Extended Abstract
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Paper/Poster Title	CO2 Emission and trade policy in Agri-food sector

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Abstract	***200 words max***
This paper considers the 'value chain' measure of greenhouse gas emissions in food system to analyse whether trade policies differ with the 'dirtiness' of products. Total GHG emissions are obtained as sum of 'direct' emissions to produce output and 'indirect' emissions connected to inputs used in production. Following the approach recently proposed by Shapiro (2021), we observe that difference in tariffs and non-tariff measures represents a sort of subsidy in CO2 embodied in the imported product, representing a lower tax rate for the 'dirty' agri-food imported products. A panel dataset where the GHG emissions imported by185 countries, as well as tariffs and ad valorem equivalent of NTMs, for 25 products of food-system and over the year 2001, 2004, 2007 and 2010 has been built.	

Keywords	Trade policy, greenhouse gas, emissions, Food system
JEL Code	Q50, Q56, Q17, F13, F18 see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction	***100 – 250 words***

Agri-food system is one of the economic sectors most at risk from climate change, but it is also a significant contributor to it, with greenhouse gas emissions (GHG) from the food supply chain equal to one-third of the global anthropogenic total in 2018 (Tubiello et al. 2021). Specifically, crop and livestock production within the farm gate contributes more than 50% of the methane (CH4) and 75% of the nitrous oxide (N2O) emissions from human activity globally (FAO, 2020). This large contribution highlights the potential of agri-food-related GHG mitigation strategies, in which carbon taxes or the new measure of Border Carbon Adjustment are included. This paper relies on the recent work of Shapiro (2021) that firstly compares the measure of pollution embodied in traded goods against actual current levels of tariffs or NTMs. Working on 43 importing countries and about 50 manufacturing industries, in year 2007, he finds that more-upstream industries in global value chains have both lower protection and greater emissions and that trade policy creates a global implicit subsidy to CO2 emissions contributing to climate change; however, when manufactured agricultural goods and manufactured food products are removed from data used, the estimated effects are not significant, giving evidence of the role played by food system. We start from these findings and, by extending the dataset and focusing the analysis on agri-food sector, we check whether trade policy of countries taxes or subsidies the pollution emissions of imported agriculture and food products.

Methodology	*100 – 250 words*

To measure differences in trade policy between industry's 'dirtiness', defined considering CO2 emissions per euro of output, we regress the mean import tariff rate (or ad valorem NTMs) on the tons of CO2 emitted per euro of (country i) imports, of product k, in year y.
We focus on three relevant pollutants in agri-food productions: Carbon dioxide (CO2), the most important greenhouse gas emitted from the use of fuel combustion; nitrous oxide (N2O), mainly emitted from agriculture and to a lesser extent industrial activity; methane (CH4), primarily released from agriculture and natural gas processing. The emissions rates, reported as tons of CO2 (equivalent) emitted per euro of imported goods, are computed from Exiobase database (3.8.1 version). Exiobase reports data on total emission rates from 1995 to 2011 for 44 countries (28 EU member states plus 16 major economies). The 44 Exiobase countries are used as exporting countries which emissions, weighted on trade, are imported by the 185 countries of our final database. These rates account for total emissions, calculated from inverting an input-output table, meaning that both direct and indirect emissions are taken into account. The final database distinguishes twenty-five Agri-food products. Trade data, used to weight the emission imports, come from BACI-CEPII database. Tariff data come from CEPII MAcMaps-HS6 database; NTMs, reported as AVEs of NTM, come from Niu et. al (2018) estimation. Throughout all the analysis the years considered are 2001, 2004, 2007 and 2010. Following the approach undertaken by Shapiro (2021) to address potential problems of endogeneity, the equation is estimated using the IV regression, with direct emissions rate of the 10 smallest countries in the dataset used as instrumental variable.

Results	*100 – 250 words*

The estimated coefficient represents the carbon tariff implicit in existing trade policy, and, if positive, it represents duties collected per ton of CO2 emitted. Finding suggest that for all the three pollutants a negative implicit carbon tax in tariff is applied. The result can be quantified as an implicit mean subsidy of 9.8, 24.5, or 7.7 euro per ton of CO2-equivalent emissions measured for CO2, N2O, and CH4, respectively. These estimated subsidies are higher when NTM AVEs are considered, and become respectively equal to 20.2, 57.6, and 16 euro per ton of CO2 embedded in agri-food imports when the two trade policies, tariffs and AVE of NTM, are summed together. Estimated separately for the main 44 (Exiobase) importer countries (representing the 90% of world GDP), the subsidy to emissions implicit in country trade policy is observed in most countries and over all the three pollutants, with larger values estimated for European countries. Specifically, Western and Northern European countries have among the largest negative environmental biases, while more polluting countries, like China, India, Russia, Brazil and Mexico, tend to apply smaller subsidies. Note that theory and evidence suggest that countries, in choosing trade policy, do not explicitly consider CO2 emissions or intent subsidize it (Shapiro, 2021).

Discussion and Conclusion	*100 – 250 words*

These findings have various political implications. The first concerns the potential application and impact of the new trade measure of border carbon adjustments (BCAs). The measure combines environmental and trade policies by levying border adjustments based on the estimated social costs of GHG. As part of a plan to decarbonize its economy by 2050, the European Union is considering the introduction of a BCA mechanism, to reduce the risk of carbon leakage and to level the field for European industries working towards decarbonization of their production processes. However, we observed that countries, and especially European countries, are imposing greater protection on clean than on dirty agri-food products, by creating an implicit carbon subsidy rather than moving to the adoption of a carbon tariff.

The second implication considers the “Farm to Fork” Strategy. At the heart of the European Green Deal, the EU wants to redesign its food systems, which today account for nearly one-third of global GHG emissions, by supporting a global transition to sustainable agri-food systems, also through its trade policies. However, we find that EU trade policy “subsidies” the import of more polluting agri-food products. Moreover, the EU import of agricultural products seems destinated to increase due to the decrease in EU productivity connected to the reduction in the use of pesticides and nutrients in agriculture by 2030, as indicated in F2F strategy, as well as by the reductions in output associated with a carbon tax that may cause domestically produced goods to be replaced by imported goods, perhaps not subject to a carbon tax, and perhaps having higher emission intensities (Martin, 2021).