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Offshoring Pollution while Offshoring Production

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Abstract

We combine international trade data from the U.S. Census Bureau with Toxics Release Inventory data from the Environmental Protection Agency to investigate the impact of firms' imports on toxic emissions by their U.S. plants. We find that goods imported from low-wage countries (LWCs) are more pollution-intensive than goods imported from the rest of the world. Moreover, plants release less toxic emissions and spend less on pollution abatement on American soil when their parent firms import more from LWCs. According to our estimates, a 10% increase in a plant's parent firm's share of imports from LWCs is associated with a 4% drop in the plant' toxic emissions and a 3.75% reduction in pollution abatement expenditures. These effects are stronger for plants located in dirtier U.S. counties, where benefits from pollution reduction are expected to be the largest. These results provide some of the first large-sample empirical evidence that U.S. firms offshore both production and pollution to the developing world.

Keywords: pollution haven, import, low-wage countries, environment

JEL codes: F18, Q56

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I. INTRODUCTION

Between 1992 and 2009, real U.S. manufacturing output grew significantly, while emissions of major air pollutants by U.S. manufacturers fell by more than half (Figure I). Reduced pollution has been largely attributed to stronger environment regulations (Shapiro and Walker 2014), which have also been blamed for declining manufacturing productivity (Greenstone, List and Syverson 2012), plant closures (Becker and Henderson 2000, Henderson 1996), losses of American jobs (Greenstone 2002), and falling wages for U.S. workers (Walker 2013). While the United States has significantly tightened its environmental regulations in the past several decades, countries whose economies are less developed have been unable to follow suit (The Economist 1998).

Environmental regulations can reduce pollution through technological innovation in the production or abatement processes (Porter and Linde 1995) or through changes in the composition of goods manufactured across countries, facilitated by international trade (Levinson 2009). According to the Pollution Haven Hypothesis (hereafter PHH), "Liberalized trade in goods will lead to the relocation of pollution intensive production from high income and stringent environmental regulation countries to low income and lax environmental regulation countries" (Taylor 2005).

A corollary of the PHH predicts that pollution rises in poor countries and falls in rich countries, an idea that has been closely scrutinized yet yields ambiguous results. For example, several studies have found that increasing imports has had little effect on industry-level pollution reduction in the U.S. manufacturing sector (Ederington, Levinson and Minier 2004, Levinson 2009). Recently, however, Lin et al. (2014) found that 17%–36% of four major anthropogenic air pollutants (SO_2, NO_x, CO, and black carbon) emitted in China are associated with the production of goods for export, and that about 21% of these export-related emissions are attributable to goods destined for export to the United States.

Studies also have yet to examine how much U.S. pollution reduction is due to international trade at the micro level. This paper takes on that question by linking firm-level imports to plant-level toxic emissions. Our data is drawn from the U.S. Census Bureau's plant-level microdata (for plant-level operating information), the Longitudinal Firm Trade Transaction Database (LFTTD) (which records international trade transactions),[1] and the Environmental Protection Agency's plant-level Toxics Release Inventory (TRI) database (which discloses toxic emissions by all manufacturing plants that employ more than 10 full-time workers and produce listed toxic substances in quantities above a given threshold). This comprehensive, combined dataset allows us to estimate the impact of imports by U.S. manufacturing firms on the amount of toxic chemicals emitted by their domestic plants.

We distinguish between imports from poor or low-wage countries (LWCs) and imports from the rest of the world. Evidence suggests that poor countries usually have lax environmental standards. According to Esty and Porter (2002), the relationship between environmental regulatory quality and GDP per capita is significantly positive (Esty and Porter 2002, Fig. 5).

While imports from LWCs have been small historically, they have increased substantially in recent years as trade barriers have been removed. Between 1992 and 2009, when the real value of total U.S. imports more than doubled, the real value of imports from LWCs grew more than seven-fold. Consequently, the share of total U.S. imports from LWCs in this period rose from 7% to about 23% (Figure II). In 1992, only 28% of importing firms imported from one or more

[1] Please refer to Bernard et al. (2009) for a detailed description of this database.

LWCs, and that figure rose to 68% by 2009. While much has been found about how trade with LWCs disrupted manufacturing industries (Bernard, Jensen and Schott 2006), workers and occupations (Ebenstein, et al. 2014), and local labor markets (Autor, Dorn and Hanson 2013) in the United States, little attention has been paid to the environmental consequences of trade with LWCs.

At the national level, the increasing share of imports from LWCs in Figure II corresponds to the decreasing air pollution in Figure I. At the industry level, Figure III shows that between 1992 and 2009, air pollution fell as the share of imports from LWCs increased, suggesting the potential for a substitution effect between LWC imports and domestic emissions.

Our firm- and plant-level results provide strong support for the national- and industry-level graphic patterns. Moreover, the micro results shed light on the relocation and substitution effects predicted by the PHH. First, goods imported by U.S. firms from LWCs are more "pollution-intensive" than goods imported from the rest of the world. We measure a good's pollution intensity based on its industry's (4-digit Standard Industrial Classification SIC) emission per dollar of output in the United States.[2] We find that goods imported from LWCs are more polluting than goods imported from the rest of the world. Our estimation results suggest that a 10% increase in a firm's share of imports from LWCs ("LWC Import Share") is associated with a 2.5% increase in the pollution intensity of the firm's imported goods. Based on the same measure of pollution intensity, we also construct an annual measure of the "pollution intensity" of a plant's

[2] Ideally, we should use pollution intensity measures using each source country's production technology. However, such across-country across-industry measures do not exist in a large sample. Using pollution intensity based on U.S. technology is a common practice in the literature (Levinson, 2009). Such measures are valid for our study if it can be assumed that the ranking order of the pollution intensity across industries in other countries is the same as in the United States, and that it remains unchanged over time.

product portfolio using the plant's annual sales by industry. Our results show that U.S. plants produce products in cleaner industries as their parents import more from LWCs.

Second, domestic plants pollute less on American soil as their parent firm imports more from LWCs. To partially control for time-varying industry changes such as technology progress and trade costs reduction, we include industry-specific year fixed effects in addition to plant fixed effects. Our results remain economically and statistically significant: they suggest that a 10% increase in a plant's parent firm's share of imports from LWCs is associated with a 4% decrease in the plant's toxic emissions on American soil. Results are also robust to including a firm's total imports, suggesting that the impact of LWC imports is additional to the impact of general imports. In 2002–2009, the sample firms' average share of imports from LWCs increased by 16% and their toxic emissions dropped by about two thirds. Our results imply that imports from LWCs accounted for about 10% of the overall drop in U.S. toxic emissions, a magnitude similar to that in Levinson (2009). When we distinguish among the effects of imports from China and the European Union (EU), we further find that importing from China lowers toxic emission at U.S. plants, while importing from EU countries has no significant effect on U.S. emissions. This evidence suggests that the source country of U.S. imports is indeed important.

Third, U.S. plants spend less on pollution abatement as their parent firms import more from LWCs. Based on the Survey of Pollution Abatement Costs and Expenditures (PACE), the most comprehensive source of pollution abatement data in the U.S. manufacturing sector, we find that U.S. plants spend less on pollution abatement if their parent firms import more from LWCs. According to our estimates, a 10% increase in a plant's parent firm's share of imports from LWCs is associated with a 3.75% drop in its pollution abatement expenditures.

