research paper series

Internationalisation of Economic Policy

Research Paper 2004/20

Endogenous Pollution Havens: Does FDI Influence Environmental Regulations?

by

Matthew A. Cole, Robert J.R. Elliott and Per G. Fredriksson

The Centre acknowledges financial support from The Leverhulme Trust
under Programme Grant F114/BF

Leverhulme Centre
for Research on Globalisation and Economic Policy

The Authors

Matthew Cole and Robert Elliott are Senior Lecturers in the Department of Economics at the University of Birmingham. Per Fredriksson is a Professor in the Department of Economics at the Southern Methodist University, Dallas.

Corresponding author: Professor Per Fredriksson, Department of Economics, Southern Methodist University, PO Box 0496, Dallas, TX 75275-0496, **pfredrik@mail.smu.edu**. This paper forms part of Cole and Elliott's ongoing research into the relationship between globalisation and the environment. For further information see;

http://www.economics.bham.ac.uk/cole/globalisation/index.htm

Acknowledgements

We would like to thank Sangeeta Bansal, Jayasri Dutta, Angeliki Kourelis, John List, Daniel Millimet and participants at presentations at Rice University, SMU, and the EAERE meetings in Budapest for helpful comments and discussions, and Jakob Svensson for some of the data. This paper was started while Fredriksson visited the Department of Economics, University of Gothenburg, and he thanks the department for its hospitality. Financial support from the Malmsten Foundation and the University of Gothenburg Jubilee Fund (Elof Hansson's Foundation Gift) is gratefully acknowledged. Cole and Elliott gratefully acknowledge the support of ESRC grant number RES-000-22-0016 and Leverhulme Trust grant number F/00094/AG. The usual disclaimers apply.

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Robert J.R. Elliott

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Abstract

We suggest a novel perspective on the relationship between the stringency of environmental policies and foreign direct investment (FDI). We develop a political economy model with imperfect product market competition where local and foreign firms jointly lobby the local government for a favorable pollution tax. FDI is found to affect environmental policy, and the effect is conditional on the local government's degree of corruptibility. If the degree of corruptibility is sufficiently high (low), FDI leads to less (more) stringent environmental policy, and FDI thus contributes to (mitigates) the creation of a pollution haven. Our empirical results using panel data from 33 countries support the model's predictions.

Keywords: Pollution Haven Hypothesis, FDI, Environmental Policy, Political Economy, Corruption.

JEL Codes: F18, F21, D72, D73, Q28.

Outline

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2. The Model
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Non-Technical Summary

Opponents to international trade and investment flows frequently argue that the presence of foreign owned firms (multinationals) causes local environmental regulations to become sub-optimally weak, and "pollution havens" to emerge. Considering that 60,000 multinationals have 800,000 foreign affiliates worldwide (UNCTAD, 2001), the literature contains surprisingly little formal work on investigating their impact on local environmental policies. Instead, the related theoretical and empirical literature has focused on the effects of local environmental regulations on investment flows. In this paper, we seek to fill this gap in the literature. We ask the following question: what are the effects on local environmental policy, and quality, of foreign direct investment?

In order to address this question, we first build a simple model of government environmental policymaking that sheds light on the political forces of interest. The theory applies to all cases of direct investment by a parent firm located outside a jurisdiction, where the subsidiary repatriates the profits to its home jurisdiction. Local politicians are assumed to value bribes (political contributions) and aggregate social welfare. We view the government's weight on campaign contributions relative to social welfare as a useful measure of the corruptibility of local policymakers. The imperfectly competitive local goods market contains both locally owned firms and foreign subsidiaries. All firms produce exclusively for the local market.

We find that the establishment of an additional foreign plant (given the number of domestic firms) has two main effects on local environmental policymaking. First, foreign direct investment leads to a greater output level produced for the local market. Thus, more is at stake in the policy outcome because the tax applies to a greater output level. This increases the size of the bribe offered by the foreign lobby for a lower pollution tax. This "bribery effect" of foreign investment leads to a lower pollution tax. Second, in an imperfectly competitive market, the government has an incentive to lower the pollution tax below the first-best level (equal to marginal damage) in order to stimulate output and raise consumer surplus. An increase in the number of firms increases the level of competition and therefore reduces the government's incentive to lower the pollution tax. This "welfare effect" of foreign direct investment leads to a higher pollution tax.

