An Empirical Test of the Pollution Haven Hypothesis with Strategic Environment and Trade Policy

Derek K. Kellenberg*
School of Economics
Georgia Institute of Technology

Abstract: Using a new dataset on the stringency and enforcement of environmental policy, this study is the first to find robust confirmation of the pollution haven hypothesis in a cross-country context while controlling for strategically determined environment and trade policy. A simple game theoretic approach to policy determination is developed which suggests an identification strategy based on other country characteristics. It is found that for the top 20th percentile of countries in terms of growth in U.S multinational affiliate value added, as much as 8.6% of that growth between 1999-2003 can be attributed to declining environmental policy. The results are robust to a number of identification tests, weak IV tests, and third country spatial effects. Further, evidence is found that more 'footloose' industries are more likely to be affected by environmental policy than more traditionally 'dirty' industries. Interesting results regarding the strategic determination of IPR policy are also discussed.

JEL Codes: F18, F23, F13

Key Words: Pollution Haven Hypothesis, Strategic Trade Policy, Multinational Firms, Intellectual Property Rights, Environmental Policy, Foreign Direct Investment

---

* Author's Correspondence: Georgia Institute of Technology, School of Economics, 781 Marietta St. NW, Atlanta, GA, 30332-0615. Tel: 1-404-894-4912. Email: Derek.Kellenberg@econ.gatech.edu.

I. Introduction

The validity of the pollution haven hypothesis continues to be one of the most contentious issues in the debate regarding international trade and the environment. With conventional forms of trade policy becoming less relevant as tariffs and quotas are phased out under sequential rounds of multilateral trade negotiations, combined with Most-Favored Nation (MFN) treatment under World Trade Organization (WTO) rules, the importance of policies that are potentially linked to trade policy but not explicitly covered under WTO purview will take on increased significance in the future determination of trade and foreign investment flows. In the past decade, interest in this issue has generated a flurry of theoretical papers on environmental regulations and their effects on trade and investment, as well as trade and investments' potential effects on the environment. In particular, strategic interaction of tariff and non-tariff policies has emerged as a prime candidate for why countries may choose to distort environmental policy[1].

Despite the fact that strategic interaction has received a great deal of attention in the theoretical literature as a potential cause of pollution havens, the empirical validity of these considerations have never explicitly been tested in a cross-country framework. Until now this has largely been a shortcoming of available cross country data on environmental policy that can be used to test the possibility that trade and domestic policy, such as environmental protection or intellectual property rights (IPR's), are endogenously determined across countries. However, Fredriksson and Millimet [2002] and Fredriksson et al. [2004] show evidence that U.S. states set environmental regulation strategically based on the regulation of neighboring states. Given that countries face greater heterogeneity in culture, endowments, geography, markets, institutions, and politics, combined with a lack of an enforceable federal government, we might expect that the potential for strategic interaction, internationally, is greater than has been found across U.S. states.

[1] See for example Krutilla [1991], Barrett [1994], Kennedy [1994], Markusen et al. [1995], or Hamilton and Requate [2004].

To date, the majority of the empirical work on the pollution haven hypothesis has been focused on inward foreign direct investment (FDI) and net imports to the U.S. A number of efforts to control for environmental policy have been attempted by using abatement costs or pollution levels as proxies. In light of difficult data constraints, prior studies have made great strides in uncovering the effects of environmental policy on trade and investment flows, but the work to date should largely be described as falling under the category of testing for a pollution haven effect, rather than an actual test of the pollution haven hypothesis[2]. That is, the majority of the empirical tests to date have focused on whether *exogenous* abatement costs (or emissions levels) per unit of output across countries, regions, or districts have had an effect on either trade flows or foreign direct investment[3]. Although tests of this nature have been enlightening, pollution haven effects from this body of work have ranged from nil to marginally significant in magnitude[4].

The strategic nature of environment and trade policy implies that a test of the pollution haven hypothesis cannot assume exogenous environmental policy. In this paper, a test of the pollution haven *hypothesis* is defined as a confirmation of a pollution haven *effect* when the endogenously determined policy choices created by strategic interaction (as well as traditional determinants of comparative advantage) have been controlled for.

---

[2] A sentiment expressed by Taylor [2004].

[3] See for example, Becker and Henderson [2000], List and Co [2000], Keller and Levinson [2002], Eskeland and Harrison [2003], Javorcik and Wei [2004], Kahn and Yoshino [2004], or Ederington, Levinson, and Minier [2005]. The three exceptions, have been Xing and Kolstad [2002], Ederington and Minier [2003], and Fredriksson et al. [2003], who instrument for measures of environmental policy. However, none of these papers controls for the joint endogeneity of income, trade policies, and environmental policies in a multi-country context.

[4] Again, the exceptions being Fredriksson et al. [2003] and Ederington and Minier [2003] who find more substantial effects of U.S. abatement costs on U.S. inward FDI and net imports into the U.S., respectively.

Using a new dataset on environmental policy stringency and enforcement this paper is the first to explicitly test the pollution haven hypothesis in a cross country context by controlling for the endogenous determination of income and strategic environment and trade policy. A general game theoretic approach to modeling international competition in policy is developed that generates an identification strategy for estimation based on other country characteristics. While the focus of this paper is on environmental policies and the pollution haven hypothesis, the approach could easily be used to analyze other issues of regional or international policy when municipalities or governments behave strategically.

The data used in this paper is unique not only for its policy variables but also for the time period analyzed. Since the rise of the internet and consumer information regarding states and firms environmental records beginning in the 1990's, and the WTO protests in Seattle in 1999, governments and firms have been under increasing pressure from constituents and consumers to protect the environment and enforce current environmental laws. With this pressure and scrutiny, the real cost of compliance with potentially more stringent regulations (from governments that feel pressure to enforce them) has arguably increased the importance of differences in environmental policy for firms looking to locate in foreign locations when compared to early points in history[5]. The five year time period from 1999-2003 used in this paper allows for the examination of environmental policy differences during a time when there has been significant U.S. multinational activity worldwide and environment and trade policy have been at the forefront of international debates.

Unlike the majority of prior studies that have found little evidence that differences in environmental policy matter for trade flows or foreign investment, this study finds robust evidence that environment and other trade policies, such as tariffs and intellectual property rights, are strategically determined. Once their endogenous determination is controlled for, a substantial pollution haven effect is found for U.S. multinational firms in foreign countries. In fact, it is found that of the countries in the top

---

[5] All of the previous empirical work regarding the pollution haven hypothesis has covered time periods ranging from the 1970's to 1994.

20th percentile in terms of U.S. multinational production growth, approximately 8.6% of that growth can be attributed to falling environmental stringency and enforcement. For developing and transition economies the impact is even more pronounced. Of the developing and transition countries in the top 20th percentile of U.S. multinational production growth, approximately 32% of their growth can be attributed to falling environmental stringency and enforcement.

Further, evidence is found to support Ederington, et al. [2005] that the most capital intensive industries are not necessarily the most likely to react to changes in environmental policy, and that pollution havens may in fact be driven more by relatively "footloose" industries. That is, industries traditionally thought to be relatively clean such as electronics, appliances, and components (due to a lack of relative capital intensity) are actually far more likely to be influenced by environmental regulation than more traditionally dirty, capital intensive, industries such as mining, utilities, chemicals or metals.

In Section II of the paper, a simple game theoretic approach to international policy is developed that incorporates the endogenous determination of multinational activity and national income with strategic environment and trade policy. A short discussion is included regarding how the approach can generally be interpreted in terms of a number of papers related to the theory of strategic trade and environment. In Section III, identification and the estimation strategy are discussed; Section IV presents the estimating equation, data, and empirical issues; Section V discusses the results; while Section VI provides concluding thoughts related to policy and future areas of research.

II. A Simple Game Theoretic Approach to International Policy Determination

Imagine a world where there are *j* countries that compete for multinational investment and production. Each country is characterized by a national income function[6]:

$$G_j(X_j, Z_j, t_j) \tag{1}$$

where *X* is the level of foreign multinational output in country *j*, *Z* are exogenous factors that affect production (such as capital, labor, technology level, resources, infrastructure,

[6] *G* can be thought of as observed GDP.

domestic policy decisions, etc.), and t is a set of government policies that affect domestic national income but also have significance for international markets[7]. No stance in taken on the exact method by which multinational firm production affects income but it could come about through knowledge spillovers to domestic firms, economies of scale, access to international markets, or increased competition that drives out less efficient domestic firms.

It is assumed that each of the j countries competes for multinational firm production from a large economy which can equally be thought of as either the 'Rest of World' (ROW) or a large economy such as the US. It is assumed that a representative multinational firm has an affiliate located in each country j and must make a choice about producing a non-negative amount of output in each country[8]. Multinational firm output in any particular location is given by

$$X_j(G_j, t_j, \xi_j) \quad (2)$$

where ξ are comparative advantage factors exogenous to the firm that affect multinational production decisions. Equation (2) summarizes three of the most commonly studied factors regarding multinational firm location: market size (G); trade, IPR, or environmental policy (t); and other forms of comparative advantage (ξ) such as

[7] It is important to note here that we are making a distinction between different policy choices. Domestic policies such as welfare policy, social health insurance, or other domestic laws that are not typically thought to have first order impacts on international trade or multinational affiliate production fall in the set Z. Policies that that we think might have direct first order impacts on international trade or multinational production such as tariff rates, intellectual property protection, or environmental policy fall in the set t.

[8] Given that the data available is aggregate data, entry and exit from countries is not considered here. That is, it is assumed that the representative multinational firm has a production facility in each location and makes output decisions for each location at the margin. Given that we only observe countries with positive aggregate levels of output, as well as the fact that there is a short time dimension to the dataset, this should be a relatively benign assumption. If we were to employ firm level data or had access to a longer time dimension then the issue of entry and exit might become more important for the analysis.

capital/labor ratios, human capital, infrastructure, institutions, distance, language, or the level of corruption in a country[9].

