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THE POLLUTION HAVEN HYPOTHESIS

# Pollution Havens and Foreign Direct Investment: Dirty Secret or Popular Myth?

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# Pollution Havens and Foreign Direct Investment: Dirty Secret or Popular Myth?*

Beata Smarzynska Javorcik and Shang-Jin Wei

## Abstract

The "pollution haven" hypothesis refers to the possibility that multinational firms, particularly those engaged in highly polluting activities, relocate to countries with weaker environmental standards. Despite the plausibility and popularity of this hypothesis, the existing literature has found only limited evidence to support it. To enhance our ability to detect the possible "dirty secret," this study makes improvements in four areas. First, we focus on investment flows from multiple countries to 25 economies in Eastern Europe and the former Soviet Union. Transition countries are a suitable region for studying this question, as they offer a large variation in terms of environmental standards. Second, we take into explicit account the effect of host country corruption. Third, we include information on both the polluting-intensity of the potential investor and the environmental stringency in the potential host country, which allows us to test whether dirty industries are relatively more attracted to locations with weak standards. And fourth, we rely on firm-level rather than industry-level data. Despite these improvements, we find no support for the "pollution haven" hypothesis. If anything, firms in less polluting industries are more likely to invest in the region. We find no systematic evidence that FDI from "dirtier" industries is more likely to go to countries with weak environmental regulations.

**KEYWORDS:** Pollution, corruption, foreign direct investment

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The possibility that pollution-intensive multinational firms relocate to developing countries with less stringent environmental standards has been labeled the "pollution haven" hypothesis. The logic sounds plausible: if it costs money to conform to more stringent environmental requirements in developed countries, profit-maximizing firms would want to relocate their production activities. The believers abound. For example, the Sierra Club states that that "in our global economy, corporations move operations freely around the world, escaping tough pollution control laws, labor standards, and even the taxes that pay for social and environmental needs."[1]

The evidence on the "pollution haven" hypothesis as related to foreign direct investment (FDI) is, however, mixed. The existing literature can be divided into three strands: studies of within-country plant location choice, examination of industrial composition of foreign direct investment inflows within a single country, and analysis of inter-country FDI flows. The first strand encompasses work by Levinson (1996), who finds little evidence that inter-state differences in environmental regulations influence the geographic location of U.S. plants, as well as several studies reaching the opposite conclusion. For instance, Becker and Henderson (2000) demonstrate that the annual designation of air quality attainment status, which triggers specific equipment requirements at the county level in the U.S., reduces the number of firm establishments in polluting industries in nonattainment areas. Similarly, Keller and Levinson (2002) and Fredriksson et al. (2003) show that differences in abatement costs between U.S. states have a moderate deterrent effect on FDI. Further, Dean et al. (2003) examine FDI inflows into Chinese provinces and find that investment from OECD countries is attracted to regions with high pollution levies (contradicting the predictions of the "pollution haven hypothesis") while the opposite is true of FDI originating Hong Kong, Macao and Taiwan.

The second approach has been followed by Eskeland and Harrison (2003) who examine the distribution of FDI across industries in Mexico, Venezuela, Morocco and Cote d'Ivoire and find little evidence in support of the "pollution haven" hypothesis. The third approach has been adopted by only one study, Xing and Kolstad (1998), which reports a positive association between the amount of sulfur emissions in a host country and inflows of U.S. FDI in heavily polluting industries. This evidence is based on a fairly small sample (no more than 22 observations in each regression), so its robustness is subject to debate.

Given that the possibility of moving polluting activities to developing countries has been at the center of the globalization debate, there is a further need to examine this question in the context of developing economies. This is the objective of this study, which follows the third approach outlined above.[2] Our contribution to the literature lies

[1] See "A Fair Trade Bill of Rights" at the Sierra Club website (http://www.sierraclub.org/trade/ftaa/rights.asp).

[2] It is beyond the scope of this study to make any normative statements about the "pollution haven" hypothesis, our objective is only to produce new evidence shedding light on its validity. While environmental activists would strongly condemn relocation of polluting activities to developing countries, a theoretical contribution of Oates and Schwab (1988) demonstrates that if pollution is local and

in four areas. First, we examine the location decision pertaining to FDI flows from multiple source countries to multiple developing economies, namely to 25 economies in Eastern Europe and the former Soviet Union. Transition countries are a suitable region for studying the "pollution haven" hypothesis. While all of them share the common heritage of more than half a century of central planning, possess relatively high human capital endowments and opened up to the world at the same time, they also offer a reasonably large variation in terms of environmental standards. Thus our sample includes countries with relatively high income and relatively high environmental standards (in terms of conformity with the European Union standards) such as Poland and Czech Republic, and at the same time also covers economies that are substantially poorer and are perceived to have much weaker environmental regimes, such as Azerbaijan and Uzbekistan. Moreover, there is a significant variation in the sample in terms of the environmental sustainability rankings. For instance, in 2002 Latvia and Hungary were ranked $10^{th}$ and $11^{th}$ among 142 countries while Turkmenistan and Ukraine occupied the $131^{st}$ and $136^{th}$ positions respectively. Therefore, while similar in some respects, the countries included in our data set allow us to compare investment destinations quite different in terms of environmental attainment and stringency of laws.

In addition to an intrinsic interest in transition, a focus on Eastern Europe and the former Soviet Union can offer insights into the broader question of the role of FDI in economic development throughout the world. While investment in other developing regions has been studied extensively, one finding of that research has been the importance of previous investment experience as a determinant of current FDI flows (see Hallward-Driemeier, 1996). Thus, the impact of current policy variables may be obscured and overcome by a long history of past policies, for which it is difficult to control. Transition economies offer almost a natural control since FDI in the region was negligible prior to 1989.

Second, we postulate there may be features of developing countries that deter FDI but at the same time are correlated with laxity of environmental protection. A leading example of such a feature is a host country's weakness in public institutions, particularly the prevalence of bureaucratic corruption. Host country A may have less stringent environmental protection than country B, which might make country A more attractive than country B to foreign direct investment, particularly from the "dirty" industries. On the other hand, country A may also have a more severe corruption problem, which tends to discourage inward foreign investment, including those from the "dirty" industries. Indeed, it seems reasonable to expect corruption and laxity of environmental protection to go together, so that statistical analysis on the effect of environmental policy on FDI that omits local corruption might fail to detect an effect.[3] To the best of our knowledge, the only study examining the impact of both corruption and environmental standards on FDI inflows is that of Fredriksson et al. (2003)

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preferences differ, allowing jurisdictions to choose their own level of environmental standards may be welfare increasing.

[3] Several studies have demonstrated that corruption in a host country is a significant deterrent to inward FDI (Hines, 1995; Wei, 1997, 2000a and 2000b; and Smarzynska and Wei, 2000).

mentioned earlier. A similar argument could be made with respect to democracy. Authoritarian governments are less likely to be concerned with protecting the environment. At the same time, multinationals may be less likely to invest in countries with authoritarian governments, perhaps out of concern for unpredictable policy changes. Indeed Busse (2004) shows that in the 1990s more democratic countries received more FDI.

Third, unlike the existing studies which *either* ask whether FDI is attracted to locations with laxer standards *or* examine whether polluting industries are more likely to undertake FDI, we take into account both the polluting-intensity of the potential investor and the environmental stringency in the potential host country. This allows us to test whether dirty industries are *relatively* more attracted to locations with weak standards.[4] To capture the strength of environmental protection in host countries, we adopt several different measures that complement one another. Specifically, we employ four types of proxies: (i) a degree of participation (ratification, signature but no ratification, or neither) in three different international environmental protection treaties, covering transboundary aspects of environmental impact, air pollution and industrial accidents; (ii) an index of the strength of the air and water ambient and emission standards system as rated by European Bank for Reconstruction and Development (EBRD, 1997); (iii) Environmental Sustainability Index (ESI), which is a measure of a country's overall progress towards environmental sustainability developed jointly by the World Economic Forum, the Yale Center for Environmental Law and Policy, and the Center for International Earth Science Information Network; (iv) the actual reduction in emissions of carbon dioxide and lead during the period in question (scaled by the GDP growth). Reductions in emissions may be viewed as proxies for a host country's effective enforcement of environmental policies. For the first two measures, effectiveness of enforcement is adjusted by using information on the number of environmental NGOs in a country relative to its population size.

We compute pollution intensity for all multinational firms in our sample, based on the data on actual pollution emissions and abatement cost of U.S. firms filed with the U.S. Environmental Protection Agency (EPA). More precisely, pollution intensity is computed for each four-digit SIC industry; and every firm in the sample is assigned to a four-digit SIC industry. We have the emissions data for 269 and the abatement cost data for 140 four-digit SIC industries in our sample. This is a labor-intensive task, but the payoff is an enhanced precision in assigning pollution intensity to the production activities of multinational firms. This is, however, still not a perfect measure. Note that we do not need to assume that the multinational firms in the source and host countries have identical pollution intensity. Instead, what we need is a weaker assumption: the relative pollution intensity between the overseas activities of the two multinational firms (e.g., Dupont Poland and Nike Poland) is proportional to their pollution intensity at home (e.g. Dupont and Nike in the U.S.).

[4] Only Dean et al. (2003) takes into account both aspects of the issue.

Fourth, as Zarsky (1999, p. 66) stated after surveying the empirical literature, "the quality of the evidence, both statistical and case study, is poor compared to the research needs. In terms of location decisions, most of the statistical studies rely on very aggregated data about 'industry choices' which shed little light on firms or production stages." This suggests the usefulness of employing a firm-level data set. Hence instead of using country- or industry-level figures, we make use of a unique firm-level data set that describes the investment decision by 143 multinational firms in 25 countries in Eastern Europe and the former Soviet Union. This represents potentially 3,575 (=143x25) investment decisions at the firm level. One of the advantages of employing firm level data is our ability to explicitly control for the characteristics of investing firms, which affect their investment decisions, such as a firm's size, R&D intensity and previous experience of trading with the region.

Levinson and Taylor (2004) point out that the existing studies may have failed to detect the pollution haven effect due to biases introduced into the estimation by aggregation, unobserved heterogeneity and endogeneity of environmental standards. Our data set allows us overcome two of these difficulties, while the third one is unlikely to be a serious concern in this case. Our analysis does not suffer from the aggregation bias as we use disaggregated measures of pollution intensity and abatement costs (at the four-digit SIC industry level). We are able to control for unobserved heterogeneity of industries by introducing firm-specific fixed effects. In a separate specification, we control for unobserved heterogeneity of host countries by adding host country fixed effects. Finally, the potential endogeneity problem is mitigated by the fact that a large part of the effort to improve environmental standards in Eastern Europe has been undertaken in the context of the expected accession to the European Union (EU).

Rather than keeping the suspense, we spell out the bottom line right now. We find little support for the "pollution haven" hypothesis. While there is some evidence indicating that countries with less stringent environmental regulations, particularly when proxied by participation in international environmental treaties, may be more attractive to foreign investors, this finding is not robust. Moreover, there is no evidence suggesting that multinationals in pollution-intensive activities are more likely to invest in locations with weaker environmental regulations. On the contrary, we find that FDI inflows to transition economies are more likely to take place in clean industries.

The first section below describes the methodology and the data employed. Section 2 discusses the empirical results. The last section concludes.

## 1. Methodology and Key Variables

### 1.1 Empirical Model

Let $FDI_{jk}$ be a dummy that takes the value of one if firm $j$ has established an investment or has concrete plans to invest in host country $k$, and zero otherwise.

