, sustainability,*
JEL Classification: *Q56, Q58, F18, Q54.*

Introduction:

The imposition of carbon tariffs also known as a carbon border adjustment mechanism (CBAM) and the adoption of the Copenhagen Accord (2009) comply with United Nations sustainable development goals (UN SDGs) that are supposed to be achieved by 2030**.** SDG 12 ensures Responsible Consumption and Production and Carbon tariffs promote sustainable production by discouraging carbon-intensive manufacturing and encouraging entrepreneurs to adopt cleaner technologies. The Copenhagen Accord (2009) aligns with SDG 13 talks about Climate Action to combat climate change and the impacts of the action.

A carbon tariff is a tax on carbon-intensive imported goods that has been proposed as a solution in which countries with a higher carbon price/tax impose a tariff on goods from countries with lower carbon prices. Carbon tariffs are complementary to domestic carbon pricing mechanisms, and ensure that environmental efforts are not undermined by imports from countries with weaker policies, thus taking Green House Gas (GHG) emission reduction to a further level. In 2009, at the 15th Conference of the Parties (COP 15) of the United Nations Framework

Convention on Climate Change (UNFCCC) in Copenhagen, Denmark, the Copenhagen Accord was agreed upon by 116 countries to reduce global carbon emissions substantially and also agreed to mobilize $100 billion in climate finance by 2020.

Literature Review:

Böhringer et al. (2016) examined carbon tariffs as a strategy to encourage international cooperation on emissions reduction. Using a numerical model, they simulated a game where a coalition of countries considers tariffs against unregulated regions. The study explored scenarios where these regions abate emissions, retaliate, or ignore tariffs. Findings suggest that tariff threats can incentivize cooperation and reduce global abatement costs. China and Russia were identified as likely to cooperate due to trade benefits.

Zhou et al. (2015) analyzed carbon tariffs' impact on sustainable supply chains using a mixed-integer linear model applied to a multinational electronics company in Taiwan. They found tariffs can push firms in unregulated countries to lower emissions, especially when combined with other policies. Effectiveness depends on factory capacity and export ability. Limiting member factories' production can also drive non-member factories to adopt low-emission technologies.

Eyland & Zaccour (2014) explored border tax adjustments (BTAs) to combat carbon leakage. Using a two-country trade model, they compared scenarios with and without cooperation. They found that a partial BTA can mimic cooperative outcomes, improving welfare and encouraging ambitious climate policies. The study also examined optimal BTA size to incentivize participation in climate agreements.

A multi-sector, multi-factor gravity model with tariffs:

In their paper, Larch and Waner (2017) develop a multi-sector, multi-factor structural gravity model that decomposes changes in emission levels into:

1. Scale Effect: Emission level increases with the overall increase in activity level, ceteris paribus.
2. Composition Effect: Emission level may decrease with an increase in the proportion of goods in the total production involving less pollution-creating activities.
3. Technique Effect: Emission level may change by changes in input mix, fuel mix, and carbon coefficients.

Utility Function and Budget Constraints:

Firstly, the multi-sector model starts with consumers' problem of maximizing the utility subject to their budget constraints. They assumed the existence of a single non-tradable sector, S, along with a set, L, comprising L tradable goods sectors in each of the N countries. Within each tradable sector, goods are differentiated based on their country of origin, with each country producing a single variety per sector. Hence, there are a total of (L+1) sectors in an economy. The consumers have N number of good varieties each in the tradable sectors and only one good variety in the non-tradable goods, in the presence of trade. The representative consumer's utility from consuming goods in a specific tradable sector is described by a CES utility function as follows:

$$U_l^j = [\sum_{i=1}^{N} (\beta_l^i)^{\frac{1-\sigma_l}{\sigma_l}} (q_l^{ij})^{\frac{\sigma_l-1}{\sigma_l}}]^{\frac{\sigma_l}{\sigma_l-1}}$$

For the sake of simplicity, consider the index i as the exporting country and j as the importing country. Thus, q_l^{ij} represents the quantity of imports from country i by country j in the sector l. Notice that this utility function represents a love of variety i.e. the greater the number of varieties, the greater will be the utility.

