Pollution Haven or Hythe?[*]
New Evidence from Mexico

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Abstract

Foreign direct investment (FDI) flows into developing countries have been increasing dramatically over the past decade. At the same time, there has been widespread concern that lax environmental standards are in part responsible for this surge. This paper revisits the pollution haven hypothesis by examining to what extent the pollution intensity of production helps explain FDI in Mexico. By focusing on pollution intensities, which are directly related to emission regulations, we avoid the problem of unobservable pollution taxes and allow for substitution between capital and pollution. Examining several different pollutants, we find a positive correlation between FDI and pollution that is both statistically and economically significant in the case of the highly regulated sulfur dioxide emissions. Industries for which the estimated relationship between FDI and pollution is positive receive as much as 40 percent of total FDI and account for as much as 30 percent of manufacturing output. Although our results suggest that environmental considerations matter for firms' location decisions, FDI locates in Mexico also in accordance with its comparative advantage in labor-intensive production processes, consistent with the previous literature.

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[*]Hythe: a small haven - Webster's Revised Unabridged Dictionary.

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1 Introduction

Concerns about the effects of environmental standards on trade and investment flows abound. There is much talk about a "race to the bottom", where developing countries in particular are said to be increasing their competitive advantage in the world economy due to lower labor and environmental standards. Some in the developed world view the lower standards as "unfair" cost advantages and have suggested ways to limit or eliminate them. For instance, the labor and environmental side agreements to the North American Free Trade Agreement (NAFTA) sought to level the "standards" between the United States and Mexico. The side agreements hoped to prevent Mexico, which has lower environmental standards, from becoming a pollution haven for U.S. and Canadian firms trying to avoid the costs associated with more stringent domestic environmental standards.[1] However, the academic literature has largely failed to find empirical support for environmental standards to affect either trade or firms' investment decisions.[2]

A variety of factors, both theoretical and empirical, may account for the failure to find much empirical support for the "pollution haven hypothesis" (PHH). On the theoretical side, as a country develops and incomes rise, several forces are at work simultaneously. Low environmental standards during the early stages of industrial development should attract a disproportionate amount of polluting industries, which is a composition effect. Moreover, the increased scale of production should give rise to more pollution. On the other hand, as new factories replace

[1] Environmental regulations and their enforcement in Mexico were very low until well into the 1980s. The scope of environmental regulation has picked up only recently. The agency in charge of enforcement of regulations is Procuraduría Federal de Protección al Ambiente (PROFEPA), whose factory inspections expanded during the 1990s from only a few inspections per year to several thousand (Dasgupta et al., 2000). As far as compliance is concerned, in a confidential survey of 236 Mexican plants in the fall of 1995, Dasgupta et al. (2000) found that 52 percent of survey respondents admitted only occasional or no compliance with environmental regulations.

[2] See Wheeler (2001) and especially Jaffe et al. (1995). More recently, Eskeland and Harrison (2003) study the effect of abatement cost and pollution intensity on FDI in Morocco, Côte d'Ivoire, Venezuela, and Mexico and find essentially no effect of either measure. Smarzynska and Wei (2001) for a sample of 24 transition countries and Dean et al. (2003) in a study of China find some, though relatively weak evidence of a pollution haven effect.

their older and more polluting counterparts, pollution will decrease due to this "technique effect". Thus, capital intensity and vintage might be important in determining the existence of pollution havens. In particular, as multinational firms locate new plants in developing countries, they generally do so using state-of-the-art technology.[3]

On the empirical side, Levinson and Taylor (2003) note that many studies have been plagued by problems such as unobserved heterogeneity, aggregation bias or endogeneity of proxies for environmental stringency. Since decisions on output, inputs, and pollution abatement are made simultaneously, regressions of trade or FDI on pollution abatement costs have produced spurious and counter-intuitive results. Compounding the endogeneity problem is the use of U.S. data on pollution abatement costs to represent environmental regulations of both developed and developing countries. When aggregate data are used, the composition of the aggregated industry may change over time, thus attributing changes in pollution output to changes in environmental stringency instead of this composition effect. Finally, many unobserved characteristics of industry are not controlled for in empirical analyses, thus also leading to biased results.

Another reason why developing countries do not tend to become pollution havens may be that the stringency of a country's environmental standards is only one, and perhaps not the most important, factor determining comparative advantage among countries. In particular, endowment of factors such as skilled labor and capital largely determine where industry is located and which goods a country will export. To the extent that heavily polluting industries also tend to be capital-intensive, the relative paucity of capital in developing countries may outweigh their abatement cost advantage (Antweiler et al., 2001; Cole and Elliott, 2002).

[3] A survey of industrial plants in Indonesia revealed that compliance by multinationals is considerably higher than that by domestic firms (Dasgupta et al., 2000). Eighty percent of multinationals reported good or superior compliance.

This study adds to and improves upon the existing literature on pollution havens in several ways. First, we recast the PHH as a relationship between pollution intensity, which follows directly from emission control, and cost of production rather than that between pollution taxes and cost. The focus on pollution intensity is useful since it allows for substitution between capital and pollution and does not require data on pollution taxes, which are treated as unobservables in most prior studies (e.g., Levinson and Taylor, 2003). Second, by focusing on FDI rather than trade, we can explicitly test the hypothesis that firms relocate in order to take advantage of laxer environmental standards. Focusing on trade flows can help assess whether stricter environmental standards may harm domestic industry, but cannot model decisions to move to another location. Third, by focusing on one developing host country for which we have detailed information on industry-specific pollution by type of pollutant, we avoid measurement and endogeneity problems that have plagued many of the earlier studies. Fourth, we have industry level information on FDI and can identify the source country of investment, allowing us to control for a range of determinants of FDI known to matter, which greatly reduces the likelihood of spurious correlations.

In our empirical work, we focus on three distinct pollutants, sulfur dioxide (SO_2), nitrogen oxide (NO_x), and particulates (PT), which were chosen not only on grounds of data availability, but on the conditions that make them relevant for a study of the effects of pollution concentration on economic activity (Antweiler et al., 2001). These three pollutants are largely regulated at stationary sources. Others, notably carbon monoxide, are regulated at mobile sources, i.e. regulations are imposed on engine design rather than the production process. Hence, location of production would not matter in this case, as long as output is sold in the same market. Also, the scope of regulation varies among the pollutants we focus on. For instance, the U.S.

Environmental Protection Agency (EPA) has imposed NO_x limitations mostly on coal-based power plants, whereas SO_2 regulations affect metal and cement processing, petroleum refineries and others in addition to power plants. It thus seems plausible that the correlation between FDI and pollution varies across pollutants and in fact may only be positive for the most regulated pollutants.

Indeed, we find a significantly positive relationship between pollution intensity and FDI flows into Mexico only in the case of sulfur dioxide, whose primary source is industrial production, and then only in industries with large firms. However, these Mexican industries receive as much as 40 percent of total inward FDI and account for as much as 30 percent of total manufacturing output, depending on the empirical specification. Consistent with the previous literature on the determinants of FDI, we find also that firms locate in Mexico in accordance with its comparative advantage in labor-intensive production.