Our strategy is to estimate some variant of the following probit specification:

$$\text{Prob}[FDI_{jk} = 1] = X_j \Gamma_j + H_k \Phi_k + Z_{jk} \Pi + \beta E_k + \gamma D_j E_k + \varphi D_j + e_{jk}$$

where $X_j$ is a vector of variables describing the characteristics of firm $j$; $H_k$ is a vector of variables describing the characteristics of host country $k$ other than its environmental standards; $Z_{jk}$ is a vector of variables describing the relationship between host country $k$ and the source country where firm $j$ originates; and $\Gamma_j$, $\Phi_k$ and $\Pi$ are vectors of parameters with corresponding dimensions. $D_j$ is an index of firm $j$'s pollution intensity or "dirtiness," and $E_k$ is an index of host country $k$'s environmental standards, possibly adjusted by the strength of enforcement. $e_{jk}$ is an iid normally distributed error term.

The parameter $\beta$ captures a "volume effect:" a negative (or positive) $\beta$ implies that a stronger environmental protection in a host country tends to discourage (or encourage) inward FDI. The parameter $\gamma$ captures a "composition effect:" a negative (or positive) $\gamma$ implies that more (or less) pollution-intensive FDI would go to a host country with relatively weaker environmental standards. In other words, the "pollution haven" hypothesis can be represented by $\beta < 0$ and/or $\gamma < 0$.

As we are also concerned about unobserved country characteristics that may affect FDI inflows, we also estimate a logit specification with host country fixed effects, in which case $\gamma$ is the coefficient of interest, as the volume effect will be captured by the fixed effects. Similarly, to take into account unobserved investor characteristics we employ a logit specification with fixed effects for investing companies.

Crucial to our empirical strategy is to have plausible measures of pollution intensity $D_j$ by multinational firms and of the strength of environment protection by host countries, $E_k$. We will discuss the construction of these measures next.

### 1.2 Measuring Pollution Intensity

We use two measures of pollution intensity of industries: one based on pollution emissions and one on abatement costs.[5] The first measure is compiled using the Toxics Release Inventory (TRI) data collected by the U.S. Environmental Protection Agency. TRI provides a comprehensive overview of toxic chemical pollution from manufacturing facilities in the United States. In 1997, the reportable TRI chemical list included 576 individually listed chemicals and 28 chemical categories. The database contains information on releases of toxic substances into air, water, land and underground injections measured by weight. A median value of emissions for reporting facilities in each 4-digit SIC code is found and then normalized by the average shipping volume in the industry.[6] The information on shipping volumes comes from the 1997 Economic Census CD-ROM. The average shipping volume was found by dividing the 1997 value of sales, shipments and receipts (given in thousands of dollars) by the

[5] The emissions and abatement cost figures are also used in Eskeland and Harrison (2003).

[6] The information on all facilities that reported both an SIC code and emissions was taken into account. The SIC code and the emissions data were matched for each facility. If a facility reported more than one SIC code, each unique facility and SIC pair was treated as an individual observation. The value of emissions for each observation was divided by the number of SIC codes reported for the facility. The data were then regrouped by SIC code and the median of all observations for a particular 4-digit SIC code was calculated for each emissions category (air, land, water, underground).

number of establishments reporting for that SIC code. If data on shipping volumes were not available for a particular SIC code, that code was dropped.

A histogram analysis of the pollution intensity (not reported to save space) indicates that the data are highly skewed. A very small number of observations are more than three standard deviations away from the mean. As we are not sure if this is caused by the outliers in the EPA data or genuine difference in pollution intensity, we adopt a simple transformation that would help us avoid the dominance of outliers in our subsequent statistical analyses. More precisely, the data on pollution were converted into a pollution intensity index taking on the values from 0 to 2 by using the following criteria: the index takes on the value of zero if emissions in all four categories (air, land, water and underground) are in the lowest 33 percentiles; the value of 2 if emissions in any category are in the top 33 percentiles; and finally, the value of 1 in all other cases.

The second measure, the abatement index, is based on the data on total pollution abatement expenditures, as reported in the Manufacturers' Pollution Abatement Capital Expenditures and Operating Costs Survey (Census Bureau, 1994). First, we aggregate operating costs and capital expenditures related to pollution abatement. Then, we follow a similar procedure to that described above to obtain median values (normalized by sales) for each SIC code. The abatement data are also converted into an index ranging from 0 (if the normalized value was below the 33$^{rd}$ percentile) to 2 (if the value was above the 66$^{th}$ percentile).

Both indices are calculated based on two 4-digit SIC codes that describe the operations of each firm in our sample.[7] If the index values for the two industry codes differ, the higher value is used. Note that dropping all firms for which index values differ between the two SIC codes does not change the conclusions of the paper. For illustration, Appendix Table A1 lists the classification of industries at the 3-digit SIC level. The regressions, however, use classification at the (more detailed) 4-digit level.

The main drawback of both indices is that they are based on the U.S. data. Thus we are assuming that the relative ranking of pollution intensity of two facilities set up by American investors overseas (e.g., Dupont Poland and Nike Poland) is the same as the relative ranking of their pollution intensity at home (e.g., Dupont and Nike in the U.S.).[8] Further, it may be argued that the total amount of pollutants emitted does not take into account the differences in toxicity risks associated with different substances. Thus, an industry emitting a large quantity of a relatively harmless substance would rank as a greater polluter than another industry emitting a small quantity of a very potent pollutant. However, Dasgupta and Meisner (1998) have shown that at the aggregate level, there is no significant variation in rankings of industries based on total emissions and toxicity risks.

[7] Note that *Worldscope* database, from which we obtained firm SIC codes, reports up to nine 4-digit SIC codes for each firm ranked in order of importance. We used the first two.

[8] Of course, this assumption would be violated if industries can separate various stages of production and move pollution-intensive stages abroad.

### 1.3 Strength of Environmental Standards

We measure the strength of environmental protection of the host countries in several different ways, recognizing that each of them has its own advantages and limitations. The definitions of all measures are described below.

#### 1.3.1 Participation in International Treaties

*Treaties I* = participation in international treaties. Five international treaties have been developed by the United Nations Economic Commission for Europe during the past twenty-one years. We take into account three treaties that came into effect before or during the time relevant for our data set (i.e., before 1995): the Convention on Long-range Transboundary Air Pollution, the Convention on Environmental Impact Assessment in a Transboundary Context and the Convention on the Transboundary Effects of Industrial Accidents.[9] The information on treaties comes from the United Nations Economic Commission for Europe. An index is created by awarding each country 1 point for ratifying each treaty prior to 1996 and 0.5 point for signing each treaty before 1996 or ratifying it after that time.[10] Thus, the index can range from 0 to 3.

*Treaties II* = ratification of international treaties. Since only ratification of a treaty results in a country having a legal obligation to comply, we restrict the index to awarding a point only for ratifying a treaty before 1996 and zero otherwise. Again the index ranges from 0 to 3.

Mindful that participation in treaties and enforcement on the ground are not the same thing, we also construct a separate measure that adjusts for possible strength of enforcement. Since active NGO movement tends to exert pressure on the government to enforce environmental regulation, we adjust for enforcement by making use of information on the number of environmentally oriented NGOs in a host country. Thus,

*Enforcement-adjusted treaty index* = *Treaties* × number of environmental NGOs per million people in country *k*. The figures on NGOs come from the *Environmental Encyclopedia and Directory* (1998).

#### 1.3.2 Quality of Air and Water Ambient and Emission Standards

*EBRD index* = index of air and water ambient and emission standards in country *k*, which ranges from 1 denoting the weakest standards to 3 denoting the strongest. The index value of 1 is awarded to countries with a maximum permissible concentration (MPC) system in place and the MPC being broadly based on the former Soviet system. The index equals 2 for countries with a new system being introduced, either as an evolution of MPC or in order to meet EU requirements. The highest index denotes countries having essentially a new standards system is in place, often following EU

[9] We exclude the Convention on the Protection and Use of Transboundary Water-courses and International Lakes as it may not be applicable to all countries.

[10] The 1996 cutoff is determined by the coverage of our sample. We want to give more weight to treaties that were ratified during the period investments included in our sample took place.

requirements. The index reflects laws on the books but not their enforcement. The source is EBRD (1997).

Similar to the previous measure, we also construct an enforcement-adjusted standard index as *Enforcement-adjusted EBRD index = EBRD index* × number of environmental NGOs per million people in country *k.*

### 1.3.3 Environmental Sustainability Index

The Environmental Sustainability Index is a measure of overall progress towards environmental sustainability. It was developed jointly by The World Economic Forum, the Yale Center for Environmental Law and Policy, and the Center for International Earth Science Information Network for 142 countries. The ESI scores are based upon a set of 20 core "indicators," each of which combines two to eight variables for a total of 68 underlying variables. The ESI permits cross-national comparisons of environmental progress in a systematic and quantitative fashion. In this study, we use the overall index as well as three of its components, which we consider the most relevant to our analysis.

*ESI overall* = the overall index expressed in standard normal percentiles.

*ESI env quality* = a component of the ESI index capturing quality of air and water, availability of water per capita and severity of human induced soil degradation; expressed in standard normal percentiles.

*ESI env stress* = reflects anthropogenic stress on the natural environment; based on data capturing, among others, air pollution emissions over populated areas, fertilizer and pesticide use; expressed in standard normal percentiles.

*ESI env institutions* = reflects the extent to which a country possesses institutions and underlying social attitudes that will enable it to foster effective responses to environmental challenges; based on information including, among others, country's technological achievement, presence of NGOs, control of corruption, subsidies on energy usage; expressed in standard normal percentiles.

Since the ESI was developed only in 2001 there is a regrettable mismatch between the time period it covers and that of our sample. Note, however, that the mismatch is smaller than it may seem as, due to lags in data reporting, the figures used to build the index were a couple years old at the time it was constructed.

### 1.3.4 Observed Actual Reduction in Various Pollutants

For a number of transition economies, we have collected data on the actual observed percentage reduction of two major pollutants (lead and $CO_2$). These might be viewed as result-based, enforcement-effort-adjusted, alternative measures of the strength of the environmental standard in the countries. Since these changes in emissions of lead and $CO_2$ may be largely due to output drop experienced by many transition countries during the early 1990s, we make an adjustment to take this into account. Thus we define

*Reduction in lead emissions* = percentage reduction in total lead emissions adjusted for percentage change in GDP during 1990-96. Source: OECD (1999, p. 47) for emissions; and *World Bank Global Development Indicators* for GDP change.

*Reduction in $CO_2$ emissions* = percentage reduction in $CO_2$ emissions relative to the growth rate of GDP during 1992-95. Both $CO_2$ and GDP figures are from the *World Development Indicators* database.

Variables *Treaties* and *EBRD index* reflect environmental standards on the book. *Adjusted Treaties* and *Adjusted EBRD index* are standards on the book adjusted for the strength of enforcement. *ESI* variables capture environmental sustainability of a country as well as its attitude towards environmental protection. The last two variables reflect the actual progress that has been made in lowering pollution emissions, thus they capture the combination of laws and their implementation. Again, each measure is useful in some ways but suffers from some drawbacks in other ways. Our strategy is to be broad-minded and not to rely exclusively on any particular measure.[11]

All measures are listed in Appendix Table A2. Summary statistics are presented in Table 1, while correlations can be found in Appendix Table A3.

## 1.4 Measuring Corruption in Host Countries

### 1.4.1 *Global Competitiveness Report/World Development Report* Corruption Index

Corruption, by its very nature, is difficult to measure. Most of the available indices are based on subjective perceptions from surveys of firms or individuals.[12] Many of them do not cover enough transition economies to be useful to us. Thus, we adopt a composite measure based on the *Global Competitiveness Report* (GCR) 1997 and the *World Development Report* (WDR) 1997 corruption indices. The *Global Competitiveness Report* is produced jointly by the Geneva-based World Economic Forum and Harvard Institute for International Development. The survey for the report was conducted in late 1996 on 2,827 firms in 58 countries. The GCR survey asked respondents to rate the level of corruption in their country on a one-to-seven scale, based on the extent of "irregular, additional payments connected with imports and exports permits, business licenses, exchange controls, tax assessments, police protection or loan applications." The GCR Corruption Index is based on the country average of the individual ratings.