The representative consumer's utility is modelled using a Cobb-Douglas function that accounts for consumption across different sectors, incorporating the negative impact of CO2 pollution.

$$U_j = (U_S^j)^{\gamma_S^j}[\prod_{l=1}^{L}(U_l^j)^{\gamma_l^j}][\frac{1}{1+(\frac{1}{\mu_j}\sum_{i=1}^{N}E^i)^2}]$$

Here, utility of a representative consumer in country j is positively related to utility from the tradable sectors and the non-tradable sector. The additional feature is the negative utility consumers get from carbon emissions, E^i. E^i represents the total energy usage in country i which corresponds to the total emissions (as emissions are created from energy usage). An important feature here is that reducing the emissions of the country in which the consumer resides does not ensure an increase in utility unless the total emissions of all countries decrease collectively.

The representative consumer's income is derived from energy (E), unskilled and skilled labor, capital, land, and natural resources, collectively represented by the set F. The total income of the representative consumer in country j is:

$$Y^j = e^j E_S^j + \sum_{l\in\mathcal{L}} e^j E_l^j + \sum_{f\in\mathcal{F}} v_f^j V_{Sf}^j + \sum_{l\in\mathcal{L}}\sum_{f\in\mathcal{F}} v_f^j V_{lf}^j + \sum_{l\in\mathcal{L}}\sum_{i=1}^{N}(\tau_l^{ij}-1)X_l^{ij}$$

τ_l^{ij} is 1 + ad-valorem tariff on imports from country i to country j on goods from sector l. This is the carbon tariff discussed earlier which is different for different goods as they embody different levels of emissions. It is assumed that the government distributes its tariff revenue among the citizens.

Therefore, it gets added to the consumers' income.

The representative consumer in j hence maximizes U^j subject to $Y^j = p_S^j q_S^j + \sum_{l\in\mathcal{L}}\sum_{i=1}^{N} p_l^{ij} q_l^{ij}$

Multi Factor Production Function:

The use of energy is directly and highly correlated with carbon emissions therefore, we incorporate energy into the production function and consider emissions as a proportional by product. That is also the reason why we represented the disutility due to emissions through energy usage values.

Decomposition of Emission Changes:

Total emissions of country i can be written as $E^i = (\alpha_{SE}^i Y_S^i + \sum_{l\in L}\alpha_{lE}^i Y_l^i)/e^i$ where $\alpha_{SE}^i Y_S^i$ gives the total amount spent on energy input by sector S (non-tradable sector) of country i and $\alpha_{lE}^i Y_l^i$ gives the total amount spent on energy input by sector l (tradable sector) of country i. Thus, dividing the total amount spent on energy input by all the sectors of the economy by the price of energy will give the total amount of energy used. Due to the assumption that emissions are created by energy use in the production process, the total energy use corresponds to the emission level of that economy. Now, taking the total nominal income without tariff revenues as $\tilde{Y}^i = Y_S^i + \sum_{l\in L} Y_l^i$, we can get the sectoral production shares as $\kappa_S^i = Y_S^i/\tilde{Y}^i$ and $\kappa_l^i = Y_l^i/\tilde{Y}^i$. Country's production-share-weighted average energy cost share, $\bar{\alpha}_E^i$, can be easily derived as $\bar{\alpha}_E^i = \alpha_{SE}^i\kappa_S^i + \sum_{l\in\mathcal{L}}\alpha_{lE}^i\kappa_l^i$. It is the weighted average of energy cost share of the economy weighted by the sectoral shares.[1] Rewriting total emissions as:

$$E^i = \bar{\alpha}_E^i \frac{\tilde{Y}^i}{P^i}\left(\frac{e^i}{P^i}\right)^{-1}$$

Taking the total derivative of the equation:

$$dE^i = \frac{\partial E^i}{\partial(\tilde{Y}^i/P^i)}d(\tilde{Y}^i/P^i) + \frac{\partial E^i}{\partial\bar{\alpha}_E^i}d\bar{\alpha}_E^i + \frac{\partial E^i}{\partial(e^i/P^i)}d(e^i/P^i)$$

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[1] Note that $\kappa_S^i + \sum_{l\in L}\kappa_l^i = 1$

Empirical Exercise conducted by Larch and Wanner (2017):

