Knowledge, evidence and learning for development

Impacts of trade facilitation on carbon emissions

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Question

What evidence is available about how trade facilitation efforts affect carbon emissions at ports of entry or across global value chains?

Contents

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1. Summary

There is very little evidence that trade facilitation measures[1] have a significant impact on carbon emissions, except in the case of trucks at land border crossings, where there is good evidence that trade facilitation can lead to significant reductions in emissions.

There is good evidence that trade facilitation measures at land border crossings can reduce traffic congestion and waiting times for trucks, but only limited evidence of the impact of these improvements on carbon emissions. Computer models of inspection stations at the USA-Mexico border suggest that improving the efficiency of land border crossings through driver, vehicle, and cargo pre-registration, automating inspection and administrative processes, and carrying out joint customs inspections could potentially reduce CO_2 emissions from trucks by up to 86% in some cases (Kear et al., 2012; North American Research Partnership, 2019; Reyna et al., 2016; Shelton et al., 2016).

There appears to be no evidence available about whether trade facilitation efforts at seaports have an impact on carbon emissions; this issue appears to not have been studied by any ports, international agencies, or researchers. Some seaports have produced estimates of their carbon footprints, but none appear to have considered customs inspection or other activities related to trade facilitation as a distinct activity.

Very few studies address the impacts of trade facilitation on carbon emissions across global value chains. Two studies that have done so suggest that trade facilitation measures could lead to small increases in CO_2 emissions, ranging from less than 0.1% to 2.23% (Aydın, 2016; Narayanan G. et al., 2017). Studies examining the more general relationship between increasing trade and carbon emissions, without specifically focusing on trade facilitation measures, have found mixed results including positive, negative, and inverse U-shaped relationships in different countries and groups of countries; several of these studies suggest that a country's level of economic development and quality of political institutions influence the relationship between trade openness and carbon emissions.

2. Impacts at land borders

There is good evidence that trade facilitation measures at land border crossings can reduce traffic congestion and waiting times for trucks, but only limited evidence of the impact of these measures on carbon emissions. All of the evidence found in the course of preparing this report comes from studies of border crossings between the USA and Mexico, and all of these studies relied on computer models to simulate traffic and emissions. Several reports noted that impacts are specific to the facilities, capacities, and layouts of individual border crossings, and that lessons from one port of entry are not necessarily transferable to others.

A study modelling emissions from trucks entering the USA from Mexico at the Mariposa port of entry in Nogales, Arizona in 2015 concluded that **increasing the efficiency of customs**

[1] Trade facilitation encompasses simplifying and harmonising formalities, procedures, and the exchange of information and documents to help make trade across borders faster, cheaper, and more predictable, and involves all organisations involved in the supply chain as well as all government agencies that intervene in the transit of goods (UNECE, 2012).

inspection processes could reduce greenhouse gas emissions by 31% to 36% (Reyna et al., 2016, p. 219). The study predicts that emissions increase dramatically as traffic volumes and congestion increase: when traffic in the model was doubled, greenhouse gas emissions increased by approximately 3.5 times, and when traffic was tripled, greenhouse gas emissions increased by approximately 6 times[2] (Reyna et al., 2016, p. 224). The US government's Free and Secure Trade (FAST) programme speeds up customs clearance for commercial carriers that have completed background checks and fulfilled requirements that include pre-registering drivers, vehicles, and cargoes, and certifying every link in the supply chain including the manufacturer, carrier, driver and importer (Reyna et al., 2016, pp. 222–223). Increasing the number of trucks enrolled in the FAST programme, would speed up processing and avoid some secondary inspection processes, leading to decreased queuing time for all vehicles, including those not enrolled in the programme. The study predicted that if all trucks were enrolled in the programme, emissions of all pollutants could be reduced by 31% to 36% (Reyna et al., 2016, pp. 225–226). Similarly, increasing the number of inspection lanes from six to eight during periods of high congestion was estimated to reduce greenhouse gas emissions by approximately 30% (Reyna et al., 2016, p. 226). The study also suggested that spreading out the arrival times of trucks to avoid peaks could potentially reduce emissions of all pollutants by up to 65% under ideal conditions of uncongested flow (Reyna et al., 2016, p. 228).

