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Trade liberalization and the environment: Evidence from NAFTA and U.S. manufacturing☆

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ABSTRACT

The unobserved responses of individual polluters are often used to rationalize the aggregate effects of international trade on the environment. In this paper, I provide the first evidence of these responses. I estimate the effects of NAFTA on the emissions of particulate matter (PM_{10}) and sulfur dioxide (SO_2) from manufacturing plants in the United States. My findings suggest that trade liberalization led to significant reductions of these pollutants at affected plants. On average, nearly two-thirds of the reductions in PM_{10} and SO_2 emissions from the U.S. manufacturing sector between 1994 and 1998 can be attributed to trade liberalization following NAFTA.

1. Introduction

Over the past twenty-five years, one of the most widely debated aspects of globalization has been the environmental consequences of trade liberalization.[1] While this debate has typically been framed in terms of industry responses to trade liberalization, these responses hinge on the behavior of individual polluters within each industry. Yet, surprisingly little is known about how trade liberalization affects the pollution emitted by individual plants.

This is largely due to the lack of disaggregate, plant-level data on emissions and other plant characteristics.[2] To date, research has primarily relied on cross-country variation in pollution levels and trade flows to examine the link between international trade and the environment.[3] Consequently, existing studies have focused on the relationship between trade and aggregate pollution levels; these studies find that trade is not necessarily bad for the environment.[4] Even so, the literature often points to the unobserved responses of individual polluters, such as the adoption of new technologies or the exit of dirty plants, to explain the mechanisms underlying this finding.

In this paper, I provide the first empirical evidence of how trade liberalization affects the pollution emitted by individual manufacturing plants. To do so, I rely on two unique longitudinal datasets constructed from two main sources: the Toxic Release Inventory and the National Establishment Time Series. Each dataset contains information on the emissions of a common pollutant (either particulate matter or sulfur dioxide) and other characteristics of U.S. manufacturing plants that were in operation during the 1991 to 1998 period. I employ these data to examine how one of the most politically contentious episodes of trade liberalization in U.S. history,

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[1] For overviews of the literature on trade and the environment, see Copeland and Taylor (2004) and Cherniwchan et al. (2017).

[2] While plant-level emissions data from emissions inventories such as the Toxic Release Inventory in the United States and the National Pollutant Release Inventory in Canada have been publicly available for close to 20 years, it is only recently that these data have started to be matched to data on plant characteristics for plants from multiple industries (e.g. Holladay (2016)).

[3] This is not to say that all studies rely on cross-country variation. Some research, such as that of Dean (2002) or Chintrakarn and Millimet (2006), relies on within-country variation in pollution and trade.

[4] See, for example, Antweiler et al. (2001) or Frankel and Rose (2005).

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the North American Free Trade Agreement (NAFTA), affected the pollution emitted by U.S. manufacturing plants.

As the origin of the debate over the environmental consequences of globalization, NAFTA is a compelling setting for examining the effects of trade liberalization on the environment. The agreement was a passionately debated policy issue because it liberalized trade between a developed country (the U.S.) and a developing country with weaker environmental policy (Mexico).[5] This difference in environmental policy led to predictions that dirty, pollution intensive production would relocate to Mexico after the agreement to take advantage of lax environmental regulations, a phenomenon now termed the pollution haven hypothesis.[6] Yet, while the evidence suggests that the agreement significantly increased North American trade (Romalis, 2007; Caliendo and Parro, 2015), there is little evidence confirming what effect, if any, NAFTA had on pollution emissions from manufacturing in the U.S. or Mexico.[7]

The structure of the agreement also makes it possible to examine the effects of changes in both domestic (U.S.) and foreign (Mexico) trade policy. There are three potential channels through which these policy changes could affect plant pollution emissions: 1) decreases in the cost of exporting to the Mexican market due to lower Mexican tariffs, 2) decreases in protection from imports of products produced in Mexico due to lower U.S. tariffs on final goods, and 3) decreases in the cost of obtaining intermediate goods from Mexican producers from lower U.S. tariffs on manufactured inputs. Previous research has shown that international trade affects various aspects of plant activity through these channels, but to date, there is no evidence of their effects on plant pollution emissions.[8]

The empirical challenge in this paper is credibly identifying the effects of increased foreign market access, decreased protection from import competition and increased access to imported intermediate inputs following NAFTA given the possibility of concurrent changes in environmental policies and other shocks. To do so, I utilize a triple-difference research design that exploits temporal and cross-industry variation due to changes in U.S. and Mexican trade policy, as well as variation due to differences in geographically determined trade frictions arising from the dispersion of manufacturing activity across the U.S. prior to NAFTA.