The net effect of an additional foreign subsidiary is conditional on the government's weight on the "bribery effect" relative to the "welfare effect", i.e. the degree of corruptibility. We find that foreign direct investment raises (reduces) local environmental policy stringency when the degree of government corruptibility is relatively low (high). Thus, when the degree of corruptibility is relatively high, foreign direct investment may create pollution havens (i.e. increase pollution levels). However, when corruptibility is low, it may result in a decline of the pollution damage, despite an increase in total output produced and sold in the domestic economy.

The empirical analysis lends support to our theoretical predictions. Using a panel of 33 developed and developing countries for the years 1982-1992, we find that inward FDI has a positive impact on the stringency of environmental regulations when the level of corruptibility is low. At higher levels of corruptibility this impact is lessened and eventually becomes negative. This is consistent with the "bribery effect" dominating (being dominated by) the "welfare effect" of FDI for high (low) levels of corruptibility.

I. INTRODUCTION

Opponents to international trade and investment flows frequently argue that the presence of foreign owned firms (multinationals) causes local environmental regulations to become sub-optimally weak, and "pollution havens" to emerge (Newell, 2001). Considering that 60,000 multinationals have 800,000 foreign affiliates worldwide (UNCTAD, 2001), the literature contains surprisingly little formal work on investigating their impact on local environmental policies (see Vogel, 2000, for some anecdotal evidence). Instead, the related theoretical and empirical literature has focused on the effects of local environmental regulations on investment flows (see, e.g., List and Co, 2000; Keller and Levinson, 2002). In this paper, we seek to fill this gap in the literature. We ask the following question: what are the effects on local environmental policy, and quality, of foreign direct investment?

In order to address this question, we first build a simple model of government environmental policymaking that sheds light on the political forces of interest. The theory applies to all cases of direct investment by a parent firm located outside a jurisdiction, where the subsidiary repatriates the profits to its home jurisdiction. Local politicians are assumed to value bribes (political contributions) and aggregate social welfare (see, for example, Grossman and Helpman, 1994; Aidt, 1998). We view the government's weight on campaign contributions relative to social welfare as a useful measure of the corruptibility of local policymakers.[1,2] The imperfectly competitive local goods market contains both locally owned firms and foreign subsidiaries (Grossman and Helpman, 1996). All firms produce exclusively for the local market.[3]

In a three-stage game, all domestic and foreign firms (with local production facilities) exogenously form separate lobby groups, which first offer prospective bribe (political

[1] Schulze and Ursprung (2001) argue that the model by Grossman and Helpman (1994) can be seen as a model of corruption, in particular since campaign contributions (bribes) are given in order to affect policy, not election outcomes (see also Damania *et al*., 2003).

[2] Corruption of local government officials is a relevant issue also in industrial countries, for example in the U.S. (see http://chicago.fbi.gov/silvershovel/silvershovel.htm). Hall (1999) reports that executives of a French firm (Général des-Eaux) were convicted of bribing the Mayor of St-Denis in order to obtain a water concession. Examples of high-level politicians that have been charged with corruption and fund-raising violations include German Chancellor Kohl, Italian Prime Minister Berlusconi, and in Israel both President Weizman and Prime Minister Barak.

[3] Thus, we abstract from modeling the decision by foreign multinationals to invest abroad and where to locate production. The decision to invest abroad has been examined by, for example, Head *et al*. (1999). Foreign firms may prefer to produce locally rather than exporting to the market due to high transportation costs or trade barriers (or the threat of such barriers), for example.

contributions) schedules to the domestic government.[4] We ignore free-riding problems among firms (see Olson, 1965), and lobby group formation is assumed to occur exogenously, as in most of the relevant literature. In the second stage, the local government sets its optimal policy, and collects the associated bribes. In the third stage the firms set output and abatement levels.

We find that the establishment of an additional foreign plant (given the number of domestic firms) has two main effects on local environmental policymaking. First, foreign direct investment leads to a greater output level produced for the local market. Thus, more is at stake in the policy outcome because the tax applies to a greater output level. This increases the size of the bribe offered by the foreign lobby for a lower pollution tax. This "bribery effect" of foreign investment leads to a lower pollution tax. Second, in an imperfectly competitive market, the government has an incentive to lower the pollution tax below the first-best level (equal to marginal damage) in order to stimulate output and raise consumer surplus (see Katsoulacos and Xepapadeas, 1995). An increase in the number of firms increases the level of competition and therefore reduces the government's incentive to lower the pollution tax. This "welfare effect" of foreign direct investment leads to a higher pollution tax.

