LETTER

Assessing the implications on air pollution of an alternative control-based criterion

Lin et al. (1) measure pollution embodied in Chinese–US international trade using an atmospheric chemical transport model and find that moving manufacturing offshore to China had an overall beneficial effect on public health in the United States but at the expense of air quality over the western region of the United States and air quality in Chinese regions. The promising line of research introduced by ref. 1 requires, in our view, a more detailed evaluation of established assumptions on emissions embodied in trade.

The research results may differ if more comprehensive international trade assignment responsibility criteria are used. In Lin et al. (1), a consumption-based responsibility criterion is adopted (2) that measures US emissions resulting from imports produced in China. These emissions were then introduced into the atmospheric chemical transport model of the United States. At this point in time, we argue that the United States should also be responsible for the emissions embodied in goods (such as shoes or tablets) that are produced in China by US multinationals and sold internationally. Foreign enterprises operating and exporting in China account for 54% (3), which will have a strong potential influence over the global production chains with respect to technology and emission intensities (4). The introduction of these emissions implies the adoption of an alternative criterion, the control-based criterion, presented in ref. 5. This measure is extended in this paper through the inclusion of all emissions embodied in linkage effects along the production chain.

A comparison between the control-based criterion proposed here and the framework presented by Lin et al. was carried out using the World Input-Output Database (WIOD) of 2009. Our results show that according to a control-based criterion, the United States is responsible for 65% more CO_2, 68% more nitrogen oxides (NO_x), and 66% more sulfur oxides (SO_x) emissions than the results of consumer responsibility estimations presented by Lin et al. (using the conservative assumption that 20% of foreign enterprises operating in China are American companies). The inclusion of such emission levels would alter atmospheric chemical transport model estimations, and the effects on the west coast of the United States would be higher.

The results of Lin et al. provide new evidence that favors mitigation and trade policy coordination between developed and developing countries. However, to extract economic policy recommendations from the scenario of avoided emissions, we should consider the possibility of supporting trade deviations in other regions due to the adoption of emission leakage mitigation policies such as, for example, full border tax adjustments. The importance of a control-based criterion lies in the fact that headquarters would still move large proportions of production chains to, for example, Mexico instead of China due to low salaries in the competing country. This modifies global and air-transported emission results due to differences in pollution intensities between both countries. Mexico's emissions in comparison with China would imply an 81% reduction of CO_2, a 75% reduction of NO_x, and an 89% reduction of SO_x.

Luis Antonio López[1], Maria Ángeles Cadarso, Jorge Enrique Zafrilla, and Guadalupe Arce

Department of Economic Analysis and Finance, Faculty of Economic and Business Sciences, University of Castilla–La Mancha, 02071 Albacete, Spain

1 Lin J, et al. (2014) China's international trade and air pollution in the United States. *Proc Natl Acad Sci USA* 111(5):1736–1741.
2 Davis SJ, Caldeira K (2010) Consumption-based accounting of CO_2 emissions. *Proc Natl Acad Sci USA* 107(12):5687–5692.
3 Feenstra RC, Hong C, Ma H, Spencer BJ (2013) Contractual versus non-contractual trade: The role of institutions in China. *J Econ Behav Organ* 94:281–294.
4 Skelton A (2013) EU corporate action as a driver for global emissions abatement: A structural analysis of EU international supply chain carbon dioxide emissions. *Glob Environ Change* 23(6):1795–1806.
5 van Rossum M, Graveland C, Schenau S, Edens B (2012) *Quantifying CO_2-Emissions According to the Control Criterion* (Statistics Netherlands, Den Haag, The Netherlands).

Author contributions: L.A.L., M.Á.C., J.E.Z., and G.A. analyzed data and wrote the paper.

The authors declare no conflict of interest.

[1]To whom correspondence should be addressed. E-mail: luis.lsantiago@uclm.es.

www.pnas.org/cgi/doi/10.1073/pnas.1406948111