Fourth, we explore if the effect of imports on pollution varies by plants' geographical locations. We rerun our emissions and abatement cost regressions but control for the general environmental status of the county where the plant is located. TRI information has been made publicly available. Websites such as www.scorecard.org routinely use TRI data to identify and publicize lists of the most polluting U.S. counties. We expect plants located in "dirty" counties face more public pressure to reduce toxic emissions than plants located in cleaner counties. Our results are consistent with that conjecture: the impacts of LWC imports on emissions and abatement costs are stronger for plants located in the dirtiest U.S. counties. For the same amount of increase in parent-firm imports from LWCs, a U.S. plant located in a dirty county emits almost half as much as a plant located in a clean county, and spends 80% less on pollution abatement..

Finally, we exploit differences between imports from related parties (foreign subsidiaries or affiliates) and imports from independent third parties. Imports are categorized in the LFTTD database as being from related parties if the importer owns, controls, or holds voting power equivalent to at least 6% of the outstanding voting stock or shares of the exporter. We find that firms' imports from related parties in LWCs do not have a statistically different impact on the emission levels of their U.S. plants, relative to firms' imports from independent parties in LWCs. In our sample, total imports from related parties in LWCs account for less than 1% of a typical firm's total imports, suggesting that the environmental effects of importing from LWCs are primarily driven by imports from independent parties in LWCs.

To be clear, we do not attempt to establish that firms import from LWCs solely because these countries have lax environmental standards. Rather, our results are the first micro-level empirical evidence advancing the argument that the United States achieves a cleaner domestic environment partly by importing pollution-intensive goods from poor countries. In other words, the "green shift" of U.S. manufacturing is accompanied by a corresponding "brown shift" for imports from poor countries. Meanwhile, U.S. plants increasingly release less toxic chemicals and reduce their pollution abatement expenditures. Previous research on the environmental impact of trade mostly relies on country- or industry-level information (see, e.g., Antweiler, Copeland and Taylor 2001, Grossman and Krueger 1995). Global trade and investment allows firms to disperse pollution-intensive activities in their value chain according to environmental regulations around the globe (Hanna 2010). We extend this literature by offering the first empirical evidence of "pollution offshoring" at the plant level.

By linking firm-level trade with data on plant-level emissions/abatement costs, our study also fills an important gap in studies at the intersection between trade and environment. This paper adds to a burgeoning literature that attempts to explain the reduction in U.S. pollution emissions. Our results are not inconsistent with prior conclusions that trade in general does not account for the majority of pollution reduction in the United States (Levinson 2009; Shapiro and Walker 2014). We bring additional clarity to these relationships by highlighting the impact of importing goods from poor countries whose limits on toxic emissions are less stringent.

The issue of U.S. reductions in pollution coming at the expense of environmental quality in other countries is at the heart of many recent anti-globalization protests. While the original PPH model assumes that pollution is local, recent research proves it is becoming a global concern. For instance, studies show that pollution from China contributes a significant portion of the sulfate concentrates found over the western United States (Lin, et al. 2014). Our empirical findings lend credence to policy makers' assertions that international trade agreements should be negotiated with domestic environmental regulations in mind (Keller and Levinson 2002).

The rest of the article is organized as follows: Section II discusses the details of our data, samples, and variables; Sections III presents the research design and results; Sections IV concludes.

II. DATA and VARIABLES

We construct our samples, which extend from 1992 to 2009, from several sources. We start with plant-level microdata and firm-level international trade data from the U.S. Census Bureau. In addition, we use plant-level toxic emissions and abatement costs data published by the U.S. Environmental Protection Agency (EPA). A plant—called an "establishment" in Census Bureau terminology and a "facility" in the TRI—is a physical location where economic activity takes place. A firm can own one or multiple plants. We link these datasets by using the existing bridge files maintained by the Census Bureau and by manually matching plant names and addresses. Below we describe the main datasets, the samples, and the key variables.

Micro Data from the Census Bureau

The Census micro-level datasets on manufacturing plants include the Census of Manufactures (CM) and the Annual Survey of Manufactures (ASM). CM data are collected during the economic census, which takes place in years ending in 2 and 7, and covers approximately 350,000 manufacturing plants each time. The ASM typically samples about 60,000 plants in non-census years. All plants with more than 250 employees and all plants of large firms are included by design. Some 40,000 other plants are selected with a probability proportional to a composite measure of their size. Once a plant is surveyed, the ASM continues surveying it to form a five-year panel. We construct several variables that may affect a plant's emissions, including capital expenditures, skill intensity (non-production worker salary as a percentage of total workforce salary), and the shipment value of output at the plant and firm levels. Both CM and ASM report product-level (5-digit SIC in the ASM's case and 7-digit SIC in the CM's case) information on output.

Trade Data from Census Bureau

The Longitudinal Firm Trade Transaction Database (LFTTD) links individual U.S. trade transactions to U.S. firms for the years 1992–2009. The database covers all shipments of goods that crossed U.S. borders. For each transaction, the database contains a firm identifier and pertinent details of the shipment, such as the date and the destination (or originating) country, as well as a 10-digit Harmonized System (HS) classification code and a (nominal) shipment value for each product.

To identify LWCs, we rely on the list provided by Bernard, Jensen, and Schott (2006), who classify a country as an LWC if its annual GDP per capita was less than 5% of the U.S. annual GDP per capita from 1972 to 1992 (Appendix, Table A1). China, India, and most African countries are on the list. We calculate a firm's LWC Import Share as the percentage of its total imports that are from LWCs. LWC Import Share has risen substantially according to our sample statistics: from 7% in 1992 to about 30% in 2009.

We match firm-level LFTTD with plant-level microdata in the CM and the ASM through firm-level bridge files provided by the Census Bureau.

Toxics Release Inventory (TRI)

The U.S. EPA's TRI program was the first large-scale initiative to track facility-level pollution emissions. Introduced by the Emergency Planning and Community Right to Know Act (EPCRA) in 1986, the TRI program requires manufacturing plants that emit more than a given threshold level for any of the 600+ designated toxic chemicals to self-report emissions data for use in a publicly available database. Evidence suggests that national toxic emissions declined by 43% between 1988 and 1999, a period in which the TRI program garnered strong public support. The EPA claims that the TRI program provides (1) information to encourage community-based environmental decision making and (2) incentives for businesses to find their own ways of preventing pollution (Bui and Mayer 2003). For each year, the TRI database contains approximately 80,000 facility-chemical reports from more than 20,000 different facilities. A significant degree of quality control and verification is carried out before the data is released to the public.[3]

Since its launch, the TRI database has become one of the most widely accessed databases providing comparative data on environmental performance across facilities and over time. It has been used by environmental researchers for studies addressing a wide range of topics, including environmental regulation (Gamper-Rabindran 2006, Hellanda and Whitford 2003, King and Lenox 2000) and the relationship between waste management and financial performance (King and Lenox 2002). Prior research shows that participation in the TRI program significantly reduces TRI emissions, even after controlling for self-selection (Khanna and Damon 1999, Potoski and Prakash 2005). In addition, both public media and the stock market respond negatively when a firm reports higher emissions in the TRI (Hamilton 1995). Firms that have

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[3]Each EPA region has a TRI enforcement program that conducts, on an annual basis, a limited number of data quality inspections (of reporting facilities) and non-reporting inspections (of facilities that are in TRI industries but did not report). Violations, whether stemming from late reporting, failure to report, or data quality issues, can lead to penalties of $25,000 per day, per chemical, or per violation, and may be subject to criminal charges.

experienced the deepest stock price declines in response to their TRI reports have subsequently reduced emissions more than their industry peers (Konar and Cohen 1997).