The net effect of an additional foreign subsidiary is conditional on the government's weight on the "bribery effect" relative to the "welfare effect", i.e. the degree of corruptibility. We find that foreign direct investment raises (reduces) local environmental policy stringency when the degree of government corruptibility is relatively low (high). Thus, when the degree of corruptibility is relatively high, foreign direct investment may create pollution havens (i.e., increase pollution levels). However, when corruptibility is low, it may result in a decline of the pollution damage, despite an increase in total output produced and sold in the domestic economy.

The empirical analysis lends support to our theoretical predictions. Using a panel of 33 developed and developing countries for the years 1982-1992, we find that inward FDI has a positive impact on the stringency of environmental regulations when the level of corruptibility is

[4] Even firms located outside the U.S. influence the U.S. government. For example, see Gawande *et al*. (2002) for empirical evidence on (successful) foreign lobbying for reductions of U.S. trade barriers. Moreover, Transparency International (2003) reports an index ranking the propensity of companies from 21 different countries to pay bribes when they do business abroad (0=high bribery; 10=low bribery). The scores included Australia (8.5), the U.S. (5.3), Japan (5.3), Italy (4.1), and Russia (3.2). The business sectors in which bribery most commonly occurs were also identified. Among heavily polluting sectors, the scores included Heavy Manufacturing (4.5), Mining (4.0), and Oil and Gas (2.7).

low. At higher levels of corruptibility this impact is lessened and eventually becomes negative. This is consistent with the "bribery effect" dominating (being dominated by) the "welfare effect" of FDI for high (low) levels of corruptibility. The sensitivity analysis reveals that our empirical findings are robust across a range of different specifications.

We believe our results may have implications for future empirical investigations of the effects of environmental policies on new plant locations by foreign firms. Many such studies to date have found few robust negative effects on foreign direct investment (see, e.g., the survey by Jaffe *et al*., 1995). This may be attributable to the fact that most empirical studies have treated environmental policy as exogenous. If foreign firms' rent-seeking activities affect environmental policy, any regression model trying to discern the impact of environmental policy on foreign investment must take into account that both variables are endogenous. Only recently has the literature begun to recognize this problem.[5] In particular, the effect of foreign direct investment on environmental policies has been ignored.

Our results also point to the need to take seriously warnings of negative effects of foreign direct investment, in particular where the degree of government corruptibility enables officials to sell policy favors to polluting firms. The model suggests that in such countries, the feared pollution havens may be more likely to emerge as a result of foreign direct investment. On the other hand, the results are encouraging for less corrupt countries. Our results further reinforce the need to reduce the level of government corruption (corruptibility) in many countries.

The paper is organized as follows. While Section II sets up the model and derives the theoretical predictions, Section III presents the empirical analysis. Section IV concludes.

II. THE MODEL

In this section, we provide a simple model that guides our subsequent empirical work. It seeks to capture the political forces that arise as foreign firms establish themselves in a domestic market. Consider a small economy where production causes local pollution damage s. A continuum of N^D domestic firms and N^F foreign subsidiaries are producing and competing (in quantities) in an imperfectly competitive local market, where $N^D + N^F = N$ (see Grossman and

Helpman, 1996). We take the existence of the number of active firms in the market as given, and assume that the market is supplied exclusively by the identical firms located within the jurisdiction's borders. The producers are shielded from the world market by, e.g., high transportation costs, and for simplicity no trade takes place.[6]

There are four types of agents in the economy: consumers, domestic producers, foreign producers, and the government. We normalize the population of consumers to one. The utility of the representative consumer is given by $U = u(Q) - s$, where Q is consumption of the polluting good with price $p = a - Q$, where a>0 reflects the local market's size. $u(Q)$ is a concave, twice differentiable sub-utility function.

Local production results in local pollution, and the government controls emissions by levying an emissions tax, $t \in T \subset R_+$, per unit of pollution. Output of firm i is given by q_i. Following Katsoulacos and Xepapadeas (1995), the gross profit function of firm i is given by

$$\pi_i = p(Q)q_i - e(q_i, w_i) - s_i t - F, \tag{1}$$

where $p(Q)$ is the inverse demand function, $Q = \sum_i q_i = Nq_i$, $e_i(q_i, w_i) = cq_i + gw_i$ is the cost function which is linear in output, q_i, and abatement expenses, w_i. The parameter g represents the marginal abatement cost. The pollution damage function equals $s_i = vq_i + \beta w_i^{-\gamma}$, which is increasing in q and decreasing in w (as in Katsoulacos and Xepapadeas, 1995). F is the fixed cost of production in this economy. The parameters c, v, β, and γ are all positive.

