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International trade and air pollution: Estimating the economic costs of air emissions from waterborne commerce vessels in the United States

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Abstract

Although there is a burgeoning literature on the effects of international trade on the environment, relatively little work has been done on where trade most directly effects the environment: the transportation sector. This article shows how international trade is affecting air pollution emissions in the United States' shipping sector. Recent work has shown that cargo ships have been long overlooked regarding their contribution to air pollution. Indeed, ship emissions have recently been deemed "the last unregulated source of traditional air pollutants." Air pollution from ships has a number of significant local, national, and global environmental effects. Building on past studies, we examine the economic costs of this increasing and unregulated form of environmental damage. We find that total emissions from ships are largely increasing due to the increase in foreign commerce (or international trade). The economic costs of SO_2 pollution range from $697 million to $3.9 billion during the period examined, or $77 to $435 million on an annual basis. The bulk of the cost is from foreign commerce, where the annual costs average to $42 to $241 million. For NO_x emissions the costs are $3.7 billion over the entire period or $412 million per year. Because foreign trade is driving the growth in US shipping, we also estimate the effect of the Uruguay Round on emissions. Separating out the effects of global trade agreements reveals that the trade agreement-led emissions amounted to $96 to $542 million for SO_2 between 1993 and 2001, or $10 to $60 million per year. For NO_x they were $745 million for the whole period or $82 million per year. Without adequate policy responses, we predict that these trends and costs will continue into the future.

Keywords: Trade and environment; Shipping; Air pollution; United States

1. Introduction

Economists have begun to develop a broad theoretical framework for analyzing the trade and sustainable development relationship. Economic integration has direct and indirect effects on environment and development. The indirect effects are those that economists have focused most on. Economic integration can also have indirect effects on sustainable development. Economists have outlined four mechanisms whereby trade and investment liberalization have indirect effects on environment and development: scale, composition, technique, and regulatory effects (Grossman and Krueger, 1993). Scale effects occur when liberalization causes an expansion of economic activity. If the nature of that activity is unchanged but scale is growing, then pollution and resource depletion will increase along with output. Ever-increasing levels of carbon dioxide emissions due to the expansion of the world economy in 1990s are often cited as examples of scale effects.

Composition effects occur when increased trade leads nations to specialize in the sectors where they enjoy a comparative advantage. When comparative advantage is derived from differences in regulatory stringency (i.e. the pollution-haven effect), then the composition effect of trade will exacerbate existing environmental and social problems in the countries with relatively lax regulations. If pollution intensive industries begin to concentrate in nations with standards that are relatively weak, it is feared that a 'race to the bottom,' in environmental standards may occur.

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Technique effects, or changes in resource extraction and production technologies, can potentially lead to a decline in pollution per unit of output. The liberalization of trade and investment may encourage the transfer of cleaner technologies to developing countries. In addition, it is said that trade-led economic growth may raise incomes to the point where newly affluent citizens begin to demand a cleaner environment.

The literature on these three effects has become quite large and it is beyond the scope of this paper (Gallagher and Werksman, 2002). There has been relatively less attention to the 'direct' effects of trade on the environment. After all, trade in and of itself is the movement of goods and services across borders. Only a few studies have examined the extent to which increases in transportation due to trade have affected the environment. One study of the increasing levels of transportation due to the North American free trade agreement (NAFTA) found that NAFTA trade has directly contributed to air pollution in the five key transportation corridors that link North American commerce. Such pollution is estimated to be 3–11% of all mobile source nitrous oxide emissions in those regions, and 5–16% of all particulate matter emissions (Consulting, 2001). A second direct effect is the introduction of alien-invasive species through trade. Again, the example of NAFTA is telling, where increased trade in alien-invasive species has been found to have 'decreased biological diversity that cost North America millions of dollars' (NACEC, 2001).

This paper builds on this emerging literature by examining the environmental effects of US shipping in the United States. A number of recent studies have shed light on the fact that waterborne commerce (or shipping) is a significant contributor to air pollution in the United States. It has been recently referred to as 'the last unregulated source of traditional air pollutants' (Corbett, 2003). Shipping accounts for 14% of nitrous oxide (NO_x) emissions from all global fossil fuels, and 16% of sulfur from all petroleum fuel (Corbett, 2003). In the US alone, shipping accounts for up to 4% of transportation-related NO_x emissions, and 8% of sulfur dioxide (SO_2) emissions (Corbett and Fishbeck, 2000; EPA, 2000). The environmental effects of shipping emissions are local, national and global in nature. Three of the busiest ports in the United States reside in California and Texas (Houston, Long Beach, and Lost Angeles) and are non-attainment areas for some of these pollutants. EPA estimates that marine diesel engines entering California and Texas account for 15 and 17% of the NO_x emissions on summer days in these regions (EPA, 1999). Emissions of these gases can also contribute to global climate change.

Obtaining estimates of the economic costs of these emissions in the US will be of use to decision-makers attempting to prioritize the nation's policies with respect to waterborne emissions from ships in particular and air pollution in general. Although this can be a highly controversial exercise, this study takes a conserve approach by extrapolating estimates from two areas where values already exist. On the one hand, private shipping entities bear abatement costs to reduce these pollutants and pass a portion of such costs to shippers through freight rates; on the other society at large bears costs by way of health, environment and other social damages. For some pollutants, pollution markets already exist for SO_2 and NO_x pollution in the US. Therefore, assigning monetary values that represent economic damages related to abatement costs by private shipping entities are relatively straightforward. However, estimating the environmental costs (and benefits) of economic activity for society can be most difficult because the environmental benefits do not often lend themselves to monetary valuation (Arrow, 2000). To estimate these costs we consult Environmental Protection Agency (EPA) studies and the peer-reviewed economics literature.

This paper builds on the work of previous studies by delineating the relative contribution and intensity of domestic and foreign waterborne commerce in US shipping emissions from 1993 to 2001. Furthermore, based on pre-existing abatement cost prices for SO_2 and NO_x pollution, the paper estimates the economic damages related to increases in foreign and domestic shipping during this period and into the future. Because we learn that international trade is driving much of the increase in waterborne commerce and related emissions, we estimate the effect of the Uruguay Round trade talks on past emissions as well.

2. International trade and shipping emissions: an analysis

This paper utilizes previous estimates of SO_2 and NO_x pollution in US waterborne commerce in 1997 to calculate the pollution-intensity of the US shipping fleet, total emissions of that fleet from 1993 to 2001, and the economic costs of total emissions from 1993 to 2001 and beyond. Estimates of SO_2 and NO_x pollution come from landmark studies that appeared in the Journals of Science and Environmental Science and Technology (Corbett and Fishbeck, 2000; Corbett, 2000). The authors used existing emissions factors, fuel statistics, cargo tonnage and so forth to estimate levels of SO_2 and NO_x, particulate matter (PM), hydrocarbons (HC), and carbon monoxide (CO) in US waterborne vessels.

Pre-existing estimates for air pollution in US ships in 1997 is used to create an index of pollution intensity for shipping in the US. The United States department of transportation maritime administration provides statistics on the amount of cargo (measured in short tons but converted to metric tons) in domestic and foreign shipping trips from 1977 to 2001. Corbett and Fischbeck provide pollution estimates for domestic and foreign shipping for 1997. To create pollution intensities for SO_2 and NO_x, we divided the amount of cargo in 1997 by the Corbett and Fischbeck pollution estimates in 1997. Table 1 exhibits the pollution