We use the TRI database to construct three variables. First, we use it to calculate the pollution intensity of a 4-digit SIC industry. Two measures of industry-level pollution intensity are adopted here. We first use the World Bank's "Industrial Pollution Projection System" (IPPS). The IPPS reports the amount (pounds per million dollars of value added) of 14 pollutants emitted from each of the 459 4-digit SIC industries, based on the 1987 TRI dataset. The IPPS has been a standard source of industry-level pollution intensities, and is frequently used in assessing the pollution content of trade (Cole 2004, Ederington, et al. 2004, Gamper-Rabindran 2006, Levinson 2009).

We next use the more comprehensive toxicity weighting model provided by the EPA, Risk-Screening Environmental Indicators (RSEI). We sum up the RSEI-based toxic emissions of all plants in each of the 459 4-digit SICs reported in the 1992 TRI, and scale emissions by the 1992 industry-level shipment values reported in the NBER-CES Manufacturing Industry Database (Bartelsman and Gray 1996),[4] to derive industry-level pollution intensities. We sum up a firm's import value in each 4-digit SIC industry[5] weighted by the corresponding industry-level pollution intensity (based on IPPS and RSEI, respectively) to derive the overall pollution intensity of a firm's imports.

Secondly, we use the TRI database to gauge plant-level toxic emissions within the United States. We match facilities in the TRI database to plants in the LBD based on plant names and

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[4] We chose 1992 because it is the first year of our sample and because EPCRA changed some reporting requirements in 1989; the next subsequent Census year was1992.

[5] We follow Pierce and Schott (2012) to link the 10-digit Harmonized System (HS) classifications to the 1987 version of the 4-digit SICs.

addresses. A TRI-LBD bridge file for the years 1987–1999 was maintained at the Census Bureau; we follow the same method by matching names and addresses and extending the match to 2009. On average, 75% of the facilities appearing in the TRI are matched to the LBD. When using the TRI, it is important to keep in mind that various pollutants have different health consequences (Chay and Greenstone 2005). Toffel and Marshall (2004) compare 13 methods of aggregating chemical-specific release data to the plant level and recommend the RSEI model (EPA 2012) as the most comprehensive model for estimating the impacts of toxic releases on human health. Therefore, we follow recent studies using the RSEI model (e.g., Gamper-Rabindran 2006) to define toxic emissions from a plant as its all-media release of designated toxic chemicals, multiplied by the RSEI toxicity weight for each chemical; emissions to air are weighted using inhalation toxicity and emissions to other media are weighted using oral toxicity.

Finally, we use the TRI database to approximate the potential benefits from emissions reduction and hence the expected environmental pressure on plants in each county. In addition to facility-level emissions, the annual TRI reports and other sources typically rank counties by total emissions to highlight those that pollute the most. Plants located in "dirty" counties face much greater public pressure to reduce toxic releases than plants located in cleaner counties. For example, according to Powers (2013), after Calhoun County, Texas, was listed as having the highest level of toxic releases in the country, local communities organized various awareness programs to inform the public about local pollution. Under public pressure, Alcoa had to commit to aggressive pollution reduction initiatives at two local plants. Similarly, when Butler County, Pennsylvania, was identified among the dirtiest counties, local communities successfully pressured the state into restricting the nitrate emissions of a major steel plant before the plant was allowed to release waste into the Connoquenessing Creek. We rank counties by the total RSEI toxicity-weighted emissions from all plants located there, based on annual emissions data and 1992 emissions data, respectively. We then select the 100 "dirtiest" counties according to the ranking.[6]

Pollution Abatement Costs and Expenditures

The Pollution Abatement Costs and Expenditures (PACE) survey is the only comprehensive survey of costs of environmental abatement activities in the United States. The survey collects facility-level pollution abatement costs data for manufacturing, mining, and electric utility industries. The costs are mostly incurred in the process of compliance with local, state, and federal regulations, or for voluntary or market-driven pollution abatement activities. Such costs include pollution treatment (to reduce or eliminate pollution that has been generated during production processes), pollution prevention (to prevent creation of pollution in the first place), recycling, and disposal.

We use the PACE surveys for the years 1992–1994, 1999, and 2005.[7] We use total Pollution Abatement Operating Costs (PAOC), which comprise salaries and wages, parts and materials, fuel and electricity, capital depreciation, contract work, equipment leasing, and additional operating costs associated with abatement of air and water pollution as well as solid waste reduction or disposal. The PAOC measure has long been used to gauge plants' pollution reduction investments (Jorgenson and Wilcoxen 1990, List and Co 2000, Pashigian 1984). Following prior studies (Becker, Jr. and Shadbegian 2013), we also normalize a plant's PAOC by its total value of shipment.

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[6] Selecting the 25 or 50 dirtiest counties generated similar results.
[7] The PACE survey was conducted annually from 1973 to 1994 with the exclusion of 1987. The survey was reinstated for 1999 with periodicity of 2-5 years. The survey was last conducted for the 2005 survey year.

We match PACE to the trade database LFTTD using the Census' common firm identifiers. The match yields 50,318 plant-years over the five years for which PACE data are available.

Samples

We construct three main samples. The first sample includes firm- and plant-level information for all manufacturing firms that import products from any country. The second sample includes plant-level data about all manufacturing plants that report toxic emissions in TRI and whose parent firms import. The third sample includes plant-level data about all manufacturing plants that report PAOC in PACE and whose parent firms import. We use the first sample to analyze the pollution intensity of imports at the firm level. This sample includes 88,458 firms and 277,768 firm-year observations with 720,909 plant-year observations in 1992–2009. Panel A in Table I provides summary statistics for this sample. As the panel shows, an average importing firm sources 16% of its manufacturing imports from LWCs, slightly higher than the national average of 15%. In 1992, only 28% of importing firms imported from one or more LWCs, and that figure rose to 68% by 2009. An average firm in our sample received 4% of its imports from LWCs in 1992 and 20% of its imports from LWCs in 2009. The number for imports from related parties in LWCs rose from 0.2% to 3% in the same period.

We use the second sample to analyze toxic emissions by U.S. plants whose parent firms import. This sample contains 17,773 plants of 7,115 U.S. parent firms. Altogether there are 136,574 plant-year observations between 1992 and 2009. Panel B in Table I provides summary statistics for this sample. The sample plants are relatively large: A typical plant has about 418 employees and manufactures a total value of $175 million of output. Their parent firms source about 89% of their imports from LWCs. The skill intensity variable has a mean of 0.35; that is, non-production workers' salaries account for about 35% of an average plant's total salaries.

We start from 171,286 plant-years matched between TRI and the manufacturing census. Of these, 136,879 have parent firms that import, which form our focal sample. About two thirds of these plants have parent firms that import from LWCs. Those plants are bigger (employing about 466 employees relative to 323 employees, producing twice as much as those not importing, and importing 20 times more) and release more toxic emissions (the median toxic-weighted emission is about four times that of plants whose parent firms do not import from LWCs). A simple calculation reveals that our importing firm sample accounts for about 90% of all manufacturing plants' total toxic emissions in the sample period.