The remainder of the paper is organized as follows: The next section builds a simple theoretical model that derives the demand for foreign capital as a function of inputs, pollution levels and other economic variables. Section three lays out the empirical framework employed and discusses some econometric issues as well as the data used. This is followed by a discussion of results and conclusions.

2 A Theoretical Model of FDI and Emissions

Following Copeland and Taylor (2003), we consider a firm that jointly produces two outputs, good X and emissions Z, using variable inputs of labor and capital. Abatement of emissions is a choice for the firm, and we assume that the firm allocates an endogenous fraction, θ, of its inputs to abatement activity. The production technology is therefore given by:

$$X = (1 - \theta)F(K, L), \tag{1}$$

where K and L denote capital and labor inputs, respectively. Pollution emitted is a function of total output and the abatement intensity, θ:

$$Z = \phi(\theta)F(K, L), \tag{2}$$

where $\phi(\theta)$ is a decreasing function of θ. With no abatement, $\theta = 0, \phi(\theta) = 1$ and pollution emitted is proportional to output: $Z = F(K, L)$. When abatement intensity $\theta > 0$, $\phi(\theta) < 1$ and pollution is reduced. Note that abatement and production use factors in the same proportion.

Rather than model the choice on abatement intensity (θ) explicitly, we transform the problem to choose the level of Z (Copeland and Taylor, 2003). To see this, let $\phi(\theta) = (1-\theta)^{\frac{1}{\alpha}}$, $\alpha \in (0, 1)$ and $F(L, K) = TK^aL^b$(Cobb-Douglas). Then,

$$X = Z^{\alpha}T^{1-\alpha}K^{\beta}L^{\delta} \tag{3}$$

where $\beta = a(1 - \alpha), \delta = b(1 - \alpha)$, and T is an indicator of the level of technology.

Prior studies on the pollution haven hypothesis have assumed that emissions, Z, is a variable input whose price (tax) is exogenous. However, they have used abatement costs and/or industry-specific (fixed) effects to represent pollution taxes or intensity. Some studies use U.S. pollution intensities as a proxy for those of other countries (Keller and Levinson, 2002; Eskeland

and Harrison, 2003; Dean et al. 2003).We differ from these studies by modeling emissions in the form of an input constraint. Pollution taxes are rarely observed, but there is evidence that countries aim to limit emissions and in some instances, scale them back to a base period level. For example, the 1990 Clean Air Act requires companies to obtain a production permit, which limits their emissions of harmful pollutants (EPA; see also List et al., 2003 and European Environment Agency (EEA)). Let w and r denote wage and capital rental rate, respectively, and firms minimize costs as follows:

$$\begin{gathered}\min_{L,K,Z} wL + rK \\ s.t.\ Z^{\alpha}T^{1-\alpha}K^{\beta}L^{\delta} \geq \overline{X}, \\ Z \leq \overline{Z}, \end{gathered} \tag{4}$$

where the first constraint is the usual (given) output level, while the second constraint represents a ceiling on emissions. The first order conditions to the cost minimization problem are:

$$\begin{aligned} L &: \quad w - \lambda_1 \delta \left(\frac{X}{L}\right) = 0 \\ K &: \quad r - \lambda_1 \beta \left(\frac{X}{K}\right) = 0 \\ Z &: \quad -\lambda_1 \alpha \left(\frac{X}{Z}\right) - \lambda_2 = 0, \end{aligned} \tag{5}$$

where λ_1 and λ_2 are the Lagrange multipliers associated with the constraints, which are assumed to hold with equality. Taking the ratio of the first order conditions with respect to L and K, and using $\overline{Z}^{\alpha}T^{1-\alpha}K^{\beta}L^{\delta} = \overline{X}$, the optimal L and K, denoted as L^o and K^o, are derived as follows:

$$\begin{aligned} L^o &= \left[\overline{Z}^{-\alpha}T^{\alpha-1}\overline{X}\left(\frac{r}{w}\right)^{\beta}\left(\frac{\delta}{\beta}\right)^{\beta}\right]^{\frac{1}{\beta+\delta}} \\ K^o &= \left[\overline{Z}^{-\alpha}T^{\alpha-1}\overline{X}\left(\frac{w}{r}\right)^{\delta}\left(\frac{\beta}{\delta}\right)^{\delta}\right]^{\frac{1}{\beta+\delta}}. \end{aligned} \tag{6}$$

Note that

$$\frac{\partial K^o}{\partial \overline{Z}} = -\frac{\alpha}{\beta+\delta}\overline{Z}^{\frac{-(\alpha+\beta+\delta)}{\beta+\delta}}\left[T^{\alpha-1}\overline{X}\left(\frac{w}{r}\right)^{\delta}\left(\frac{\beta}{\delta}\right)^{\delta}\right]^{\frac{1}{\beta+\delta}} < 0, \quad (7)$$

which suggests a negative relationship (substitution) between optimal capital and emissions, given an output level ($\overline{X}$).

Then, the cost function is given by:

$$\begin{aligned} C(w,r;\overline{X},\overline{Z}) &= wL^o + rK^o & (8) \\ &= \omega \overline{Z}^{-\frac{\alpha}{\beta+\delta}} T^{\frac{\alpha-1}{\beta+\delta}} \overline{X}^{\frac{1}{\beta+\delta}} w^{\frac{\delta}{\beta+\delta}} r^{\frac{\beta}{\beta+\delta}} \end{aligned}$$

where $\omega = \left[\left(\frac{\delta}{\beta}\right)^{\frac{\beta}{\beta+\delta}} + \left(\frac{\beta}{\delta}\right)^{\frac{\delta}{\beta+\delta}}\right]$.[4]

The effect of emissions on cost of production is given by:

$$\frac{\partial C}{\partial \overline{Z}} = -\left(\frac{\alpha}{\beta+\delta}\right)\overline{Z}^{\frac{-(\alpha+\beta+\delta)}{\beta+\delta}}\left[\omega T^{\frac{\alpha-1}{\beta+\delta}}\overline{X}^{\frac{1}{\beta+\delta}} w^{\frac{\delta}{\beta+\delta}} r^{\frac{\beta}{\beta+\delta}}\right] < 0, \quad (9)$$

i.e., if $\overline{Z}$ increases, costs decline. If a country allows greater emissions either by lower taxes or lax regulations, it would lower the cost of producing $\overline{X}$. For $\alpha = 0.25$, $\beta + \delta = 1.25$, figure 1 illustrates the relationship between $C(\overline{Z})$ and $\overline{Z}$, holding all else constant.

