Revisiting the environmental bias of trade policies based on an environmentally extended GTAP MRIO Data Base

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Abstract

Recently, Shapiro (2021) identified a new fact which shows an environmental bias of trade policies. This fact reveals that in most countries both import tariffs and non-tariff barriers are much lower on dirty than on clean goods—where "dirtiness" is defined as a commodity's emission intensity measured in terms of CO_2 emissions from fossil fuel combustion per dollar of that commodity's value. In this paper, we revisit this fact by using a newly-developed environmentally-extended GTAP MRIO Data Base and extend an earlier analysis in several ways. Our preliminary results that rely on the emissions embodied into trade (EEBT) approach and consider import tariffs only (i.e. do not include NTBs) indicate that when looking at the global average indicators, the environmental regressivity/progressivity of trade policy substantially depends on the scope of emissions coverage. We find substantial evidence of environmental bias of trade policies when only CO_2 emissions from fossil fuel combustion are considered. In contrast, when a broader set of GHG emissions is analyzed, an opposite relation is observed with more GHG-intensive commodities facing higher tariffs. The latter is largely driven by the fact that import tariffs are high for agricultural and food commodities (e.g. meat and rice) that are relatively clean as they combust less fossil-fuel related CO_2 emissions, but are much more emission intensive, when non-CO_2 GHGs are accounted for. Our preliminary results also indicate that in the case of fine particulate matter ($PM_{2.5}$) emissions, one of the major cause of pre-mature mortality worldwide, a positive relation between import tariffs and emission intensities is observed.

1. Introduction

Recently, Shapiro (2021) identified a new fact which shows an environmental bias of trade policies. This fact reveals that in most countries both import tariffs and non-tariff barriers are much lower on dirty than on clean goods—where "dirtiness" is defined as a commodity's emission intensity measured in terms of CO_2 emissions from fossil fuel combustion per dollar of that commodity's value. In this paper, we revisit this fact by using a newly-developed environmentally-extended GTAP MRIO Data Base and extend the original analysis of Shapiro (2021) in several ways.

First, aside from CO_2 emissions from fossil fuel combustion, we additionally account for CO_2-equivalent (CO_2e) emissions from industrial processes (e.g. chemicals, cement) and non-CO_2 greenhouse gases (GHGs) such as methane (CH_4), nitrous oxide (N_2O) and fluorinated gases (F-gases) based on GTAP non-CO_2 data by Chepeliev (2020). Doing this allows for a more complete evaluation of emission intensities across commodities and, in particular, provides a better measure of emission intensities of agricultural and food commodities (mainly due to non-CO_2 GHGs) which are often associated with high tariff and non-tariff barriers.

Second, we extend the assessment of emission intensities to include nine air pollutants based on the database developed by Chepeliev (2021). According to the Global Burden of Disease study (Cohen et al., 2017), ambient air pollutant emissions in 2015 caused 4.2 million deaths and resulted in a loss of 103.1 million disability-adjusted life-years, making it the fifth-ranked global risk factor. In terms of the welfare costs of mortality and illnesses associated with outdoor air pollutant emissions, global estimates range between $2.7-3.2 trillion, which is equivalent to 40% of global health expenditures (Coady et al., 2015; WB, 2021). Therefore, it is important to additionally consider air pollutant emissions in the overall context of environmental damages.

Third, for estimating emission intensities, we consider and compare two distinct approaches: (a) emissions embodied into trade (EEBT) method, which assumes that the production technology is based on fixed proportions or that that the production of domestically supplied commodities have the same characteristics as the exported products; and (b) using trade to final consumers methodology or a full MRIO model. A discussion and comparison of two methodologies (EEBT and MRIO) can be found in Peters (2008).

To achieve these three research objectives, we extend the most recent GTAP 10A MRIO Data Base (Carrico et al. 2020) to an environmentally-extended GTAP MRIO (GTAP EE-MRIO) Data Base. Apart from GHG and air pollutant emission accounts, the latter also incorporates data on the extraction of ferrous and non-ferrous metal ores, as well as non-metallic minerals (in volume terms). The newly developed GTAP EE-MRIO also includes data on the volumes of biomass supply by primary agricultural sectors identified in the GTAP Data Base, thereby allowing for an assessment of the distribution of wide range of materials (in quantity terms) along the value chain. To our knowledge, this is the first instance of an environmentally extended GTAP MRIO data that relies on the HStoBECtoSNA concordance table—i.e., the United Nations Statistics Division (UNSD) 6-digit Harmonized System (HS) 2012 to Broad Economic Categories (BEC) concordances revision 4 to System of National Accounts (SNA) end-use framework. Previously constructed versions of environmentally extended GTAP MRIO used assumed proportional sourcing of imports for all agents (e.g. Peters et al., 2011).