The output and abatement levels that maximize profits satisfy the first-order conditions

$$\frac{\partial \pi_i}{\partial q_i} = a - Q - q_i - c - vt = 0, \tag{2}$$

$$\frac{\partial \pi_i}{\partial w_i} = -g - t\gamma\beta w_i^{-(\gamma+1)} = 0. \tag{3}$$

Applying the implicit function theorem to (2) and (3) yields $dq_i/dt = -v/(1+N) < 0$, and $dw_i/dt = w/t(1+\gamma) > 0$. Let $h = \beta\gamma/g$. Expressions (2) and (3) gives firm i's Nash equilibrium

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[5] See Fredriksson *et al*. (2003) for an empirical study of the effect of environmental policy on foreign direct investment into the U.S. that treats environmental policy endogenously. Levinson and Taylor (2003) account for endogeneity in a study of the effect of environmental regulations on trade flows.

[6] The introduction of an additional market complicates the analysis without adding further insights; hence we ignore this aspect of the problem.

output and abatement levels, given the pollution tax, t,

$$q_i = \frac{a - c - vt}{1 + N}, \tag{4}$$

$$w_i = (ht)^{\frac{1}{1+\gamma}}. \tag{5}$$

Foreign firms' profits are assumed fully repatriated to the firms' home jurisdictions, and are consequently not part of the government's social welfare function. We define the consumers' aggregate welfare as:

$$W^{CO}(t) = \int_0^Q p(x)dx - p(Q)Q + N(t-1)s(q,w), \tag{6}$$

which is the sum of consumer surplus, pollution tax revenues (redistributed equally to all consumers), less the damage from pollution, respectively.

The Game The model is a three-stage game. In the first stage, all firms active in the local economy join either the domestic (D) or foreign (F) firm lobby group k, k=D,F.[7] Lobby group k offers a prospective bribe schedule $C^k(t)$ to the government, which is contingent on its pollution tax policy choice. In the second stage, the government selects its environmental policy and collects the corresponding bribes from the lobbies. In the third stage, the firms set output and abatement expenditure levels.

Since the organized producer lobbies contain a negligible number of individuals, they ignore consumer surplus and revenues, and thus have utility functions simply given by

$$V^D(t) \equiv N^D\pi; \tag{7.1}$$

$$V^F(t) \equiv N^F\pi. \tag{7.2}$$

We assume that the government maximizes a weighed sum of bribes (political contributions) received and aggregate (gross-of-bribes) social welfare, given by

$$G(t) = \sum_{k=D,F} C^k(t) + \alpha W^A(t), \tag{8}$$

where $C^k(t)$ is the bribe given by lobby k, $\alpha > 0$ is the weight given by the government to aggregate social welfare relative to bribes. The weight α in (8) is commonly regarded as a

[7] Our results would not change if all firms banded together in one single firm lobby group. Since the focus is on FDI effects, we opt to keep the two groups' political activities separate, for simplicity.

measure of the level of government corruptibility (corruption) (see, e.g., Damania *et al*., 2003).[8] Only domestic firms' profits are included in aggregate social welfare, which is given by

$$W^A(t) = W^{CO}(t) + N^D\pi. \tag{9}$$

Following Bernheim and Whinston (1986) and Grossman and Helpman (1994), the subgame perfect Nash equilibrium pollution tax, t^*, is found using two necessary conditions:[9]

$$t^* = \arg\max_t \sum_k C^{k*}(t) + \alpha W^A(t) \text{ on T}; \tag{C1}$$

$$t^* = \arg\max_t \underbrace{[V^k(t) - C^{k*}(t)]}_{A} + \underbrace{[\sum_k C^{k*}(t) + \alpha W^A(t)]}_{B} \text{ on T}. \tag{C2}$$

The FOC of (C1) implies that term *B* of the FOC of (C2) equals zero. Thus, term *A* in the FOC of (C2) implies $\frac{\partial V^k(t^*)}{\partial t} = \frac{\partial C^{k*}(t^*)}{\partial t}$, which can be substituted back into the FOC of (C1) to yield the (standard) equilibrium characterization

$$\sum_k \frac{\partial V^k(t^*)}{\partial t} + \alpha \frac{\partial W^A(t^*)}{\partial t} = 0. \tag{10}$$

The first term represents the effect of the pollution tax *t* on the lobby groups' profits, and the second term reflects its effect on aggregate social welfare. In equilibrium, the government trades off the two terms in (10) at a rate α.