III. RESULTS

In this section we investigate five questions about the environmental impact of firm imports: (A) Are imports from LWCs dirtier? (B) Do domestic plants pollute less in the United States when their parent firms import more from low-wage countries? (C) Are the effects in (B) stronger for plants located in dirtier U.S. counties, where the benefits of "pollution offshoring" are expected to be greatest? (D) Do domestic plants spend less on pollution abatement in the United States when their parent firms import more from low-wage countries, and is this effect stronger for plants located in dirtier U.S. counties? (E) Do firms importing more from related parties in LWCs pollute less on domestic soil?

A. Are imports from LWCs dirtier?

To estimate the relation between a firm's LWC Import Share and the pollution content and intensity of its imports, we use the following specification:

$$\text{Dirty Imports}_{jt} = \alpha_j + \alpha_t + \beta \text{LWC Import Share}_{jt} + X_{jt} + \varepsilon_{jt} \quad (1),$$

where Dirty Import_{jt} is one of the four measures of dirtiness of firm *j*'s imports in year *t*: (1) the logarithm of a firm's "pollute import", or the total value of the firm's imports across all manufacturing industries, weighted by industry-level pollution intensities based on 1987 IPPS, as described earlier; (2) the logarithm of a firm's "toxic imports", or the total value of the firm's imports across all manufacturing industries, weighted by industry-level pollution intensities based on 1992 TRI and RSEI data, as described earlier; (3) the pollution intensity of the firm's imports based on IPPS, or its "pollute import" scaled by its total imports; (4) the pollution intensity of the firm's imports based on TRI-RSEI, or its "toxic import" scaled by its total imports. The key explanatory variable of interest, LWC Import Share_{jt} is described above.[8] We control for firm *j*'s size (total value of shipment) and total value of imports in addition to firm and year fixed effects. Standard errors are clustered at the firm level.

Our results, presented in Table II, are very similar across all four measures of import dirtiness. The dirtiness of a firm's imports is positively and significantly related to its LWC Import Share. The economic significance of the point estimate is sizeable. Coefficients in columns (1) and (2) imply that a 10% increase in a firm's LWC Import Share is associated with a 2.5% increase in the pollution content of its imports, based on the intensity measure derived from

[8] In an alternative specification, we use the logarithm of LWC import value, results are qualitatively unchanged and are available upon request.

the 1992 TRI. Coefficients in columns (3) and (4) imply that a 10% increase in a firm's LWC Import Share raises the pollution intensity of its imports by about 0.10, or approximately 20% of the sample's median value of import intensity. Larger firms import more polluting products, although the effects of the intensity measures are not statistically significant in columns (3) and (4). Firms that import more in general also import more polluting goods.

Although plants included in the ASM and the CM do not change their industry classification very often, they report detailed product-level (5-digit SIC for ASM and 7-digit SIC for CM) output. We then aggregate the product-level output into 4-digit SIC industry level output for each plant and calculate a plant's output dirtiness based on the industry-level toxic index used above. We estimate the effect of importing from LWCs on a plant's toxic output using a similar specification as in Equation (2) and report the results in Table III.

Results indicate that U.S. plants produce cleaner goods as their parent firms import more from LWCs. The point estimate in Column (4) in Table III indicates that a 10% increase in share of imports from LWCs lowers the toxic-weighted output by merely 0.3%. This evidence is consistent with the finding in Shapiro and Walker (2014) that most of the reduction in manufacturing pollution occurs within products rather than across products.

B. Do domestic plants pollute less when their parent firms import more from LWCs?

Our main analyses focus on the implications of parent firm imports on subsidiary plants' domestic pollution reduction. We use the following specification to estimate toxic emissions at the plant level:

$$\text{Toxic Emission}_{ijt} = \alpha_i + \alpha_t + \beta \text{LWC Import Share}_{jt} + X_{ijt} + \varepsilon_{ijt} \quad (2),$$

where Toxic Emissions$_{ijt}$ is either the logarithm of the total toxicity-weighted emissions of plant i of parent firm j, or the logarithm of plant *i*'s total toxicity-weighted emissions scaled by the shipment value of its output, in year *t*.

We control for several plant-level characteristics that are known to affect a plant's toxic emission, such as the plant's scale (the logarithm of its sales), the logarithm of its capital expenditures, and the skill intensity (share of non-production workers over the entire workforce), which can proxy for a plant's characteristics of production technology. We also control for the parent firm's total imports to examine how imports in general affect a plant's pollution.

We report the estimation results in Table IV. Columns (1) and (2) use the logarithm of a plant's toxic emission as the dependent variable, whereas the dependent variable in columns (3) and (4) is the logarithm of a plant's toxic emission scaled by its output. All columns include plant fixed effects. In addition, columns (1) and (3) include year fixed effects, and columns (2) and (4) include industry*year fixed effects to control for changes in industry-specific technology and reductions in trade costs over time.

The results are qualitatively similar across all columns. They show that a firm's LWC Import Share has a significantly negative impact on its domestic plants' toxic emissions, as well as on its toxic emissions per dollar of shipment. The economic effect of the point estimates is considerable. For instance, the coefficient of -0.401 in column (1) implies that a 10% increase in a plant's parent firm's LWC Import Share lowers the plant's toxic emissions by about 4%. Our results imply that, over the 18-year sample period, when the economy-wide share of import from LWCs grew by 16%, a plant would reduce its toxic emission by about 6.4%—a reduction that accounts for around 10% of the total drop in U.S. toxic emissions. Coefficients on other explanatory variables are consistent with our expectation. In general, larger plants, plants with larger capital expenditures, and plants with a larger proportion of production workers tend to produce greater toxic emissions. Finally, total import does not have a statistically significant impact on toxic emissions and its inclusion does not qualitatively change the coefficients of LWC Import Share.

One might worry that the variable of LWC Import Share could reflect other economy-wide trends. We investigate the effects of importing from China and importing from the EU on domestic plant pollution. The following specification is employed.

$$\text{Toxic Emission}_{ijt} = \alpha_i + \alpha_t + \beta_1 \text{China Import Share}_{jt} + \beta_2 \text{EU Import Share}_{jt} + X_{ijt} + \varepsilon_{ijt} \quad (3),$$

Results are reported in Table V. The coefficient estimates on China Import Share are significantly negative while the estimates on EU Import Share are positive but statistically insignificant. This evidence reveals that the source country of imports matters. Comparing the column (2) estimate in Table V with that in Table IV, one can see that the effects of LWC Import Share are mainly driven by imports from China.

C. Is the negative effect of importing from low-wage countries on domestic toxic emissions stronger for plants located in dirty U.S. counties?

Information about toxic emissions from U.S. plants has been made publically available to consumers and other stakeholders (e.g., investors, employees, and community activists). For instance, the website www.scorecard.org, developed by the U.S.-based nonprofit environmental advocacy group Environmental Defense Fund, routinely publishes the 100 most polluted communities in the United States. Plants in these communities face more public and regulatory pressure to reduce pollution (Environmental Protection Agency 2003; Powers 2013). We therefore expect the benefit of "pollution offshoring" to be greater for plants located in dirtier counties. Accordingly, we estimate the following specifications:

$$\text{Toxic Emissions}_{ijt} = \alpha_i + \alpha_t + \beta_1 \text{LWC Import Share}_{jt} + \beta_2 \left(\text{LWC Import Share}_{jt} * \text{100 Dirtiest Counties}_{it}\right) + X_{ijt} + \varepsilon_{ijt} \quad (4),$$

where Toxic Emissions_{ijt} is defined as before and 100 Dirtiest Counties_{it} is a dummy variable that represents whether plant *i* is located in any of the 100 dirtiest U.S. counties (based on total toxic emissions) in year *t* (or in 1992, for an alternative specification).