A government planner seeks to maximize a national welfare function by choosing a set of policies that affect domestic markets and multinational production in their country. The set of policy choice variables t available to the government are the stringency of environmental regulation (e), trade policy (τ), and intellectual property protection (ψ). The national welfare function for country j can be represented as

$$W_j = W_j[G_j(X_j, Z_j, t_j(e_j, \tau_j, \psi_j)), D_j(Z_j, t_j)], \qquad (3)$$

where D are net external costs associated with policy choices. Including net external costs of policy decisions in the welfare function is important, as many policy choices by national governments have external costs or benefits to society that are not captured by national accounts such as GDP. For example, lax environmental standards or regulation may cause an increase in multinational activity and GDP (i.e. and increase in G and X), but these measures would overstate welfare if pollution were increasing in the country (i.e. an increase in D). Thus, D captures the external cost component of increased pollution from lax environmental standards.

Likewise, increasing intellectual property rights that protect domestic and international producers inventions may increase GDP and attract multinational production, but may also create unobserved external benefits to society in the form of agglomeration externalities and knowledge spillovers that are not explicitly captured in national accounts. In this case, D captures the net external benefits to society of increased IPR protection. A simple way to think about the difference between G and D is that G captures the observed net gain or loss to a country's income from policy choices, while D captures unobserved external costs or benefits of those same policies that are not captured in national accounts (but may be accounted for by the social planner).

[9] The literature on the determinants of multinational firms is quite extensive. For the importance of market size, relative factor endowments, and trade costs see, for example, Markusen and Venables [1998], Markusen and Venables [2000], and Carr et al. [2001].

Politicians in each country choose a set of policies $t_j(e_j, \tau_j, \psi_j)$ to maximize national welfare, W_j. Each country plays a Nash strategy to maximize W_j given each of the other countries strategies that are competing for multinational output[10]. The politician in country *j* then solves[11]

$$\max_{t_j} W_j[(G_j(X_j(t_j), Z_j, t_j)), D_j(t_j) \big| t_{-j}] \text{ where } -j = \forall k \neq j. \quad (4)$$

In equilibrium, each country chooses its optimal set of policies t_j^* conditional on other countries' set of policies, t_{-j}^*, while accounting for their own endowments Z_j and the effect that their policies will have on multinational production, national income, and net external costs. Notice that each country's best response bundle of t_j^* identifies G_j^*, D_j^*, and X_j^*. The best response bundle of policies for each individual country may not be unique as multiple equilibria are possible given the multi-country, multi-policy framework[12]. The framework does however lead to an estimation strategy that can be used to estimate the current *observed equilibrium* values (t_j^*, G_j^*, D_j^*, and X_j^*) and to say something about how marginal changes in endogenous environmental policy affect multinational affiliate production in the presence of strategic policy choices.

A nice feature of the general model outlined above is that it encompasses a number of possible theoretical explanations given for why governments may behave

[10] No explicit assumptions are made about the order in which each policy is determined. For example, one could think of trade policy as being determined in a first stage, and secondary policies being determined in a second stage as in Copeland [1990] or a set of policies might be determined jointly as in Ederington [2001]. This issue is discussed further later in this section.

[11] Note that the government official is not setting policy for the sole purpose of attracting multinational firm investment but is also internalizing the direct effects of policy through *G*. For example, a government official will internalize both the direct effect of a tariff on domestic firms (possibly in the form of protection), but also the effect that it will have on multinational firms that may want to use the country as an export platform (but may be dissuaded by high tariffs on imported intermediate goods).

[12] Note however that a unique equilibrium is not necessarily ruled out.

strategically that have been explored in prior work. For example, in Barrett [1994] and Kennedy [1994] two governments play a Nash game, strategically choosing the stringency of their environmental policy by taking account of the tradeoff between domestic firm profits (i.e. an affect on *G*) and social damages (i.e. an affect on *D*). Depending on assumptions about the nature of competition (i.e. quantity or price), the strategically optimal environmental policy may be higher or lower than the efficient policy level[13].

Other papers have looked at strategic environmental policy while also accounting for trade policy. Krutilla [1991] considers a single large trading country that has the ability to influence the world price of goods (which in this context can be thought of as through *G*) and must solve a coordinated problem of setting both environmental taxes and tariff rates (the set of policies *t*). The country's explicit ability to affect the terms of trade suggests that the optimal environmental policy is not independent of the country's tariff policy.

Burguet and Sempere [2003] extend the idea that trade policy and environmental policy are linked in a two country setting. In a Brander-Spencer trade model with imperfect competition they show that marginal decreases in tariffs can have competing effects on strategic environmental policy. On one hand, a decrease in tariffs increases domestic output and pollution (i.e. *G* and *D*) and raises marginal social damage, thus increasing the incentive to raise the stringency of environmental policy. On the other hand, decreasing tariffs reduce tariff revenue for the government, creating a negative influence on the stringency of environmental policy.

Markusen, Morey, and Olewiler [1995] go beyond trade in goods by considering government competition in environment and export taxes when firms are imperfectly

[13] In a similar non-cooperative policy game between countries, Hamilton and Requate [2004] show that the trade-off between competitive advantage for local firms and environmental quality that leads to strategic environmental policy can be eliminated when domestic downstream exporters are able to form vertical contractual commitments with upstream input suppliers. While antitrust laws may make perfect execution of vertical contracts in this context unrealistic to completely eliminate the so called 'environment-for-trade' tradeoff, it none-the-less remains an interesting possibility.

competitive and plant locations are internationally mobile. They find that given different plant location configurations, equilibria can arise where governments non-cooperatively choose lower environmental taxes to attract multinational production, while other plant specifications can produce a 'not-in-my-backyard' effect where governments strategically choose higher environmental taxes. In this case governments choose environmental taxes to maximize societal welfare by trading off consumer surplus, national firm profits, and tariff revenues (i.e. *G*) against the disutility to consumers of higher pollution levels (i.e. *D*).

Additionally, both Copeland [1990] and Ederington's [2001] models of strategic interaction between countries can be generally interpreted in the context of the above model. Whether one thinks of countries as playing a two stage game where they must cooperatively commit to a trade barrier level in the first round and then compete non-cooperatively in a second policy instrument in the second round (as in Copeland [1990]), or where countries cooperatively commit to a set of trade and domestic polices jointly or face reversion to the non-cooperative equilibrium (as in Ederington [2001]), the above model is general enough for either interpretation. That is, no restrictions are made on the nature of the game whereby the set of policies t_j^* is set. Each instrument may be set in consecutive stages of negotiation or they may be set jointly and no restrictions are made on whether policies are cooperatively or non-cooperatively set. The only assumption is that countries do, in fact, behave strategically and that each countries individual set of policies is a function of competing countries policies.

The overriding theme of all of the aforementioned papers is that depending on the assumptions or parameterizations of the model, strategic trade policy can potentially lead governments to higher or lower levels of environmental policy than is socially efficient. The framework outlined above does not allow us to explicitly identify whether countries are raising or lowering their environmental policy in response to competitor's policies. Consistent estimation of t_j^* would require that we have information on unobservable net external damages of policy choices, *D*. The framework does however suggest an estimation strategy for identifying the effects of environment and trade policies on multinational firm production while controlling for traditional notions of comparative advantage and strategic interaction.

III. Identification and Estimation Strategy

The goal is to identify whether endogenous environmental policy has an affect on multinational affiliate production when other endogenous policy options are also available. In terms of the above model this means that we want to identify the effect of an endogenous set of policies, t_j^*, on multinational production, X_j^*. That is, we would like to estimate

$$X_j^*(G_j^*, t_j^*, \xi_j), \qquad (5)$$

which requires that both the endogenous determination of income per capita, G_j^*, as well as endogenous policy variables that affect multinational firms, t_j^*, are controlled for. Solve for the equilibrium values of G_j^* and t_j^* to get:

$$G_j^*(X_j^*(\xi_j), Z_j, t_j^*, D_j^*), \qquad (6)$$

and

$$t_j^*(X_j^*(\xi_j), G_j^*(Z_j), t_{-j}^*, D_j^*), \qquad (7)$$

which suggests that Z_j and t_{-j}^* are available as instruments in identifying the effect of G_j^* and t_j^* on X_j^*. However, t_j^* is endogenously determined with t_{-j}^* in the Nash game between countries. So other countries policies are not valid instruments for country *j*'s policies. But one can solve for other country reaction functions, t_{-j}^*, to get[14]:

$$t_{-j}^*(X_{-j}^*(\xi_{-j}), G_{-j}^*(Z_{-j}), t_j^*, D_{-j}^*). \qquad (8)$$

Plugging equation (8) into equation (7), t_j^* can be rewritten as[15]:

$$t_j^*(X_j^*(\xi_j), G_j^*(Z_j), X_{-j}^*(\xi_{-j}), G_{-j}^*(Z_{-j}), D_j^*, D_{-j}^*). \qquad (9)$$

Notice that X_j^* in equation (5) can be identified using Z_j, Z_{-j}, and ξ_{-j} (from equations (6) and (9)) as instruments for G_j^* and t_j^*[16]. Importantly, no information regarding

[14] It is assumed that t_{-j}^* is invertible and can be solved for.

[15] Again, it is assumed that *G*, *D*, and *X* are invertible and can be solved for *t*.

pollution emissions, abatement costs, or unobserved external costs in any country are necessary to identify the effect of pollution policy on multinational firm production[17].

IV. Estimating Equation, Data, and Econometric Issues

A first order linear approximation of equation (5) is given by[18]:

$$\ln X_{jit} = R_r + \alpha_i + \beta_t + \delta_1 \ln G_{jt} + \delta_2 \ln e_{jt} + \delta_3 \ln \tau_{jit} + \delta_4 \ln \psi_{jt} + \sum_h \delta_h \ln \xi_{jit}^h + \varepsilon_{jit}, \quad (10)$$

---

[16] It is the case that some elements of ξ and Z are the same. For instance, we expect that corruption or the quality of infrastructure in a country will affect both domestic output as well as a country's ability to attract investment. Identification of the effect of G on X requires that we find instruments that belong to Z but not ξ. This matter is taken up in more detail in the empirical section.

[17] It is important to note here that identification of the model is dependent on the assumption that multinational firm production is not directly affected by any unobserved externalities. That is, we allow for policy choices to have unobserved positive or negative effects on society that affect decision makers policies, but we assume that those externalities only affect multinational firms through the policy choices that governments then internalize, but not directly. For example, this implies that multinational firm output is not directly influenced by pollution such as specified in Copeland and Taylor [1999] where a dirty manufacturing process directly damages a sensitive farming sector. Since our focus in the empirical section is on the manufacturing, mining, and utility sectors (not agricultural sectors or others that we might think of as being directly harmed by pollution) this is not likely to be of concern.