A later study of the Mariposa border crossing examined the impact of the Unified Cargo Processing (UCP) programme, under which US and Mexican authorities work side by side to carry out joint inspections of goods, eliminating the need for separate inspections (CT Strategies, 2018; North American Research Partnership, 2019, p. 16). The study concluded that **the combined UCP and FAST programmes reduced queuing and inspection times substantially, leading to an 86% reduction in emissions of CO_2** and 85% to 86% reductions in other pollutants (North American Research Partnership, 2019, pp. 6, 40). The emissions reductions are largely the result of participating northbound trucks being able to bypass inspection on the Mexican side of the border and proceed to the joint inspection station on the US side of the border, reducing congestion at the Mexican facility which has insufficient capacity (North American Research Partnership, 2019, p. 40).

One study at the Ysleta-Zaragoza port of entry between El Paso, USA and Ciudad Juarez, Mexico modelled the impact of combining US and Mexican customs inspections for northbound trucks to reduce queuing and delay associated with separate inspection processes (Kear et al., 2012, pp. 1.4, 5.1). The study estimated that 'delay and queuing account for approximately half of the emissions associated with traffic crossing the border at port of entry' and that **combining customs inspections could reduce particulate and NOx emissions by 9.7% and 9.9%**, respectively; carbon emissions were not modelled (Kear et al., 2012, p. 5.1).

Another study at the Ysleta-Zaragoza port of entry modelled changes in vehicle emissions under eight scenarios that included varying waiting times and the number of inspection booths operating (Shelton et al., 2016, p. x). In this study, **emissions from commercial vehicles were found to be insensitive to changes in waiting times**, with CO_2 emissions varying by no more than plus or minus 1% in response to reductions in waiting times of up to 25% (Shelton et al.,

[2] Based on visual estimation from a chart included in the study, as exact figures for greenhouse gases were not provided.

2016, pp. 34–35). The study also estimated that reducing the number of inspection lanes available would reduce CO_2 emissions by 2% to 3%, but this effect is due to the fact that with fewer lanes open, fewer trucks could queue within the boundaries of the study area (Shelton et al., 2016, p. 34).

A report on reducing air pollution at land borders between Canada, the United States, and Mexico by the tri-national Commission for Environmental Cooperation identified eight promising practices including engine and vehicle technologies, anti-idling initiatives, truck stop electrification, and eco-driving[3] (Commission for Environmental Cooperation, 2016, p. v). The report's only recommendation related to border crossing formalities was to implement 'trusted traveller' programmes such as the US FAST programme to speed up border crossings, but it did not provide any data on the impacts of such programmes for commercial vehicles (Commission for Environmental Cooperation, 2016, pp. v, 24–25).

3. Impacts at seaports

There appears to be no evidence available about whether trade facilitation efforts at seaports have an impact on carbon emissions; this issue appears to not have been studied by any ports, international agencies, or academic researchers. Some seaports have estimated their carbon footprints, but none have addressed the potential impacts of trade facilitation. Existing carbon footprint estimates use non-standardised and non-comparable methodologies, including different scopes, activities, and sources of emissions (Azarkamand et al., 2020, p. 13; Merk, 2014, pp. 8–9). These studies often rely on estimates rather than 'real data' (Azarkamand et al., 2020, p. 13), but different estimation procedures and assumptions can lead to very different results: for example, a study at the Port of Leixões in Portugal comparing the two methodologies most frequently used to estimate carbon emissions at ports[4] found that one method produced an estimate of CO_2 emissions that was 85% higher than the other (Sorte et al., 2021). Organisations such as the Greenport Congress and the *Laboratorio de ingeniería sostenible* have called for the development of common standards and an easy-to-use tool for calculating carbon footprints at seaports (Azarkamand et al., 2020, p. 13). Existing guidelines for measuring emissions, such as the International Maritime Organization's *Port Emissions Toolkit* and other programmes seeking to reduce emissions, do not mention trade facilitation initiatives (GloMEEP, 2018; Merk, 2018).