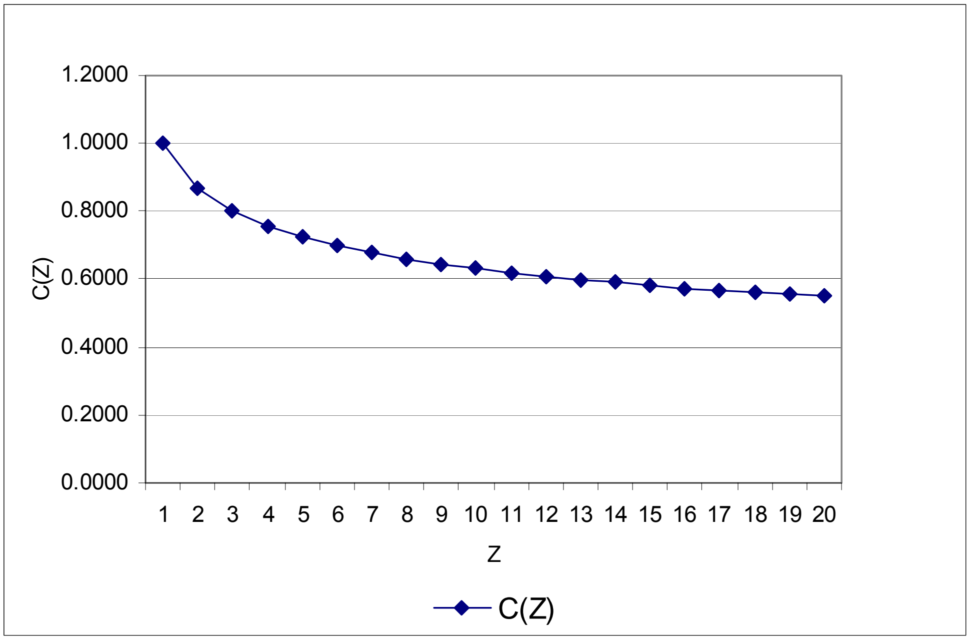
Given the cost function above, consider a representative multinational firm that produces and sells in two markets: home and foreign. The cost function for overseas production carries the * superscript for $X, Z, K, L, T, w, r, \alpha, \beta$, and δ and is given by $C^*(\overline{X}^*) = C^*(w^*, r^*; \overline{X}^*, \overline{Z}^*)$. Profit maximization in this context involves choosing both sales (S and S^*) and output ($\overline{X}$ and $\overline{X}^*$) in both markets:[5]

$$\pi = \max_{S,S^*,\overline{X},\overline{X}^*} P_S(S,\eta)S + P_{S^*}(S^*,\eta^*)S^* - C(\overline{X}) - C^*(\overline{X}^*), \quad (10)$$

[4] Note that in the derivation of the cost function, we have allowed for constant, increasing or decreasing returns to scale. The value of $\beta + \delta$ determines the degree of returns to scale, where $\beta + \delta = 1$ implies constant returns.

[5] While we do not include intermediate goods, it would be straightforward to extend the model to include multiple production stages. For instance, the cost function can be modified such that the locations of intermediate and final goods production are endogenous.

Figure 1: Cost and Emissions



$$s.t.\ S + S^* = \overline{X} + \overline{X}^*,$$

where $P_S(.)$ and $P_{S^*}(.)$ are inverse demand functions with shifters η and η^* respectively, which represent other factors affecting demand such as aggregate market size. Note that trade in goods $(S^* - \overline{X}^*$ or $S - \overline{X})$ is redundant in this specification. The first order conditions are:

$$\begin{aligned} \pi_S &: \quad MR - \psi = 0, \\ \pi_{S^*} &: \quad MR^* - \psi = 0, \\ \pi_{\overline{X}} &: \quad -MC + \psi = 0, \\ \pi_{\overline{X}^*} &: \quad -MC^* + \psi = 0, \end{aligned} \tag{11}$$

where MR and MR^* (MC and MC^*) denote marginal revenue (cost) in home and foreign markets, respectively, and ψ is the Lagrange multiplier associated with the constraint. Using implicit function theorem, the endogenous variables $(S, S^*, \overline{X}, \overline{X}^*)$ are derived as functions of all exogenous variables. For instance, foreign production, $\overline{X}^*$, is given by:

$$\overline{X}^* = \overline{X}^*(\overline{Z}, \overline{Z}^*, T, T^*, \eta, \eta^*, w, w^*, r, r^*). \tag{12}$$

The foreign investment demand, an optimal input demand function, is obtained from the cost function using Shephard's lemma:

$$\frac{\partial C^*}{\partial r^*} = K^* = K^*(w^*, r^*; \overline{X}^*, \overline{Z}^*). \tag{13}$$

Continuing on the Cobb-Douglas example in the cost minimization problem, note that the foreign production level ($\overline{X}^*$) is endogenous in the multinational's foreign investment demand function. Therefore, the effect of emissions on foreign capital flows has two components:

$$\frac{dK^*}{d\overline{Z}^*} = \frac{\partial K^*}{\partial \overline{Z}^*} + \frac{\partial K^*}{\partial \overline{X}^*}\frac{\partial \overline{X}^*}{\partial \overline{Z}^*}, \tag{14}$$

where we showed earlier that $\frac{\partial K^*}{\partial \overline{Z}^*} < 0$ (substitution effect, equation 7). Since we optimize over $\overline{X}^*$ there is a second effect, which we refer to as the "output effect." An increase in emission substitutes for capital in foreign production, but the lower costs abroad increase foreign output as well. As foreign output increases, so does the demand for capital. Using the Cobb-Douglas example again, we find that the derivatives, $\frac{\partial K^*}{\partial \overline{X}^*}$ and $\frac{\partial \overline{X}^*}{\partial \overline{Z}^*}$, are both positive. The derivative $\frac{\partial K^*}{\partial \overline{X}^*}$ denotes the increase in foreign capital demand due to a unit increase in foreign output, while $\frac{\partial \overline{X}^*}{\partial \overline{Z}^*}$ is the pollution intensity of foreign production. The net effect of emissions on foreign capital flows depends on the relative strength of the substitution and the output effects, which are presumably empirical questions. For instance, if the latter effect dominates, a higher ceiling on emissions would encourage foreign capital flows, despite K^* and $\overline{Z}^*$ substitutability.

3 Empirical Framework

This section shows how we use the theoretical setup from the previous section plus insights from the vast theoretical literature on the determinants of FDI to arrive at an estimating equation. In addition, it discusses some econometric issues that arise from the data structure and describes the data, its sources and limitations, in more detail.