[18] Consistent with a large literature on trade and foreign direct investment, a log-linear estimating equation is employed here. One concern with this approach is that if a country/industry observation has zero production then it is effectively dropped, which may create inconsistent estimates. This is not a concern with respect to the data employed here. Of the 2250 possible observations, only 242 (roughly 10%) have zeros for the explanatory variable, the large majority of which are in the mining and utility sectors. Attempts to include these observations (by taking *ln (X+1)* for example) only add 20 observations or so because most X observations of zero also have missing capital and/or labor information. All regressions were run with mining and utilities excluded and the results of the paper remain the same.

where X is the value added of majority owned U.S. multinational affiliates in country j, region r, industry i, and year t. The analysis covers 50 countries and 9 industries over the 5 year time period from 1999-2003. The coefficients R_r, α_i and β_t are region, industry and time fixed effects The variable G is gross domestic product[19]; e, and ψ are indexes of environmental and intellectual property protection, respectively; τ is the average tariff rate for manufactured goods; and ξ^h are other factors that influence multinational location decisions such as capital/labor ratios, distance from the U.S., language, quality of political institutions, infrastructure, the quality of public schools, and the prevalence of organized crime. Tables of descriptive statistics, countries, and data sources are included in the Appendix. However, the environmental policy variables deserve mention here.

The environmental policy variables (as well as the IPR policy variable) employed in this paper are constructed from survey data from the Global Competitiveness Report (GCR) published by the World Economic Forum (WEC). The WEC has been publishing the GCR since the late 1970's but only started surveying executives on environmental issues in the mid 1990's. Unfortunately, the questions have changed over time and so the early questions on environmental policy are not directly comparable to the later year survey questions. In this paper, two of the survey questions that have been available since 2000 that are of direct importance to measuring the strength of environmental policy across countries are used. The first asks executives about the stringency of environmental regulation in their country, while the second asks about the consistency of enforcement of the given regulations[20].

The advantage of this data is that it is the only dataset that provides a measure of both the stringency *and* enforcement levels of environmental regulations across countries. This cross country panel component that explicitly accounts for actual firm perceptions of regulation and enforcement is crucial for testing the pollution haven hypothesis. Studies such as List and Co [2000] Keller and Levinson [2002], Ederington and Minier [2003], Ederington et al. [2004], Levinson and Taylor [2004], or Ederington et al. [2005] that use U.S. abatement costs to look at inward FDI or imports across states have furthered our

[19] All dollar denominated variables have been converted to real 2000 PPP international $'s.

[20] The actual survey questions are provided in the Appendix in Table A2.

understanding of how differences in environmental costs affect firm location or the composition of industries in a developed country. However, the focus on U.S. regulation alone is limiting for making general statements about the extent of pollution havens on a global scale.

Eskeland and Harrison [2003] find little evidence of pollution haven effects when looking at U.S. outbound investment in Côte de Ivoire, Morocco, Mexico, and Venezuela. However, their pollution haven story is driven by variation in the host country's environmental policy (i.e. the U.S.), again using U.S. abatement costs as a measure of environmental policy. Assuming that other countries policies are constant, using U.S. abatement costs as a proxy for differences in policy can tell us how changes in U.S. policy affect the compositional output of U.S. FDI in foreign countries. However, if foreign country environmental or trade policy is strategically linked to U.S. or other regional countries policies (and therefore not constant, nor exogenous) then estimates based solely on U.S. abatement costs will be inconsistent.

As an alternative, Eskeland and Harrison [2003], as well as Xing and Kolstand [2002] and Co et al. [2004], also use a measure of emissions[21] as a proxy for cross-country differences in environmental regulation. However, emission specific proxies such as SO_2, energy intensity, or lead content only capture one component of environmental stringency and will be biased towards affecting capital and energy intensive industries. This poses a couple of problems for finding a pollution haven effect. First, the use of energy content or air pollution measures such as SO_2 or NO_x have typically been justified given our *a priori* beliefs that pollution havens are driven by the *dirtiest* industries (aka, chemical, metal, and other capital intensive industries). But the work by Ederington, et al. [2005] suggests that a pollution haven effect may be difficult to detect in capital intensive industries with large fixed costs, where it may not be easy to move production. In which case, proxies that are designed to detect pollution or environmental regulation in industries typically thought to be "the dirtiest" may mask pollution haven effects in more "footloose" industries. For example, energy intensity or

[21] Eskeland and Harrison [2003] use energy intensity, Xing and Kolstad [2002] use SO_2 emissions, and Co et. al. [2004] use lead content, as their proxies for environmental policy.

emissions measures are not adequate for capturing the stringency of environmental regulation related to lead, mercury, solid or hazardous waste, biological oxygen demand, or recycled content standard regulations that may have much larger impacts on more footloose industries such as manufactured food, computers or electronics.

One caveat to the GCR data is that, like all survey data, the GCR data could be opened up to criticism based on survey methodology or sample selection. However, the GCR has taken a number of steps to ensure the robustness of their measures by taking representative samples across sectors in each country based on employment, firm size, and firm nationality[22]. The true advantage of this approach is that executives are likely to base their answer to pollution stringency and enforcement questions, at least in part, on how regulatory levels in their own industry affect their firm. Which means the GCR measure may be able to pick up a number of unobserved cross industry measures of environmental policy that cannot be captured in other more quantitative measures such as abatement costs (even if abatement costs across countries were actually available) or emissions of a few particular pollutants. To the extent that it does, GCR data quantifies a valuable qualitative measure of environmental policy across countries that can be used to test the pollution havens hypothesis while controlling for strategic trade and environment policy.

The real advantage of the strategic framework expressed in this paper is that, unlike prior work, the model in this paper gives a clear indication of the appropriate instruments to be used for identification. Specifically, elements of Z that are not found in ξ, as well as Z_{-j} and ξ_{-j} can be used to identify G, e, τ, and ψ. Since the multinational data being employed is in the manufacturing, mining, and utility sectors, components of the national economy that influence G but not X are necessary. That is, identification requires elements of Z that are not elements of ξ. Here, information on the agricultural sector is used. The two instruments for G are the arable land per agricultural worker and the number of tractors per agricultural worker, or put differently, agricultural land/labor and capital/labor ratios. These two instruments should provide information on the

[22] The reader is referred to the Executive Opinion Survey section of any of the 2000-2006 GCR publications for detailed information on the methodology and robustness of the GCR variables.

relative technology levels of the agricultural sectors across countries that will affect gross domestic product, but should not directly influence multinationals in the manufacturing, mining, or utility sectors.

Identification of e, τ, and ψ requires that other country exogenous characteristics that are contained in Z_{-j} and ξ_{-j} be employed. The instruments are constructed based on the Fredriksson and Millimet [2002] result that regions are most affected by the regions closest to them. Thus, countries are divided into five general regions[23]: Europe, Middle East and Africa, Central Asia, Asia and Pacific, and Latin America. Then for each country, a GDP weighted average is constructed based on the other countries in the same region for of each of the exogenous characteristics. The instruments are weighted by the average market size to capture the fact that larger, richer countries will likely have a greater influence on policies in the region. Overall, the identification strategy yields eight instruments[24] for four potentially endogenous policy variables.

V. Results

In Table 1, estimates of equation (10) are presented for various specifications regarding the endogeneity of the policy variables while controlling for region, year, and industry effects[25]. In column (1), it is assumed that all policy variables and GDP are exogenous and the model is estimated by OLS. Market size, capital/labor ratios and

---

[23] For purposes of constructing instruments, Canada is included in Europe and Mexico is included in Latin America.

[24] For country j, the eight instruments are *own* country tractor/agricultural worker and land/agricultural worker (from the set Z_j), as well as *other* country capital/labor ratio, infrastructure, organized crime, tractors/agricultural worker, land/agricultural worker, and public schools located within the same world region (from the sets Z_{-j} and ξ_{-j}).

[25] Region, industry, and year dummies are included in all regressions reported in the paper. Given the special geographic and economically diverse effects that Canada and Mexico have on US multinational activity, Canada and Mexico are given their own dummy observations. The excluded region dummy is Europe. Ideally, country level fixed effects would be included, however, it is not possible given the short time dimension of the panel.

intellectual property rights have a positive and significant effect on multinational affiliate production while environmental policy has a small but insignificant negative impact on multinational affiliate production. This is reminiscent of much of the pollution havens literature that has found little to no impact of environmental policy once other determinants of location choice have been controlled for. However, if multinational production is endogenously determined with market size and the set of trade and environment policies, then the estimates in column (1) are inconsistent.

Following Copeland [1990], in column (2) it is assumed that countries are constrained by cooperative agreements on trade and IPR policy through the WTO and TRIPS agreement (which occurred prior to 1999) determined in the first stage of a game and are now competing in environmental policy in the second stage. Thus, it is assumed that tariffs and IPR policy are exogenous and that countries strategically compete in environmental policy. Endogeneity of multinational production and GDP (as suggested by the model in Section II) is controlled for using the full set of instruments described in Section IV using a generalized method of moments instrumental variables estimator (GMM-IV). The GMM-IV estimates in column (2) reveal that when strategic interaction across countries is controlled for, environmental policy has a strong and statistically significant negative impact on U.S. multinational production. The significant Durbin-Wu-Hausman test statistic suggests a strong rejection of the exogeneity of GDP and environmental policy.

In columns (3)-(6) of Table 1 the nature of strategic competition is extended. If countries are forward looking they will anticipate competition in environmental policy in the second round (as in Copeland [1990]) or perhaps strategically compete over a set of policies at a given stage (as in Ederington [2001]). Either way, the full set of policy choices should now be considered endogenously determined. Therefore, in column (3) tariff policy is added to GDP and environmental policy on the list of endogenous variables. Grossman and Lai [2004] suggest that IPR protection is also strategically determined across countries. Thus, in column (4) the full model is estimated with GDP, environmental policy, tariffs, and IPR policy as endogenous[26].

[26] Again, for each GMM-IV regression the full instrument set is employed.