Case studies reviewed during the preparation of this report presented estimates of carbon emissions either in aggregate for an entire port, or grouped in ways that reflect how the port is organised or managed. None of the case studies reviewed for this report reflected on potential links between greenhouse gas emissions and border clearance procedures or the storage of goods pending customs clearance. Port-based emissions are mostly attributed to ships, making up more than 70% of emissions in ports in wealthy countries; trucks and locomotives contribute around 20% of the total, although significantly more in developing countries, and emissions from other equipment typically contribute less than 15% (Merk, 2014, p.

[3] Driving in a manner that significantly reduces fuel consumption and thus emissions.

[4] One methodology was developed by US Starcrest Consulting Group and the other by the European Monitoring and Evaluation Program, European Environment Agency.

10). Emissions estimates are normally based on estimates of fuel consumption and electricity consumption for vehicles, equipment, and buildings. Port-based emissions make up a small proportion of the total emissions of the shipping industry, and a study for the UK Department for Transport in 2019 considered the potential for port-related emission reduction measures to have 'low' potential for reducing greenhouse gas emissions in the shipping industry[5] (Smith et al., 2019, pp. 8–11). Recent Time Release Studies following World Customs Organization standard methodologies in Brazil, India, and the Philippines do not consider potential impacts of customs operations on carbon emissions (Government of India, 2020; Philippine Bureau of Customs, 2019; Receita Federal do Brasil, 2020). Examples of carbon emissions estimates at various seaports include:

- At the Port of Chennai, India, carbon emissions are attributed to the ships using the port (55%), the port's fishing harbour (25%) and container terminals (4%), port-operated tugs, other vehicles, and equipment (2%), commercial trucks (2%), and electricity consumption (11%) (Misra et al., 2017, pp. 49–53).
- A study of four container terminals in Mumbai, India attributed the majority of carbon emissions to fuel used by rubber-tired gantry cranes and tractor trailers, and to electrical power for rail-mounted gantry cranes and refrigerated containers (Vasanth et al., 2012).
- The port of Santos, Brazil, reports total carbon emissions at each of its eight sites in its annual sustainability report, distinguishing emissions arising from fuel consumption and indirectly from electricity consumption without providing any more detailed breakdown (Santos Brazil, 2019).
- An academic study examining the four container terminals of the port of Shenzhen, China, estimated carbon emissions in 2013 to be attributable to ships and road vehicles (60%), heavy equipment for loading and unloading cargo (22%), packaging materials (14%), and electricity consumption (5%); this study mentions that customs clearance normally takes one day for exports and one to three days for imports, but makes no attempt to estimate any associated carbon emissions (Yang et al., 2017, pp. 10–12).
- The Port of Olympia in Washington, USA, attributed its carbon emissions in 2017 to electricity use (53%), boats and land vehicles (42%), and other on-site fuel use (5%) (Pioneer Technologies Corporation, 2018).
- Taichung Port, Taiwan, reported on greenhouse gas emissions across three zones within the port (heavy industry, export-processing, and harbour areas) and found that the majority of point-source emissions were associated with the heavy industry zone (98% of all emissions) and the majority of mobile emissions were associated with the harbour zone (0.6%), but the port's environmental report does not break down emissions further (Port of Taichung, 2016, p. 26).
- Giurgiulești International Free Port in Moldova reported in 2017 on carbon emissions arising from diesel and gasoline engines in cargo handling equipment (29% of all emissions), other motor vehicles, ships, and equipment (22%), natural gas for heating (6%) and overall electricity consumption (43%) (Danube Logistics, 2018, pp. 5–8).

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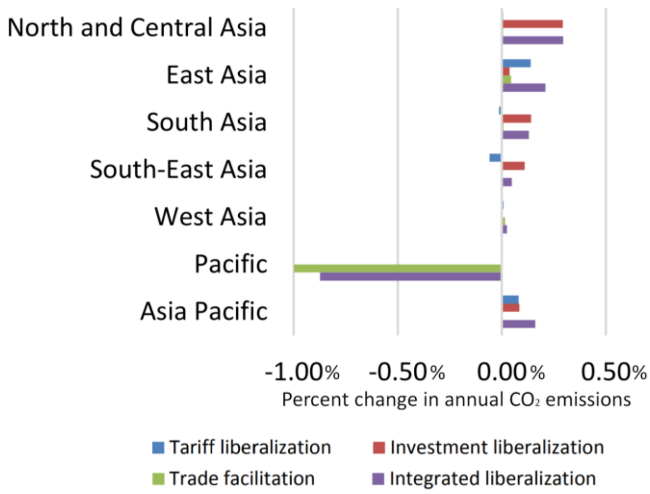
[5] Alternative fuels, use of catalysts to remove methane from exhaust gases, and on-board carbon capture, storage and sequestration technologies were identified as having 'high' potential.

