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Analysis

Pollution havens and the trade in toxic chemicals: Evidence from U.S. trade flows

John P. Tang *

The Australian National University, U.S. Trade in Toxic Chemicals, Australia

A R T I C L E I N F O

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A B S T R A C T

National registries of toxic chemical emissions and facilities are increasingly used to raise public awareness of potential health hazards in local areas, but an unintended consequence may be the offshoring of production to less regulated countries. Using disaggregated U.S. trade data, this study examines the impact of registry listing on subsequent bilateral trade flows. Estimates from a difference-in-differences model indicate a significant shift toward imports from poorer countries following registry listing. Assuming that environmental protection is a normal good, this result suggests the emergence of pollution havens due to more stringent U.S. environmental regulation.

1. Introduction

Do changes in environmental regulation affect where pollution-intensive goods are produced? Differences in environmental policy coupled with trade liberalization may lead to the emergence of pollution havens, with polluting activity relocating to areas with less stringent regulation (Jaffe et al., 1995; Copeland and Taylor, 2004; Brunnermeier and Levinson, 2004; Taylor, 2004). Less clear is whether changes to environmental regulation itself have a similar impact on trade patterns, with production moving off-shore in response to mandated restrictions, heightened scrutiny, and financial considerations.

This paper examines American trade in toxic chemicals, specifically those designated as toxic by the U.S. Environmental Protection Agency's Toxics Release Inventory (TRI) program. Following the 1984 industrial accident at a Union Carbide plant in Bhopal, India that killed nearly four thousand people within days and poisoned an estimated half a million in the following years, the United States Congress passed the Emergency Planning and Community Right-to-Know Act (EPCRA) two years later (Broughton, 2005). The act required domestic industrial facilities to report to TRI the quantity of releases and transfers of certain toxic chemicals. These data are made available to the public under the premise that this information creates incentives for companies to improve their chemical management and reduce toxic releases. TRI data collection began in 1988 with 332 chemicals listed as toxic and has increased coverage to the current 683 chemicals and chemical categories.[1]

This study examines whether the implementation of the toxic chemicals registry program affects trade flows, and if so, how. While the intuition behind this question is straightforward in that increased domestic regulation in a globalized market can lead to increased imports as substitutes for domestic output, identifying a causal relationship from actual trade patterns is much less so. This owes to difficulties in mapping between regulation and economic activity, which are usually measured differently, and isolating the regulatory effect from other confounding factors like location- or time-specific trends.

Besides seeing whether trade patterns change, there is the narrower issue of whether toxic chemical imports are disproportionately sourced from less regulated jurisdictions, a phenomenon commonly known as the pollution haven hypothesis. This issue is controversial in part because it is not obvious that poorer countries, given their factor endowments, would have a comparative advantage in producing capital intensive goods like chemicals despite the common perception that such countries are more likely to host dirty industries given lax environmental standards. Furthermore, environmental regulation may induce technological improvements to domestic manufacturers and allow them to produce more efficiently, thus mitigating adverse impacts from increased costs and scrutiny.

To analyze the trade of TRI chemicals over the past two decades, this paper uses bilateral trade data derived from records collected by U.S. Customs and Border Protection and processed by the Foreign Trade

* The Australian National University, Research School of Economics, 26 LF Crisp Building, Acton, ACT 2601, Australia.
E-mail address: john.tang@anu.edu.au.

[1] http://www2.epa.gov/toxics-release-inventory-tri-program/tri-listed-chemicals.

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Division of the U.S. Census Bureau. These data are disaggregated at the Harmonized Schedule ten-digit level and comprise all trade in chemicals between the years 1989 and 2006 for 180 trade partners. The highly detailed nature of these data provide a methodological advantage in that, unlike existing studies of trans-national pollution havens, economy activity is observed at the commodity level instead of industry or subsector and thus corresponds to the individual chemicals listed on the TRI. This mitigates concerns regarding the composition of an industry's output, some of which may be pollution-intensive and subject to regulation while others are not.

Commodity disaggregation also allows comparison of the listed chemicals to those not subject to regulatory change, which can be used to control for pre-existing trends and comparability between chemicals. The analysis uses a difference-in-differences least squares regression model to identify an average treatment effect on imports before and after a chemical is listed on TRI, with the identification strategy further sharpened by variation across a panel of chemicals and different years of registry listing. Differences among trade partners, such as distance, trade barriers, and regulatory stringency, are accounted for by direct measures of shipping costs, paid duties, and per capita income, respectively.

The results from the regression model indicate that overall imports of chemicals listed on TRI do not significantly change compared to all other chemical imports; however, they are disproportionately sourced from poorer countries after listing. At the same time, I find a statistically significant fall in exports of listed chemicals, which may proxy for domestic output, thus suggesting that the TRI program may increase foreign production among developing economies at the expense of domestic manufacturers. In other words, this points to the creation of pollution havens from environmental regulation.