In all of the GMM-IV specifications, environmental policy is negative and statistically significant. Tariff rates are also negative and significant when treated as an endogenous variable in column (3), but are not significant when IPR policy is included as an endogenous variable in column (4). *A priori* expectations of the effect of tariff rates on multinational firm production are difficult. If firms are engaged in strictly horizontal multinational activity then one might expect tariff rates to have a positive sign as multinational firms attempt to "jump" tariff barriers. However, to the extent that firms segment stages of production and rely on trade in intermediate goods, tariff rates will have a negative impact on multinational production decisions[27]. The negative sign suggests that it is the latter explanation, which is consistent with a rapidly growing percentage of international trade taking place between multinational parents and their affiliates[28].

Interestingly, once the endogenous determination of IPR policy is controlled for in column (4), IPR policy remains positive but is no longer significant. This is in contrast to the findings by Maskus and Penubarti [1995], Lee and Mansfield [1996], and Co. et al. [2004], who find a positive and significant effect of patent protection on trade flows and FDI when IPR policy is treated as exogenous. The results here suggest that U.S. multinational activity in foreign countries may have more to do with influencing IPR policy than IPR policy has for attracting U.S. affiliate production[29].

With respect to the other exogenous variables in the model, the GMM-IV estimates also give more plausible results than those found in the OLS estimation. For example, in columns (2)-(4) the quality of public schools (which proxies for the level of human capital and the supply of skilled workers) and institutional quality are both positive and significant which is in line with the work of Carr et al. [2001] and Asiedu [2006]. Likewise, the positive and significant coefficient on corruption in the OLS

---

[27] See Markusen [2002] for a discussion of how trade costs affect horizontal vs. vertically oriented firms.

[28] According to BEA figures, more than 40% of U.S. trade takes place between units of multinational firms.

[29] This is a conjecture and is certainly an important issue for future research. However, the direction of causality regarding multinational firms and IPR policy is not taken up in this paper as our primary concern is with the pollution haven hypothesis.

regression is a bit startling given Javorcik and Wei's [2004] result of organized crime having a negative influence on FDI. However, consistent with Fredriksson et al. [2003] no statistically significant direct effects of organized crime on U.S. affiliate value added are found once endogenous environmental policy is controlled for[30].

Robustness and Identification Tests

In column (5) of Table 1, the sensitivity of the main results is tested by adding other right-hand side explanatory variables that have been suggested in the literature as determinants of multinational affiliate production and investment. The variables include clustering, the presence of hidden trade barriers, and hiring and firing practices. Although hiring and firing practices are of the expected sign, the additional variables are not significant and do not affect the policy results[31]. The model is also estimated using U.S. affiliate value added per capita and the ratio of U.S. affiliate value added per unit of GDP as dependent variables, the results of which are included in the Appendix[32]. The qualitative results are identical to Table 1, with environmental policy having a

[30] 'Organized crime' and 'corruption' are taken to be fairly synonymous here. Although the first stage regression results are not reported, organized crime does have a statistically significant negative effect on environmental policy in all of the GMM-IV specifications for which environmental policy is treated as endogenous. This is consistent with the findings of both Fredriksson et al. [2003] and Fredriksson and Svensson [2003], which implies that corruption does not have any significant direct effects on foreign investment once corruption's effects on policy have been controlled for.

[31] However, hiring and firing practices do end up being statistically significant in column (6) when spatial third country effects are included. Given the work by Wheeler and Mody [1992] and Eskeland and Harrison [2003] who find positive effects of agglomeration measures, the negative and significant sign on clustering is surprising. However, the positive effects of agglomeration are often the result of unobserved infrastructure quality, educational knowledge spillovers, and market size. Given that these three things have already been explicitly controlled for, the negative sign on clustering may be picking up a lesser discussed aspect of agglomeration, which is increased competition.

[32] See Table A3 in the Appendix.

significantly negative impact on U.S. affiliate activity once strategic policy interactions have been controlled for.

One of the crucial identifying assumptions of this paper is that country *j*'s policy choices can be identified as a function of other country's exogenous characteristics. However, a number of recent papers by Yeaple [2003], Head and Mayer [2004], Helpman, Melitz, and Yeaple [2004], Baltagi, Egger, and Pfaffermayer [2007], and Blonigen et al. [2007] highlight both theoretically and empirically how third country effects may have direct implications on country *j* multinational production. In particular, the empirical papers mentioned above[33] explore the possibility that if other country characteristics are spatially correlated with country *j*'s level of multinational production (and thus the error term), then own country characteristics may be inconsistent. This work finds mixed evidence in support of spatially weighted third country effects. The strongest result being a positive and significant effect of third country spatially weighted market potential, although Baltagi, Egger, and Pfaffermayer [2007] find support that spatially weighted third country factor endowments also have direct effects on country *j* affiliate activity.

In light of this research, the regional GDP weighted instruments used in this analysis (which are intended to capture the political influence of countries in a region in the Nash policy game) are subjected to a number of identification tests. For each of the GMM-IV estimates in Table 1, both the Hansen J-statistic for over identification and the Anderson likelihood ratio statistic for the relevance of the excluded instruments are reported. The joint null hypothesis of the Hansen J-statistic is that the instruments are valid, while the null hypothesis of the Anderson L-R statistic is that the equation is under-identified. Both tests provide strong support for the instrument set. In addition, results of the first stage regressions of the excluded instruments on the endogenous variables are jointly and individually significant[34]. As a further test of the validity of the instruments,

[33] See Head and Mayer [2004], Baltagi, Egger, and Pfaffermayer [2007], and Blonigen et al. [2007].

[34] As an example, first stage regression results for the excluded instruments are reported in Table A5 of the Appendix that correspond to the most general regression (i.e. GDP, environmental policy, tariffs, and IPR policy are endogenous) in column (4) of Table 1.

the most general GMM-IV specification in column (4) of Table 1 is estimated with each instrument dropped from the excluded instrument set and included as a right hand side explanatory variable in the second stage. None of the instruments are statistically significant in the second stage results and the parameter estimates with respect to environmental policy remain quite robust. Results of these regressions are reported in the Appendix[35].

As a final test of the validity of the instruments, spatially weighted third country characteristics suggested by recent empirical work are included as explanatory variables in column (6) of Table 1[36]. The results reveal support for prior work in that country *j* multinational production does appear to be positively influenced spatially by third country market potential and infrastructure but negatively influenced by corruption. Importantly, the environmental policy variable remains robust to the addition of the spatially weighted third country variables.

For each of the GMM-IV regressions the Cragg-Donald statistic as described in Stock and Yao [2002] is calculated to test for the presence of weak instruments. With the exception of column (5), the null hypothesis of weak instruments can be rejected at the 5% level for maximal bias levels of the IV estimator relative to OLS of 0.3 or less[37].

---

[35] See Table A4 of the Appendix.

[36] Following prior work, a spatially weighted 3rd country variable for country *j* is the sum of a variable over all other countries in the sample weighted by their distance to country *j*. For example, market potential for country *j* is the sum of all other countries GDP's weighted by their distance to country *j*. Distance is calculated as kilometers between capital cities.

[37] Significance is based on critical values provided in Table 1 of Stock and Yogo [2002] which only provide critical values for up to three endogenous variables. For situations in this analysis where four or more endogenous variables are estimated, significance is based on a conservative extrapolation of Stock and Yogo's critical values which are declining in both the number of instruments and the number of endogenous regressors.

Extension to Industries and Multiple Environmental Policy Dimensions

In Table 2, the model is estimated with GDP and the three strategic policy variables treated as endogenous on each of the nine industries individually. Prior intuition and much of the early literature on the pollution haven effect would lead one to believe that mining, utilities, chemicals, or primary and fabricated metals would be the prime candidates for industries that would be driven to pollution havens, due to high capital/labor ratios and energy intensity. However, in columns (3), (6) and (9) we see that it is food, machinery, and electrical equipment, appliances and components that are negatively and significantly influenced by stronger environmental policy[38]. Although this may at first seem counterintuitive, there are two very plausible explanations for this result.

First, Ederington, et al. [2005] show that one of the reasons researchers have had a difficult time finding pollution haven effects is that the focus has been on the most capital intensive industries, which are presumed to be the dirtiest. However, capital intensive industries, industries with large fixed costs, or industries with high trade costs may not be very 'footloose', and thus, less willing to move for environmental costs that are small relative to overall operations. In Table 3 we see that compared to mining, utilities, or chemicals, the electronic product, appliances, components and machinery industries tend to be less capital intensive. Also, given the physical weight of shipping natural resources or metal products, electrical and appliance equipment will certainly have lower unit transport costs. All of which suggests that industries related to electronic products, appliances or machinery are more footloose than traditionally perceived dirty industries; and more footloose industries may be more easily influenced at the margin by changes in the costs of more stringent environmental policy. But do we have reason to suspect that these industries are facing tighter regulation?

There is ample evidence that during 1999-2003, there were significant changes in environmental policy taking place in a number of countries that would have significant

---

[38] Given the failure to reject the Cragg-Donald statistic of weak IV's at the 5% level for relative bias levels of the OLS estimator relative to the IV estimator of less than 0.3, a bit of caution regarding inference of the industry specific regressions is warranted.

impacts on electrical equipment, appliance and component manufacturers. Problems related to 'e-waste' in landfills as well as the associated environmental problems related to lead and mercury in electronic products generated a great deal of legislation in the late 1990's and early 2000's. For example, in 2002 the European Commission passed the Directive on Waste from Electronic and Electrical Equipment (WEEE) which will oblige all EU member states to make producers responsible for end-of-life waste management costs for their products. Perhaps more importantly, producers will be subject to higher recycled content standards and required to phase out the use of lead, mercury, cadmium, and certain types of flame retardants (Directive 2002/95/EC). Since 2001 Japan has also had a recycling law that requires increased recycled content standards and end-of-life responsibility for producers (Nimmo [1999]). In January of 2001 the Ecological Solid Waste Management Act of 2000 was signed into law in the Philippines to provide for comprehensive ecological solid waste management which contains, among other things, sections requiring eco-labeling of packaging products and an increased emphasis on recycling systems.

One interesting feature of the WEEE legislation is that while the Directive uniformly covers the stringency of regulation for all member states, Article 8 requires that all member states determine their own penalties for non-compliance. This raises another important question regarding the pollution haven hypothesis that has not been addressed in prior literature. Are firms influenced by the level of environmental stringency or the actual enforcement of given policies? It is not implausible that countries may commit to more stringent environmental regulation but then not allocate resources to enforcement of policies. To address this question, in Table 4 the models in Table 1 are run again but with the environmental policy index broken down into its two components: the stringency of environmental policy and the enforcement of environmental policy[39].