4. Impacts through global value chains

Very few studies address the impacts of trade facilitation, specifically, on carbon emissions across global value chains. Two studies that have done so suggest that trade facilitation measures could lead to small increases in CO_2 emissions ranging from less than 0.1% to 2.23%.

One study in the Asia-Pacific region suggests that trade facilitation measures could lead to an **increase in CO_2 emissions of less than 0.1%** while producing significant trade and GDP gains (Narayanan G. et al., 2017). The study estimated the impacts of trade facilitation, tariff liberalisation, investment liberalisation, a combination of these three measures, and other policy measures[6] on trade, GDP, and CO_2 emissions from 2015 to 2030 using a model based on the Global Trade Analysis Project-Power (GTAP-POWER) model (Narayanan G. et al., 2017, pp. 8–12). Trade facilitation was represented in the model by reductions in trade costs to reflect implementation of the WTO Trade Facilitation Agreement and the Framework Agreement on Facilitation of Cross-Border Paperless Trade in Asia and the Pacific (Narayanan G. et al., 2017, pp. 17, 29). The impact on the environment was limited, with CO_2 emissions increasing by less than 0.1% annually; tariff liberalisation also led to emissions increasing by less than 0.1%, investment liberalisation led to CO_2 emissions increasing by 0.1%, and a combination of all three measures led to an increase of 0.16% (Narayanan G. et al., 2017, pp. 12–17). As illustrated in Figure 1, the impact of trade facilitation on CO_2 emissions was small across all subregions except the Pacific, but in the Pacific emissions were very low to begin with so the change is large in percentage terms but small in absolute terms (Narayanan G. et al., 2017, pp. 14, 18). Under the protectionist ‘tariff war’ scenario, CO_2 emissions across the region declined due to overall lower economic activity (Narayanan G. et al., 2017, p. 25).

Figure 1: Modelled impacts of tariff liberalisation, investment liberalisation and trade facilitation scenarios on CO_2 emissions in the Asia-Pacific region



Source: Narayanan G. et al. 2017, p. 14. Used with permission.

[6] Implementation of the Paris Accord, income transfers from skilled to unskilled labour, a combination of trade, environmental, and social policies, and a protectionist ‘tariff war’ scenario.

A study focusing on the BRICS countries (Brazil, Russia, India, China, and South Africa) predicted that a combination of trade liberalisation and free capital flows could lead to **carbon emissions increasing across these five countries by 0.23% to 2.23% in the long term**, alongside decreased emissions in the rest of the world (Aydın, 2016, pp. 214–216). The study used the Global Trade Analysis Project – Energy (GTAP-E) model to estimate the impacts of 'full trade liberalisation' involving reducing import tariffs to zero, reducing non-tariff barriers, and increasing the availability of technology to improve the management of cross-border trade, both in the short term and in the longer term with an assumption of free capital flows (Aydın, 2016, pp. 211, 213–215). The study predicts that trade liberalisation among the BRICS countries would lead to changing patterns of production and consumption, and rising trade volumes, GDPs, and standards of living across all five countries, with significant implications for carbon emissions as shown in Table 1 (Aydın, 2016, pp. 214–217). In the short-run scenario, composition effects (shifting production to follow comparative advantage) outweighed scale effects (increased production volume) for Brazil and South Africa, leading to reductions in carbon emissions in those countries, with the reverse happening in China and Russia, while in the long-run scenario, carbon emissions increased in all countries, especially South Africa, Russia, and India which saw significant increases in outputs of petroleum products and almost all energy-intensive sector outputs (Aydın, 2016, pp. 215, 217).