Tables VI reports regression the results of Equation (2). The interaction terms are significantly negative, suggesting that the negative impact of imports from LWCs on domestic toxic emissions is indeed stronger for plants in dirtier U.S. counties. On average, across columns (1) to (4), the negative impact of imports from LWCs on domestic emissions is approximately doubled for plants located in the 100 dirtiest counties, relative to plants located elsewhere. After controlling for these interaction terms, the main effect of LWC Import Share remains mostly significantly negative. The results in columns (5) to (8) report the results when we use toxic emissions scaled by plant sales. While the main effect on LWC Import Share becomes insignificant, the interaction term is significantly negative, reaffirming the story described above.

D.Do firms importing more from LWCs spend less on pollution abatement in the U.S?

In addition to toxic emissions, we also examine plants' efforts to reduce emissions. Tables VII and VIII report estimates of specifications similar to Equation (2) and Equation (4), except that we replace the dependent variable with plant expenditures on environmental pollution abatement. We also replace plant fixed effects with 4-digit SIC industry fixed effects to take into account of the significant gaps in time coverage of PACE. Following prior studies, we use both the abatement costs and the abatement costs divided by a plant's total employment; results are similar.

Table VII shows that domestic plants spend less on pollution abatement when their parent firms import more from LWCs. The coefficient of –0.375 implies that a 10% increase in a plant's parent firm's LWC Import Share reduces the plant's pollution abatement costs by about 3.75%. In terms of dollar value, a 10% increase in imports from LWCs can substitute for about 26,400 nominal dollars, relative to about 704 thousand dollars spent on PAOC by an average plant in our sample.

The results in Table VIII bear a strong resemblance to those in Table VI. They suggest that the effect identified above is much stronger for plants located in dirty U.S. counties, where the benefit of "pollution offshoring" is expected to be greater. The negative impact of a parent firm's LWC Import Share on the pollution abatement costs of its plants in dirtier U.S. counties is 80% greater than the impact on its plants located in cleaner counties.

E. Do firms importing more from related parties in LWCs pollute less on domestic soil?

Multinational enterprises mediate a substantial majority of U.S. trade (Bernard, Jensen, and Schott 2009). The environmental conduct of multinational enterprises is unclear. On the one hand, multinational enterprises often arbitrage in regulatory differences across countries to maximize profits (Vernon 1971). If they also arbitrage in differences in environmental regulations across countries, we would expect their imports from LWCs to have a larger negative impact on emissions in the United States. On the other hand, multinational corporations may self-regulate in accordance with their internal standards, including self-regulating their environmental conduct in countries with weak environmental regulations (Christmann and Taylor 2001). In order to shed light on these two opposite expectations, we compare the impact of LWC imports through arm's length transactions vs. those from related parties. In Table IX, we estimate specifications similar to Equations (2), respectively, except that we include an additional explanatory variable to measure the share of imports from related parties in LWCs. Table IX shows that adding LWC imports from related parties does not qualitatively change the impact of LWC Import Share on plant-level toxic emissions estimated in Table III. In addition, estimates in columns (1) and (2) suggest that LWC imports through related parties do not further lower the toxic emissions of domestic plants. Imports from related parties in LWCs do not affect a plant's toxic emission per value of shipment in a significant fashion. On average, in our sample, the imports from related parties in LWCs account for less than 1% of a firm's total imports. Therefore, the economic significance of importing from related parties in LWCs remains small. In sum, our findings suggest that the environmental effects of importing from LWCs are primarily driven by imports from arm's length transactions with unrelated parties.

IV. CONCLUSIONS

This paper investigates the relationship between international trade and U.S. firms' pollution reduction efforts. Our analyses show that, (1) imports by U.S. firms from LWCs are dirtier than goods imported from the rest of the world; (2) U.S. plants pollute less as their parent firms import more from LWCs, and this effect is stronger for plants in dirtier U.S. counties, where potential benefits from pollution reduction are expected to be greater; (3) U.S. plants spend less on pollution abatement as their parent firms import more from LWCs, and this effect is stronger for plants in dirtier U.S. counties; and finally, (4) the environmental effects of importing from LWCs are primarily driven by imports from arm's length transactions rather than U.S. multinationals importing from their foreign subsidiaries.

We believe these results are the first empirical evidence supporting the argument that the United States enjoys a cleaner domestic environment partly by importing pollution-intensive goods from poor countries. Furthermore, our results provide indirect support to prior findings that the economic costs of environmental regulations discourage investments in the United States while encouraging U.S. firms to imports from abroad. Our paper also represents the first empirical evidence of "pollution offshoring" at the firm level. By linking firm-level trade and plant-level emissions and abatement costs data, our study sheds more light on the relations between trade and the environment.

Finally, our paper contributes to an emerging literature on the implications of trade with LWCs. While much has been discovered regarding the ways in which trade with LWCs has depressed U.S. wages and employment, little attention has been paid to the impact of imports from LWCs on firms' environmental performance. Our paper fills this void and calls for more coordination between international trade agreements and domestic environmental regulations.

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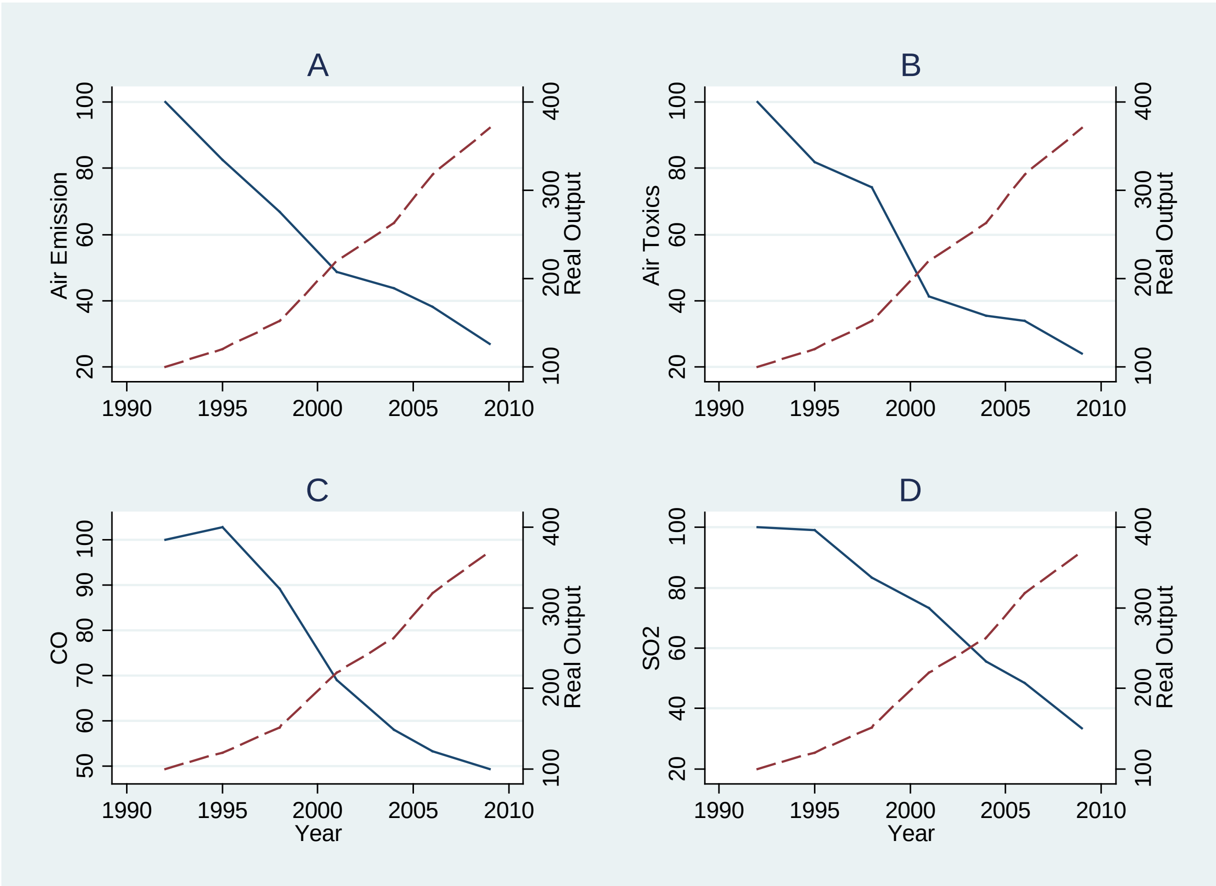