Like Table 1, the OLS specification in Table 4 yields no statistically significant effect for the stringency of environmental policy or enforcement. Once the strategic effects of trade and environment policy are controlled for there is robust evidence that

[39] Note that the model is still identified as there are eight instruments for the five endogenous variables.

U.S. multinational production is negatively influenced predominantly by the enforcement of environmental policy. Notice that, conditional on the stringency of environmental policy, the magnitude of the enforcement variable is 2 to 3 times greater than the stringency variable depending on the specification. This suggests that countries may in fact be competing in environmental policy in the less transparent of the policy dimension. This is important because in most countries it could be argued that the stringency of environmental policy is more widely available to the general public and electorate through environmental laws on the books, while actual enforcement of those policies is far less transparent, except to government officials and firms. Further, countries may be able to cooperate on the stringency of environmental policy such as the WEEE, but non-cooperatively compete by choosing their Article 8 enforcement and penalty levels.

Economic Significance of the Results

The results above provide robust evidence that U.S. multinational production is negatively influenced by more stringent environmental policy and that pollution haven effects may be driven by more 'footloose' industries rather than traditionally perceived dirty industries. While the estimates regarding measures of environmental policy have a negative and significant influence on US multinational affiliate value added, it is important to examine whether environmental policy has a significant economic influence on multinational firm affiliate activity.

In Table 5 the top 20th and bottom 20th percentile countries in terms of U.S. multinational affiliate value added from 1999 to 2003 as well as the respective changes in their Environmental Policy Index are presented. The results are quite revealing. The top 20th fastest growing countries in terms of US multinational affiliate value added had an average growth rate of 81% while their average Environmental Policy Index fell by 2.5%. In contrast, the bottom 20th percentile had an average growth rate of -9.5% in U.S. multinational affiliate value added while increasing their Environmental Policy Index by more than 14%. Using the elasticity estimate of -2.8 from column (4) in Table 1, a rough calculation of the importance of environmental policy for the top 20th percentile implies that a 2.5% decrease in environmental quality increased U.S. affiliate value added by approximately 7%. Put differently, approximately 8.6% of U.S. affiliate value added growth by the top 20th percentile countries can be attributed to falling environmental policy[40].

For developing and transition countries, the importance of environmental policy is even greater. In Table 6, the developed countries in the sample are dropped and the top 20th and bottom 20th percentile developing and transition countries in terms of U.S. affiliate value added growth, as well as their Environmental Policy Index are examined. The countries with the highest growth in U.S. affiliate value added, on average, had a declining Environmental Policy Index of -12.56%, while the slowest growing developing and transition countries had an average Environmental Policy Index that improved by nearly 4%. Using the elasticity of -2.8, a 12.56% decline in the Environmental Policy Index corresponds to approximately a 35% increase in U.S. affiliate value added. That is, approximately (35%/109%=) 32% of the top 20th percentile's growth in U.S. affiliate value added for developing and transition economies can be attributed to declining environmental policy.

VI. Conclusions

The strategic interaction of environment and trade policy has been an important feature of the theoretical literature regarding the pollution haven hypothesis over the past 10 years, while empirically, data constraints on environmental policy measures have hampered cross country tests of the pollution haven hypothesis. This paper uses the framework of the strategic trade literature to develop an estimation strategy to test the pollution haven hypothesis in a cross country setting for the first time. In doing so, a statistically significant pollution haven effect is found on U.S. outward multinational affiliate production, controlling for the endogenously determined strategic policy interactions across countries. This provides the most robust cross-country confirmation of the pollution haven hypothesis found to date.

In addition, support is found for Ederington et al's [2005] assertion that industries most likely to locate in pollution havens are not necessarily the industries that have typically been labeled "the dirtiest" industries. Rather, more 'footloose' industries such

[40] The value 8.6% is found by dividing 7% (MNE growth attributed to environmental policy) by 81% (total MNE growth).

as electronic and appliance manufacturers are more adversely affected by stringent environmental policy than more traditionally dirty industries such as mining, chemicals, or metals. This is not surprising considering the increase in legislation targeting e-waste, the phase out of lead and fire retardants, and recycling content standards imposed in a number of countries over the sample period.

The results of the paper are unique not only for the strategic approach to environment and trade policy but also for the data used. Prior data has relied on abatement costs or measures of emissions as proxies for environmental policy. In this paper a new survey measure of environmental stringency and enforcement is used to construct an environmental policy index that is capable of capturing differences in environmental policy across countries. This not only allows for the estimation of the effects of policy on U.S. affiliate activity in the presence of strategic motives but it also allows us to investigate the importance of the stringency of environmental policy relative to actual enforcement of policies. Controlling for stringency levels, it appears that the enforcement of environmental policy is more of a deterrent to U.S. multinational activity than the level of the regulation itself. This is an interesting result that has not been focused on in the environment and trade literature. While environmental regulations on the books are often fairly transparent to the electorate and general public, governments and firms are likely to be better informed than the public about the actual strictness of enforcement of those policies. This potential informational asymmetry between firms, government, and the general public regarding the level of regulation and actual enforcement may create incentives for countries to cooperatively adopt relatively stringent environmental laws, but non-cooperatively compete in their level of enforcement. This is an area of future research that should be considered more fully in the strategic environment policy literature. How European countries adapt their Article 8 enforcement policies of the WEEE Directive may provide a natural experiment for more complete future tests of this result.

Although the focus of this paper has been to test the pollution haven hypothesis while controlling for strategic interaction of trade and environment policies across countries, the approach in this paper also yields interesting results regarding the endogeneity of U.S. multinational production and intellectual property rights protection.

When IPR policy is assumed exogenous, it is found that stronger IPR's have a positive and significant effect on U.S. multinational production, which is consistent with prior empirical literature. However, once the strategic interaction of IPR's with tariff and environmental policy are controlled for, the statistical significance of IPR policy disappears. This suggests that the causality between stronger IPR policy and U.S. multinational firm production may have more to do with U.S. multinational firm presence exerting influence on IPR policy in foreign countries than the other way around. This endogenetiy concern has not been fully explored in prior work. Consideration of the strategic interaction of IPR policies across countries should be an additional focus of future research.

References

Asiedu, Elizabeth, 2006, Foreign Direct Investment in Africa: The Role of Natural Resources, Market Size, Government Policy, Institutions and Political Instability, World Economy, 63-77.

Baltagi, Badi H., Peter Egger, and Michael Pfaffermayr, 2007, Estimating models of complex FDI: Are there third-country effects?, Journal of Econometrics, *forthcoming*.

Barrett, Scott, 1994, Strategic environmental policy and international trade, Journal of Public Economics, 54, 325-338.

Becker, Randy and Vernon Henderson, 2000, Effects of Regulations on Polluting Industries, Journal of Political Economy, 108(2), 379-421.

Blonigen, Bruce A., Ronald B. Davies, Glen R. Waddell, and Helen T. Naughton, 2007, FDI in space: Spatial autoregressive relationships in foreign direct investment, European Economic Review, *forthcoming*.

Burguet, Roberto, and Jaume Sempere, 2003, Trade liberalization, environmental policy, and welfare, Journal of Environmental Economics and Management, 46, 25-37.

Carr, David L., James R. Markusen, and Keith E. Maskus, 2001, Estimating The Knowledge-Capital Model of the Multinational Enterprise, American Economic Review, 91(3), 995-1001.

Co, Catherine Y., John A. List, and Larry D. Qui, 2004, Intellectual Property Rights, Environmental Regulations, and Foreign Direct Investment, Land Economics, 80(2), 153-173.

Copeland, Brian R., 1990, Strategic interaction among nations: negotiable and non-negotiable trade barriers, Canadian Journal of Economics, 23(1), 84-108.

Copeland, Brian R. and M. Scott Taylor, 1999, Trade, Spatial Separation, and the Environment, Journal of International Economics, 47(1), 137-168.

Directive 2002/95/EC of the European Parliament and of the Council, 2003, Official Journal of the European Union, 13.3.2003, 19-23.

Ederington, Josh, 2001, International Coordination of Trade and Domestic Policies, American Economic Review, 91(5), 1580-93.

Ederington, Josh, Arik Levinson, and Jenny Minier, 2004, Trade Liberalization and Pollution Havens, Advances in Economic Policy & Analysis, 4(2), Article 6.

Ederington, Josh, Arik Levinson, and Jenny Minier, 2005, Footloose and Pollution-Free, The Review of Economics and Statistics, 87(1), 92-99.

Ederington, Josh, and Jenny Minier, 2003, Is environmental policy a secondary trade barrier? An empirical analysis, Canadian Journal of Economics, 36(1), 137-154.

Eskeland, Gunnar S. and Ann E. Harrison, 2003, Moving to greener pastures? Multinationals and the pollution haven hypothesis, Journal of Development Economics, 70, 1-23.

Fredriksson, Per G., John A. List, and Daniel L. Millimet, 2003, Bureaucratic corruption, environmental policy and inbound US FDI: theory and evidence, Journal of Public Economics, 87, 1407-1430.

Fredriksson, Per G., John A. List, and Daniel L. Millimet, 2004, Chasing the smokestack: strategic policymaking with multiple instruments, Regional Science & Urban Economics, 34, 387-410.

Fredriksson, Per G., and Daniel L. Millimet, 2002, Strategic Interaction and the Determination of Environmental Policy across U.S. States, Journal of Urban Economics, 51, 101-122.

Fredriksson, Per G., and Jakob Svensson, 2003, Political instability, corruption and policy formation: the case of environmental policy, Journal of Public Economics, 87, 1383-1405.

Grossman, Gene M., and Edwin L.-C. Lai, 2004, International Protection of Intellectual Property, American Economics Review, 94(5), 1635-1653.

Hamilton, Stephen F., and Till Requate, 2004, Vertical structure and strategic environmental trade policy, Journal of Environmental Economics and Management, 47, 260-269.

Head, Keith, and Thierry Mayer, 2004, Market Potential and the Location of Japanese Investment in the European Union, The Review of Economics and Statistics, 86(4), 959-972.