[11] While it would be interesting to endogenize the environmental standards as has been done in an excellent paper by Fredriksson et al. (2003), the data limitations prevent us from doing so. The potential endogeneity problem is mitigated by the fact that a large part of the effort to improve environmental standards in Eastern Europe has been undertaken in the context of the expected accession to the European Union. We also hope that the inclusion of host country fixed effects would attenuate the problem.

[12] Wei (2000b) discusses the relative merits and drawbacks of four types of corruption measures.

**Table 1: Summary Statistics**

| Variable | No. of obs. | Mean | Std. dev. | Min | Max |
|---|---|---|---|---|---|
| Firm size | 143 | 14.2 | 1.7 | 8.0 | 18.7 |
| R&D-intensity | 143 | 2.9 | 3.2 | 0.0 | 17.4 |
| Regional experience | 143 | .52 | 0.5 | 0.0 | 1.0 |
| Emissions | 116 | 0.8 | 0.7 | 0.0 | 2.0 |
| Abatement | 83 | 1.3 | 0.9 | 0.0 | 2.0 |
| GDP | 25 | 8.6 | 1.6 | 6.1 | 12.1 |
| Relative GDP per capita | 5725 | 3.4 | 1.1 | -0.8 | 5.7 |
| Corporate tax | 23 | 29.6 | 6.4 | 15.0 | 40.0 |
| Distance | 3289 | 7.9 | 0.9 | 4.6 | 9.7 |
| Corruption I | 19 | 4.5 | 0.8 | 2.6 | 5.5 |
| Corruption II | 23 | 4.3 | 1.8 | 0.0 | 8.0 |
| Treaties I | 25 | 1.5 | 0.9 | 0.0 | 3.0 |
| Treaties II | 25 | 0.9 | 0.9 | 0.0 | 3.0 |
| EBRD index | 25 | 1.5 | 0.7 | 1.0 | 3.0 |
| NGOs/ pop | 25 | 2.9 | 4.2 | 0.2 | 19.3 |
| Reduction in lead emissions | 25 | 13.0 | 28.1 | -42.1* | 84.8 |
| Reduction in $CO_2$ emissions | 10 | 27.1 | 23.8 | -25.9* | 63.4 |
| ESI overall | 22 | 50.0 | 8.0 | 36.8 | 63.2 |
| ESI env quality | 22 | 48.6 | 10.8 | 25.7 | 65.4 |
| ESI env stress | 22 | 59.2 | 12.1 | 31.0 | 76.8 |
| ESI env institutions | 22 | 41.5 | 13.1 | 20.5 | 66.2 |

* a negative value indicates that the decrease in GDP was larger than the reduction in emissions.
Firm size, GDP, relative GDP per capita and distance are expressed in logarithms.

The WDR index comes from a 1996 World Bank survey of 3,866 firms in 73 countries conducted in preparation for the *World Development Report 1997*. Question 14 of that survey asks: "Is it common for firms in my line of business to have to pay some irregular, 'additional' payments to get things done?" The respondents were asked to rate the level of corruption on a one-to-six scale. The WDR corruption index is based on the country average of the individual answers.

For both corruption indices, the original sources are such that a higher number implies lower corruption. To avoid awkwardness in interpretation, they are re-scaled in this paper so that a high number now implies high corruption.

Each measure covers a different subset of countries for which we have investment data, thus we use a composite corruption index derived by Wei (2000b) and call it *Corruption I*. Since both measures come from surveys with similar

methodologies and similar questions and are highly correlated (0.83), Wei combined them using the following procedure: (1) use GCR as the benchmark; (2) compute the ratio of GCR to WDR for all countries that are available in both GCR and the WDR; and (3) for those countries that are covered by WDR but not GCR (which is relatively rare), convert the WDR rating into the GCR scale by using the ratio in (2).

### 1.4.2 Neumann Corruption Index

Additionally, we use a corruption measure based on the information obtained by Peter Neumann (1994), a journalist at a German business publication *Impulse*, from people with business experience in each host country, mainly German exporters (*Corruption II*). Neumann interviewed on average ten individuals (or minimum three) per country with a guarantee of strict confidentiality. The measure indicates the proportion of the transactions that involved corrupt payments. Note that in the year in which Peter Neumann conducted his interviews, it was not against any German law for German firms to offer bribes to foreign government officials. The Neumann measure has two advantages, it is a "harder" and "more objective" than the other index used and it is based on the information collected in 1994 which was just a year before our FDI data were obtained.[13]

## 1.5 Other Variables

Following the existing literature on determinants of FDI, our regressions also include proxies for market size (GDP), corporate tax rate, openness to trade (sum of exports and imports divided by the GDP), distance between source and host country, and the GDP per capita of the source economy relative to that of the host.[14] GDP and GDP per capita data refer to 1993 and come from EBRD (1994) for transition economies and *IMF International Financial Statistics* for source economies. The use of two different sources is motivated by a more complete coverage of transition countries by the EBRD. Relative GDP per capita is defined as the log difference between the GDP per capita of the source and home economy. Information on corporate tax rates is from PriceWaterhouseCoopers. Tax rates are expressed in percentages. If several rates apply, the highest one is used. Trade figures are from the UN COMTRADE database. Distance between the capital cities is measured in kilometers. The primary source is Rudloff (1981), supplemented by Pearce and Smith (1984).

The model also includes a proxy for the level of democracy in the host country. As mentioned earlier, authoritarian governments may be less concerned with protecting the environment and at the same time, multinationals may be less likely to invest in countries with authoritarian governments, perhaps out of concern for unpredictable policy changes. The proxy for democracy is a composite measure based on two indicators constructed by Freedom House (2002): political rights and civil liberties. Both indicators range from 1 to 7 with higher numbers implying fewer rights and

[13] Neumann's index was first used by Ades and Di Tella (1997).
[14] For a review of the literature on FDI determinants see Caves (1982) and Froot (1993).

liberties. In the analysis, we use a composite measure derived by Helliwell (1994) and recently employed by Busse (2004)

*Democracy* = [14 – (Political Rights + Civil Liberties)]/12.

The dependent variable comes from a unique firm-level data set based on the EBRD Foreign Investment Survey conducted in January 1995. A brief questionnaire was sent to about 9,500 firms from all over the world asking them about their planned or undertaken investment projects in Eastern Europe and the former Soviet Union.[15] Additional information about the type of the project was requested. The criterion for including a firm in the survey was a firm's listing in a commercial database *Worldscope*, which provides detailed financial statements and business descriptions for public companies located in more than fifty countries. Sending the questionnaire to all firms listed assured that all major public companies in the world were included. Responses were obtained from 1,405 firms.[16] Unfortunately, the survey did not ask about the time when each investment was undertaken. However, since the magnitude of FDI inflows into the region was marginal before 1989, the information collected pertains to the period 1989-94.[17] Thus our dataset is cross-sectional in nature but varies in two dimensions—by firm and by potential destination country.

Our empirical analysis focuses on investment in manufacturing facilities, since investment in service sectors or in distribution alone is not likely to have a significant environmental impact. As the objective of this study is to explore the impact of government policies on the magnitude and nature of FDI inflows, firms in the oil, gas and coal sector, which are likely to be attracted to natural resource endowments, are excluded from the estimations. Moreover, to limit the number of zeros on the left hand side of the regression, we include only firms with at least one manufacturing investment in the region. Thus, our final sample includes 143 firms that undertook 355 investment projects in the region. The potential number of observation in our sample is equal to 3,575 (=143×25) investment decisions at the firm level.[18]

Information on firm characteristics, such as a firm's size and R&D intensity, is from *Worldscope*. From the survey, we get the proxy for regional experience, defined as a dummy variable taking on the value of one if a given firm had had a trading relationship with the region before the transition process began in 1990 and zero otherwise.

[15] The source countries in the sample listed in order of importance include: United Kingdom, United States, Japan, Canada, Germany, France, Finland, Switzerland, South Africa, Sweden, Ireland, Australia, Norway, Italy, Malaysia, Netherlands, Belgium, Denmark, New Zealand, Austria, Singapore, Portugal, Argentina, Colombia, Greece, Philippines, South Korea and Hong Kong, China.

[16] The question of response bias is discussed in the Appendix.

[17] Eastern Europe and the Soviet Union were virtually closed to foreign investment before 1989 (see Meyer, 1995; Dunning and Rojec, 1993; Hunya, 1997).

[18] The actual number in the regressions is smaller due to missing values of pollution or environmental standard proxies.

## 2. Estimation Results

### 2.1 Basic Regressions

We begin the test of the "pollution haven" hypothesis with regressions employing participation in international treaties as a proxy for environmental standards in a host country. The results, presented in terms of marginal effects, can be found in Table 2. Standard errors, adjusted for clustering by host country, are listed in brackets. As stated in the last section, the coefficient on the environmental regime (labeled *Env Std*) captures a *volume effect* – the (marginal) effect of the strength of environmental protection in a host country on the overall volume of inward FDI. The coefficient on the product of the host country's environmental regime and the investing firm's pollution intensity captures a *composition effect* – whether stronger environmental protection discourages the investment from more polluting industries by a greater amount.

The results provide some support for the volume effect but no evidence of the composition effect. The coefficient on environmental standards is negative and statistically significant in three out of six regressions. Interestingly, in all but one case, it is statistically significant only when environmental standard is accompanied by a corruption proxy as an explanatory variable. This gives support to our argument suggesting the importance of including the corruption variable. The interaction term between environmental regime and the emission index does not reach the conventional significance levels. Probably the strongest finding relevant to the "pollution haven" hypothesis is that firms in less polluting industries (as proxied by the emissions index) appear to be more likely to undertake FDI in transition economies. The last finding has two potential explanations: the region is oversaturated with heavy industry and thus attracts less FDI to these sectors (which tend to be pollution-intensive) and/or foreign investors may be unwilling to acquire existing companies in polluting sectors out of concern about unresolved liability for the past environmental damage.

The other variables have the expected signs. We find that larger and less R&D-intensive firms are more likely to undertake FDI. As far as host country characteristics are concerned, the data indicate that larger and more democratic countries as well as those located close to the investor's home country are more attractive to FDI. High corporate taxes and a greater incidence of corruption tend to discourage foreign investors, but they do not appear to be significant in all regressions. Higher difference in income levels between source and host countries is associated with more FDI, while the opposite is true in the case of host countries which are more open to trade. These effects, however, appear to be significant only in two cases.

Table 3 presents results of regressions in which environmental standards on the books are adjusted for enforcement. The findings suggest the presence of a volume effect. In three out of four regressions we find a negative and significant coefficient on the measures of environmental standards, which indicates that countries with higher standards attract less FDI. There is no evidence in favor of a composition effect. The interaction term between environmental regime and the emission index reaches the

conventional significance levels only in two cases, but contrary to our expectations it bears a positive sign. The presence of environmental NGOs does not have a deterring effect on FDI, to the contrary, it seems to be associated with higher inflows.