3.1 The Empirical Model

Our empirical FDI specification is:

$$\begin{aligned} FDI_{ijt} = {} & \beta_0 + \beta_1 pollutionmex_i + \beta_2 \left(pollutionmex_i * output_i\right) \\ & + \beta_3 pollutionsrc_{ij} + \beta_4 capintensitymex_i + \beta_5 capintensity_{ij,t-1} \\ & + \beta_6 skillabundancemex_t + \beta_7 skillabundance_{jt} + \beta_8 skillintensity_{it} \\ & + \beta_9 numplants_i + \beta_{10} MexGDP_t + \beta_{11} GDP_{jt} + \beta_{12} FDIaglom_{it} \\ & + \beta_{13} invcostmex_t + \beta_{14} tradeopenmex_t + \beta_{15} tradeopenpar_{jt} + \beta_{16} distance_j + \varepsilon_{ijt} \end{aligned} \tag{15}$$

The subscripts indicate each regressor's variation over time (t), across industries (i) and source countries (j). The variables *pollutionmex* and *pollutionsrc* denote Mexican and source country pollution intensities, respectively. Similarly, Mexican and source country capital intensities are represented by *capintensitymex* and *capintensity*. The source country's capital intensity variable is lagged by one period to avoid contemporaneous determination of FDI and capital stock in an industry.[6]

Note that emissions have a direct substitution effect on FDI flows, but there is an indirect effect that is a combination of the emissions effect on foreign production (pollution intensity) and

[6] Unfortunately, no time series variation is available for Mexican capital intensities.

output of foreign production. To capture these two effects, therefore, we include both pollution intensity and its interaction with plant output.[7] Applying the derivative in (14) to our empirical specification in (15) shows that:

$$\frac{\partial FDI_{ijt}}{\partial pollutionmex_i} = \beta_1 + \beta_2 \; output_i \tag{16}$$

The expected sign of β_1 is negative, the substitution effect. The expected sign of β_2 is generally positive and for the pollution haven hypothesis to hold, the entire derivative in (16) would need to be positive.[8]

In our empirical work, we focus on three distinct pollutants, sulfur dioxide (SO_2), nitrogen oxide (NO_x), and particulates (PT). Antweiler et al. (2001) outline a number of conditions that make a pollutant relevant in a study of the effects of pollution concentration on economic activity. Similarly, we claim that for a pollutant to be useful for us, it should (a) be a by-product of goods production, (b) vary in emission intensity across industries, (c) be subject to regulations because of its noxious effect on the population, and (d) have abatement technologies available for implementation. The potential harm of a pollutant together with the possibility to avoid at least some of its effect through abatement gives rise to regulation which, in turn, affects the cost of production in different locales. In addition, for practical purposes, the choice of pollutants is driven by data availability. Antweiler et al. (2001) use only sulfur dioxide which they claim satisfies essentially all of the above properties. Others, e.g. Cole and Elliott (2003), use a number of pollutants to check the robustness of results to the choice of pollutant.

The scope of regulation and the source of emissions varies widely across pollutants and thus, we expect the results of our analysis to differ across pollutants. All three pollutants are regulated

[7] In line with the theory, this should only be output of foreign-owned plants. Since the output data are not differentiated by ownership, total industry output is used to calculate plant output. The advantage of this measure is that it should mitigate endogeneity concerns.

[8] Note, however, that the output effect, and hence β_2, may be negative if the emissions constraint $\overline{Z}$ is not binding, as may be the case with a pollutant that is not or only weakly regulated in industry, such as PT.

at stationary sources. This is not true for other pollutants, notably carbon monoxide, which is largely regulated at mobile sources, making the location of production less relevant. The SO_2 regulations affect a much wider range of industries than regulations of NO_x or PT, which are largely imposed on coal-based power plants. Finally, the extent of industrial production processes being the source of emissions should be a rough indicator of the relevance of a particular pollutant to industry. OECD (2002) provides information on emission sources for pollutants for a number of countries and years. In 1999 U.S. data, the main source of SO_2 emissions were industry and energy transformation, while the main source of NO_x (and to an even greater extent carbon monoxide) emissions was transportation.

Equations (12) and (13) suggest that there are a number of other determinants of foreign capital and we make use of the literature on the determinants of FDI to select appropriate variables. Moreover, we note that although the focus of this study is on the effect of pollution, it is crucial to control for as many known determinants of FDI as possible in order to minimize the problem of omitted variable bias.

If countries are in different cones of diversification, endowment differences reflect factor price differences. Following Markusen (1997; 2002), Carr et al. (2001) and Markusen and Maskus (2002), we use parent country and Mexican measures of skilled-labor endowments (*skillabundance* and *skillabundancemex*) to capture such differences.[9] If FDI is, in addition to environmental considerations, determined by comparative advantage stemming from factor en-

[9] Markusen's (2002) "knowledge-capital model" assumes that headquarter services of a multinational firm (e.g. R&D) can be geographically separated from production activities and supplied simultaneously to several production facilities at low cost. The ordering of skill-intensities in the economy is such that headquarter services are more skilled-labor intensive than production, which in turn is more skilled-labor intensive than the rest of the economy. Then, if countries differ sufficiently with respect to their endowments such that they are in different cones of diversification, the skilled-labor abundant country will be the headquarter site, while the unskilled-labor abundant country will have a comparative advantage in hosting the production facility. Consequently, foreign investment in unskilled-labor abundant countries should flow into industries that are relatively unskilled-labor intensive.

dowments, FDI should originate in countries that are skilled-labor abundant relative to Mexico. Skill abundance is measured as the endowment share of skilled labor in the source country and Mexico, respectively. In addition, FDI should flow into industries that are relatively unskilled-labor intensive. *Skillintensity* is measured as the share of skilled workers in an industry. This is consistent, e.g., with the definition used by Feenstra and Hanson (1997). Skill intensities exhibit substantial heterogeneity across sectors, ranging from 11 to 63 percent skilled labor (see the summary statistics in Table 1).

Additional factors affecting industry-level FDI are plant and corporate scale economies and the degree of concentration.[10] Markusen (1997; 2002) and Brainard (1997) emphasize the positive effect of firm level scale economies on FDI as headquarter services can be spread across many plants. However, FDI is negatively affected by plant scale economies, which encourage concentration of production. Finally, multinationals tend to operate in imperfectly competitive industries with positive profits and hence a high degree of concentration in an industry would also encourage FDI. Data availability precludes the use of the same measures used in Brainard (1997), so we use the number of plants (*numplants*) as a proxy for plant level scale economies. The advantage of our measure is that we use information from industries that FDI is actually flowing into. Both Brainard (1997) and Yeaple (2003) use U.S. measures of scale economies, which may not be applicable to developing (host) economies.

Aggregate U.S. and Mexican GDP, representing shifters η and η^* in the inverse demand functions, are also included in our empirical model. Parent country GDP is expected to be positive as larger countries tend to have more outward FDI in absolute terms. A positive coefficient on Mexican GDP would indicate the importance of host country market size.

The inclusion of accumulated FDI recognizes the fact that more FDI tends to flow into

[10] Recall that we allow for increasing returns to scale in the derivation of the cost function.

industries with a previous presence of foreign investors, due to positive spillover effects or the availability of specialized inputs. Wheeler and Mody (1992), for example, find strong evidence that agglomeration economies positively affect FDI.