Javorcik, Beata Smarzynska and Shang-Jin Wei, 2004, Pollution Havens and Foreign Direct Investment: Dirty Secret or Popular Myth?, Contributions to Economic Analysis & Policy, 3(2), article 8.

Kahn, Matthew E., and Yutaka Yoshino, 2004, Testing for Pollution Havens Inside and Outside of Regional Trading Blocs, Advances in Economic Analysis & Policy, 4(2), Article 4.

Keller, Wolfgang and Arik Levinson, 2002, Pollution Abatement Costs and Foreign Direct Investment Inflows to U.S. States, The Review of Economics and Statistics, 84(4), 691-703.

Kennedy, Peter W., 1994, Equilibrium Pollution Taxes in Open Economies with Imperfect Competition, Journal of Environmental Economics and Management, 27, 49-63.

Krutilla, Kerry, 1991, Environmental Regulation in an Open Economy, Journal of Environmental Economics and Management, 20, 127-142.

Lee, Jeong-Yeon, and Edwin Mansfield, 1996, Intellectual Property Protection and U.S. Foreign Direct Investment, The Review of Economics and Statistics, 78(2), 181-186.

Levinson, Arik, and M. Scott Taylor, 2004, Unmasking the Pollution Haven Effect, NBER Working Paper 10629.

List, John A. and Catherine Y. Co, 2000, The Effects of Environmental Regulations on Foreign Direct Investment, Journal of Environmental Economics and Management, 40, 1-20.

Markusen, James R., 2002, Multinational Firms and the Theory of International Trade, MIT Press: Cambridge, Massachusetts.

Markusen, James R., Edward R. Morey, and Nancy Olewiler, 1995, Competition in regional environmental policies when plant locations are endogenous, Journal of Public Economics, 56, 55-77.

Markusen, James R., and Anthony J. Venables, 1998, Multinational Firms and the New Trade Theory, Journal of International Economics, December, 46(2), 183-203.

Markusen, James R. and Anthony J. Venables, 2000, The Theory of Endowment, Intra-Industry and Multinational Trade, Journal of International Economics, 52(2), 209-235.

Nimmo, Kay, 1999, Environmental Issues in Electronics and the Transition to Lead-Free Soldering, SMTA International Conference Proceedings.

Stock, James H., and Motohiro Yogo, 2002, Testing for Weak Instruments in Linear IV Regression, NBER Working Paper 284.

Taylor, M. Scott, 2004, Unbundling the Pollution Haven Hypothesis, Advances in Economic Analysis and Policy, 4(2), 1-26.

<u>The Global Competitiveness Report 2000</u>, 2000, Oxford University Press, Geneva.

The Global Competitiveness Report 2001-2002, 2002, Oxford University Press, Geneva.

The Global Competitiveness Report 2002-2003, 2003, Oxford University Press, Geneva.

The Global Competitiveness Report 2003-2004, 2004, Oxford University Press, Geneva.

The Global Competitiveness Report 2004-2005, 2005, Oxford University Press, Geneva.

Wheeler, David, and Ashoka Mody, 1992, International Investment Location Decisions: The Case of U.S. Firms, Journal of International Economics, 33(1-2), 57-76.

Xing, Yuquing and Charles D. Kolstad, 2002, Do Lax Environmental Regulations Attract Foreign Investment? Environmental and Resource Economics, 21, 1-22.

Yeaple, Stephen R., 2003, The complex integration strategies of multinationals and cross country dependencies in the structure of foreign direct investment, Journal of International Economics, 60, 293-314.

Table 1: OLS and GMM-IV Estimates of U.S. Affiliate Value Added with Strategic Policy

	Dependant Variable: Ln (U.S. Affiliate Value Added)											
	OLS		GMM-IV									
	(1)		(2)		(3)		(4)		(5)		(6)	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Ln (GDP)	0.679***	(0.046)	0.743***	(0.164)	0.972***	(0.217)	0.755***	(0.253)	0.751***	(0.199)	1.443***	(0.209)
Ln (Environmental Policy Index)	-0.148	(0.239)	-3.049***	(0.684)	-2.726***	(0.693)	-2.780***	(0.714)	-2.214**	(1.014)	-2.141*	(1.122)
Ln (Average industry tariff rate)	-0.034	(0.021)	-0.024	(0.029)	-0.148*	(0.082)	-0.077	(0.093)	-0.108	(0.091)	-0.322***	(0.078)
Ln (IPR policy index)	2.301***	(0.497)	3.724***	(0.585)	3.158***	(0.684)	1.090	(1.352)	1.074	(1.903)	2.487	(1.902)
Ln (Industry capital/labor ratio)	0.880***	(0.044)	0.871***	(0.047)	0.846***	(0.049)	0.875***	(0.052)	0.876***	(0.048)	0.768***	(0.050)
Ln (Infrastructure index)	-0.291	(0.334)	0.366	(0.393)	0.080	(0.432)	1.179	(0.780)	0.893	(1.082)	-0.875	(0.703)
Ln (Quality of public schools)	-0.299	(0.303)	1.266**	(0.545)	1.264**	(0.537)	1.819***	(0.628)	1.548	(0.995)	1.552	(1.164)
Ln (Organized Crime Index)	0.410***	(0.103)	0.242	(0.218)	0.099	(0.238)	0.240	(0.252)	0.279	(0.171)	-0.199	(0.229)
Ln (Law making institution quality)	-0.159	(0.244)	0.759**	(0.346)	0.495	(0.375)	1.153**	(0.535)	1.178	(0.737)	0.840	(0.757)
Ln (Distance)	-0.007	(0.203)	-0.138	(0.263)	-0.298	(0.274)	-0.344	(0.280)	-0.242	(0.330)	0.024	(0.428)
Common language	0.753***	(0.122)	0.741***	(0.139)	0.972***	(0.199)	1.036***	(0.200)	1.012***	(0.209)	1.184***	(0.243)
Ln (Hidden Trade Barriers)									-0.188	(0.610)	0.330	(0.756)
Ln (Clustering index)									-0.627	(0.754)	-1.978***	(0.595)
Ln (Hiring and firing practices)									-0.291	(0.331)	-0.764*	(0.428)
Spatially weighted 3rd country effects												
Ln (Market Potential)											1.272***	(0.417)
Ln (Industry capital/labor ratio)											0.082	(0.074)
Ln (Infrastructure index)											8.164***	(2.480)
Ln (Quality of public schools)											2.544	(2.292)
Ln (Organized Crime Index)											-11.424***	(3.189)
Observations	1617		1617		1617		1617		1617		1617	
R-squared (Centered R-squared)	0.59		(0.54)		(0.54)		(0.54)		(0.54)		(0.52)	
Durbin-Wu-Hausman Test statistic (χ^2)	--		18.77***		21.01***		23.84***		11.15**		29.21***	
Hansen J-statistic (χ^2)	--		9.23		6.32		3.35		3.41		4.51	
Anderson L-R statistic (χ^2)	--		115.19***		51.22***		35.70***		27.64***		56.56***	
Cragg-Donald Weak IV statistic	--		14.59^{+}		6.37^{++}		4.42^{+++}		3.41		7.01^{++}	

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

For the Cragg-Donald Weak IV statistic, $^{+}$, $^{++}$, and $^{+++}$ denote rejection of the null hypothesis of weak instruments at a 5% significance level for maximal bias levels of the IV estimator relative to OLS of 0.1, 0.2, and 0.3, respectively.

Table 2: GMM-IV Estimates of U.S. Affiliate Value Added with Strategic Policy by Industry

	Dependent Variable: Ln (US affiliate value added) [a]								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
			Manufacturing						
Variable	**Mining**	**Utilities**	**Food**	**Chemicals**	**Primary and Fabricated Metals**	**Machinery**	**Computers and Electronic Products**	**Electrical Equipment, Appliances, and Components**	**Transportation Equipment**
Ln (GDP)	-1.185*	1.122***	1.013	0.586***	1.251***	1.807***	0.436	1.911***	2.141***
	(0.679)	(0.416)	(0.720)	(0.164)	(0.354)	(0.358)	(0.678)	(0.611)	(0.321)
Ln (Environmental Policy Index)	-6.849	3.409	-5.612**	-0.445	-0.293	-2.487*	1.757	-6.794**	-3.739
	(5.851)	(2.716)	(2.332)	(0.830)	(1.788)	(1.272)	(1.940)	(2.896)	(2.377)
Ln (Average manf. tariff rate)	0.468	-1.981**	0.052	0.105	-0.213	-0.294**	-0.249	-0.444*	-0.394**
	(0.362)	(0.791)	(0.343)	(0.095)	(0.206)	(0.132)	(0.266)	(0.262)	(0.200)
Ln (IPR policy index)	11.146	-15.316*	2.328	2.393	-14.083**	-2.877	4.825	-0.740	2.866
	(8.847)	(8.131)	(4.359)	(1.858)	(5.582)	(4.140)	(3.225)	(4.232)	(5.106)
Ln (Industry capital/labor ratio)	1.313***	0.666***	0.523*	1.265***	0.124	1.248***	0.526	0.514***	0.724***
	(0.182)	(0.184)	(0.296)	(0.100)	(0.324)	(0.192)	(0.462)	(0.144)	(0.228)
Observations	161	90	205	232	192	196	171	192	178
Centered R-squared	0.21	0.19	0.35	0.82	0.22	0.65	0.55	0.30	0.41
Durbin-Wu-Hausman Test statistic (χ^2)	22.71***	23.16***	23.89***	11.13**	24.05***	35.54***	13.02**	11.19**	28.29***
Hansen J-statistic (χ^2)	3.01	5.17	2.77	2.99	1.15	1.86	21.08***	1.88	4.37
Anderson L-R statistic (χ^2)	4.67	4.71	3.35	8.11	9.34*	14.39**	9.23*	6.46	11.39**
Cragg-Donald Weak IV statistic	0.5	0.44	0.37	0.92	1.03	1.62	1.00	0.71	1.26

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] In columns (1) - (9), each industry is estimated individually using the same specification as that in column (4) of Table 1.