**Table 2: Participation in International Treaties**

| | Treaties I (ratification and/or signing) | | | Treaties II (ratification only) | | |
|---|---|---|---|---|---|---|
| Firm size | 0.020*** | 0.0195*** | 0.0173*** | 0.0195*** | 0.0195*** | 0.0172*** |
| | [0.003] | [0.0033] | [0.0035] | [0.0034] | [0.0034] | [0.0034] |
| R&D intensity | -0.008*** | -0.0079*** | -0.0071*** | -0.0079*** | -0.0079*** | -0.0071*** |
| | [0.003] | [0.0028] | [0.0027] | [0.0027] | [0.0027] | [0.0026] |
| Regional experience | 0.006 | 0.0057 | 0.0077 | 0.0053 | 0.0053 | 0.0074 |
| | [0.011] | [0.0111] | [0.0113] | [0.0112] | [0.0112] | [0.0113] |
| Distance | -0.031*** | -0.0306*** | -0.0285** | -0.0303*** | -0.0302*** | -0.0280*** |
| | [0.009] | [0.0092] | [0.0113] | [0.0087] | [0.0086] | [0.0102] |
| Relative GDP per capita | 0.01 | 0.0096 | 0.0194* | 0.0078 | 0.0078 | 0.0218* |
| | [0.012] | [0.0122] | [0.0117] | [0.0119] | [0.0120] | [0.0118] |
| GDP | 0.048*** | 0.0474*** | 0.0460*** | 0.0470*** | 0.0470*** | 0.0482*** |
| | [0.005] | [0.0054] | [0.0052] | [0.0055] | [0.0055] | [0.0056] |
| Corporate tax | -0.001 | -0.0013 | -0.0001 | -0.0013* | -0.0014* | -0.0003 |
| | [0.001] | [0.0008] | [0.0011] | [0.0007] | [0.0007] | [0.0012] |
| Democracy | 0.057 | 0.0557 | 0.1310*** | 0.0574* | 0.0578* | 0.1372*** |
| | [0.043] | [0.0423] | [0.0380] | [0.0327] | [0.0325] | [0.0323] |
| Openness | -0.037* | -0.0373* | -0.0241 | -0.032 | -0.0319 | -0.0249 |
| | [0.022] | [0.0214] | [0.0192] | [0.0199] | [0.0198] | [0.0193] |
| Corruption I | **-0.023*** | **-0.0227**** | | -0.0168 | -0.0167 | |
| | **[0.012]** | **[0.0114]** | | [0.0111] | [0.0111] | |
| Env Std | **-0.019*** | **-0.0228**** | -0.0154 | **-0.0179*** | -0.0158 | -0.0168 |
| | **[0.011]** | **[0.0116]** | [0.0167] | **[0.0108]** | [0.0118] | [0.0118] |
| Emissions | **-0.014***** | **-0.0258**** | -0.0221 | **-0.0143***** | -0.011 | -0.0099 |
| | **[0.004]** | **[0.0128]** | [0.0138] | **[0.0044]** | [0.0070] | [0.0068] |
| Env Std×Emissions | | 0.006 | 0.005 | | -0.0028 | -0.0027 |
| | | [0.0067] | [0.0072] | | [0.0052] | [0.0054] |
| Number of obs | 2204 | 2204 | 2668 | 2204 | 2204 | 2668 |
| Psedo $R^2$ | 0.28 | 0.28 | 0.24 | 0.28 | 0.28 | 0.25 |
| obs. P | 0.12 | 0.12 | 0.11 | 0.12 | 0.12 | 0.11 |
| pred. P | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |

All results are presented in terms of marginal effects evaluated at the sample mean.
Standard errors, listed in brackets, have been adjusted for clustering by host country.
***, **, * denotes significance at the 1, 5 and 10 percent level respectively.

## 2.2 Robustness Checks and Extensions

To check the robustness of our findings, we present results from regressions using alternative measures of environmental regulation (Table 4). No support is found for the "pollution haven" when the raw or enforcement-adjusted EBRD's rating of the

air and water standard is used. Furthermore, there is no support for the hypothesis when reductions in emissions are used as a proxy for environmental regime or when the ESI indices are employed. Strikingly, we find again that multinationals in cleaner industries are more likely to engage in FDI. Thus, the evidence from Table 4 is consistent with that found in the previous table.

**Table 3: Enforcement Adjusted Treaties**

| | Treaties I | | Treaties II | |
|---|---|---|---|---|
| Firm size | 0.0200*** | 0.0168*** | 0.0204*** | 0.0174*** |
| | [0.0032] | [0.0034] | [0.0036] | [0.0035] |
| R&D intensity | -0.0077*** | -0.0069*** | -0.0075*** | -0.0067*** |
| | [0.0027] | [0.0025] | [0.0027] | [0.0024] |
| Regional experience | 0.0055 | 0.0077 | 0.0048 | 0.0072 |
| | [0.0113] | [0.0112] | [0.0112] | [0.0113] |
| Distance | -0.0269*** | -0.0248*** | -0.0270*** | -0.0245*** |
| | [0.0089] | [0.0087] | [0.0086] | [0.0087] |
| Relative GDP per capita | -0.0059 | 0.0223* | -0.013 | 0.0123 |
| | [0.0120] | [0.0123] | [0.0145] | [0.0117] |
| GDP | 0.0411*** | 0.0491*** | 0.0375*** | 0.0436*** |
| | [0.0036] | [0.0052] | [0.0051] | [0.0052] |
| Corporate tax | -0.0007 | 0.0005 | 0.0001 | 0.0007 |
| | [0.0004] | [0.0011] | [0.0004] | [0.0011] |
| Democracy | 0.1259*** | 0.1228*** | 0.0800** | 0.1222*** |
| | [0.0388] | [0.0379] | [0.0325] | [0.0281] |
| Openness | -0.0103 | -0.019 | -0.0091 | -0.0166 |
| | [0.0177] | [0.0181] | [0.0171] | [0.0186] |
| Corruption I | 0.012 | | 0.0073 | |
| | [0.0108] | | [0.0113] | |
| Env Std | **-0.0210*** ** | -0.0032 | **-0.0092*** ** | **-0.0068*** ** |
| | **[0.0051]** | [0.0064] | **[0.0028]** | **[0.0022]** |
| Emissions | **-0.0186*** ** | **-0.0166*** ** | **-0.0134** ** | **-0.0106* ** |
| | **[0.0061]** | **[0.0058]** | **[0.0060]** | **[0.0054]** |
| Env Std ×Emissions | **0.0010*** ** | **0.0008** ** | -0.0001 | -0.0011 |
| | **[0.0003]** | **[0.0004]** | [0.0017] | [0.0018] |
| NGOs/pop | **0.0340*** ** | 0.0072 | **0.0031*** ** | **0.0027* ** |
| | **[0.0081]** | [0.0094] | **[0.0010]** | **[0.0015]** |
| Number of obs | 2204 | 2668 | 2204 | 2668 |
| Psedo $R^2$ | 0.29 | 0.25 | 0.28 | 0.25 |
| obs. P | 0.12 | 0.11 | 0.12 | 0.11 |
| pred. P | 0.06 | 0.05 | 0.06 | 0.05 |

All results are presented in terms of marginal effects evaluated at the sample mean. Standard errors, listed in brackets, have been adjusted for clustering by host country.
***, **, * denotes significance at the 1, 5 and 10 percent level respectively.

**Table 4: Alternative Measures of Environmental Standards in Host Countries**

| | EBRD index | Adjusted EBRD index | Reduction in emissions | | Environmental Sustainability Index | | | |
|---|---|---|---|---|---|---|---|---|
| | | | $CO_2$ | lead | overall | env quality | env stress | env institutions |
| Firm size | 0.019*** | 0.0191*** | 0.0195*** | 0.0256*** | 0.0198*** | 0.0202*** | 0.0202*** | 0.0198*** |
| | [0.003] | [0.0034] | [0.0034] | [0.0035] | [0.0038] | [0.0038] | [0.0037] | [0.0036] |
| R&D | -0.008*** | -0.008*** | -0.0080*** | -0.0094* | -0.008*** | -0.008*** | -0.008*** | -0.008*** |
| Intensity | [0.003] | [0.0028] | [0.0028] | [0.0049] | [0.0030] | [0.0030] | [0.0030] | [0.0030] |
| Regional | 0.006 | 0.0058 | 0.0058 | 0.014 | 0.005 | 0.005 | 0.0049 | 0.005 |
| Experience | [0.011] | [0.0112] | [0.0112] | [0.0179] | [0.0119] | [0.0119] | [0.0119] | [0.0120] |
| Distance | -0.030*** | -0.0256*** | -0.0297*** | -0.0268* | -0.031*** | -0.031*** | -0.032*** | -0.031*** |
| | [0.009] | [0.0078] | [0.0093] | [0.0141] | [0.0097] | [0.0095] | [0.0100] | [0.0096] |
| Relative GDP per capita | 0.014 | 0.0073 | 0.0104 | -0.0094 | 0.0175 | 0.0128 | 0.0113 | 0.0171 |
| | [0.012] | [0.0114] | [0.0129] | [0.0267] | [0.0131] | [0.0138] | [0.0136] | [0.0134] |
| GDP | 0.046*** | 0.0373*** | 0.0485*** | 0.0631*** | 0.0499*** | 0.0480*** | 0.0504*** | 0.0497*** |
| | [0.006] | [0.0067] | [0.0053] | [0.0090] | [0.0034] | [0.0037] | [0.0045] | [0.0038] |
| Corporate | -0.001 | -0.0001 | -0.0013* | -0.0058* | -0.0006 | -0.0004 | 0.0000 | -0.001 |
| Tax | [0.001] | [0.0005] | [0.0007] | [0.0030] | [0.0010] | [0.0010] | [0.0016] | [0.0011] |
| Democracy | 0.007 | 0.0807** | 0.0181 | -0.0656 | 0.0284 | 0.0577 | 0.0453 | 0.0064 |
| | [0.039] | [0.0344] | [0.0407] | [0.0853] | [0.0436] | [0.0447] | [0.0487] | [0.0477] |
| Openness | -0.033 | -0.0107 | -0.0313 | -0.0418* | -0.0380* | -0.0344 | -0.0327 | -0.0346 |
| | [0.022] | [0.0182] | [0.0211] | [0.0228] | [0.0222] | [0.0220] | [0.0244] | [0.0240] |
| Corruption | **-0.025*** | 0.0232 | **-0.0272**** | **-0.0445***** | **-0.0275**** | **-0.0233**** | **-0.0325***** | -0.021 |
| I | **[0.013]** | [0.0202] | **[0.0113]** | **[0.0089]** | **[0.0127]** | **[0.0112]** | **[0.0116]** | [0.0166] |
| Env Std | 0.008 | **0.0241**** | 0.0001 | **0.0014***** | 0.0003 | 0.0006 | 0.0006 | 0.0007 |
| | [0.011] | **[0.0099]** | [0.0003] | **[0.0004]** | [0.0010] | [0.0004] | [0.0008] | [0.0012] |
| Emissions | **-0.026**** | **-0.018***** | **-0.016***** | -0.0107 | **-0.081**** | -0.0386 | -0.0162 | **-0.053***** |
| | **[0.010]** | **[0.0052]** | **[0.0050]** | [0.0107] | **[0.0355]** | [0.0287] | [0.0199] | **[0.0201]** |
| Env Std× | 0.006 | **0.0007***** | 0.0002 | 0.0000 | **0.0012*** | 0.0005 | 0.0000 | **0.0008*** |
| Emissions | [0.005] | **[0.0002]** | [0.0002] | [0.0003] | **[0.0006]** | [0.0005] | [0.0003] | **[0.0004]** |
| NGOs/pop | | **-0.0443**** | | | | | | |
| | | **[0.0186]** | | | | | | |
| Number of obs | 2204 | 2204 | 2204 | 1044 | 2088 | 2088 | 2088 | 2088 |
| Psedo $R^2$ | 0.28 | 0.28 | 0.28 | 0.23 | 0.27 | 0.27 | 0.27 | 0.27 |
| obs. P | 0.12 | 0.12 | 0.11 | 0.12 | 0.12 | 0.12 | 0.12 | 0.11 |
| pred. P | 0.05 | 0.06 | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 | 0.04 |

All results are presented in terms of marginal effects evaluated at the sample mean.
Standard errors, listed in brackets, have been adjusted for clustering by host country.
***, **, * denotes significance at the 1, 5 and 10 percent level respectively.