Finally, our assessment uses more up-to-date tariff and non-tariff barrier estimates, as well as provides a more detailed regional coverage to better assess the environmental bias of trade policies. For tariffs, we rely on the ITC MACMAP database which is incorporated in the GTAP 10 Data Base (Aguiar et al., 2019). We also compare the 2004 and 2014 reference years to identify potential shifts in tariff policies. For non-tariff barriers (NTBs), in addition to Kee et al. (2009) considered in Shapiro (2021), we also use an up-to-date set of NTB estimates from Cadot et al. (2018). We also provide a more spatially-detailed analysis of the issue, owing to greater regional coverage of the GTAP Data Base which includes more developing countries and regions compared to WIOD and EXIOBASE MRIOs used in Shapiro (2021).

2. Results and Discussion

Our preliminary results that rely on the EEBT approach and consider import tariffs only (i.e. do not include NTBs) indicate that when looking at the global average indicators, the environmental regressivity/progressivity of trade policy substantially depends on the scope of emissions coverage. Looking at the top 5 dirties and cleanest commodities (Table 1), we find substantial evidence of environmental bias of trade policies when only CO_2 emissions from fossil fuel combustion are considered. Indeed, this confirms that more CO_2 emission intensive commodities (e.g. ferrous metals, chemicals, etc.) face lower tariff rates than cleaner goods (e.g. rice, natural gas, petroleum products).[1] In contrast, when a broader set of GHG emissions is considered—i.e., direct fossil fuel-related CO_2 emissions plus process CO_2 emissions, methane, nitrous oxide and fluorinated gases—an opposite relation is observed with more GHG-intensive commodities facing higher tariffs. The latter is largely driven by the fact that import tariffs are high for agricultural and food commodities (e.g. meat and rice) that are relatively clean as they combust less fossil-fuel related CO_2 emissions, but are much more emission intensive, when non-CO_2 GHGs are accounted for (Table 1). Our preliminary results also indicate that in the case of fine particulate matter ($PM_{2.5}$) emissions, one of the major cause of pre-mature mortality worldwide,[2] a positive relation between import tariffs and emission intensities is observed (Table 1).

Table 1. Cleanest and dirtiest commodities based on global average data for 2014

	CO_2 from fossil fuel combustion only			All greenhouse gases			Fine particulate matter ($PM_{2.5}$)		
	Sector	**CO_2, kg per 1USD**	**Import tariff, %**	**Sector**	**GHG, kg per 1USD**	**Import tariff, %**	**Sector**	**PM2.5, kg per 1000USD**	**Import tariff, %**
Dirtiest goods	Mineral products	1.09	4.10	Bovine cattle	14.96	1.02	Processed rice	3.76	11.25
	Ferrous metals	0.91	1.69	Paddy rice	5.35	3.31	Oil seeds	2.98	8.23
	Plant-based fibers	0.58	0.57	Bovine meat	4.42	8.95	Plant-based fibers	2.75	0.57
	Other extraction	0.53	0.90	Processed rice	3.23	11.25	Paddy rice	2.74	3.31
	Chemicals	0.50	2.23	Coal	2.64	0.53	Cereal grains	2.65	19.13
	Mean	**0.72**	**1.90**	**Mean**	**6.12**	**5.01**	**Mean**	**2.98**	**8.50**
Cleanest goods	Beverages, tobacco	0.18	8.38	Machinery	0.31	1.87	Forestry	0.157	0.97
	Other meat products	0.18	8.41	Beverages, tobacco	0.28	8.38	Motor vehicles	0.111	4.23
	Transport equipment	0.18	2.02	Transport equipment	0.23	2.02	Basic pharma	0.089	0.80
	Motor vehicles	0.15	4.23	Motor vehicles	0.19	4.23	Gas	0.071	0.33
	Basic pharma	0.10	0.80	Basic pharma	0.14	0.80	Oil	0.059	0.22
	Mean	**0.16**	**4.77**	**Mean**	**0.23**	**3.46**	**Mean**	**0.10**	**1.31**

Notes: Top 5 dirtiest and cleanest sectors are identified in the table. Global weighted average tariff estimates are reported in the table based on the values of bilateral imports. Forty four GTAP sectors are considered in the assessment. Electricity, raw milk and gas distribution GTAP sectors are excluded from the analysis due to small trade volumes.