The final elements that impact FDI in this framework are transport and more generally trade and investment costs. If transport costs are low, a firm might substitute exports for foreign production. Parent country trade costs should have a negative effect on multinational activity of all types since exporting back to the home country from a foreign country would be more costly relative to home production. Host country trade costs, on the other hand, should encourage multinational activity, the well-known tariff-jumping argument. Host country investment costs should have a negative effect. The measure of Mexican investment cost accounts for both formal investment barriers as well as the overall economic climate that affects the decision where to invest. Source country and host country (Mexican) trade costs are measured by the ratio of exports plus imports to GDP, an often used measure of the trade openness of a country. This measure is used over others since it is available for the entire sample period. Since greater openness corresponds to lower trade costs, a positive sign is expected for parent country, but a negative sign for host country trade costs. Finally, distance is measured as the distance between country capitals. Its sign is theoretically ambiguous since it can proxy for both trade and investment costs. It is included since it usually performs well in gravity-type models.

3.2 Econometric Issues

The theoretical model derives an expression for the demand of foreign capital, that is the foreign capital stock, K^*. However, we only observe capital flows F^* in the data. A partial adjustment model describes flows as

$$F_t^* = (1-\alpha)\left(K_t^* - K_{t-1}^*\right) \tag{17}$$

where α is an adjustment parameter. Substituting equation (13) into (17) relates capital flows to all the determinants of the model. Additionally, the lagged capital stock is included, which we proxy with accumulated FDI, by industry. To the extent that reported capital stock data are compiled from historical flows, this should be a good approximation.

Since there are many source country-industry pairs with no FDI in a given year, there is a prevalence of zeros in the data. Hence, we estimate a tobit model. While FDI flows can be positive or negative for a given industry in a given year, their negative value cannot exceed the stock of FDI. Specifically, let $F^{desired}$ be a latent variable signifying the amount of the desired foreign investment flow. We observe

$$\begin{aligned} F &= F^{desired} \text{ if } F^{desired} \geq 0 \\ F &= F^{desired} \text{ if } F^{desired} < 0 \text{ and } \left|F^{desired}\right| \leq K^* \\ F &= -K^* \text{ if } F^{desired} < 0 \text{ and } \left|F^{desired}\right| > K^* \end{aligned} \tag{18}$$

Again, since no stocks are observed, observations are treated as censored if an industry-year-source country observation is zero and there has not been a positive flow in that industry in a previous time period. If anything, this treats too many observations as censored and results are biased against finding significant effects.

Since not all regressors vary along all dimensions, disturbances may be correlated within groups. While the coefficients would still be unbiased, they are inefficient and variances and hence standard errors could be biased (Kloek 1981, Moulton 1986). Thus, clustering is taken into account and all estimates are adjusted accordingly. A complicating factor is that there are two clusters: industries as well as source countries. Below, we focus on results that are adjusted for clustering on industry.[11] Finally, industry size varies substantially, implying potential heteroscedasticity in the error structure. We deal with this issue by using industry size as weights and estimating robust standard errors.

3.3 Data

FDI data come from the Mexican National Statistical Institute (INEGI). These are nominal FDI inflows into Mexico in U.S. dollars from 1994 to 2000.[12] The data are at the 4-digit industry level, using the Mexican Industrial Classification System (CMAP), which is very similar to the 1968 International Standard of Industrial Classification. Just over 60 percent of FDI has gone into the manufacturing sector during this seven-year period. Within the manufacturing sector, the bulk of FDI goes into production of metal products, including automobiles. Thus not surprisingly, many automobile manufacturers, such as General Motors, Ford, DaimlerChrysler and Volkswagen, are among the largest foreign investors.

For the entire sample period, FDI inflows fluctuate around $10 billion per year. This is considerably more than Mexico received on an annual basis prior to 1994. Foreign investment flows were low for much of the 1980s. The first substantial increase in FDI in the late 1980s and early 1990s coincided with a major overhaul of Mexico's investment laws in 1989. Many obstacles to foreign investors, such as licensing requirements and restrictions pertaining to majority ownership, were removed. This change reversed Mexico's long-standing policy of reserving ownership in many sectors to Mexican nationals or the Mexican state and encouraging foreign investment only in sectors that were deemed crucial to the pursuit of import substitution policies. At the

[11] Adjusting for clustering on country rather than industry gives very similar results.

[12] These are converted to real flows in the estimation below. Note that the detailed information on FDI is not available prior to 1994 when Mexico started complying with World Bank standards for data collection.

same time, and earlier than in many other countries in the region, substantial privatizations occurred. By 1994, the number of state-owned enterprises had decreased to only 80, down from 1155. However, foreign investors participated in this sale only to a small degree. FDI from privatization constituted only 7.9 percent of total FDI between 1990 and 1995 (Franko 1999: 158-61). Yet, during the first half of the 1990s, Mexico was the major recipient of FDI in Latin America, with a big surge occurring in 1994 after the inception of NAFTA.

During the sample period, most FDI comes from the United States, with European Union countries a distant second. The only other major source countries of FDI are Japan and South Korea. Not surprisingly, investments from developed countries vastly dominate Mexican inward FDI with negligible amounts from developing countries. Altogether, OECD countries account for over 95 percent of all FDI flows.

Data on pollution intensities are available for only a small number of countries and industries. For the purpose of this paper, we have data on U.S. and Mexican pollution intensities. We are using the U.S. data for all source countries of FDI, which assumes that pollution intensities in these (mostly developed) countries are approximately similar. The novel point is that we use different pollution intensity data for the FDI host country, Mexico. The data on pollution intensities for the U.S. come from the World Bank's Industrial Pollution Projection System (IPPS). This comprehensive data set was developed in coordination with the U.S. Environmental Protection Agency (EPA) and the U.S. Census Bureau. The information is based on surveys of more than 200,000 U.S. factories in 1987. While we would rather have more recent data, they are not available.[13] The data for Mexico have also been produced by the World Bank, in collaboration with Mexico's Instituto Nacional de Ecologia (INE). They derive from surveys of

[13] The fact that pollution intensities are measured at a point in time before the start of the FDI series does have the advantage that we need not be concerned that pollution intensities might be endogenous.

a total of 5,799 small, medium, and large firms. U.S. pollutants are originally in pounds per $1 million in (1987) output and were converted to tons per $1000 in (1995) output. Mexican pollution intensities were originally in tons per employee, but were also converted to tons per $1000 in (1995) output, using employment and output information for each industry from the Mexican Industrial Census.

Data on industry level capital intensities come from two sources. For Mexico, we have information from the (comprehensive) 1998 industrial census, which is comparable in scope to the U.S. Census of Manufacturing. Annual data are available only from surveys of a limited number of establishments and a cursory check reveals large discrepancies between those numbers and the ones obtained from the Census for many industries. Moreover, we do not expect capital intensities to change very quickly and are thus confident that the lack of time series variation will not adversely affect our results.

For source countries, we take information on capital from the OECD's STAN database, where capital flows are converted to stocks using the perpetual inventory method. Unfortunately, there are a large number of missing values, leading to a dramatic drop in the number of observations. We therefore assume that technologies outside of Mexico are identical and can be represented by U.S. technologies, where we have information on all the industries that we also have pollution information for.[14] GDP and exchange rate data come from *International Financial Statistics (IFS)*. Other data sources are standard as well and have been used in the literature on the determinants of FDI, e.g. Carr et al. (2001), Blonigen et al. (2003), or Markusen (2002). For further details, see the summary statistics in Table 1.