As another robustness test, we re-estimate the model using the abatement cost index to capture a firm's pollution intensity (Table 5). When this change is made, four of the twelve interaction terms are significant, but their signs are negative in two regressions and positive in the other two cases. The same is true of the coefficients on environmental standards. Thus, again the data produce no robust support for the "pollution haven" hypothesis. Note that when abatement costs are used as a proxy for industry pollution intensity, we find no systematic relationship between "dirtiness' of the sector and the firm's propensity to undertake FDI.

Further, we re-estimate our model employing *Corruption II* (Neumann index) as a measure of corruption incidence in host countries. The regression results, presented in Table 6, give no support to the hypothesis.

Since our measures of investor pollution intensity have been calculated using U.S. data, one could argue that this calls for limiting our sample to U.S. firms only. When we re-estimate our model on this sub-sample (see Table 7), in five out of twelve cases we find evidence in support of the volume effect. There is, however, no support for the composition effect. As before, the data suggest that firms in dirty industries are less interested in establishing presence in the region.

One may argue that omitted country specific variables may have affected our results. Thus, we also re-estimate the models replacing country specific variables with fixed effects (see Tables 8 and 9). We find no support at all for the composition effect when either the emissions or the abatement cost index is used. The previous result suggesting weak propensity of firms in dirty industries to invest in the region, is still present, albeit only in a handful of cases. When industry pollution intensity is proxied with abatement cost index the latter result disappears.

Being concerned about unobserved investor characteristics, we also estimate a model with firm fixed effects, which, does not change our earlier conclusions. As before, we find no support whatsoever for the composition effect when either of the pollution-intensity proxies is used. A handful of cases produce results consistent with the volume effect (see Tables 10 and 11).

We have performed further robustness checks that are not reported here to save space. For instance, we narrowed the sample to include only firms in highly polluting industries (emissions or abatement index equal to two) but the results produced gave very little support to the "pollution haven" hypothesis.

As alternative way of adjusting the measures of environmental standards for enforcement, we divided them by the corruption index. This adjustment, however, did not alter the qualitative results since the coefficients of interest remained insignificant in almost all the regressions.

**Table 5: Alternative Measure of Pollution Intensity (Abatement Costs)**

| | Treaties I | Treaties II | Enforcement adjusted treaties I | Enforcement adjusted treaties II | EBRD index | Adjusted EBRD index | Reduction in emissions $CO_2$ | Reduction in emissions lead | Environmental Sustainability Index overall | Environmental Sustainability Index env quality | Environmental Sustainability Index env stress | Environmental Sustainability Index env institutions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Corruption I | -0.017 | -0.0085 | **0.0253**** | 0.0117 | **-0.0224*** | 0.0179 | **-0.0240**** | **-0.036***** | **-0.0231*** | -0.0165 | **-0.027**** | -0.0163 |
| | [0.012] | [0.0101] | **[0.0102]** | [0.0116] | **[0.0121]** | [0.0216] | **[0.0104]** | **[0.0083]** | **[0.0124]** | [0.0112] | **[0.0113]** | [0.0159] |
| Env Std | -0.026 | -0.023 | **-0.0228***** | **-0.0099***** | -0.0023 | **0.0195*** | -0.0003 | 0.0008 | 0.0007 | **0.0011**** | 0.0012 | 0.001 |
| | [0.021] | [0.0145] | **[0.0064]** | **[0.0033]** | [0.0113] | **[0.0109]** | [0.0004] | [0.0007] | [0.0011] | **[0.0005]** | [0.0009] | [0.0013] |
| Abatement | -0.004 | 0.0013 | 0.0068 | 0.0018 | -0.012 | 0.0054 | -0.0005 | 0.007 | -0.0266 | 0.0034 | 0.0236 | -0.0149 |
| | [0.021] | [0.0105] | [0.0044] | [0.0063] | [0.0097] | [0.0047] | [0.0038] | [0.0222] | [0.0450] | [0.0255] | [0.0176] | [0.0253] |
| Env Std | 0.003 | 0.0008 | **-0.0007**** | 0.001 | **0.0070*** | **-0.0005**** | **0.0003*** | 0.0001 | 0.0005 | 0.0000 | -0.0004 | 0.0004 |
| ×Abatement | [0.009] | [0.0058] | **[0.0003]** | [0.0024] | **[0.0039]** | **[0.0002]** | **[0.0001]** | [0.0006] | [0.0008] | [0.0005] | [0.0003] | [0.0005] |
| NGOs/pop | | | **0.0389***** | **0.0025***** | | -0.0338 | | | | | | |
| | | | **[0.0097]** | **[0.0010]** | | [0.0207] | | | | | | |
| Number of obs | 1577 | 1577 | 1577 | 1577 | 1577 | 1577 | 1577 | 747 | 1494 | 1494 | 1494 | 1494 |
| Psedo $R^2$ | 0.34 | 0.34 | 0.35 | 0.34 | 0.34 | 0.34 | 0.34 | 0.31 | 0.33 | 0.33 | 0.32 | 0.33 |
| obs. P | 0.10 | 0.10 | 0.11 | 0.11 | 0.11 | 0.11 | 0.10 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |
| pred. P | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.06 |

All results are presented in terms of marginal effects evaluated at the sample mean.
Standard errors, listed in brackets, have been adjusted for clustering by host country.
***, **, * denotes significance at the 1, 5 and 10 percent level respectively.

**Table 6: Alternative Measure of Corruption (Neumann Index)**

| | Treaties I | Treaties II | Enforcement adjusted treaties I | Enforcement adjusted treaties II | EBRD index | Adjusted EBRD index | Reduction in emissions $CO_2$ | Reduction in emissions lead | Environmental Sustainability Index overall | env quality | env stress | env institutions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Corruption II | 0.000 | 0.0015 | -0.0023 | -0.0001 | -0.0009 | 0.0035 | 0.0012 | **-0.0314*** | -0.0011 | -0.0002 | 0.0038 | -0.0042 |
| | [0.006] | [0.0064] | [0.0053] | [0.0057] | [0.0052] | [0.0044] | [0.0049] | **[0.0169]** | [0.0052] | [0.0053] | [0.0048] | [0.0057] |
| Env Std | -0.021 | **-0.0240*** | -0.0046 | **-0.0082***** | **0.0249*** | **0.015***** | **0.0009**** | **0.002***** | **0.0022**** | **0.0014**** | 0.0011 | **0.0022**** |
| | [0.024] | **[0.0145]** | [0.0075] | **[0.0025]** | **[0.0141]** | **[0.0037]** | **[0.0004]** | **[0.0005]** | **[0.0010]** | **[0.0006]** | [0.0008] | **[0.0011]** |
| Emissions | **-0.031**** | **-0.015**** | **-0.017***** | **-0.0120*** | **-0.024**** | **-0.016***** | **-0.016***** | -0.0167 | **-0.0751*** | -0.0306 | -0.0234 | **-0.0493**** |
| | **[0.014]** | **[0.0073]** | **[0.0063]** | **[0.0061]** | **[0.0105]** | **[0.0051]** | **[0.0051]** | [0.0147] | **[0.0391]** | [0.0247] | [0.0197] | **[0.0202]** |
| Env Std | 0.01 | 0.0013 | **0.0009**** | -0.0006 | 0.0059 | **0.0006**** | 0.0003 | 0.0002 | **0.0012*** | 0.0003 | 0.0002 | **0.0008*** |
| ×Emissions | [0.007] | [0.0047] | **[0.0004]** | [0.0019] | [0.0055] | **[0.0002]** | [0.0002] | [0.0004] | **[0.0007]** | [0.0004] | [0.0003] | **[0.0004]** |
| NGOs/pop | | | 0.0092 | **0.0027*** | | **-0.027***** | | | | | | |
| | | | [0.0111] | **[0.0016]** | | **[0.0078]** | | | | | | |
| Number of obs | 2436 | 2436 | 2436 | 2436 | 2436 | 2436 | 2436 | 1160 | 2320 | 2320 | 2320 | 2320 |
| Psedo $R^2$ | 0.23 | 0.23 | 0.24 | 0.24 | 0.24 | 0.25 | 0.24 | 0.21 | 0.23 | 0.23 | 0.23 | 0.23 |
| obs. P | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.10 | 0.12 | 0.12 | 0.12 | 0.12 |
| pred. P | 0.06 | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |

All results are presented in terms of marginal effects evaluated at the sample mean.
Standard errors, listed in brackets, have been adjusted for clustering by host country.
***, **, * denotes significance at the 1, 5 and 10 percent level respectively.

**Table 7: The Sub-Sample of U.S. Firms**

| | Treaties I | Treaties II | Enforcement adjusted treaties I | Enforcement adjusted treaties II | EBRD index | Adjusted EBRD index | Reduction in emissions $CO_2$ | Reduction in emissions lead | Environmental Sustainability Index overall | Environmental Sustainability Index env quality | Environmental Sustainability Index env stress | Environmental Sustainability Index env institutions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Corruption I | -0.001 | 0.0022 | 0.015 | 0.0104 | -0.0078 | -0.0092 | -0.0063 | **0.0403*** ** | -0.0032 | -0.0011 | -0.0129 | 0.0099 |
| | [0.010] | [0.0115] | [0.0125] | [0.0147] | [0.0107] | [0.0216] | [0.0118] | **[0.0053]** | [0.0103] | [0.0113] | [0.0126] | [0.0117] |
| Env Std | **-0.029**** | **-0.024**** | **-0.018***** | **-0.0111***** | -0.0157 | 0.0005 | 0.0001 | **-0.002***** | 0.0005 | 0.0009 | **0.002***** | 0.001 |
| | **[0.011]** | **[0.0109]** | **[0.0051]** | **[0.0042]** | [0.0111] | [0.0090] | [0.0003] | **[0.0002]** | [0.0011] | [0.0006] | **[0.0008]** | [0.0007] |
| Emissions | **-0.09***** | **-0.066***** | **-0.047***** | **-0.0550***** | **-0.08***** | **-0.048***** | **-0.05***** | **-0.0407**** | **-0.210***** | **-0.083**** | 0.0068 | **-0.144***** |
| | **[0.031]** | **[0.0201]** | **[0.0163]** | **[0.0169]** | **[0.0224]** | **[0.0168]** | **[0.0167]** | **[0.0203]** | **[0.0546]** | **[0.0346]** | [0.0212] | **[0.0324]** |
| Env Std | **0.026**** | **0.0178*** | 0.0003 | 0.0059 | **0.023***** | 0.0005 | 0.0002 | 0.0000 | **0.003***** | 0.0007 | **-0.0009**** | **0.002***** |
| ×Emissions | **[0.013]** | **[0.0100]** | [0.0014] | [0.0046] | **[0.0080]** | [0.0012] | [0.0003] | [0.0005] | **[0.0009]** | [0.0006] | **[0.0005]** | **[0.0006]** |
| NGOs/pop | | | **0.027***** | -0.0004 | | -0.0022 | | | | | | |
| | | | **[0.0085]** | [0.0015] | | [0.0168] | | | | | | |
| Number of obs | 399 | 399 | 399 | 399 | 399 | 399 | 399 | 189 | 378 | 378 | 378 | 378 |
| Psedo $R^2$ | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.36 | 0.36 | 0.36 | 0.38 | 0.36 | 0.36 | 0.38 |
| obs. P | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.11 | 0.12 | 0.12 | 0.12 | 0.12 |
| pred. P | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.04 | 0.03 |

All results are presented in terms of marginal effects evaluated at the sample mean.
Standard errors are listed in brackets.
***, **, * denotes significance at the 1, 5 and 10 percent level respectively.