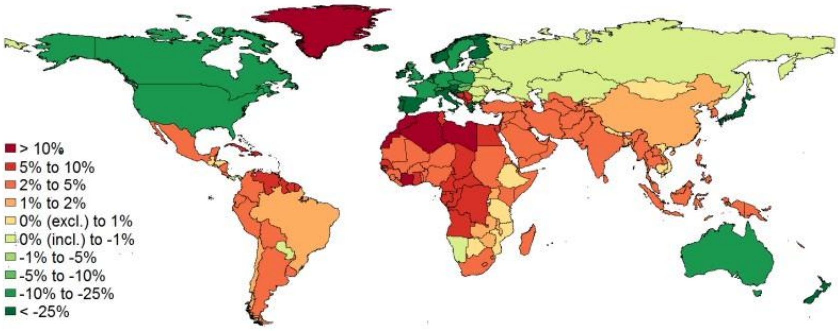
Data and Method Applied:

The data was collected from the Global Trade Analysis Project (GTAP) 8 database. It was then aggregated across 57 sectors of all countries into one non-tradable and 14 tradable sectors. All the data of other variables was then aggregated according to this sectoral structure. The changes in trade flows in percent were normalized ($X_l^{ij}/Y^{\,i}$) and then the welfare and carbon emissions were calculated. 2007 was taken as the base year for comparisons.

Results:

At the 15th session of the Conference of the Parties (COP), 2009, the Copenhagen Accord was agreed upon which took Kyoto Protocol commitments towards the next steps. A few nations agreed to keep their emissions constant, while others agreed to reduce their emissions. Emissions increased majorly for non-committing countries, especially in Latin America, Africa and Asia. From this arrangement, those who committed to reducing the emissions were supposed to bear the costs of the global emission reductions, whereas the non-committing countries were to gain doubly.

Figure A6: Percentage changes in carbon emissions (Copenhagen scenario)



Notes: This figure shows the percentage changes in carbon emissions due to the counterfactual implementation of the Copenhagen Accord. Red represents an increase in a country's emission level, while green represents a reduction. The values range between -57.4 percent for Cyprus and 12.6 percent for Rest of North Africa. The corresponding change in world carbon emissions is a 8.4 percent decrease.

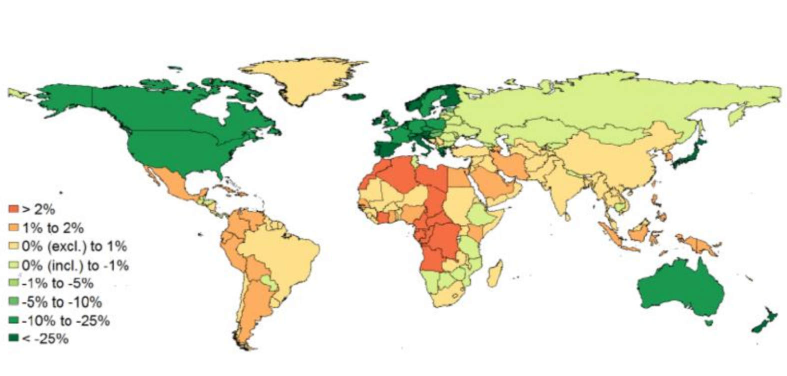
Figure 1: Larch and Wanner (2017)

A higher carbon price can reduce energy demand in countries that implement a carbon tariff. This leads to fall in world market prices for energy and hence lead to a more emission-intensive production in other countries. (Felder and Rutherford, 1993) This is termed as energy market leakage. (McAusland and Najjar, 2015) They took a scenario where carbon tariffs equalize the levels of the implicit carbon taxes across the economies. Tariffs are implemented so that, for each country pair, the country with the higher implicit carbon tax imposes a tariff on imports from the other country.

Carbon tariffs incentivize the producers to alter their production composition towards less energy consuming activities which resulted in reduced emissions. Also, the gains from trade shrank because of higher cost of trade and thus leading to a decreased welfare in developing countries. From the exercise carried out by the authors, composition effect has been followed by scale effect i.e. two-thirds of the decrease in carbon emissions has been a result of variations in composition, rest of the decrease is because of a decline in production globally. Technical effect has been negative and is more significant in case of production-based tariff than product-based tariff. This may be because production–based tariffs target more on emission-intensive industries.

A decrease in energy demand globally, decreases international energy price. Thus, an increase in energy-intensive production which would eventually lead to a significant rise in world emissions. Carbon taxes imposed by European nations are far higher than nations of Africa and Asia.