[14] Since most FDI source countries are developed countries, we do not think of this as an overly restrictive assumption.

4 Results

Results are shown in Tables 2-4. Each table shows the results from a different pollutant. We focus our discussion on the most important pollutant, sulfur dioxide (Table 2). Each table contains four specifications. The first, in column (1), estimates equation (15) in levels. First note that the coefficient on Mexican pollution is significantly negative, as predicted by theory. This reflects the substitution effect. The coefficient on the interaction between pollution and output is positive, reflecting what we termed an "output effect" above. A Wald test reveals that the two coefficients are jointly significant.[15] The total effect of Mexican pollution on FDI flows can then be computed according to (16). It is negative for 84 percent of source country-industry pairs, suggesting that for the most part, the substitution effect dominates the output effect. However, larger firms also receive more FDI. Those industries where average output is large enough that the correlation between pollution intensity and FDI is positive account for close to 40 percent of total FDI flows during the sample period (see bottom of Table 2). Their share of total output exceeds 30 percent. Moreover, since SO_2 intensity is measured in terms of output, the total amount of pollution generated by these firms is quite large. There is thus compelling evidence of a pollution haven effect.

The signs of other determinants of FDI are in line with the theory. Both source country and Mexican GDP have a significantly positive effect on FDI, reflecting market size effects. Source countries tend to be more skill abundant, as evidenced by the significantly positive coefficient on that variable. The negative coefficient on the number of plants suggests that industries that receive more FDI are characterized by scale economies. Mexican skill intensity has the expected negative sign, but it is not significant. This might be because we already control for aggregate

[15] All three coefficients involving pollution intensity (including the source country one) are jointly significant as well.

skill differences between source countries and Mexico, leaving no independent effect for sector-level skill differences. Mexican capital intensity of production, on the other hand, is significantly negative, confirming that Mexico has a comparative advantage in labor-intensive production.

To gauge the robustness of our results, we make various modifications to the basic specification, three of which we report in columns (2) through (4). In column (2), we add economy-wide measures of the capital-labor ratio ($capitalabundance(mex)$), separately for Mexico and the source countries. These can be viewed as proxies for aggregate factor price differences between Mexico and the source countries of FDI, to the extent that endowment differences reflect factor price differences. None of the results except Mexican GDP are affected. The latter becomes insignificant due to its near-collinearity with the aggregate Mexican capital-labor ratio. Note also the persistence of the quantitative importance of those investors for whom the correlation between pollution intensity and FDI is estimated to be positive.

Empirical FDI studies based on the knowledge-capital model usually include a measure of total (host and source country) market size and focus on skill endowment differences, rather than skill endowments separately (e.g. Carr et al., 2001; Markusen, 2002). Accordingly, column (3) replaces the separate measures of source and Mexican GDP and source and Mexican skill endowments with the sum of GDP and skill differences, respectively. Both new variables are significant, with expected signs, yet the pollution results change neither qualitatively nor quantitatively.

In column (4), we estimate (15) in logs rather than levels. Then, the estimated coefficients directly denote elasticities. We have not chosen to make this our base specification due to the prevalence of zeros and some negative values of FDI flows. For the log specification, we set observations with a value of zero equal to one, so that $ln(1) = 0$, and drop the 14 negative flow observations. We caution that results obtained by changing the functional form and changing the sample size are not directly comparable to the other results, but note that the signs and significance levels of our central variables of interest are virtually unchanged. Most notably, the direct pollution effect is significantly negative at the one percent level, while the interaction term (the output effect) is significantly positive. The estimated elasticity of substitution between pollution and FDI is much larger than the elasticity of FDI with respect to output, confirming our earlier results. The major difference is that the estimated quantitative significance of industries for which the total pollution effect on FDI is positive is smaller. Specifically, these industries account for just over five percent of total FDI and total output now. The signs and significance levels of other variables are comparable, with the exception of the number of plants, which are now, counterintuitively, significantly positive.

Overall, the results confirm the findings of previous literature: FDI into Mexico is driven by its comparative advantage based on factor endowments, specifically its abundance of (unskilled) labor, as well as market size. The novel result is that there is also a positive relationship between the ability to pollute in Mexico and FDI inflows. It is economically significant, but the precise quantitative effect does depend on the empirical specification. Hence, Mexico can be characterized at least as a pollution hythe, if not a haven.

Table 3 shows the results from the same four specifications, but using nitrogen oxide intensity as the measure of pollution. In the levels specifications, all of the Mexican pollution variables have the expected signs, but none of them are significant. In the log specification (column 4), only the interaction with output is significantly positive. Thus, these results suggest that NO_x pollution is not a significant determinant of FDI in Mexico. Since, as noted earlier, the dominant source of NO_x pollution is transportation, not industry, we are not surprised to find that FDI is not attracted to NO_x-intensive industries. As before, the results for other coefficients are consistent with theory and other empirical studies.

We comment only briefly on the results for particulate matter (Table 4). Particulate matter does not appear to have any effect on FDI, as evidenced by the insignificance of the pollution variables in any specification. This result further supports our contention that the pollution haven hypothesis is only relevant with respect to industries that are pollution intensive and are highly regulated in industrialized countries.

To sum up, our results indicate that for a highly regulated pollutant whose primary source is industrial production, such as SO_2, laxer environmental regulations appear to attract some polluting industries. These industries may account for a sizeable fraction of FDI flows, output and overall emissions. Comparative advantage resulting from factor abundance remains a significant determinant of the location of production. Pollution intensities of other, less-regulated pollutants do not appear to drive FDI flows. While this result in itself is novel, the inclusion of other robust determinants of FDI makes us confident that we have indeed isolated the effect of pollution intensity of an industry on FDI flows and that the results are unlikely to be due to omitted variable bias.

5 Conclusion

This study has revisited the pollution haven hypothesis for the case of Mexico. We investigate whether FDI flows into Mexico are indeed determined by the pollution intensity of production. On the one hand, laxer environmental regulation in Mexico, in spite of recent improvements in laws and enforcement in the wake of NAFTA, may make Mexico an attractive production location for polluting industries. On the other hand, the existing literature has largely failed to find much evidence for the validity of the PHH, in accordance with the notion that pollution abatement costs simply constitute too small a fraction of total cost to drive location decisions of firms.

We improve on and complement the existing literature in several ways. By focusing on pollution intensities rather than abatement cost, we allow for the substitution of pollution and capital and avoid the problem of unobservable pollution taxes. We have information on host country pollution intensities and thus do not need to assume identical pollution intensities in Mexico and its (largely developed) source countries. The availability of detailed FDI information, including the source country of investment, allows us to control for a wide range of determinants of FDI drawn from theory and thus greatly reduces the likelihood of finding spurious correlations.