I begin my analysis by examining NAFTA's effects on the levels of particulate matter (PM_{10}) and sulfur dioxide (SO_2) emitted by U.S. manufacturing plants. I find robust evidence that NAFTA significantly reduced the emissions of both PM_{10} and SO_2 from affected plants.[9] These reductions are due to responses to two aspects of the liberalization: (i) increased access to the Mexican market, and (ii) increased access to imported intermediate inputs from Mexico. My preferred estimates indicate that, for the average plant, a 1% increase in Mexican tariff preferences for U.S. goods reduced PM_{10} emissions by close to 1.30% and reduced SO_2 emissions by just under 1.46%. Given that Mexican tariff preferences affect the decision of an American plant to export to Mexico, these estimates suggest that exporting can improve environmental quality by reducing pollution emissions from existing plants. Yet, I find that the effects of liberalized trade in intermediate inputs are much larger; for the average plant, a 1% increase in U.S. tariff preferences for Mexican intermediate inputs reduced PM_{10} and SO_2 emissions by approximately 3.25% and 13.19% respectively. Given that tariff preferences for intermediates alter the cost of sourcing inputs from abroad, these estimates suggest that importing can affect environmental quality by affecting the inputs available to plants.[10]

Together, these estimates suggest that NAFTA played an important role in the clean-up of U.S. manufacturing since the early 1990s. Recent research by Shapiro and Walker (2016) indicates that, on average, emissions of criteria pollutants from U.S. manufacturing fell by roughly 60% between 1990 and 2008, despite a 35% increase in output. Similarly, Levinson (2015) shows that aggregate PM_{10} and SO_2 emissions from U.S. manufacturing fell by 3.55% and 3.61% annually over this period, with nearly all of the decrease driven by within-industry changes in pollution emissions. My estimates imply that the effects of NAFTA account for nearly two-thirds of these reductions on average; for the average affected plant, NAFTA reduced PM_{10} emissions by 1.69% per year and reduced SO_2 emissions by 3.06% per year.

This finding stands in contrast to the results presented by Shapiro and Walker (2016), who suggest that the clean-up is primarily due to the effects of changing environmental regulation. As such, one concern with my baseline estimates is that they are simply capturing the effects of ongoing revisions to environmental policy. To ensure that this is not the case, I adopt two strategies that allow the effects of environmental regulation to vary across plants on the basis of how long they have been regulated. The resulting estimates provide additional evidence that my baseline estimates are not capturing the effects of environmental regulation, which further suggests that trade liberalization following NAFTA played an important role in the clean-up of the U.S. manufacturing sector.

The next step in my analysis is to examine whether the changes in emissions levels that I observe are due to changes in the physical quantity of output produced, or changes in the level of pollution emitted per unit of output (the emission intensity of production). By definition, trade liberalization can effect pollution emissions via either one of these two channels; to distinguish between the two, I analyze the effect of trade liberalization on the emission intensity of production at each plant. These estimates indicate that the changes in emission levels that I observe are primarily due to changes in emission intensity, not changes in the levels of output at affected plants.

Finally, I turn to examine three possible explanations for the reductions in emission intensity. First, I investigate whether the reductions result from extensive margin changes due to plant entry and exit. Given recent evidence that more productive firms have lower emission intensities (e.g. Bloom et al. (2010), Shapiro and Walker (2016)), standard models of international trade featuring firm heterogeneity (e.g. Melitz (2003), Melitz and Ottaviano (2008)) would predict that trade liberalization could lead to lower average plant emission intensity as a result of entry and exit.[11] Moreover, previous studies have emphasized that the decline in pollution from

[5] The agreement also liberalized trade between Canada and Mexico, but did not affect trade between Canada and the U.S. which was previously liberalized as a result of the Canada-U.S. Free Trade Agreement.

[6] For example, during the 1992 presidential debates Ross Perot predicted that NAFTA would lead to a "giant sucking sound" as U.S. production relocated to Mexico.

[7] Research on the environmental effects of NAFTA follows from the influential work of Grossman and Krueger (1991), who suggested that Mexico would not necessarily become a pollution haven following the agreement. Subsequent studies that have examined NAFTA's effect on the environment, such as Cole (2004) and Gamper-Rabindran (2006), examine changes in trade flows from clean and dirty industries rather than examining changes in emissions from production directly. Other research, such as Davis and Kahn (2010), has examined the effects of NAFTA on the pollution from consumption.

[8] Examples of this research include the work of Trefler (2004), Amiti and Konings (2007), and Bustos (2011).

[9] My baseline estimates include controls for the effects of the Mexican Peso Crisis, changes in environmental regulations under the Clean Air Act, and ongoing trade liberalization due to the Canada-U.S. free trade agreement. In the appendix, I also show that my baseline estimates are robust to accounting for anticipatory responses by plants and are not simply capturing the effects of pre-existing trends.

[10] Although the estimates for PM_{10} and SO_2 suggest that trade liberalization will lower plant pollution emissions necessarily, such reductions are not ubiquitous. In the appendix, I show that NAFTA had little to no effect on the emissions of volatile organic compounds from U.S. manufacturing plants.

[11] For such a model see, for example, Baldwin and Ravetti (2014) or Cherniwchan et al. (2017).