Table 3: Average Capital/Labor Ratios Across Industry

Industry	Average Capital/Labor Ratio (1000 $'s/worker)
Utilities	6,250
Mining	3,703
Chemicals	628
Computers and Electronic Products	390
Food	375
Primary and Fabricated Metals	347
Transportation Equipment	284
Electrical Equipment, Appliances, and Components	236
Machinery	230

Table 4: OLS and GMM-IV Estimates of U.S. Affiliate Value Added with Strategic Environmental Stringency and Enforcement

	Dependant Variable: Ln (U.S. Affiliate Value Added)											
	OLS		GMM-IV									
	(1)		(2)		(3)		(4)		(5)		(6)	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Ln (GDP)	0.689***	(0.048)	0.750***	(0.162)	0.967***	(0.216)	0.717***	(0.256)	0.725***	(0.200)	1.432***	(0.208)
Ln (Environmental Stringency)	0.041	(0.333)	-1.254	(1.453)	-1.188	(1.438)	-0.912	(1.460)	-0.772	(1.421)	1.529	(2.490)
Ln (Environmental Enforcement)	-0.526	(0.495)	-5.029***	(1.576)	-4.451***	(1.590)	-4.930***	(1.647)	-4.561**	(1.961)	-4.741**	(1.927)
Ln (Average industry tariff rate)	-0.036*	(0.021)	-0.031	(0.029)	-0.147*	(0.082)	-0.064	(0.094)	-0.086	(0.093)	-0.264***	(0.083)
Ln (IPR policy index)	2.342***	(0.498)	3.780***	(0.574)	3.245***	(0.672)	1.034	(1.345)	1.005	(1.906)	2.777	(1.927)
Ln (Industry capital/labor ratio)	0.880***	(0.044)	0.879***	(0.047)	0.854***	(0.050)	0.888***	(0.053)	0.887***	(0.049)	0.799***	(0.054)
Ln (Infrastructure index)	-0.282	(0.335)	0.317	(0.392)	0.038	(0.434)	1.277	(0.803)	1.092	(1.106)	-0.822	(0.711)
Ln (Quality of public schools)	-0.248	(0.306)	1.267**	(0.540)	1.267**	(0.531)	1.858***	(0.624)	1.767*	(1.011)	0.509	(1.306)
Ln (Organized Crime Index)	0.392***	(0.105)	0.205	(0.218)	0.071	(0.237)	0.234	(0.254)	0.238	(0.176)	-0.288	(0.237)
Ln (Law making institution quality)	-0.098	(0.255)	1.051***	(0.400)	0.754*	(0.435)	1.550**	(0.617)	1.554*	(0.795)	0.650	(0.756)
Ln (Distance)	-0.028	(0.204)	-0.219	(0.264)	-0.356	(0.273)	-0.414	(0.282)	-0.377	(0.348)	-0.052	(0.434)
Common language	0.750***	(0.122)	0.703***	(0.141)	0.922***	(0.201)	0.973***	(0.202)	0.972***	(0.208)	1.185***	(0.245)
Ln (Hidden Trade Barriers)									-0.042	(0.626)	0.305	(0.764)
Ln (Clustering index)									-0.251	-0.251	-1.784***	-1.784***
Ln (Hiring and firing practices)									-0.220	-0.220	-0.337	-0.337
Spatially weighted 3rd country effects												
Ln (Market Potential)											1.496***	(0.445)
Ln (Industry capital/labor ratio)											0.101	(0.074)
Ln (Infrastructure index)											10.491***	(2.821)
Ln (Quality of public schools)											-2.768	(3.958)
Ln (Organized Crime Index)											-8.441**	(3.623)
Observations	1617		1617		1617		1617		1617		1617	
R-squared (Centered R-squared)	0.59		(0.55)		(0.55)		(0.54)		(0.55)		(0.53)	
Durbin-Wu-Hausman Test statistic (χ^2)	--		20.12***		21.90***		25.21***		13.43**		32.39***	
Hansen J-statistic (χ^2)	--		7.22		6.32		1.26		1.32		1.97	
Anderson L-R statistic (χ^2)	--		68.08***		51.22***		33.31***		27.10***		27.68***	
Cragg-Donald Weak IV statistic	--		8.5^{++}		5.89^{++}		4.12^{+++}		3.34		3.40	

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

For the Cragg-Donald Weak IV statistic, $^{+}$, $^{++}$, and $^{+++}$ denote rejection of the null hypothesis of weak instruments at a 5% significance level for maximal bias levels of the IV estimator relative to OLS of 0.1, 0.2, and 0.3, respectively.

TABLE 5: Percent Change in US MNE Value Added and Environmental Policy for the Top and Bottom 20th Percentiles for All Countries, 1999 to 2003

Countries	% Δ in U.S. Multinational Affiliate Value Added	% Δ in Environmental Policy Index	Average GDP (bill) from 1999-2003
Top 20th percentile in MNE growth			
Egypt	172.85	-11.29	234.0
Argentina	117.10	3.36	424.6
Turkey	110.05	-11.36	436.2
Venezuela	103.48	-14.09	134.1
Russia	93.29	-19.38	1,080.7
Hungary	60.29	-0.78	138.3
Poland	54.16	3.75	407.4
Ireland	45.87	-7.34	125.8
Korea	38.40	21.87	793.4
Philippines	37.42	2.48	309.8
Top 20th Weighted Average	***81.07***	***-2.54***	
Bottom 20th percentile in MNE growth			
Ecuador	2.76	-10.49	42.5
Dominican Republic	2.57	5.74	54.7
Singapore	-0.15	-4.37	93.8
Greece	-1.24	49.01	199.1
Germany	-2.47	21.26	2,093.8
Austria	-9.17	-2.13	231.4
Hong Kong	-13.79	9.50	170.6
United Kingdom	-14.73	9.32	1,588.6
Finland	-15.12	2.45	133.0
Israel	-72.29	-1.32	144.6
Bottom 20th Weighted Average	***-9.58***	***14.69***	

TABLE 6: Percent Change in US MNE Value Added and Environmental Policy for the Top and Bottom 20th Percentiles for Developing and Transition Economies, 1999 to 2003

Countries	% Δ in U.S. Multinational Affiliate Value Added	% Δ in Environmental Policy Index	Average GDP (bill) from 1999-2003
Top 20th percentile in MNE growth			
Egypt	172.85	-11.29	234.0
Argentina	117.10	3.36	424.6
Turkey	110.05	-11.36	436.2
Venezuela	103.48	-14.09	134.1
Russia	93.29	-19.38	1,080.7
Top 20th Weighted Average	***109.48***	***-12.56***	
Bottom 20th percentile in MNE growth			
Panama	12.98	4.41	18.2
Malaysia	10.81	5.04	208.2
Indonesia	4.30	4.32	644.9
Ecuador	2.76	-10.49	42.5
Dominican Republic	2.57	5.74	54.7
Bottom 20th Weighted Average	***5.70***	***3.91***	

Appendix A

Data Appendix

Countries classified as developed in the analysis are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Israel, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, and the United Kingdom. Countries classified as developing or transition economies are: Argentina, Brazil, Chile, China, Colombia, Costa Rica, Czech Republic, Dominican Republic, Ecuador, Egypt, Honduras, Hungary, India, Indonesia, Malaysia, Mexico, Nigeria, Panama, Peru, Philippines, Poland, Russia, South Africa, Thailand, Turkey, and Venezuela[41].

Table A1: Descriptive Statistics

Variable	Mean	Std. Dev.	Min.	Max
US affiliate value added (mill)	1,881.3	4,962.0	0.1	54,134.3
GDP (bill)	643.0	963.0	15.3	6,090.0
Environmental policy index	20.2	10.0	5.3	40.9
Stringency of environmental policy	4.5	1.2	2.0	6.7
Environmental enforcement	4.3	1.1	2.1	6.4
Ave. manufacturing tariff rate	8.1	6.1	0.0	33.6
Intellectual property rights	4.4	1.3	2.1	6.6
Infrastructure quality	4.5	1.4	1.8	6.9
Public school quality	4.3	1.5	1.6	6.7
Distance (km)	7,982.2	3,838.7	743.0	16,350.5
Industry capital/labor ratio (1000 $'s/worker)	989.2	4,986.7	0.6	120,822.4
Organized Crime	2.0	1.2	0.2	5.1
Institution quality	3.6	1.1	1.3	6.3
Hidden Trade Barriers	4.9	1.1	2.5	6.8
Cluster development	3.7	0.8	2.2	6.0
Hiring and Firing Practices	3.5	1.0	1.6	5.9

Note: The max capital/labor ratio of $120,822,000 per worker comes from the utility industry for India. There are a few observations in the dataset in the utility and mining industries that are quite large. All regressions in the paper have been estimated with these large outlier observations removed without any change in results.

Data on U.S. majority owned multinational affiliate value added is from the BEA[42]. Aggregate industry level data is available for 7 manufacturing industries (food; chemicals; primary and fabricated metals; machinery; computers and electronic products;

[41] Country classification is generally guided by World Bank classifications.

[42] All $ denominated values are converted to real 2000 international PPP $'s using PPP conversion factors from the World Development Indicators 2005.

electrical equipment, appliances and components; and transportation equipment) as well as the non-manufacturing sectors of mining and utilities. Industry capital/labor ratios are calculated by dividing the total assets of multinational firms in each country and industry by the total number of multinational firm employees in each country and industry, yielding capital $/worker. Data on assets and the number of employees across country and industry are also available from the BEA.

Table A2: Questions Determining Variables from the Global Competitiveness Report

Variable	Survey Question
Organized Crime	In your country, organized crime such as racketeering and extortion: (1 = imposes significant costs on business, 7 = does not impose significant costs on business)
Overall Infrastructure Quality	General infrastructure in your country is: (1 = poorly developed and inefficient, 7 = among the best in the world)
Quality of Public Schools	Public (free) schools in your country are (1 = of poor quality, 7 = equal to the best in the world)
Hiring and Firing Practices	Hiring and firing of workers is: (1= impeded by regulations, 7 = determined by employers)
Intellectual Property Protection	Intellectual property protection in your country is: (1 = weak or nonexistent, 7 = equal to the world's most stringent)
Stringency of Environmental Regulations	The stringency of overall environmental regulation in your country is: (1 = lax compared with most other countries, 7 = among the world's most stringent)
Consistency of Regulation Enforcement	Environmental regulation in your country is: (1 = not enforced or enforced erratically, 7 = enforced consistently and fairly)
Effectiveness of Law-Making Bodies	How effective is your national Parliament/Congress as a law-making and oversight institution? (1 = very ineffective, 7 = very effective--the best in the world)
State of cluster development	How common are clusters in your country? (1 = limited and shallow, 7 = common and deep)

Real GDP, total number of hectares of arable land, total number of tractors, and the total number of agricultural workers are from the World Development Indicators 2005. Average manufacturing tariff rates are the average applied import tariff rates on non-agricultural and non-fuel products and are obtained from the UNCTAD TRAINS database. Data on environmental stringency, environmental enforcement, IPR’s, infrastructure quality, public schools, law making institutions, organized crime, hidden trade barriers, and hiring practices are based on survey data from the 2000-2001 through 2005-2006 editions of The Global Competitiveness Report (GCR) published by the

World Economic Forum[43]. Each survey question is ranked on a score of 1 to 7. Table A2 provides a list of the GCR variables used in the paper as well as the actual survey questions asked. Note from the table that the question regarding organized crime implies that higher levels of organized crime receive a lower score. That is, a score of 1 indicates very high levels of crime. In the paper, the organized crime variable is inverted such that 7 corresponds to higher organized crime levels.