We find that there is indeed evidence of a pollution haven effect. While only a few industries are estimated to have a positive correlation between pollution and FDI flows, these may account for a substantial share of received FDI and output. Depending on the empirical specification, they account for anywhere between five and 40 percent of total FDI and between five and 30 percent of output over the sample period. Other than that, FDI is largely driven by Mexico's comparative advantage in labor-intensive production processes. Finally, these results are obtained for sulfur dioxide emissions, a highly regulated pollutant that largely originates in industry. For other pollutants that are less regulated or come largely from non-industry sources, no systematic relationship between FDI and pollution is detected.

The finding that pollution and FDI flows have a positive relationship has important policy implications. Lowering developed (home) country environmental regulations may not be desirable or politically feasible, but options exist to induce a host country to raise its regulatory level (e.g., side agreements to NAFTA or EU accession). However, inducing one or a small group of countries to tighten regulation is likely to simply shift the problem of pollution-intensive production to other favorable developing country hosts over time. Restricting imports from pollution havens may violate WTO agreements and likely addresses only a part of the problem if FDI is used instead to access host or other foreign country markets. It might be in the best interest of developed economies to achieve a minimum set of global environmental standards, which can provide policy options to regulate pollution locally and globally.

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Table 1: Summary Statistics

Variable	Unit	Median	Standard Deviation	Minimum	Maximum
Real FDI	$1,000	0	23,815	-355,271	870,290
SO_2 Mexico	*	649.1	2,236	15.46	12,543
SO_2 source	*	433.9	2,608	5.727	14,096
NO_x Mexico	*	700.3	909.9	16.33	4,454
NO_x source	*	389.9	1,147	0.657	4,735
PT Mexico	*	517.3	1,562	7.557	6,696
PT source	*	111.6	833.5	0.328	4,779
capintensitymex	#	23.51	58.91	3.740	318.2
capintensity	#	76.74	108.3	8.697	756.9
skillabundancemex	share	15.05	0.476	14.56	15.81
skillabundance	share	26.33	10.69	5.948	46.09
skilldifferences		10.88	10.69	-9.702	30.27
capitalabundancemex	#	67.24	3.002	65.29	74.79
capitalabundance	#	93.87	10.09	78.81	112.1
skillintensity	share	25.50	10.95	11.23	62.77
industrysize	$million	3,355	6,281	165.6	41,422
numplants		1,892	8,470	27	38,029
output per plant	$million	1.760	20.45	0.026	94.33
MexGDP	$billion	321.6	28.19	286.6	375.2
GDP	$billion	115.8	1,506	3.96	9,049
SumGDP	$billion	446.3	1,507	290.6	9,424
FDIaglom	$1,000	14,130	705,989	-9,994	5,588,123
invcostmex	index	62	2.794	57	66
tradeopenmex	share	62.26	6.167	38.48	65.33
tradeopenpar	share	66.72	53.22	16.44	339.1
distance	km	9,442	3,920	1,236	16,641

* All pollution intensities are measured as tons per $1 million in real output (base year=1995).
# Capital intensity and capital abundance are measured in $1,000 per employee.
All dollars are real values with base year 1995.

Table 2: Estimation Results for Sulfur Dioxide

	Dependent Variable: Inward FDI			
Regressors	(1)	(2)	(3)	(4) logs
pollutionmex	-8.357**	-8.363**	-8.308**	-0.850***
	(3.753)	(3.754)	(3.744)	(0.228)
pollutionmex∗output	0.355**	0.357**	0.318**	0.200***
	(0.140)	(0.140)	(0.133)	(0.071)
pollutionsrc	-3.452	-3.444	-3.590	0.336
	(2.169)	(2.166)	(2.194)	(0.245)
capintensitymex	-303.0***	-303.0***	-297.7***	-1.228***
	(88.86)	(88.84)	(87.15)	(0.372)
capintensity	-56.35	-57.02	-38.68	-0.394
	(59.25)	(59.25)	(59.25)	(0.709)
skillabundancemex	-937.9	-4,786		4.389
	(3,503)	(8,141)		(3.449)
skillabundance	1,155**	1,149**		1.976**
	(501.1)	(497.4)		(0.819)
skilldifferences			1,155**	
			(499.0)	
capitalabundancemex		-488.7		
		(874.4)		
capitalabundance		1,023		
		(823.5)		
skillintensity	-117.3	-113.2	-205.4	0.955
	(229.8)	(230.9)	(216.8)	(0.939)
numplants	-1.015***	-1.016***	-0.992**	1.198***
	(0.394)	(0.394)	(0.388)	(0.461)
MexGDP	269.7**	10.44		0.996
	(129.5)	(213.1)		(1.613)
GDP	6.236***	6.260***		1.660***
	(1.832)	(1.836)		(0.317)
SumGDP			6.322***	
			(1.847)	
FDIaglom	0.003	0.003	0.004	0.572***
	(0.003)	(0.003)	(0.003)	(0.116)
invcostmex	977.6	1,573	-635.1**	-2.555
	(1,278)	(1,600)	(264.2)	(2.826)

continued

Notes: All results from estimating a censored regression model as described in the text. Robust standard errors are in parentheses; ***, **, * denote significance at the 1, 5, and 10 percent level, respectively; all regressions include a constant (not reported).

Table 2, continued: Estimation Results for Sulfur Dioxide

Regressors	Dependent Variable: Inward FDI (1)	(2)	(3)	(4) logs
tradeopenmex	177.3	-332.8	969.7***	171.3
	(186.2)	(642.8)	(280.8)	(186.2)
tradeopenpar	48.02	48.38	46.58	49.97
	(73.71)	(73.97)	(71.90)	(72.10)
distance	-1.211	-1.210	-1.210	-1.238
	(0.944)	(0.942)	(0.941)	(0.934)
Observations	12,926	12,926	12,926	12,912
Log likelihood	-15,805	-15,804	-15,813	-5,607
Wald χ^2	120.7	146.4	99.00	358.5
Prob > χ^2, p-value	0.00	0.00	0.00	0.00
Joint significance of all pollution coefficients, p-value	0.00	0.00	0.00	0.00
Joint significance of all Mexican pollution coefficients, p-value	0.00	0.00	0.00	0.00
Share of FDI into industries with $\frac{dFDI}{dpollutionmex} > 0$	0.395	0.395	0.394	0.051
Share of output of industries with $\frac{dFDI}{dpollutionmex} > 0$	0.307	0.307	0.293	0.057

Notes: All results from estimating a censored regression model as described in the text. Robust standard errors are in parentheses; ***, **, * denote significance at the 1, 5, and 10 percent level, respectively; all regressions include a constant (not reported).