FIGURE I

POLLUTION EMISSIONS FROM U.S. MANUFACTURING, 1992–2009

This figure shows air pollution (solid line) and real output (dashed line) from the U.S. manufacturing sector in 1992–2009, where we set the 1992 level as 100. Panel A shows the total release of fugitive and stack air from all manufacturing facilities in TRI. Panel B shows the total release of toxic content in fugitive and stack air from all manufacturing facilities in TRI. Panel C shows the emission of CO from industrial activities in National Emissions Inventory. Panel D shows the emission of SO2 from industrial activities in National Emissions Inventory.

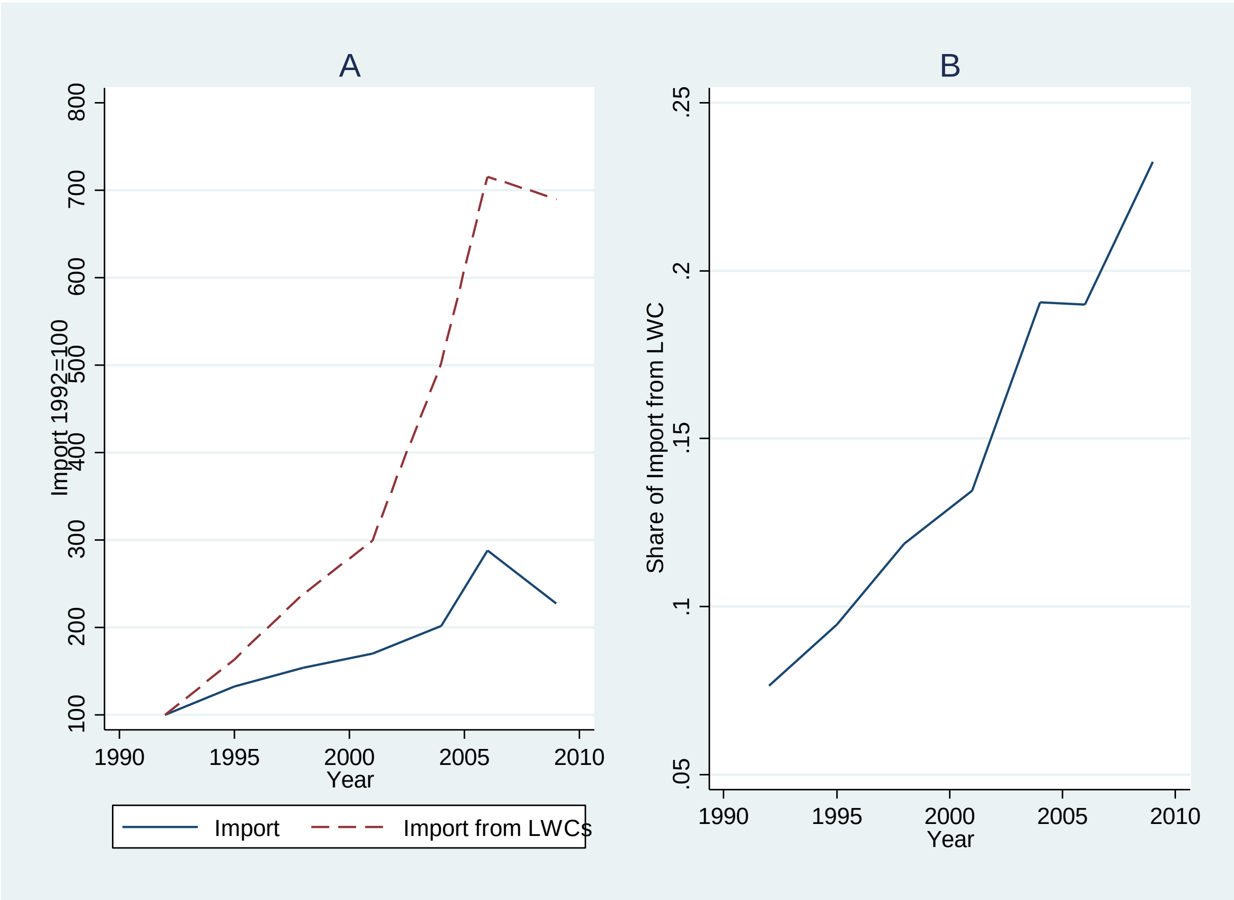

FIGURE II

U.S. IMPORTS AND IMPORTS FROM LWCs, 1992–2009

This figure shows total U.S. imports and imports from LWCs in 1992–2009, where we index the 1992 level to 100. Panel A shows the real value of total imports and imports from LWCs. Panel B shows the share of imports originating from LWCs.

FIGURE III

CHANGES IN IMPORTS FROM LWCs AND CHANGES IN TOXIC AIR EMISSIONS, 1992–2009

This figure shows the changes in each industry's toxic air emission in 1992–2009 (where we set the 1992 level as 100) against changes in the share of imports from LWCs. Panel A shows the relation based on pounds of emissions. Panel B shows the relation based on toxic content of emissions.

Appendix

Table A1
The list of low-wage countries

Afghanistan	China	India	Pakistan
Albania	Comoros	Kenya	Rwanda
Angola	Congo	Lao PDR	Samoa
Armenia	Equatorial Guinea	Lesotho	Sao Tome
Azerbaijan	Eritrea	Madagascar	Sierra Leone
Bangladesh	Ethiopia	Malawi	Somalia
Benin	Gambia	Maldives	Sri Lanka
Bhutan	Georgia	Mali	St. Vincent
Burkina Faso	Ghana	Mauritania	Sudan
Burundi	Guinea	Moldova	Togo
Cambodia	Guinea-Bissau	Mozambique	Uganda
Central African Rep	Guyana	Nepal	Vietnam
Chad	Haiti	Niger	Yemen

Table I

SUMMARY STATISTICS

Panel A: Firm level	N	Mean	SD
Firm's total shipment value of output (in thousand dollars)	277768	210690.7	3727718
Firm's total import (in thousand dollars)	277768	39700	630000
Share of import from LWCs	277768	0.162	0.318
Ln(Toxic content of imports)	277768	25.009	7.723
Ln(Pollution content of imports)	277768	11.863	5.288
Toxic content of imports/Firm's total imports	277768	10.903	30.879
Pollution content of imports/Firm's total imports	277768	6.455	20.144