Figure A8: Percentage changes in carbon emissions (Copenhagen scenario with tariffs)



Notes: This figure shows the percentage changes in carbon emissions due to the counter-factual implementation of the Copenhagen Accord with carbon tariffs. Red represents an increase in a country's emission level, while green represents a reduction. The values range between -57.4 percent for Cyprus and 2.4 percent for Cote d'Ivoire. The corresponding change in world carbon emissions is a 9.3 percent decrease.

Figure 2: Larch and Wanner (2017)

Most of the countries (79 %) show a decrease in welfare. Whereas the countries which gain received a comparatively small amount of welfare gain as compared to welfare loss. The countries in which high reductions in trade flows occurred, faced strong welfare losses. Most of these countries are developing countries of Africa and Asia, so poor nations became poorer as their trade was adversely affected. Developed countries with comparatively high carbon taxes either increased or slightly reduced their carbon emissions whereas, most of the developing countries reduced their emissions by a significant amount after introduction of tariff.

Comments on the Empirical Exercise:

This paper effectively shows that carbon tariffs alone are not a complete solution to climate change. While tariffs reduce emissions, they also lower global welfare, and high-polluting countries often increase emissions.

Several issues in the framework need addressing. First, the model lacks a dynamic aspect, keeping technology and production functions fixed. Climate change's impact on productivity is not considered. Second, it assumes rising energy demand increases prices, but alternative energy demand could lower prices, preventing higher emissions. The technique effect may also improve efficiency—higher energy prices might push firms to adopt eco-friendly methods previously deemed too costly. This potential productivity gain was overlooked, leading to a perceived negative effect. Lastly, the analysis of Copenhagen Accord commitments does not account for significant differences in target achievements among Annex I countries, which could alter the actual impact on emissions, trade, and welfare.

Empirical Analysis:

The paper examined the impact of the emission reduction commitments made by Annex I countries in the Copenhagen Accord. Now, to make the analysis a bit more complete we inspect whether the countries achieved their targeted emission levels and if so, to what extent. Table 1 represents the targeted emission reductions of the Annex I countries in the Copenhagen Accord. The actual reduction in emissions is calculated using data from the World Bank Database for these countries. The Annex I countries pledged a reduction in their emission levels in the year 2010 to be achieved by the year 2020. We took their percentage reduction from 2010 to 2019. The emission level of the year 2020 was not considered as it was an outlier in which many production activities were severely undercut due to COVID-19. If the year 2020 were to be considered, it would show a greater reduction than the countries were actually able to achieve through planning. Comparing the actual and targeted reductions, it is clear that almost half of the countries were able to achieve their target level of reductions and some even overachieved it by a huge margin. Some countries came very close to achieving their targets but could not quite reach the pledged level. Many of the countries missed their targets by a huge margin. Thus, the results seem to be mixed. Notice that the countries with reduction targets of 0 percent intend to keep their emission levels constant. Thus, if the authors had taken their actual emission reductions into account instead, the results would have been very different.

The United States of America has been very vocal about its intentions in reducing the carbon emissions. It is one of the biggest proponents of reducing carbon emissions to control climate change. It has also been criticising the developing countries like China and India about their high carbon emissions. But the truth is that the per capita carbon emissions of the USA is much higher than that of China and India. Plus the fact that it imports a lot of products which are originally manufactured in China (essentially meaning that they are exporting their pollution). This theory has been very popular that countries, in order to reduce their emissions put on high restrictions for pollution creating activities but it comes at the expense of those countries which have lax restrictions.