The Equilibrium Characterization In order to find an explicit expression for the equilibrium characterization (10), we study the effect of the pollution tax on consumers' welfare, (6), given by

$$\frac{\partial W^{CO}(t)}{\partial t} = N\left[s - \frac{vqN}{1+N} - (t-1)\left(\frac{v^2}{1+N} + \frac{(\beta\gamma)^2 w^{-(\gamma+1)}}{(1+\gamma)g}\right)\right]. \tag{11}$$

The effect of the pollution tax on lobby group *k*'s welfare is given by

$$\frac{\partial V^D(t)}{\partial t} = -sN^D, \tag{12.1}$$

[8] Schulze and Ursprung (2001) argue that "the portrayed interaction between the organized interest groups and the government meets the circumstances of corruption" (p. 68). This perspective is consistent with Shleifer and Vishny's (1993, p. 599) view of corruption as "the sale by government officials of government property for personal gain," where government property refers to government policies (see also López and Mitra, 2000).

[9] Condition (C1) requires that the equilibrium policy, t^*, maximizes the government's utility function, while by (C2) the tax also maximizes the joint utility of the lobby and the government.

$$\frac{\partial V^F(t)}{\partial t} = -sN^F. \tag{12.2}$$

Substitute (11) and (12.1) into the partial derivative of (9). Substitute the result into (10) together with (12.1) and (12.2). This gives us the following expression for the equilibrium characterization:

$$\underbrace{-(I^D + \alpha)N^D s - I^F N^F s}_{A} + \alpha N \underbrace{\left[s - \frac{vqN}{1+N} - (t-1)\left(\frac{v^2}{1+N} + \frac{(\beta\gamma)^2 w^{-(1+\gamma)}}{g(1+\gamma)} \right) \right]}_{B} = 0, \tag{13}$$

where the indicator variable I^k, $k = D, F$, equals one and is included to illustrate the bribery pressure from lobby *k*. Term *A* is the effect of the two lobby groups, and term *B* is the government's consideration of consumers' welfare. In this model, the pollution tax is subject to several downward pressures. These contribute to reduce it below the pollution tax set by a welfare maximizing government when the output market is perfectly competitive (the first-best pollution tax). First, both lobby groups bid for a lower pollution tax. Second, with imperfect competition in the output market, the government lowers the pollution tax to raise consumer surplus (see Barnett, 1980; Katsoulacos and Xepapadeas, 1995). Since term *A* in (13) is unambiguously negative, term *B* is positive. We make the following assumption on the equilibrium pollution tax: **Assumption 1:** *In equilibrium*, $t^* < 1$.

This assumption simplifies the discussion below, but does not drive the results. It implies that t^* is set below marginal social damage from pollution.[10]

III. FOREIGN DIRECT INVESTMENT AND ENVIRONMENTAL POLICY

We now investigate the effect of foreign direct investment by polluting firms.

Proposition 1: *In the political equilibrium, the pollution tax increases* (*decreases*) *with the number of foreign firms if the degree of corruptibility is sufficiently low* (*high*).

Proof: Differentiation of (13) yields

$$\frac{dt}{dN^F} = \frac{\overbrace{-I^F s}^{A} + \alpha \overbrace{\left(\beta w^{-\gamma} + \frac{vq(1+N(N-1))}{1+N} - \frac{(t-1)(\beta\gamma)^2 w^{-(1+\gamma)}}{g(1+\gamma)} \right)}^{B}}{-D}, \qquad (14)$$

where D is the second-order condition of the equilibrium characterization (13), which is the solution to the government's maximization problem. We assume $D<0$. Term *A* in the numerator of (14) is negative, and term *B* is positive under Assumption 1. With a positive denominator, -*D*, it follows that $\underset{\alpha\to 0}{Lim}\frac{dt}{dN^F} < 0$, and $\underset{\alpha\to\infty}{Lim}\frac{dt}{dN^F} > 0$. *Q.E.D.*

The effect of the (exogenous) establishment of an additional foreign subsidiary (given the number of domestic firms) on environmental policy depends on the level of corruptibility of the local policymakers. The net impact is determined by two main effects. First, an increase in the number of firms active in the domestic (output and political) markets increases the political pressure for a lower pollution tax. This is because the foreign firms' output level increases, and the stakes involved with pollution taxation thus increases for the foreign firm lobby group. This results in a less stringent policy (term *A*). We denote this a "bribery effect" of foreign direct investment. Second, an increase in the number of active firms increases the level of product market competition. This reduces the government's incentive to lower the stringency of the pollution tax in order to keep output and consumer surplus high, a "welfare effect" of foreign direct investment. This causes the policy stringency to increase (term *B*).