**Table 8: Regressions with Host Country Fixed Effects — Treaties and EBRD index**

| | | Treaties I | Treaties II | Enforcement adjusted treaties I | treaties II | EBRD index | Adjusted EBRD index |
|---|---|---|---|---|---|---|---|
| Panel A. Specification with Emissions | | | | | | | |
| Firm size | 0.305*** | 0.305*** | 0.306*** | 0.306*** | 0.305*** | 0.304*** | 0.3055*** |
| | [0.052] | [0.052] | [0.0524] | [0.052] | [0.0523] | [0.0523] | [0.0524] |
| R&D | -0.117*** | -0.116*** | -0.1167*** | -0.117*** | -0.116*** | -0.1164*** | -0.1164*** |
| Intensity | [0.028] | [0.028] | [0.0284] | [0.028] | [0.0284] | [0.0284] | [0.0284] |
| Regional | 0.111 | 0.11 | 0.1115 | 0.112 | 0.1104 | 0.11 | 0.112 |
| experience | [0.158] | [0.158] | [0.1584] | [0.158] | [0.1585] | [0.1585] | [0.1585] |
| Distance | -0.361*** | -0.362*** | -0.3595*** | -0.355*** | -0.359*** | -0.3638*** | -0.3541*** |
| | [0.083] | [0.083] | [0.0831] | [0.083] | [0.0831] | [0.0832] | [0.0831] |
| Emissions | **-0.183*** | -0.331 | -0.1272 | **-0.231*** | -0.1369 | -0.3882 | **-0.2361**** |
| | **[0.099]** | [0.362] | [0.1869] | **[0.119]** | [0.1320] | [0.2557] | **[0.1153]** |
| Env Std×Emissions | | 0.076 | -0.0473 | 0.01 | -0.0271 | 0.1006 | 0.0093 |
| | | [0.179] | [0.1347] | [0.014] | [0.0515] | [0.1150] | [0.0102] |
| Number of obs | 2552 | 2552 | 2552 | 2552 | 2552 | 2552 | 2552 |
| LR $Chi^2$ | 67.95 | 68.14 | 68.08 | 68.52 | 68.23 | 68.72 | 68.79 |
| Prob > $Chi^2$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Pseudo R2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Panel B. Specification with Abatement | | | | | | | |
| Abatement | 0.063 | -0.143 | 0.048 | 0.128 | -0.028 | -0.2085 | 0.1184 |
| | [0.113] | [0.537] | [0.2382] | [0.134] | [0.1583] | [0.3042] | [0.1313] |
| Env Std× | | 0.102 | 0.0122 | -0.013 | 0.0558 | 0.125 | -0.009 |
| Abatement | | [0.260] | [0.1698] | [0.014] | [0.0696] | [0.1308] | [0.0107] |
| Number of obs | 1328 | 1328 | 1328 | 1328 | 1328 | 1328 | 1328 |
| LR $Chi^2$ | 55.27 | 55.43 | 55.28 | 56.08 | 55.95 | 56.18 | 55.96 |
| Prob > $Chi^2$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Psedo $R^2$ | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |

Regressions in Panel B also include firm size, R&D intensity, regional experience and distance, which are not reported to save space.
All results are presented in terms of marginal effects evaluated at the sample mean. Standard errors are listed in brackets.
***, **, * denotes significance at the 1, 5 and 10 percent level respectively.

Summing up, despite our best efforts to give a chance for the "pollution haven" hypothesis to show up in the data, we were unable to find more than occasional weak support for the hypothesis. Our data indicate that host country environmental standards have very little impact on FDI inflows both in terms of the volume and in terms of composition. We do not find robust evidence of foreign investment in pollution-intensive industries flocking to countries with weak environmental regimes. On the contrary, the data indicate that firms in cleaner sectors are more likely to undertake FDI.

**Table 9: Regressions with Host Country Fixed Effects—Reduction in Emissions and ESI Index**

| | Reduction in emissions | | Environmental Sustainability Index | | | |
|---|---|---|---|---|---|---|
| | $CO_2$ | lead | overall | env quality | env stress | Env Institutions |
| Panel A. Specification with Emissions | | | | | | |
| Firm size | 0.3056*** | 0.3585*** | 0.2999*** | 0.3005*** | 0.3007*** | 0.2998*** |
| | [0.0524] | [0.0795] | [0.0525] | [0.0526] | [0.0526] | [0.0525] |
| R&D intensity | -0.1167*** | -0.1345*** | -0.1154*** | -0.1157*** | -0.1158*** | -0.1155*** |
| | [0.0284] | [0.0445] | [0.0285] | [0.0285] | [0.0285] | [0.0285] |
| Regional | 0.1111 | 0.2188 | 0.0965 | 0.0972 | 0.0971 | 0.0964 |
| experience | [0.1585] | [0.2416] | [0.1592] | [0.1591] | [0.1591] | [0.1591] |
| Distance | -0.3608*** | -0.3859*** | -0.3645*** | -0.3638*** | -0.3644*** | -0.3662*** |
| | [0.0830] | [0.1200] | [0.0832] | [0.0833] | [0.0834] | [0.0832] |
| Emissions | **-0.2348**** | -0.2586 | -1.0258 | -0.4074 | -0.2773 | -0.6802 |
| | **[0.1162]** | [0.2900] | [0.7531] | [0.4482] | [0.4312] | [0.4354] |
| Env Std× | 0.0051 | 0.004 | 0.0158 | 0.0045 | 0.0018 | 0.0105 |
| Emissions | [0.0059] | [0.0076] | [0.0139] | [0.0086] | [0.0075] | [0.0088] |
| Number of obs | 2552 | 1160 | 2436 | 2436 | 2436 | 2436 |
| LR $Chi^2$ | 68.72 | 40.42 | 67.54 | 66.51 | 66.29 | 67.66 |
| Prob > $Chi^2$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Pseudo R2 | 0.05 | 0.07 | 0.05 | 0.05 | 0.05 | 0.05 |
| Panel B. Specification with Abatement | | | | | | |
| Abatement | -0.0009 | 0.2851 | -0.6205 | 0.0344 | 0.5541 | -0.3706 |
| | [0.1360] | [0.4743] | [0.9537] | [0.5203] | [0.4790] | [0.5771] |
| Env Std× | 0.0063 | -0.0017 | 0.0124 | 0.0006 | -0.0088 | 0.0087 |
| Abatement | [0.0076] | [0.0117] | [0.0173] | [0.0098] | [0.0083] | [0.0114] |
| Number of obs | 1328 | 747 | 1328 | 1328 | 1328 | 1328 |
| LR $Chi^2$ | 55.96 | 36.52 | 55.79 | 55.28 | 56.4 | 55.85 |
| Prob > $Chi^2$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Pseudo $R^2$ | 0.07 | 0.11 | 0.07 | 0.07 | 0.07 | 0.07 |

Regressions in Panel B also include firm size, R&D intensity, regional experience and distance, which are not reported to save space. All results are presented in terms of marginal effects evaluated at the sample mean. Standard errors are listed in brackets.
***, **, * denotes significance at the 1, 5 and 10 percent level respectively.

## 3. Concluding Remarks

This paper tests whether polluting activities move from industrialized countries to developing economies, as claimed by many anti-globalization activists. To enhance our ability to detect the possible "dirty secret" that multinational firms flock to countries with weak environmental protection and that this is particularly the case for more pollution-intensive industries, we examine the location decision pertaining to FDI flows from multiple source countries to 25 economies in Eastern Europe and the former Soviet Union. Transition countries are a suitable region for studying the "pollution haven" hypothesis. While all of them share the common heritage of more than half a

century of central planning and opened up to FDI at the same time, they also offer a reasonably large variation in terms of environmental standards.

As a host country's weakness in public institutions, particularly the prevalence of bureaucratic corruption, may deter FDI but at the same time may be correlated with laxity of environmental protection, statistical analysis on the effect of environmental policy on FDI that omits local corruption might fail to detect an effect. Therefore, we explicitly account the effect of host country corruption.

Further, unlike existing studies that examine *either* whether FDI is more likely to flow to locations with laxer standards *or* whether polluting industries are more likely to engage FDI, we take into account both the polluting-intensity of the potential investor and the environmental stringency in the potential host country. Thus we are able to test whether dirty industries are *relatively* more attracted to locations with weak standards.

Finally, we rely on firm-level rather than country- or industry-level data, which allows us to avoid aggregation bias and gives us an opportunity to control for firm characteristics that may affect investment decisions.

Despite these improvements, we find no support for the "pollution haven" hypothesis. On the contrary, our results indicate that firms in less polluting industries are more likely to invest in the region. Our findings are still subject to caveats. The measures of pollution intensity and of the strength of environmental protection are possibly too noisy for us to obtain precise estimates. While we have employed multiple measures of environmental standards, we have not allowed them to be endogenous. Future work will, hopefully, improve on these dimensions.

## Appendix: Response Bias

The response rate in the survey was close to fifteen percent. It is likely that firms that perceived the survey as more relevant (for instance, firms that had invested or considered investing in transition economies) were more likely to respond. To check this hypothesis, we examine the list of major foreign investors in Poland compiled by the Polish State Investment Agency (PAIZ, 1995). Poland was chosen for this exercise since it was the most popular destination country in the sample. Out of 329 firms on the list, 118 received the EBRD survey and fifty percent of them responded.

Formal tests on difference in means could not reject the null hypothesis that the means of firm specific variables in the respondent and non-respondent groups were not significantly different from each other. Thus, among the investing firms, the decision to respond to the survey was not systematically related to firm characteristics observable in the data. Unfortunately, it was not possible to identify which among the firms that did not respond to the survey were not interested in undertaking investment in Eastern Europe and the former Soviet Union. We have no reason, however, to suspect that in the case of these firms, the decision to answer the survey was systematically related to their characteristics. Therefore, the data set can be treated as if the investing firms had been over-sampled. This does not affect the results presented in this study, however, since all of regressions focus on firms that invested in at least one country in the region.