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[1] If we consider CO_2 emissions from fossil fuel combustion only, fossil fuels (FF) themselves are relatively clean goods, since their production process is not very energy intensive, while most emissions occur at the intermediate of final use stage (e.g. electricity generation, transportation, heating), when FFs are combusted.

[2] https://www.eea.europa.eu/themes/air/health-impacts-of-air-pollution

At the country level, our preliminary results indicate a diverse trend across OECD and non-OECD regions (Figure 1). A positive correlation between import tariff and emission intensity is observed for the case of GHG emissions in OECD countries and CO_2 emissions in non-OECD countries, while the opposite holds for the two remaining cases under consideration (Figure 1). At the same time, even cases with positive linear regression slope (i.e. positive correlation) correspond to a relatively low carbon price level of \$1.6/tCO_2e for GHG emissions in OECD and \$6.5/tCO_2e for non-OECD countries. On the one hand, these estimates can be considered as some indication of environmental bias in trade policy since the estimated social cost of carbon (SCC) is substantially above these numbers – around \$51/tCO_2e at 3% discount rate.[3] On the other hand, considering that the global weighted average carbon price is around \$2/tCO_2eq. (UN, 2021), the identified level of environmental progressivity of tariffs in these cases is consistent with the currently observed level of mitigation efforts. These preliminary results would be further verified and explored in much more detail using a wider set of techniques and indicators, as discussed in the methodological part of the paper.