The Environmental Policy Index variable is intended to capture both the stringency and the enforcement of environmental policies. It is constructed by multiplying the Stringency of Environmental Regulation score by the Consistency of Environmental Regulation score. Thus, those countries who have both high stringency environmental standards and enforce them receive the highest Environmental Policy Index score.

[43] Since BEA data is only available through 2004, GCR data from the 2000-2001 edition corresponds with the 1999 BEA observation, the 2001-2002 GCR edition corresponds with the 2000 BEA edition, and so on. Given that the GCR surveys are conducted at the beginning of each year (i.e. the surveys for the 2000-2001 edition are conducted in early 2000), respondents are largely basing their answers on their most recent years experience; that is, their experience during the 1999 year.

Table A3: Alternative Specifications of U.S. Affiliate Value Added with Endogenous Strategic Policy

	Dependent Variable: Ln (US affiliate value added/capita)			Dependent Variable: Ln (US affiliate value added/GDP)		
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	OLS	**GMM-IV**		**OLS**	**GMM-IV**	
Ln (GDP/capita)	0.565***	0.506	0.279			
	(0.187)	(0.597)	(1.230)			
Ln (Environmental Policy Index)	-0.496**	-2.702***	-1.572	-0.584**	-2.820***	-2.265**
	(0.231)	(0.701)	(1.631)	(0.231)	(0.699)	(1.099)
Ln (Average manf. tariff rate)	-0.090***	-0.167***	-0.252***	-0.069***	-0.152***	-0.255***
	(0.022)	(0.053)	(0.072)	(0.021)	(0.050)	(0.070)
Ln (IPR policy)	2.305***	2.707	5.990	2.034***	1.454	3.660**
	(0.526)	(2.049)	(4.763)	(0.518)	(1.346)	(1.667)
Ln (Industry capital/labor ratio)	0.842***	0.839***	0.814***	0.848***	0.847***	0.814***
	(0.045)	(0.045)	(0.044)	(0.045)	(0.044)	(0.044)
Ln (Infrastructure quality)	-0.126	0.713	-0.839	-0.399	0.721	-0.632
	(0.358)	(0.603)	(0.813)	(0.344)	(0.616)	(0.671)
Ln (Quality of public schools)	0.723**	1.995***	0.819	0.352	1.863***	1.148
	(0.342)	(0.637)	(1.361)	(0.292)	(0.633)	(1.122)
Ln (Law making institution quality)	-0.554**	0.304	-0.163	-0.266	0.828*	1.030
	(0.277)	(0.758)	(2.277)	(0.250)	(0.425)	(0.728)
Ln (Organized Crime)	0.084	0.106	0.359	0.026	0.023	0.196
	(0.088)	(0.149)	(0.305)	(0.088)	(0.112)	(0.124)
Ln (Distance)	-0.205	-0.282	0.820	-0.310	-0.477**	0.605*
	(0.208)	(0.336)	(0.524)	(0.201)	(0.241)	(0.318)
Common language	1.068***	1.269***	1.162***	0.866***	1.139***	1.084***
	(0.148)	(0.227)	(0.237)	(0.121)	(0.174)	(0.223)
Ln (Clustering)			-1.627**			-1.298***
			(0.788)			(0.488)
Ln (Hidden Trade Barriers)			-0.351			-0.717*
			(0.813)			(0.413)
Ln (Hiring and firing practices)			-0.676			-0.540
			(0.647)			(0.581)
Spatially weighted 3rd country effects						
Ln (Market Potential)			0.400			0.641**
			(0.475)			(0.261)
Ln (Industry capital/labor ratio)			0.058			0.031
			(0.088)			(0.067)
Ln (Infrastructure index)			5.096			6.769***
			(3.999)			(2.269)
Ln (Quality of public schools)			1.147			2.138
			(2.840)			(2.213)
Ln (Organized Crime Index)			-6.278			-9.029***
			(5.948)			(2.865)
Observations	1617	1617	1617	1617	1617	1617
R-squared (Centered R-squared)	0.57	(0.53)	(0.55)	0.47	(0.41)	(0.45)
Durbin-Wu-Hausman Test statistic (χ^2)	--	20.40***	15.76***	--	23.14***	14.84***
Hansen J-statistic (χ^2)	--	3.71	9.00*	--	4.25	9.64*
Anderson L-R statistic (χ^2)	--	57.52***	10.24*	--	137.32***	64.46***
Cragg-Donald Weak IV statistic	--	7.17^{++}	1.25	--	17.54^{+}	8.01^{+}

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

For the Cragg-Donald Weak IV statistic, $^{+}$, $^{++}$, and $^{+++}$ denote rejection of the null hypothesis of weak instruments at a 5% significance level for maximal bias levels of the IV estimator relative to OLS of 0.1, 0.2, and 0.3, respectively.

[a] In column (2), GDP/capita and Environmental Policy are treated as endogenous; in column (3) GDP/capita, Environmental Policy, Tariffs, and IPR's are treated as endogenous; in column (5) Environmental Policy is treated as endogenous; in column (6) Environmental Policy, Tariffs, and IPR's. Industry, region and time dummies are included in all regressions but are supressed for exposition.

Table A4: Robustness tests of the Inclusion of Each Instrument as a 2nd Stage Explanatory Variable

	Dependant Variable: Ln (U.S. Affiliate Value Added)							
	GMM-IV							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln (GDP)	0.687	0.930***	0.690**	0.762***	0.814***	0.836***	0.699***	0.746***
	(0.464)	(0.280)	(0.269)	(0.251)	(0.262)	(0.272)	(0.267)	(0.260)
Ln (Environmental Policy Index)	-2.649**	-1.429	-2.721***	-2.462***	-3.115***	-3.018***	-2.851***	-2.879***
	(1.035)	(1.057)	(0.724)	(0.745)	(0.751)	(0.767)	(0.730)	(0.939)
Ln (Average industry tariff rate)	-0.065	0.102	-0.059	-0.110	-0.063	-0.099	-0.053	-0.069
	(0.115)	(0.141)	(0.096)	(0.095)	(0.094)	(0.097)	(0.100)	(0.103)
Ln (IPR policy index)	1.050	2.259	0.874	1.138	5.337	0.582	1.250	1.082
	(1.361)	(1.578)	(1.383)	(1.343)	(3.364)	(1.501)	(1.374)	(1.355)
Dropped Instrumental Variable included in 2nd Stage Regression								
Land/agricultural worker	0.009							
	(0.051)							
Tractors/agricultural worker		-0.930						
		(0.566)						
Regional industry capital/labor			0.000					
			(0.000)					
Regional land/agricultural worker				0.097				
				(0.074)				
Regional tractors/agricultural worker					3.325			
					(2.341)			
Regional infrastructure						-0.019		
						(0.021)		
Regional public schools							0.014	
							(0.022)	
Regional organized crime								-0.046
								(0.282)
Observations	1617	1617	1617	1617	1617	1617	1617	1617
Centered R-squared	0.54	0.56	0.54	0.53	0.54	0.53	0.54	0.55
Durbin-Wu-Hausman Test stat. (χ^2)	21.51***	11.63**	23.72***	18.44***	23.60***	22.00***	22.42***	22.14***
Hansen J-statistic (χ^2)	3.33	0.77	2.82	3.32	2.90	2.54	1.12	1.68
Anderson L-R statistic (χ^2)	15.23***	20.28***	33.07***	28.93***	31.44***	32.90***	25.53***	34.90***
Cragg-Donald Weak IV statistic	2.14	2.85	4.67*	4.08	4.44^{+}	4.65^{+}	3.60	4.93^{+}

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

For the Cragg-Donald Weak IV statistic, $^{+}$, $^{++}$, and $^{+++}$ denote rejection of the null hypothesis of weak instruments at a 5% significance level for maximal bias levels of the IV estimator relative to OLS of 0.1, 0.2, and 0.3, respectively.

Specification of the above regressions is the same as given in column (4) of Table 1.

Table A5: 1st Stage Regression Results

	1st Stage Dependent Variable							
	Ln (GDP)		Ln (Environmental Policy Index)		Ln (Average industry tariff rate)		Ln (IPR policy index)	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Land/agricultural worker	0.085***	(0.014)	-0.010***	(0.002)	0.040*	(0.021)	-0.001	(0.001)
Tractors/agricultural worker	0.891***	(0.090)	0.173***	(0.021)	2.901***	(0.246)	-0.012*	(0.007)
Regional industry capital/labor	0.000	(0.000)	-0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Regional land/agricultural worker	0.058	(0.044)	-0.027***	(0.008)	0.329***	(0.069)	-0.004	(0.004)
Regional tractors/agricultural worker	0.907	(0.812)	0.214*	(0.130)	4.151***	(1.072)	-0.675***	(0.068)
Regional infrastructure	0.013	(0.011)	-0.008***	(0.002)	-0.046***	(0.018)	-0.006***	(0.001)
Regional public schools	0.014	(0.014)	0.014***	(0.003)	-0.066	(0.022)	0.004***	(0.001)
Regional organized crime	-0.088	(0.122)	-0.147***	(0.027)	1.506***	(0.237)	0.016	(0.012)
Observations	1617		1617		1617		1617	
F-test on excluded instruments	23.08***		20.86***		27.53***		19.12***	

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

1st stage results are for column (4) of Table 1.