Table 3: Estimation Results for Nitrogen Oxide

	Dependent Variable: Inward FDI			
Regressors	(1)	(2)	(3)	(4) logs
pollutionmex	-4.594	-4.605	-4.506	0.101
	(6.059)	(6.049)	(6.137)	(0.280)
pollutionmex∗output	0.216	0.219	0.159	0.219***
	(0.401)	(0.400)	(0.412)	(0.056)
pollutionsrc	0.233	0.256	-0.188	-0.262
	(4.458)	(4.449)	(4.513)	(0.275)
capintensitymex	-362.8***	-362.8***	-359.4***	-0.860**
	(96.49)	(96.43)	(95.51)	(0.408)
capintensity	-76.95	-77.74	-58.63	-0.638
	(56.68)	(56.58)	(55.41)	(0.766)
skillabundancemex	-893.2	-4,616		4.358
	(3,518)	(8,113)		(3.433)
skillabundance	1,186**	1,180**		1.965**
	(516.0)	(512.2)		(0.815)
skilldifferences			1,185**	
			(513.5)	
capitalabundancemex		-472.6		
		(880.3)		
capitalabundance		1,012		
		(840.6)		
skillintensity	-38.27	-33.83	-129.6	1.755
	(243.1)	(244.1)	(232.3)	(1.009)
numplants	-1.140***	-1.140***	-1.118***	1.083***
	(0.438)	(0.438)	(0.432)	(0.359)
MexGDP	267.1**	10.43		1.164
	(123.8)	(220.6)		(1.749)
GDP	6.420***	6.443***		1.672***
	(1.868)	(1.873)		(0.317)
SumGDP			6.504***	
			(1.883)	
FDIaglom	0.007**	0.007**	0.008**	0.621***
	(0.003)	(0.003)	(0.004)	(0.108)
invcostmex	1,005	1,589	-577.6**	-2.068
	(1,286)	(1,599)	(280.6)	(2.892)

continued

Notes: All results from estimating a censored regression model as described in the text. Robust standard errors are in parentheses; ***, **, * denote significance at the 1, 5, and 10 percent level, respectively; all regressions include a constant (not reported).

Table 3, continued: Estimation Results for Nitrogen Oxide

	Dependent Variable: Inward FDI			
Regressors	(1)	(2)	(3)	(4) logs
tradeopenmex	192.7	-300.2	1,035***	0.195
	(202.3)	(692.7)	(268.2)	(1.011)
tradeopenpar	54.38	54.78	52.72	1.081*
	(78.28)	(78.59)	(76.26)	(0.646)
distance	-1.203	-1.202	-1.202	-2.030***
	(0.987)	(0.985)	(0.984)	(0.558)
Observations	12,926	12,926	12,926	12,912
Log likelihood	-15,846	-15,845	-15,853	-5,617
Wald χ^2	142.4	149.3	108.8	268.4
Prob > χ^2, p-value	0.00	0.00	0.00	0.00
Joint significance of all pollution coefficients, p-value	0.70	0.70	0.77	0.00
Joint significance of all Mexican pollution coefficients, p-value	0.50	0.49	0.58	0.00
Share of FDI into industries with $\frac{dFDI}{dpollutionmex} > 0$	$0^{\#}$	$0^{\#}$	$0^{\#}$	$1^{\#}$
Share of output of industries with $\frac{dFDI}{dpollutionmex} > 0$	$0^{\#}$	$0^{\#}$	$0^{\#}$	$1^{\#}$

Notes: All results from estimating a censored regression model as described in the text. Robust standard errors are in parentheses; ***, **, * denote significance at the 1, 5, and 10 percent level, respectively; all regressions include a constant (not reported).
Share=0 in columns (1)-(3) since pollution coefficients are insignificant. Share=1 in column (4) since the pollution interaction term is positive, but *pollutionmex* is insignificant.

Table 4: Estimation Results for Particulate Matter

	Dependent Variable: Inward FDI			
Regressors	(1)	(2)	(3)	(4) logs
pollutionmex	-1.705	-1.709	-1.671	-0.001***
	(2.309)	(2.310)	(2.307)	(0.000)
pollutionmex∗output	-0.315	-0.314	-0.336	-0.000*
	(0.417)	(0.417)	(0.414)	(0.000)
pollutionsrc	-9.138*	-9.138*	-9.163*	-0.000
	(4.733)	(4.732)	(4.766)	(0.000)
capintensitymex	-264.1***	-263.7***	-267.7***	-0.636
	(85.89)	(85.70)	(85.92)	(0.453)
capintensity	-51.27	-51.83	-37.25	-0.408
	(49.57)	(49.74)	(46.71)	(0.755)
skillabundancemex	-885.1	-4,512		4.051
	(3,496)	(8,092)		(3.487)
skillabundance	1,212**	1,207**		1.992**
	(518.2)	(514.6)		(0.802)
skilldifferences			1,211**	
			(515.7)	
capitalabundancemex		-458.6		
		(870.7)		
capitalabundance		1,014		
		(831.0)		
skillintensity	-111.2	-107.6	-184.6	1.168
	(258.9)	(260.7)	(243.3)	(0.893)
numplants	-1.038***	-1.038***	-1.022***	-0.010
	(0.395)	(0.395)	(0.390)	(0.331)
MexGDP	257.2**	-0.413		-1.208
	(127.2)	(209.4)		(1.992)
GDP	6.411****	6.433***		1.661***
	(1.863)	(1.868)		(0.318)
SumGDP			6.489***	
			(1.873)	
FDIaglom	0.006**	0.006**	0.007**	0.840***
	(0.003)	(0.003)	(0.003)	(0.116)
invcostmex	985.3	1,566	-535.8**	-2.120
	(1,283)	(1,608)	(258.0)	(3.122)

continued

Notes: All results from estimating a censored regression model as described in the text. Robust standard errors are in parentheses; ***, **, * denote significance at the 1, 5, and 10 percent level, respectively; all regressions include a constant (not reported).

Table 4, continued: Estimation Results for Particulate Matter

Regressors	Dependent Variable: Inward FDI (1)	(2)	(3)	(4) logs
tradeopenmex	179.2	-319.1	993.9***	-1.106
	(198.7)	(668.8)	(284.7)	(1.036)
tradeopenpar	52.45	52.83	50.83	1.058*
	(77.82)	(78.10)	(75.93)	(0.628)
distance	-1.260	-1.259	-1.257	-2.041***
	(1.017)	(1.015)	(1.015)	(0.556)
Observations	12,926	12,926	12,926	12,912
Log likelihood	-15,835	-15,835	-15,842	-5,622
Wald χ^2	129.8	150.1	102.8	203.5
Prob > χ^2, p-value	0.00	0.00	0.00	0.00
Joint significance of all pollution coefficients, p-value	0.27	0.27	0.27	0.00
Joint significance of all Mexican pollution coefficients, p-value	0.56	0.56	0.55	0.00
Share of FDI into industries with $\frac{dFDI}{dpollutionmex} > 0$	$0^{\#}$	$0^{\#}$	$0^{\#}$	$0^{\#}$
Share of output of industries with $\frac{dFDI}{dpollutionmex} > 0$	$0^{\#}$	$0^{\#}$	$0^{\#}$	$0^{\#}$

Notes: All results from estimating a censored regression model as described in the text. Robust standard errors are in parentheses; ***, **, * denote significance at the 1, 5, and 10 percent level, respectively; all regressions include a constant (not reported).

$^{\#}$ Share=0 in columns (1)-(3) since pollution coefficients are insignificant. Share=0 in column (4) since both *pollutionmex* and the pollution interaction term are negative.