**Table 10: Regressions with Firm Fixed Effects — Emissions**

| | Treaties I | Treaties II | Enforcement adjusted treaties I | Enforcement adjusted treaties II | EBRD index | Adjusted EBRD index | Reduction in emissions $CO_2$ | Reduction in emissions lead | Environmental Sustainability Index overall | Environmental Sustainability Index env quality | Environmental Sustainability Index env stress | Environmental Sustainability Index env institutions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distance | -1.96*** | -1.931*** | -1.841*** | -1.811*** | -1.93*** | -1.78*** | -1.93*** | -1.76*** | -1.93*** | -1.929*** | -1.93*** | -1.93*** |
| | [0.195] | [0.1928] | [0.201] | [0.1971] | [0.1950] | [0.2016] | [0.1949] | [0.2872] | [0.1967] | [0.1976] | [0.1963] | [0.1969] |
| Relative GDP | -0.11 | -0.2314 | -0.399 | -0.8448** | 0.0451 | -0.1453 | -0.0501 | 0.352 | -0.0357 | -0.0297 | -0.0393 | -0.028 |
| per capita | [0.259] | [0.2732] | [0.296] | [0.3879] | [0.2601] | [0.2666] | [0.2517] | [0.5633] | [0.2891] | [0.2538] | [0.2513] | [0.2840] |
| GDP | 0.890*** | 0.8843*** | 0.758*** | 0.6582*** | 0.8712*** | 0.762*** | 0.898*** | 0.909*** | 0.868*** | 0.862*** | 0.872*** | 0.868*** |
| | [0.085] | [0.0855] | [0.105] | [0.1204] | [0.0824] | [0.1042] | [0.0961] | [0.1985] | [0.0825] | [0.0853] | [0.0839] | [0.0822] |
| Corporate tax | -0.028** | -0.0333** | -0.017 | -0.0046 | -0.0188 | -0.0071 | -0.0222 | -0.0306 | -0.0148 | -0.0138 | -0.0079 | -0.0148 |
| | [0.014] | [0.0137] | [0.012] | [0.0123] | [0.0120] | [0.0122] | [0.0156] | [0.0663] | [0.0128] | [0.0127] | [0.0218] | [0.0118] |
| Democracy | 0.234 | -0.0115 | 1.058 | -0.0205 | -0.824 | 0.2615 | -0.5113 | -0.6156 | -0.4249 | -0.3205 | -0.194 | -0.4235 |
| | [0.769] | [0.7014] | [0.927] | [0.7231] | [0.7471] | [0.7567] | [0.6896] | [1.4110] | [0.7636] | [0.8406] | [0.9181] | [0.6852] |
| Openness | -0.247 | -0.0437 | 0.215 | 0.478 | -0.2359 | 0.1295 | -0.1791 | -0.9223 | -0.285 | -0.2795 | -0.2254 | -0.2827 |
| | [0.316] | [0.3432] | [0.376] | [0.4138] | [0.3089] | [0.3659] | [0.3503] | [0.5724] | [0.3103] | [0.3108] | [0.3490] | [0.3111] |
| Corruption I | 0.156 | 0.2719 | 0.553* | **0.6645**** | 0.0169 | **0.6321*** | -0.0055 | -0.3487 | -0.0524 | -0.036 | -0.0631 | -0.0447 |
| | [0.224] | [0.2290] | [0.308] | **[0.3073]** | [0.1983] | **[0.3515]** | [0.2049] | [0.2138] | [0.1901] | [0.2001] | [0.1891] | [0.2209] |
| Env Std | -0.483 | **-0.4069**** | **-0.309**** | **-0.1814**** | 0.1733 | **0.3450**** | 0.0011 | 0.0055 | -0.0037 | 0.0025 | 0.0036 | -0.001 |
| | [0.307] | **[0.1956]** | **[0.135]** | **[0.0732]** | [0.1811] | **[0.1641]** | [0.0083] | [0.0113] | [0.0193] | [0.0101] | [0.0142] | [0.0180] |
| Env Std× | -0.025 | -0.0297 | 0.002 | 0.0151 | 0.0369 | 0.0016 | 0.004 | 0.0039 | 0.0043 | -0.0009 | 0.0014 | 0.0023 |
| Emissions | [0.181] | [0.1297] | [0.017] | [0.0463] | [0.1040] | [0.0123] | [0.0050] | [0.0082] | [0.0134] | [0.0076] | [0.0069] | [0.0089] |
| NGOs/pop | | | **0.511**** | **0.0551*** | | **-0.614**** | | | | | | |
| | | | **[0.213]** | **[0.0307]** | | **[0.3055]** | | | | | | |
| Number of obs | 3078 | 3078 | 3078 | 3078 | 3078 | 3078 | 3078 | 900 | 2916 | 2916 | 2916 | 2916 |
| LR $Chi^2$ | 675.25 | 679.18 | 677.95 | 680.48 | 673.43 | 677.24 | 672.58 | 249.88 | 643.8 | 643.76 | 643.88 | 643.76 |
| Prob > $Chi^2$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Pseudo $R^2$ | 0.44 | 0.44 | 0.44 | 0.44 | 0.44 | 0.44 | 0.44 | 0.46 | 0.43 | 0.43 | 0.43 | 0.43 |

All results are presented in terms of marginal effects evaluated at the sample mean.
Standard errors are listed in brackets.
***, **, * denotes significance at the 1, 5 and 10 percent level respectively.

**Table 11: Regressions with Firm Fixed Effects — Abatement**

| | Treaties I | Treaties II | Enforcement adjusted treaties I | Enforcement adjusted treaties II | EBRD index | Adjusted EBRD index | Reduction in emissions $CO_2$ | Reduction in emissions lead | Environmental Sustainability Index overall | Environmental Sustainability Index env quality | Environmental Sustainability Index env stress | Environmental Sustainability Index env institutions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distance | -2.16*** | -2.13*** | -2.064*** | -2.012*** | -2.13*** | -2.009*** | -2.14*** | -1.631*** | -2.119*** | -2.105*** | -2.144*** | -2.0990*** |
| | [0.256] | [0.253] | [0.264] | [0.260] | [0.257] | [0.266] | [0.2570] | [0.3683] | [0.2575] | [0.2572] | [0.2599] | [0.2582] |
| Relative GDP | 0.062 | -0.082 | -0.465 | -0.860* | 0.13 | -0.074 | 0.1091 | -0.1029 | 0.2791 | 0.1498 | 0.0991 | 0.3182 |
| Per cap | [0.312] | [0.333] | [0.382] | [0.516] | [0.316] | [0.333] | [0.3083] | [0.8876] | [0.3498] | [0.3061] | [0.3035] | [0.3606] |
| GDP | 0.812*** | 0.809*** | 0.683*** | 0.607*** | 0.799*** | 0.728*** | 0.789*** | 0.9514*** | 0.8083*** | 0.7692*** | 0.8139*** | 0.8088*** |
| | [0.104] | [0.105] | [0.133] | [0.155] | [0.101] | [0.130] | [0.1193] | [0.2867] | [0.1030] | [0.1058] | [0.1049] | [0.1026] |
| Corporate tax | -0.027 | -0.034** | -0.019 | -0.006 | -0.018 | -0.008 | -0.015 | -0.0582 | -0.013 | -0.0126 | 0.0035 | -0.0183 |
| | [0.016] | [0.016] | [0.014] | [0.015] | [0.014] | [0.015] | [0.0202] | [0.0902] | [0.0154] | [0.0152] | [0.0258] | [0.0140] |
| Democracy | 0.446 | 0.323 | 2.184* | 0.5 | -0.058 | 0.875 | 0.0555 | 0.2474 | 0.3914 | 0.6182 | 0.7178 | 0.1845 |
| | [0.944] | [0.865] | [1.220] | [0.903] | [0.914] | [0.952] | [0.8582] | [1.7207] | [0.9599] | [1.0428] | [1.1018] | [0.8794] |
| Openness | -0.545 | -0.344 | 0.298 | 0.443 | -0.542 | 0.042 | -0.5875 | -0.3468 | -0.5949 | -0.5396 | -0.3752 | -0.5329 |
| | [0.388] | [0.424] | [0.507] | [0.552] | [0.386] | [0.473] | [0.4579] | [1.0266] | [0.3844] | [0.3832] | [0.4289] | [0.3843] |
| Corruption I | -0.04 | 0.11 | **0.751*** | **0.705*** | -0.164 | 0.632 | -0.1956 | **-0.5456**** | -0.1524 | -0.0918 | -0.2099 | -0.0344 |
| | [0.269] | [0.279] | **[0.402]** | **[0.398]** | [0.239] | [0.426] | [0.2548] | **[0.2630]** | [0.2344] | [0.2478] | [0.2280] | [0.2767] |
| Env Std | -0.156 | -0.301 | **-0.395**** | **-0.207*** | -0.059 | **0.357*** | -0.0093 | 0.0136 | 0.0039 | 0.0082 | 0.0198 | 0.0143 |
| | [0.219] | [0.279] | **[0.177]** | **[0.110]** | [0.238] | **[0.195]** | [0.0126] | [0.0199] | [0.0270] | [0.0143] | [0.0180] | [0.0254] |
| Env Std | -0.15 | -0.077 | -0.014 | 0.023 | 0.084 | -0.008 | 0.0059 | -0.0015 | 0.01 | 0.0012 | -0.0034 | 0.0064 |
| ×Abatement | [0.444] | [0.149] | [0.017] | [0.055] | [0.113] | [0.013] | [0.0059] | [0.0117] | [0.0151] | [0.0084] | [0.0074] | [0.0103] |
| NGOs/pop | | | **0.706**** | **0.084**** | | -0.591 | | | | | | |
| | | | **[0.279]** | **[0.037]** | | [0.365] | | | | | | |
| Number of obs | 2166 | 2166 | 2166 | 2166 | 2166 | 2166 | 2166 | 621 | 2052 | 2052 | 2052 | 2052 |
| LR $Chi^2$ | 486.07 | 488.77 | 493.91 | 492.79 | 485 | 491.12 | 485.41 | 182.69 | 460.61 | 460.54 | 460.64 | 460.83 |
| Prob > $Chi^2$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Pseudo $R^2$ | 0.4535 | 0.456 | 0.4608 | 0.4597 | 0.4525 | 0.4582 | 0.45 | 0.48 | 0.44 | 0.44 | 0.44 | 0.44 |

All results are presented in terms of marginal effects evaluated at the sample mean.
Standard errors are listed in brackets.
***, **, * denotes significance at the 1, 5 and 10 percent level respectively.

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## Appendix Tables

**Table A1: Classification of 3-digit SIC Sectors by Pollution Intensity**

| | | | |
|---|---|---|---|
| **High Pollution** | | | |
| 102 ~ | Copper ores | 276 # | Manifold business forms |
| 109 ~ | Miscellaneous metal ores | 278 ~ | Blank books and bookbinding |
| 131 ~ | Crude petroleum and natural gas | 282 * | Plastics materials and synthetics |
| 132 ~ | Natural gas liquids | 283 * | Drugs |
| 172 ~ | Painting and paper hanging special trade contractors | 284 * | Soaps, cleaners, and toilet goods |
| 175 ~ | Carpentry and floor work special trade contractors | 287 * | Agricultural chemicals |
| 179 ~ | Miscellaneous special trade contractors | 308 | Miscellaneous plastics products, n.e.c. |
| 205 # | Bakery products | 314 ~ | Footwear, except rubber |
| 206 # | Sugar and confectionery products | 325 ~ | Structural clay products |
| 224 ~ | Narrow fabric mills | 326 * | Pottery and related products |
| 226 * | Textile finishing, except wool | 327 * | Concrete, gypsum, and plaster products |
| 235 ~ | Hats, caps, and millinery | 328 ~ | Cut stone and stone products |
| 239 ~ | Miscellaneous fabricated textile products | 329 * | Miscellaneous nonmetallic mineral products |
| 241 ^ | Logging | 331 * | Blast furnace and basic steel products |
| 242 | Sawmills and planing mills | 332 * | Iron and steel foundries |
| 243 | Millwork, plywood, and structural members | 333 # | Primary nonferrous metals |
| 249 | Miscellaneous wood products | 341 # | Metal cans and shipping containers |
| 251 | Household furniture | 344 * | Fabricated structural metal products |
| 252 # | Office furniture | 345 * | Screw machine products, bolts, etc. |
| 254 | Partitions and fixtures | 347 * | Metal services, n.e.c. |
| 259 ~ | Miscellaneous furniture and fixtures | 354 * | Metalworking machinery |
| 261 # | Pulp mills | 367 * | Electronic components and accessories |
| 262 # | Paper mills | 373 | Ship and boat building and repairing |
| 263 # | Paperboard mills | 385 ~ | Ophthalmic goods |
| 272 ~ | Periodicals | 387 ~ | Watches, clocks, watchcases, and parts |
| 273 # | Books | 393 ~ | Musical instruments |
| 275 | Commercial printing | | |
| **Low Pollution** | | **Medium Pollution** | |
| 142 ~ | Crushed and broken stone, including riprap | 201 | Meat products |
| 154 ~ | General building contractors—nonresidential buildings | 204 * | Grain mill products |
| 202 ~ | Dairy products | 205 * | Bakery products |
| 204 # | Grain mill products | 214 # | Tobacco stemming and redrying |
| 206 * | Sugar and confectionery products | 221 # | Broad woven fabric mills, cotton |
| 211 ~ | Cigarettes | 226 # | Textile finishing, except wool |
| 214 * | Tobacco stemming and redrying | 245 ~ | Wood buildings and mobile homes |
| 221 * | Broad woven fabric mills, cotton | 252 * | Office furniture |
| 222 | Broad woven fabric mills, manmade fiber and silk | 253 ~ | Public building and related furniture |
| 223 ~ | Broad woven fabric mills, wool | 262 * | Paper mills |
| 227 ~ | Carpets and rugs | 263 * | Paperboard mills |
| 232 ~ | Men's and boys' furnishings | 265 # | Paperboard containers and boxes |