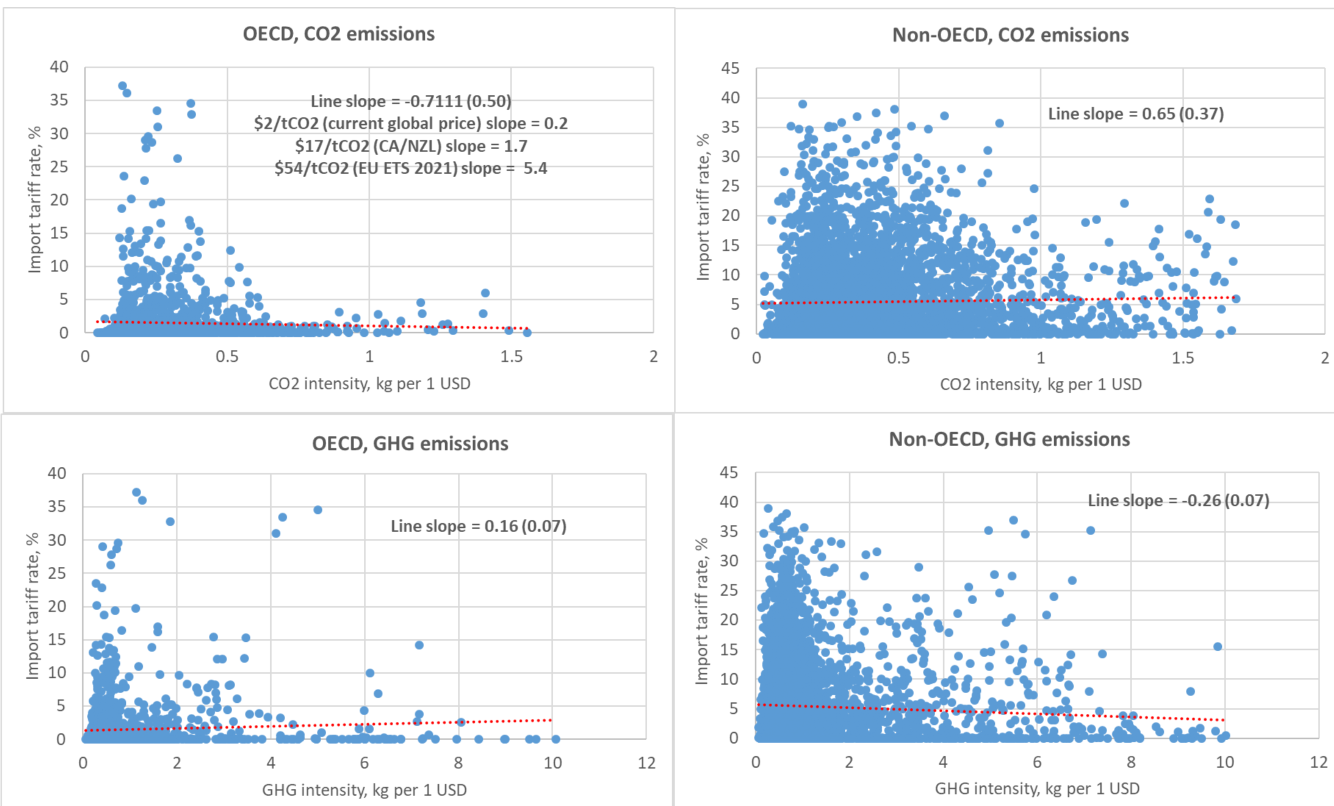

Figure 1. Import tariffs versus emission intensities for OECD and non-OECD countries in 2014

Notes: Each point represent a country-commodity pair. Top 1% of cases with largest tariffs and 1% of cases with highest emission intensities have been excluded from the analysis. Numbers enclosed in parenthesis near the line slope estimates indicate standard errors. The vertical axis on each chart reports the import tariff rate (percent) while the horizontal axis reports emission intensity in kg per ton of CO_2-e.

[3] https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf

3. References

Aguiar, A., Chepeliev, M., Corong, E., McDougall, R., and van der Mensbrugghe, D. 2019b. The GTAP Data Base: Version 10. Journal of Global Economic Analysis. v. 4, n. 1, p. 1-27, June 2019. ISSN 2377-2999. https://jgea.org/resources/jgea/ojs/index.php/jgea/article/view/77

Cadot, O., J. Gourdon and F. van Tongeren. 2018. Estimating Ad Valorem Equivalents of Non-Tariff Measures: Combining Price-Based and Quantity-Based Approaches, *OECD Trade Policy Papers*, No. 215, OECD Publishing, Paris, https://doi.org/10.1787/f3cd5bdc-en.

Carrico, C., E. Corong, and D. van der Mensbrugghe. 2020. The GTAP version 10A Multi-Region Input Output (MRIO) Data Base. GTAP Memorandum 34. Center for Global Trade Analysis, Purdue University. https://www.gtap.agecon.purdue.edu/resources/download/10043.pdf

Chepeliev, M. 2021. Developing an Air Pollutant Emissions Database for Global Economic Analysis. *Journal of Global Economic Analysis, 6*(2), 31-85. https://doi.org/10.21642/JGEA.060202AF

Chepeliev, M. 2020. Development of the Non-CO_2 GHG Emissions Database for the 617 GTAP 10A Database. GTAP Research Memorandum No. 32. 618 https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=5993

Coady, D., I. Parry, L. Sears, and B.Shang. 2015. How Large are Global Energy Subsidies? IMF Working Paper WP/15/105. http://www.imf.org/ external/pubs/cat/longres.aspx?sk=42940.0

Cohen, A., M. Brauer, R. Burnett, H.R. Anderson, J. Frostad, K. Estep, and K. Balakrishnan. 2017. Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Disease study 2015. The Lancet. 10082 (2017): 1907-1918.

International Trade Center (ITC). 2021. Market Access Map (MACMAP). https://www.macmap.org/

Kee, H. L., Nicita, A., Olarreaga, M. 2009. Estimating Trade Restrictiveness Indices. Economic Journal, 119 (2009), 172–199. https://doi.org/10.1111/j.1468-0297.2008.02209.x

Peters, G.P., Andrew, R., and Lennox, J. 2011. Constructing an environmentally-extended multi-regional input–output table using the GTAP database, Economic Systems Research, 23:2, 131-152, DOI: 10.1080/09535314.2011.563234

Peters, G.P. 2008. From production-based to consumption-based national emission inventories. Ecological Economics, Volume 65, Issue 1, 15 March 2008, Pages 13-23. https://doi.org/10.1016/j.ecolecon.2007.10.014

Shapiro, J.S. 2021. The Environmental Bias of Trade Policy, *The Quarterly Journal of Economics*, Volume 136, Issue 2, May 2021, Pages 831–886, https://doi.org/10.1093/qje/qjaa042

United Nations (UN). 2021. Asia-Pacific Trade and Investment Report 2021: Accelerating Climate-smart Trade and Investment for Sustainable Development. https://www.unescap.org/sites/default/d8files/knowledge-products/APTIR2021_3.pdf

World Bank (WB). 2021. Health expenditure, total (% of GDP). https://data.worldbank.org/indicator/SH.XPD.CHEX.GD.ZS