The remainder of the paper is outlined as follows. Section 2 reviews existing research relating to trade and environmental regulation as well as the historical background of the TRI program. Section 3 describes the hypotheses, data, and empirical framework used for analysis. Section 4 presents the results, and Section 5 concludes with a discussion of the findings.

2. Existing Scholarship and the Toxics Release Inventory

There is an extensive and growing literature on the relationship between trade and the environment, with a number of possible impacts. Increased trade has the potential to worsen environmental quality if the general scale of industrial activity also rises commensurate with economic growth; this is known as the scale effect (Antweiler et al., 2001; Grossman and Krueger, 1993). Over time, however, an economy's sectoral composition may change as the country exploits its comparative advantage; thus, those with greater relative endowments of capital will produce more capital-intensive goods, so depending on the pollution intensity of production overall pollution levels may rise or fall (Jaffe et al., 1995). Regulation plays a role if environmental quality is a normal good, so as an economy becomes wealthier, public demand for clean air and water increases and the government responds with increasingly stringent controls on polluting activities, at which point firms may adopt cleaner production technologies, substitute away from more toxic inputs, or use pollution abatement equipment (Wheeler, 2002). In early stages of development the converse may hold, with pollution increasing as economies shift away from agarian and labor-intensive production to more industrial, capital-intensive activities.

Numerous studies have examined whether this inverse-U relationship between per capita income and pollution, known as the environmental Kuznets curve (EKC), holds across a variety of pollutants and regions. In their study of the possible effects of NAFTA on Mexico and the United States, Grossman and Krueger (1993) find that Mexico at the time was at a level of per capita income where further increases in income would likely lead to increased demand for environmental protection. In addition, they find that freer trade would likely reinforce Mexico's comparative advantage in labor intensive manufacturing, which tends to be less pollution intensive. As a result, they conclude that increased trade may improve the Mexican environment as a whole, in contrast to the concerns of environmental groups at the time. Similarly, Antweiler et al. (2001) model and estimate the scale, composition, and technique effects of international trade on sulfur dioxide concentrations and find that free trade would improve global environmental quality. Looking at seven different pollutants and their environmental outcomes, Frankel and Rose (2005) find that trade is beneficial to the environment on a few measures, has no effect on others, and potentially has a detrimental effect on one (carbon dioxide).

Other scholarship has been more critical and nuanced, with Hettige et al. (2000) noting the lack of improvement in industrial water pollution for countries with middle income status or higher, although pollution intensity as a share of output declines with increased income. Stern (2004) finds that developing countries may adopt higher regulatory standards faster than wealthier ones, while Birdsall and Wheeler (1993) find that the EKC holds for more protectionist countries and depends on the period of analysis, with lower pollution intensity in the 1980s than the previous decade. On the issue of the dynamic interaction between regulation and cleaner technology, Porter and van der Linde (1995) suggest that higher standards may induce firms to undertake greater innovation to offset the costs of compliance, leading to absolute advantages over firms in countries with weaker policies. Costantini and Crespi (2008) find support for the Porter hypothesis in their study of the energy sector, using a gravity model to show that regulation leads to an increase in the export of environmental technologies from European Union countries. Similarly, in a study of five different manufacturing sectors, Costantini and Mazzanti (2012) show that environmental policies may increase green exports through more efficient production processes.

The variation in findings may owe to the different levels of aggregation and measures used in the analyses. For example, the effect on trade from environmental regulation as proxied by expenditures on pollution abatement depends on whether the unit of analysis is at the industry, county, or facility level (e.g., Kalt, 1988; Tobey, 1990; Grossman and Krueger, 1993; Becker and Henderson, 2000; Ederington and Minier, 2003; Levinson and Taylor, 2008). Another form of regulation, pollution release and transfer registries (PRTRs), varies in coverage of chemicals and hazardous waste materials across national regimes and is used mainly by the mostly wealthy OECD countries. The non-comparability across countries and selection bias in participants make assessing the efficacy of PRTRs difficult, with some studies indicating little or no effect on industrial emissions or changes in trade between developing and developed economies (Hibiki and Managi, 2010; Kerret and Gray, 2007; Thomas and Fannin, 2011). Notwithstanding the issue of trans-national waste shipping, many PRTRs cover materials used as production inputs and were motivated by domestic concerns with minimal regard to potential trade consequences.

The U.S. Toxics Release Inventory, which was the world's first national PRTR, illustrates this point. On 3 December 1984, over 40 tons of methyl isocyanate gas leaked from a Union Carbide plant in Bhopal, India, killing thousands within days and affecting hundreds of thousands in the years since. Shortly after, in January 1985, the EPA announced that 28 leaks of methyl isocyanate had occurred in the previous five years at a similar Union Carbide plant in Institute, West Virginia, and on 11 August 1985, that same plant experienced a chemical release that led to the hospitalization of 135 workers and nearby residents. These events are cited as being among the primary motivations for the federal Emergency Planning and Community Right-to-Know Act (EPCRA), which was signed into law in October 1986.[2]

[2] http://www.epa.gov/tri/.