**Table A1 continued**

| Low Pollution | | | Medium Pollution | | |
|---|---|---|---|---|---|
| 261 | * | Pulp mills | 271 | ^ | Newspapers |
| 265 | * | Paperboard containers and boxes | 282 | # | Plastics materials and synthetics |
| 273 | * | Books | 285 | | Paints and allied products |
| 274 | ~ | Miscellaneous publishing | 287 | # | Agricultural chemicals |
| 276 | * | Manifold business forms | 291 | | Petroleum refining |
| 277 | ~ | Greeting cards | 295 | * | Asphalt paving and roofing materials |
| 279 | ~ | Printing trade services | 306 | | Fabricated rubber products, n.e.c. |
| 283 | # | Drugs | 311 | | Leather tanning and finishing |
| 284 | # | Soaps, cleaners, and toilet goods | 321 | ~ | Flat glass |
| 295 | # | Asphalt paving and roofing materials | 322 | | Glass and glassware, pressed or blown |
| 299 | | Miscellaneous petroleum and coal products | 323 | | Products of purchased glass |
| 301 | | Tires and inner tubes | 324 | | Cement, hydraulic |
| 302 | ~ | Rubber and plastics footwear | 326 | # | Pottery and related products |
| 305 | | Hose and belting and gaskets and packing | 327 | # | Concrete, gypsum, and plaster products |
| 317 | ~ | Handbags and personal leather goods | 329 | # | Miscellaneous nonmetallic mineral products |
| 331 | # | Blast furnace and basic steel products | 332 | # | Iron and steel foundries |
| 333 | * | Primary nonferrous metals | 336 | * | Nonferrous foundries (castings) |
| 334 | | Secondary nonferrous metals | 339 | | Miscellaneous primary metal products |
| 335 | | Nonferrous rolling and drawing | 344 | # | Fabricated structural metal products |
| 336 | # | Nonferrous foundries (castings) | 346 | * | Metal forgings and stampings |
| 341 | * | Metal cans and shipping containers | 347 | # | Metal services, n.e.c. |
| 343 | | Plumbing and heating, except electric | 348 | * | Ordnance and accessories, n.e.c. |
| 345 | # | Screw machine products, bolts, etc. | 353 | # | Construction and related machinery |
| 346 | # | Metal forgings and stampings | 354 | # | Metalworking machinery |
| 348 | # | Ordnance and accessories, n.e.c. | 356 | * | General industrial machinery |
| 353 | * | Construction and related machinery | 358 | | Refrigeration and service machinery |
| 356 | # | General industrial machinery | 359 | ~ | Industrial machinery, n.e.c. |
| 361 | | Electric distribution equipment | 362 | | Electrical industrial apparatus |
| 364 | # | Electric lighting and wiring equipment | 364 | * | Electric lighting and wiring equipment |
| 366 | | Communications equipment | 365 | ~ | Household audio and video equipment |
| 367 | # | Electronic components and accessories | 372 | # | Aircraft and parts |
| 372 | * | Aircraft and parts | 374 | | Railroad equipment |
| 376 | | Guided missiles, space vehicles, parts | 382 | ~ | Measuring and controlling devices |
| 381 | ~ | Search and navigation equipment | 386 | | Photographic equipment and supplies |
| 391 | | Jewelry, silverware, and plated ware | 395 | # | Pens, pencils, office, and art supplies |
| 395 | * | Pens, pencils, office, and art supplies | | | |

# emission but in another abatement category
* abatement but in another emission category
^ only abatement data were available
~ only emission data were available

**Table A2: Measures of Environmental Standards and Corruption**

| Country | Corruption I | Corruption II | Treaties I | Treaties II | EBRD index | NGOs/ pop | Reduction in emissions | | Environmental Sustainability Index | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lead | $CO_2$ | overall | env quality | env stress | env institutions |
| Albania | 4.4 | | 2.0 | 2 | 1 | 1.3 | | 59.3 | 44.2 | 44.6 | 65.4 | 39.6 |
| Armenia | 4.5 | 6 | 1.5 | 0 | 1 | 2.2 | | 17.2 | 50.6 | 50.3 | 74.2 | 39.3 |
| Azerbaijan | 5.5 | 6 | 0.5 | 0 | 1 | 1.6 | | -9.9 | 46.4 | 38.9 | 65.2 | 27.8 |
| Belarus | 5.0 | 4 | 1.5 | 1 | 1 | 1.3 | 63.4 | 8.9 | 48.0 | 53.6 | 66.0 | 28.6 |
| Bulgaria | 5.5 | 4 | 3.0 | 3 | 1 | 3.1 | 20.7 | -19.4 | 47.4 | 25.7 | 59.2 | 33.5 |
| Croatia | | 4 | 2.0 | 1 | 2 | 5.6 | 15.8 | 2.5 | 54.1 | 57.0 | 59.1 | 49.3 |
| Czech Rep. | 3.3 | 4 | 2.0 | 1 | 3 | 1.6 | | 22.4 | 57.2 | 53.3 | 31.0 | 60.0 |
| Estonia | 2.6 | 2 | 1.5 | 0 | 2 | 19.3 | 42.6 | 20.3 | 57.7 | 59.1 | 66.5 | 54.1 |
| Georgia | 5.0 | 4 | 0.5 | 0 | 1 | 2.0 | | 84.8 | | | | |
| Hungary | 3.9 | 6 | 2.5 | 2 | 3 | 1.2 | | 1.5 | 61.0 | 50.4 | 64.1 | 56.6 |
| Kazakhstan | 5.1 | 4 | 1.5 | 0 | 1 | 0.9 | -25.9 | 0.9 | 41.6 | 48.8 | 76.8 | 21.5 |
| Kyrgyzstan | 4.9 | 4 | 0.5 | 0 | 1 | 1.1 | | 17.1 | 39.6 | 42.8 | 67.8 | 26.8 |
| Latvia | 4.6 | 4 | 2.0 | 1 | 2 | 2.7 | | 12.5 | 56.3 | 58.3 | 55.2 | 50.7 |
| Lithuania | 3.9 | 0 | 2.0 | 1 | 1 | 2.1 | 22.7 | 13.2 | 60.3 | 57.9 | 64.4 | 49.1 |
| Macedonia FYR | | 8 | 1.0 | 0 | 1 | 11.4 | | -1.9 | 39.2 | 38.7 | 37.8 | 38.5 |
| Moldova | 5.0 | | 3.0 | 3 | 1 | 1.4 | | 10.2 | 47.4 | 49.4 | 68.7 | 36.0 |
| Poland | 4.6 | 4 | 2.0 | 1 | 3 | 0.6 | 45.2 | 23.3 | 47.6 | 34.3 | 45.5 | 45.8 |
| Romania | | 6 | 1.5 | 1 | 2 | 0.7 | | 18.8 | 44.1 | 36.8 | 62.1 | 38.4 |
| Russia | 5.3 | 8 | 2.5 | 2 | 1 | 0.2 | | -12.4 | 56.2 | 65.4 | 69.8 | 42.6 |
| Slovak Rep. | 3.6 | 4 | 1.5 | 1 | 2 | 5.3 | 36.3 | 28.1 | 63.2 | 60.9 | 49.5 | 60.0 |
| Slovenia | | 2 | 1.5 | 1 | 2 | 3.5 | | -0.2 | 59.9 | 63.8 | 43.4 | 66.2 |
| Tajikistan | | 4 | 0.0 | 0 | 1 | 0.9 | | 76.0 | | | | |
| Turkmenistan | | 4 | 0.0 | 0 | 1 | 1.2 | | -42.1 | | | | |
| Ukraine | 4.3 | 4 | 1.5 | 1 | 1 | 0.2 | 18.0 | -18.9 | 36.8 | 32.8 | 45.7 | 28.2 |
| Uzbekistan | 5.2 | 4 | 0.0 | 0 | 1 | 0.4 | 32.5 | 11.8 | 41.6 | 46.9 | 64.8 | 20.5 |

**Table A3: Correlations between Country Specific Variables**

| | GDP | Relative GDP per capita | Corpo-rate tax | Distance | Corrup-tion I | Corrup-tion II | Treaties I | Treaties II | EBRD index | NGOs/ pop | Reduction in emissions | | ESI overall | ESI env quality | ESI env stress |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | lead | $CO_2$ | | | |
| GDP | 1.00 | | | | | | | | | | | | | | |
| Relative GDP per capita | -0.39 | 1.00 | | | | | | | | | | | | | |
| Corporate tax | 0.47 | -0.17 | 1.00 | | | | | | | | | | | | |
| Distance | 0.04 | 0.20 | 0.05 | 1.00 | | | | | | | | | | | |
| Corruption I | 0.39 | 0.28 | 0.08 | 0.31 | 1.00 | | | | | | | | | | |
| Corruption II | 0.57 | 0.05 | 0.40 | 0.19 | 0.55 | 1.00 | | | | | | | | | |
| Treaties I | 0.22 | -0.51 | -0.47 | -0.27 | 0.05 | -0.15 | 1.00 | | | | | | | | |
| Treaties II | 0.21 | -0.22 | -0.20 | -0.18 | 0.37 | 0.13 | 0.79 | 1.00 | | | | | | | |
| EBRD index | 0.49 | -0.65 | 0.40 | -0.27 | -0.42 | 0.08 | 0.12 | -0.10 | 1.00 | | | | | | |
| NGOs/pop | -0.53 | -0.28 | -0.36 | -0.20 | -0.79 | -0.36 | 0.05 | -0.24 | 0.31 | 1.00 | | | | | |
| Reduction in lead emissions | -0.24 | 0.07 | 0.19 | -0.32 | -0.25 | -0.02 | -0.08 | 0.11 | 0.39 | 0.24 | 1.00 | | | | |
| Reduction in $CO_2$ emissions | -0.07 | -0.39 | 0.53 | -0.16 | -0.52 | -0.25 | -0.34 | -0.50 | 0.65 | 0.34 | 0.44 | 1.00 | | | |
| ESI overall | -0.37 | -0.53 | 0.10 | -0.33 | -0.67 | -0.59 | 0.23 | 0.05 | 0.35 | 0.53 | 0.34 | 0.66 | 1.00 | | |
| ESI env quality | -0.61 | -0.04 | 0.14 | -0.07 | -0.61 | -0.48 | -0.40 | -0.59 | 0.03 | 0.44 | 0.18 | 0.71 | 0.67 | 1.00 | |
| ESI env stress | -0.55 | 0.21 | -0.44 | 0.27 | 0.14 | -0.26 | -0.20 | -0.37 | -0.52 | 0.18 | -0.37 | -0.01 | -0.02 | 0.41 | 1.00 |
| ESI env institutions | -0.10 | -0.65 | 0.15 | -0.41 | -0.79 | -0.47 | 0.32 | 0.08 | 0.64 | 0.58 | 0.38 | 0.62 | 0.89 | 0.44 | -0.37 |