Table 1: Modelled changes in carbon emissions due to trade liberalisation among BRICS countries

	Brazil	Russia	India	China	South Africa	USA	EU	Rest of World
Short-term change in emissions (full trade liberalisation)	-0.10%	+0.16%	+0.04%	+0.13%	-0.44%	-0.04%	-0.10%	-0.08%
Long-term change in emissions (full trade liberalisation and free capital flows)	+0.76%	+0.52%	+0.70%	+0.23%	+2.23%	-0.18%	-0.34%	-0.39%

Source: Adapted from Aydın, 2016, pp. 214, 216

Studies examining the more general relationship between increased trade and carbon emissions or environmental degradation without specifically focusing on trade facilitation measures have found mixed results including positive, negative, and inverse U-shaped relationships in different countries and groups of countries (Sun et al., 2019, p. 2; Zafar et al., 2019, p. 15163). Several studies suggest that the impact of trade openness on carbon emissions is influenced by the level of economic development of a country and find support for the environmental Kuznets curve hypothesis, which argues that in developing countries, economic growth up to a certain point causes to environmental degradation, after which further increases in economic development contribute to reducing environmental degradation. Other studies suggest that political institutions also influence how trade openness affects carbon emissions. Examples of recent studies, all of which are statistical analyses, looking at these relationships for various groups of countries include the following:

- A study of the relationship between trade and carbon dioxide emissions in 49 high-emission countries in regions associated with the Chinese Belt and Road Initiative from 1991 to 2014 found that increasing international trade significantly increased CO_2 emissions in countries at all levels of economic development across Southeast Asia, Central Asia, the Middle East/Africa, and South Asia, but reduced emissions in Europe and produced no significant change in East Asia (Sun et al., 2019, pp. 1, 13). The authors suggest that the countries with increased emissions rely more heavily on coal-powered technologies, high-pollution industries, and specialisation in high-pollutant commodities, while Europe and East Asia 'were relocating their dirty industries to emerging economies with lenient or nonexistent environmental regulations' (Sun et al., 2019, p. 13).
- An analysis covering 60 emerging and developing economies from 2002 to 2012 found that trade openness increases countries' CO_2 emissions, but does not have a significant effect on countries' overall Environmental Performance Index (a composite of twenty national-level environmental indicators) because it produces some environmental benefits that mitigate some of the negative impacts (Bernard & Mandal, 2016, pp. 195, 205).
- A study focusing on ten 'newly industrialised countries' (Brazil, China, Indonesia, India, Mexico, Malaysia, the Philippines, Thailand, Turkey, and South Africa) between 1971 and 2013 found that trade openness negatively and significantly affects emissions in these countries, and finds support for the environmental Kuznets curve hypothesis in these countries (Zhang et al., 2017, p. 17616).
- Analysis of 40 countries in sub-Saharan Africa from 2000 to 2010 finds that increased trade contributes to increased CO_2 emissions in countries with weak institutions (those ranking low on the Ibrahim Index of African Governance), but brings environmental benefits for countries with high quality institutions (Ibrahim & Law, 2016, pp. 323–324, 337). The authors suggest that high quality institutions, including prevalence of law and order, quality of bureaucracy, absence of corruption, and accountability of public officials, may help countries resolve trade-offs between economic growth and environmental degradation (Ibrahim & Law, 2016, p. 325).
- Another study covering 105 countries from 1980 to 2014, finds that trade openness contributes to increased CO_2 emissions, but specific impacts vary from country to country and the study finds evidence for the environmental Kuznets curve in countries at all income levels (Shahbaz et al., 2017, pp. 221, 231).
- An analysis using the World Input-Output Database, which divides the world into 41 economies made up of individual countries and groups of countries, over the period 1995-2009 found that growing trade volumes drove up CO_2 emissions overall, although changes in the intensity and composition of exports led to some mitigation of emissions, particularly after 2005 (Wang & Ang, 2018, pp. 146, 151, 154).
- A study covering 183 countries from 1987 to 2013 found that when countries liberalise trade through preferential trade agreements, low-income countries increase their ecological footprint exports, although this finding was not matched by the expected increase in footprint imports of high-income countries (Kolcava et al., 2019, p. 108). The

study also investigated the role of democratic institutions, and found that countries with greater democratic accountability are more likely to transfer environmental burdens to other countries, while less democratic countries are more likely to receive environmental burdens (Kolcava et al., 2019, p. 108).

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