Panel B: Plant Level	N	Mean	SD
Ln(Toxic emissions)	136574	12.978	6.09
Total number of employees	136574	417.583	802.24
Plant's total value of shipment (in thousand dollars)	136574	175201	586365
Skill intensity	136574	0.351	0.193
Total capital expenditures (in thousand dollars)	136574	6129.05	36024
Parent firm's share of imports from LWCs	136574	0.087	0.186
Dirtiest 100 counties	136574	0.222	0.416
Dirtiest 100 counties (in 1992)	136574	0.244	0.429

Table II FIRMS' IMPORTS FROM LWCs AND THEIR POLLUTION CONTENTS

	IPPS		TRI		IPPS		TRI	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ln(Pollute Import)		Ln(Toxic Import)		$\frac{\text{Pollute Import}}{\text{Total Imports}}$		$\frac{\text{Toxic Import}}{\text{Total Imports}}$	
LWC Import Share	0.348***	0.350***	0.239***	0.247***	0.642***	0.661***	1.008***	1.043***
	(0.041)	(0.041)	(0.028)	(0.028)	(0.190)	(0.190)	(0.280)	(0.281)
Ln(Firm Size)	0.074***	0.072***	0.028***	0.026***	-0.061	-0.085*	-0.106	-0.129*
	(0.011)	(0.011)	(0.007)	(0.007)	(0.052)	(0.051)	(0.073)	(0.073)
Ln(Total Imports)	1.173***	1.173***	1.093***	1.092***	0.248***	0.252***	0.330***	0.327***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.034)	(0.034)	(0.042)	(0.042)
Year FE	Yes		Yes		Yes		Yes	
Industry*year FE		Yes		Yes		Yes		Yes
Plant FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	277768	277768	277768	277768	277768	277768	277768	277768
Adjusted R^2	0.786	0.786	0.830	0.830	0.652	0.653	0.636	0.636

N=277,768. This table reports regression estimates of the impact of LWCs import share on the pollution intensity of a firm's imports, from 1992 to 2009, based on Equation (1). The sample includes all firms that import. We use industry-level pollution intensities based on the IPPS and the TRI and multiply by a firm's import value in each industry to calculate the pollution content of a firm's imports. All regressions include a constant and control for firm and year fixed effects. Standard errors are clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE III FIRMS' IMPORTS FROM LWCs AND THEIR PLANTS' TOXICITY-WEIGHTED OUTPUT

	Ln(Toxic Output)		$\frac{\text{Toxic Output}}{\text{Plant Output}}$	
	(1)	(2)	(3)	(4)
LWC Import Share	-0.030***	-0.030***	-1.437**	-1.588**
	(0.013)	(0.012)	(0.681)	(0.682)
Ln(Plant Shipment)	0.999***	1.002***	-1.502	-1.312
	(0.003)	(0.003)	(1.333)	(1.338)
Skill Intensity	-0.030***	-0.034***	3.295**	2.603**
	(0.013)	(0.013)	(1.302)	(1.300)
Ln(Capex)	0.001	0.001*	0.112	0.118
	(0.001)	(0.001)	(0.162)	(0.161)
Ln(Total Imports)	0.001	0.001	0.148**	0.057
	(0.002)	(0.002)	(0.064)	(0.064)
Year FE	Yes		Yes	
Industry*year FE		Yes		Yes
Plant FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.936	0.937	0.423	0.428

N=702,909 This table reports regression estimates of the impact of firms' imports from LWCs on their plant-level toxicity-weighted output in the U.S. in 1992–2009. The sample includes all firms that import and are listed in the CM or ASM product database. We use industry-level pollution intensities based on TRI to construct the toxic index of each 4-digit SIC industry in 1992. We then multiply that index by each plant's output in the corresponding industry to generate each plant's toxic output. Standard errors are clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table IV FIRMS' IMPORTS FROM LWCs AND THEIR PLANTS' TOXIC EMISSIONS

	Ln(Toxic Emission)		$\text{Ln}(\frac{\text{Toxic Emission}}{\text{Plant Shipment}})$	
	(1)	(2)	(3)	(4)
LWC Import Share	-0.583***	-0.401***	-0.133***	-0.089**
	(0.143)	(0.130)	(0.043)	(0.044)
Ln(Plant Shipment)	0.449***	0.451***	-0.062***	-0.061***
	(0.035)	(0.035)	(0.019)	(0.019)
Skill Intensity	-0.778***	-0.703***	-0.403***	-0.385***
	(0.154)	(0.150)	(0.055)	(0.055)
Ln(Capex)	0.056***	0.047***	0.015***	0.012***
	(0.009)	(0.009)	(0.004)	(0.004)
Ln(Total Imports)	0.0221**	0.0249**	-0.0033	-0.0021
	(0.011)	(0.011)	(0.004)	(0.004)
Year FE	Yes		Yes	
Industry*Year FE		Yes		Yes
Plant FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.712	0.715	0.759	0.761

N=136,574. This table reports regression estimates of the impact of firms' imports from LWCs on their plant-level toxic emissions in the U.S. in 1992–2009, based on Equation (2). The sample includes all firms that import and are surveyed by the TRI. The dependent variable is a plant's toxic content from all-media pollutant emissions. Standard errors are clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table V FIRMS' IMPORTS AND THEIR PLANTS' TOXIC EMISSIONS, CHINA vs. EU

	Ln(Toxic Emission)		$\text{Ln}(\frac{\text{Toxic Emission}}{\text{Plant Shipment}})$	
	(1)	(2)	(3)	(4)
China Import Share	-0.555***	-0.348***	-0.128***	-0.077
	(0.165)	(0.146)	(0.047)	(0.049)
EU Import Share	0.012	0.029	0.015	0.020
	(0.080)	(0.075)	(0.027)	(0.027)
Ln(Plant Size)	0.449***	0.451***	-0.062***	-0.061***
	(0.035)	(0.035)	(0.019)	(0.019)
Skill Intensity	-0.777***	-0.702***	-0.403***	-0.385***
	(0.154)	(0.150)	(0.055)	(0.055)
Ln(Capex)	0.056***	0.047***	0.015***	0.012***
	(0.009)	(0.009)	(0.004)	(0.004)
Ln(Total Imports)	0.0222*	0.0254**	-0.003	-0.002
	(0.011)	(0.011)	(0.004)	(0.004)
Year FE	Yes		Yes	
Industry*year FE		Yes		Yes
Plant FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.712	0.715	0.759	0.761

N=136,574. This table reports regression estimates of the impact of firms' imports from LWCs on their plant-level toxic emissions in the U.S. in 1992–2009, based on Equation (2). The sample includes all firms that import and are surveyed by the TRI. The dependent variable is a plant's toxic content from all-media pollutant emissions. Standard errors are clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table VI
FIRMS' IMPORTS FROM LWCs AND THEIR PLANTS' TOXIC EMISSIONS, BY LOCATION