Figure 3: Actual vs Targeted Emission Reduction Percentage

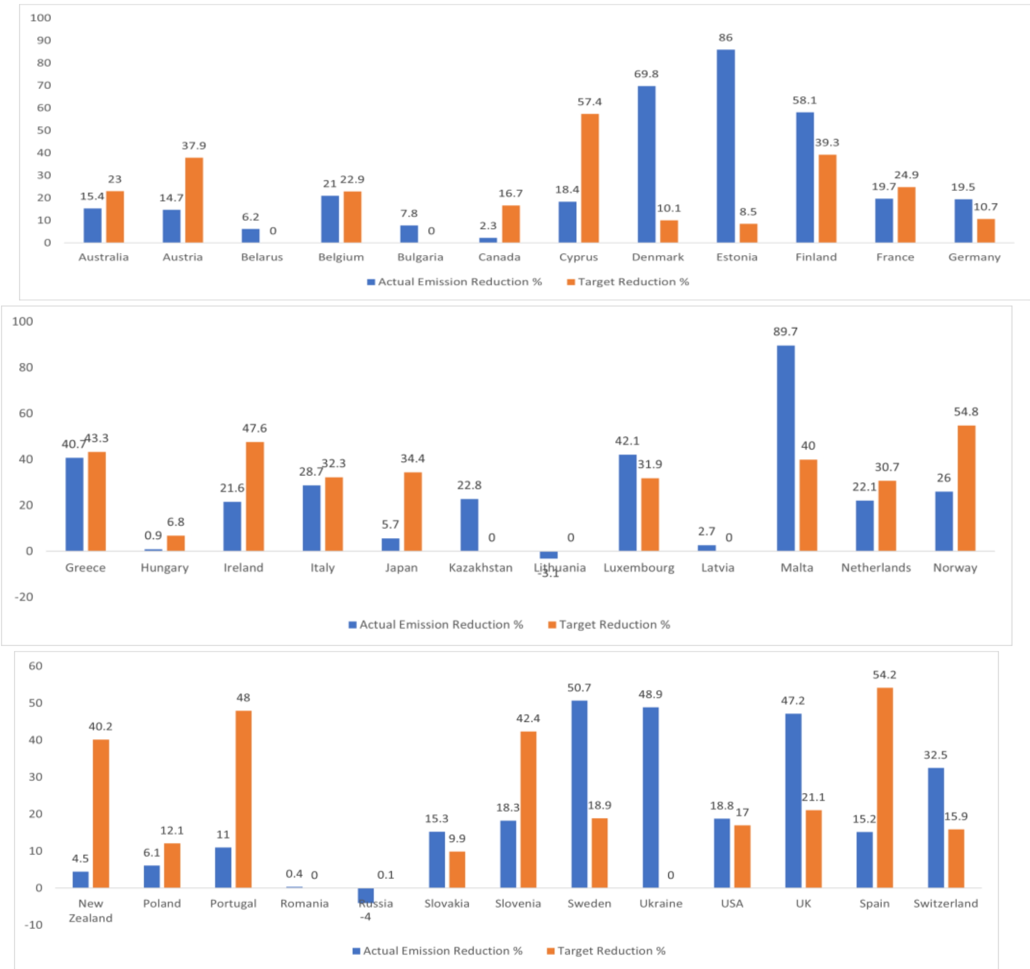


Table 1: Targeted vs Actual Emission Reduction of Annex I Countries in Copenhagen Accord

Country	Target Reduction %	Actual Emission Reduction %
Australia	23	15.4
Austria	37.9	14.7
Belarus	0	6.2
Belgium	22.9	21
Bulgaria	0	7.8
Canada	16.7	2.3
Cyprus	57.4	18.4
Denmark	10.1	69.8
Estonia	8.5	86
Finland	39.3	58.1
France	24.9	19.7
Germany	10.7	19.5
Greece	43.3	40.7
Hungary	6.8	0.9
Ireland	47.6	21.6
Italy	32.3	28.7
Japan	34.4	5.7
Kazakhstan	0	22.8
Lithuania	0	-3.1
Luxembourg	31.9	42.1
Latvia	0	2.7
Malta	40	89.7
Netherlands	30.7	22.1
Norway	54.8	26
New Zealand	40.2	4.5
Poland	12.1	6.1
Portugal	48	11
Romania	0	0.4
Russia	0.1	-4
Slovakia	9.9	15.3
Slovenia	42.4	18.3
Spain	54.2	15.2
Sweden	18.9	50.7
Switzerland	15.9	32.5
Ukraine	0	48.9
UK	21.1	47.2
USA	17	18.8

Table 2: USA and Its Exporters' Emission Changes

Country	Time Coefficient	Significance	Change (%)
USA	-0.1846	***	-24.39249
China	0.23489	***	297.2718
Canada	0.01595		1.859694
Vietnam	0.094058	***	1126.934
Japan	0.003898		-3.292605
Germany	-0.10055	***	-34.2157
India	0.042617	***	178.5446
Mexico	0.01851	***	9.6573
Ireland	-0.07024	*	-17.7673
Korea	0.20151	***	104.2267
Italy	-0.06861	***	-25.66407
Malaysia	0.169347	***	161.671
WA 1 (72.5% imports)	0.077914	***	29.75752
WA 2 (55.7% imports)	0.080177	***	25.03825