	Ln(Toxic Emission)				$Ln(\frac{\text{Toxic Emission}}{\text{Plant Shipment}})$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LWC Import Share	-0.508***	-0.316***	-0.469***	-0.265***	-0.079*	-0.036	-0.068	-0.025
	(0.090)	(0.091)	(0.094)	(0.095)	(0.047)	(0.047)	(0.049)	(0.050)
Dirty 100	0.567***	0.576***			0.497***	0.496***		
	(0.048)	(0.048)			(0.028)	(0.028)		
LWC*Dirty100	-0.351**	-0.395**			-0.252***	-0.243*		
	(0.176)	(0.176)			(0.096)	(0.096)		
LWC*Dirty 100 in 92			-0.480***	-0.564***			-0.274***	-0.264***
			(0.184)	(0.184)			(0.097)	(0.098)
Ln(Plant Shipment)	0.446***	0.448***	0.449***	0.451***	-0.064***	-0.063***	-0.062***	-0.061***
	(0.026)	(0.035)	(0.026)	(0.025)	(0.019)	(0.019)	(0.019)	(0.019)
Skill Intensity	-0.779***	-0.702***	-0.778***	-0.702***	-0.404***	-0.384***	-0.403***	-0.385***
	(0.105)	(0.104)	(0.105)	(0.104)	(0.055)	(0.055)	(0.055)	(0.055)
Ln(Capex)	0.055***	0.046***	0.056***	0.047***	0.014***	0.011**	0.015***	0.012**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.004)	(0.004)	(0.004)	(0.004)
Ln(Total Imports)	0.022***	0.025***	0.022***	0.025***	-0.003	-0.002	-0.003	-0.002
	(0.007)	(0.007)	(0.007)	(0.007)	(0.004)	(0.004)	(0.004)	(0.004)
Year FE	Yes		Yes		Yes		Yes	
Industry*year FE		Yes		Yes		Yes		Yes
Plant FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.713	0.716	0.712	0.715	0.760	0.762	0.759	0.761

N=136,574. This table reports regression estimates of the impact of firms' imports from LWCs on their plant-level toxic emissions in the U.S. in 1992–2009, based on Equation (3). The sample includes all firms that import and are surveyed by the TRI. "100 Dirtiest Counties" refers to the top 100 counties in the U.S. in terms of toxic emissions based on the TRI. All regressions include a constant and control for plant and year fixed effects. Standard errors are clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table VII

FIRMS' IMPORTS FROM LWCs AND THEIR PLANTS' EXPENDITURES ON POLLUTION ABATEMENT EXPENDITURES

	Ln(PAOC)		$\text{Ln}\left(\frac{\text{PAOC}}{\text{Plant Shipment}}\right)$	
	(1)	(2)	(3)	(4)
LWC Import Share	-0.392***	-0.375***	-0.172***	-0.171***
	(0.096)	(0.096)	(0.042)	(0.042)
Ln(Plant Shipment)	0.505***	0.512***	-0.188***	-0.186***
	(0.037)	(0.037)	(0.022)	(0.021)
Skill Intensity	-1.508***	-1.494***	-0.522***	-0.516***
	(0.093)	(0.091)	(0.041)	(0.041)
Ln(Capex)	0.491***	0.483***	0.255***	0.252***
	(0.034)	(0.034)	(0.020)	(0.020)
Ln(Total Imports)	0.045**	0.046**	0.015**	0.015**
	(0.007)	(0.007)	(0.003)	(0.003)
Year FE	Yes		Yes	
Industry*year FE		Yes		Yes
Industry FE	Yes		Yes	
Adjusted R^2	0.403	0.405	0.244	0.249

N=50,263. This table reports regression estimates of the impact of firms' imports from LWCs on their plant-level pollution abatement costs in the U.S. in 1992, 1993, 1994, 1999, and 2005. The sample includes all firms that import and are surveyed by the PACE. Standard errors are clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table VIII FIRMS' IMPORTS FROM LWCs AND THEIR PLANTS' EXPENDITURES ON POLLUTION ABATEMENT, BY LOCATION

	Ln(PAOC)				$\text{Ln}(\frac{\text{PAOC}}{\text{Plant Shipment}})$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LWC Import Share	-0.325***	-0.311***	-0.331***	-0.318***	-0.143***	-0.144***	-0.144***	-0.146***
	(0.104)	(0.103)	(0.103)	(0.102)	(0.045)	(0.044)	(0.044)	(0.044)
Dirty 100	0.008	0.006			0.016	0.015		
	(0.033)	(0.033)			(0.016)	(0.016)		
LWC*Dirty 100	-0.303*	-0.287*			-0.132**	-0.123*		
	(0.158)	(0.158)			(0.065)	(0.065)		
Dirty 100 in 92			-0.009	-0.013			0.017	0.014
			(0.033)	(0.033)			(0.016)	(0.016)
LWC*Dirty 100			-0.274*	-0.258*			-0.123**	-0.113*
			(0.152)	(0.151)			(0.061)	(0.061)
Ln(Plant Size)	0.506***	0.512***	0.506***	0.512***	-0.188***	-0.186***	-0.188***	-0.186***
	(0.037)	(0.037)	(0.037)	(0.037)	(0.022)	(0.021)	(0.022)	(0.021)
Skill Intensity	-1.506***	-1.492***	-1.504***	-1.489***	-0.523***	-0.516***	-0.524***	-0.517***
	(0.093)	(0.091)	(0.092)	(0.091)	(0.041)	(0.041)	(0.041)	(0.041)
Ln(Capex)	0.491***	0.483***	0.491***	0.483***	0.255***	0.252***	0.255***	0.252***
	(0.034)	(0.034)	(0.034)	(0.034)	(0.020)	(0.020)	(0.020)	(0.020)
Ln(Total Imports)	0.045**	0.046**	0.046**	0.045**	0.015**	0.015**	0.015**	0.015**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.003)	(0.003)	(0.003)	(0.003)
Year FE	Yes		Yes		Yes		Yes	
Industry*year FE		Yes		Yes		Yes		Yes
Industry FE	Yes		Yes		Yes		Yes	
Adjusted R^2	0.403	0.405	0.403	0.405	0.244	0.249	0.244	0.249

N=50,263 This table reports regression estimates of the impact of firms' imports from LWCs on their plant-level pollution abatement costs in the U.S. in 1992, 1993, 1994, 1999, and 2005. The sample includes all firms that import and are surveyed by the PACE. Standard errors are clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table IX FIRMS' IMPORTS FROM LWCs AND THEIR PLANTS' TOXIC EMISSIONS, RELATED PARTY

	Ln(Toxic Emission)		$\text{Ln}(\frac{\text{Toxic Emission}}{\text{Plant Shipment}})$	
	(1)	(2)	(3)	(4)
LWC Import Share	-0.565***	-0.429***	-0.113***	-0.084*
	(0.147)	(0.133)	(0.045)	(0.046)
LWC Import Share from Related Party	0.194	0.289	-0.205	-0.052
	(0.537)	(0.515)	(0.146)	(0.147)
Ln(Plant Size)	0.449***	0.451***	-0.062***	-0.061***
	(0.035)	(0.035)	(0.019)	(0.019)
Skill Intensity	-0.778***	-0.703***	-0.403***	-0.385***
	(0.154)	(0.150)	(0.055)	(0.055)
Ln(Capex)	0.056***	0.047***	0.015***	0.012***
	(0.009)	(0.009)	(0.004)	(0.004)
Ln(Total Imports)	0.022**	0.025**	-0.003	-0.002
	(0.011)	(0.011)	(0.004)	(0.004)
Year FE	Yes		Yes	
Industry*year FE		Yes		Yes
Plant FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.712	0.715	0.759	0.761

N=136,574. This table reports regression estimates of the impact of firms' imports from LWCs on their plant-level toxic emissions in the U.S. in 1992–2009, based on Equation (2). The sample includes all firms that import and are surveyed by the TRI. The dependent variable is a plant's toxic content from all-media pollutant emissions. Standard errors are clustered at the firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.