To test its scope, we look at the emission levels of USA and its major exporters for the period 1990-2019.The following regression equation is run for each country:

$E_t = \alpha + \beta t + \epsilon_t$

where E_t means the emission levels at time t, t takes the value 0, 1,..., 29 for the year 1990, 1991 ,..., 2019.The coefficient of t i.e. β is estimated for each country which essentially tells that if t increases by 1 then by how much the emissions will change. β can also be interpreted as the change in emission level if we go an year forward in time. A positive coefficient would represent increasing emissions with time and vice versa.

In Table 2, the regression results from the estimated equation have been depicted. The countries being considered here are the USA (the benchmark country which has reduced its emissions over the years as apparent from the time coefficient of the USA), China, Canada, Vietnam, Japan, Germany, India, Mexico, Ireland, Korea, Italy, and Malaysia. All the rest of the countries (except the USA) have been taken because they are the top exporters to the USA. All these countries, combined, account for 72.5% of the imports of US. WA 1 is the weighted average of emissions of all these exporting countries weighted by their share in the exports of USA. WA 2 is the weighted average of emissions of the top 10 exporting countries weighted by their share in the exports of USA.

From the regression estimation, China, Vietnam, India, Mexico, Korea, and Malaysia have a positive and significant time coefficient which means that their emissions have increased with time. Germany, Ireland, and Italy have a negative and significant coefficient which means that their emission levels have been decreasing over time. Canada and Japan have an insignificant coefficient. These results are pretty mixed. Thus, we can't say conclusively if the exporters of USA have increased their emission levels or not. In order to solve this dilemma, we see the time coefficient for the weighted average of the emission levels of its top exporters. Time coefficient for WA 1 and WA 2 are both positive and highly significant. This shows that, overall, there is an increase in the emission levels of USA's exporters. Thus, we cannot rule out the possibility that the US has just exported its emissions to other, mostly developing, countries. This has an implication for consumer welfare as well. In the theoretical model discussed earlier, we saw that the utility level of the consumers is not only negatively related to the emissions of their respective country but the emissions of the whole world. Thus, having a strict carbon policy in the home country might not increase the welfare level of the consumers as the emission level of the world as a whole might not decrease.

References:

1. Böhringer, C., Carbone, J. C., & Rutherford, T. F. (2016). The strategic value of carbon tariffs. *American Economic Journal: Economic Policy*, *8*(1), 28–51. https://doi.org/10.1257/pol.20130327
2. Copeland, B. R., & Taylor, M. S. (1994). North-South trade and the environment. *The Quarterly Journal of Economics*, *109*(3), 755–787. https://doi.org/10.2307/2118421
3. Eyland, T., & Zaccour, G. (2014). Carbon tariffs and cooperative outcomes. *Energy Policy*, *65*, 718–728. https://doi.org/10.1016/j.enpol.2013.10.043
4. Grossman, G. M., & Krueger, A. B. (1991). Environmental impacts of a North American Free Trade Agreement. *National Bureau of Economic Research* (Working Paper No. 3914). https://doi.org/10.3386/w3914
5. Felder, S., & Rutherford, T. F. (1993). Unilateral CO_2 reductions and carbon leakage: The consequences of international trade in oil and basic materials. *Journal of Environmental Economics and Management*, *25*(2), 162–176. https://doi.org/10.1006/jeem.1993.1040
6. Larch, M., & Wanner, J. (2017). Carbon tariffs: An analysis of the trade, welfare, and *emission* effects. *Journal of International Economics*, *109*, 195–213. https://doi.org/10.1016/j.jinteco.2017.09.005
7. McAusland, C., & Najjar, N. (2015). Carbon footprint taxes. *Environmental and Resource Economics*, *61*(1), 37–70. https://doi.org/10.1007/s10640-014-9772-2
8. United Nations Framework Convention on Climate Change (UNFCCC) (2009). *Information provided by Parties to the Convention relating to the Copenhagen Accord.* Copenhagen Climate Change Conference - December 2009. https://unfccc.int
9. Zhou, Y., Gong, D.-C., Huang, B., & Peters, B. A. (2015). The impacts of carbon tariff on green supply chain design. *IEEE Transactions on Automation Science and Engineering*.