Where the degree of corruptibility is high (α is low), term *A* dominates and the additional foreign firm causes a decrease in environmental policy stringency. Where the degree of corruptibility is low (α is high), term *B* dominates and the additional foreign firm causes an increase in policy stringency. Proposition 1 yields the prediction tested below. Moreover, the effect of foreign direct investment on total pollution levels follows from Proposition 1.

Corollary 1: *In the political equilibrium, the pollution level is decreasing (increasing) in the number of foreign firms iff*

[10] Assumption 1 appears relatively weak. Note that if we assumed that all firms' profits were included in aggregate social welfare, it would hold automatically.

$$\frac{d(Ns)}{dN^F} = \underbrace{s}_{A} - N\left(\underbrace{\frac{vq}{1+N}}_{B} + \underbrace{\frac{v^2}{1+N}\frac{\partial t}{\partial N^F}}_{C} + \underbrace{\frac{\gamma\beta h^{-\frac{1}{1+\gamma}} t^{-\frac{2\gamma+1}{1+\gamma}}}{1+\gamma}\frac{\partial t}{\partial N^F}}_{D} \right) < (>) 0. \tag{15}$$

Proof: Total differentiation of *Ns* yields expression (15). *Q.E.D.*

The intuition is as follows. The aggregate effect on pollution depends on the four terms in expression (15). Term *A* is the direct effect of an increase in the number of foreign firms. Term *B* is the decline in output per firm due to the increased degree of competition. Term *C* is the change in output per firm due to the tax change. From (14), $\partial t / \partial N^F > (<) 0$. Term *D* is the change in abatement due to the tax change. Assuming $\partial t / \partial N^F > 0$ (corruptibility is sufficiently low) terms *C* and *D* may together with term *B* contribute to outweigh term *A*. In this case, the pollution level falls on the margin due to the investment, and a pollution haven is mitigated (environmental quality improves) by foreign direct investment. On the other hand, in the case $\partial t / \partial N^F < 0$ (corruptibility is relatively high), only term *B* reduces pollution. Foreign direct investment is more likely to create a pollution haven in this case.

IV. EMPIRICAL ANALYSIS

Specification and Methodology In the empirical analysis, we seek to test the main implication generated by our model to shed new light on the pollution haven hypothesis debate. In particular, we analyze the relationship between environmental policy, foreign direct investment (FDI), and corruptibility, formulated in Proposition 1. We do this by estimating the following equation:

$$REGS_{it} = \alpha_i + \gamma_t + \beta' X + \varepsilon_{it} \tag{16}$$

where $REGS_{it}$ denotes environmental regulatory stringency in country *i* in year *t*, α_i is a time-invariant country fixed effect, γ_t is a location-invariant time fixed effect, *X* is our vector of independent variables, and ε_{it} is the error term. Equation (16) is estimated using both fixed and random effects specifications.

Our model predicts that the impact of foreign direct investment on environmental regulations in country *i* is *conditional* upon country *i*'s level of corruptibility. In particular, FDI should have a positive (negative) effect on the stringency of environmental regulations when corruptibility is low (high) (Proposition 1). In order to capture this effects, vector *X* contains a continuous measure of inward FDI (*FDI*), a measure of the degree of corruptibility (*CORRUPT*), and the interaction term *FDI×CORRUPT*. We therefore expect the estimated coefficient on *FDI* to be positive, while the coefficients on *FDI×CORRUPT* is expected to be negative.

We also include a number of control variables. We expect the demand for environmental quality to increase with per capita income (*GDP*). The urban population share (*URBANPOPsh*) controls for the greater exposure to industrial pollution suffered by citizens in more urbanized countries, and should have a positive effect on regulatory stringency as a result of greater political pressure. However, the marginal effect of both *GDP* and *URBANPOPsh* may be diminishing, consistent with the literature on the environmental Kuznets curve (see, for example, Millimet *et al*., 2003). Quadratic terms are therefore also included. Conversely, *MANUFsh* represents the pressure from workers in the manufacturing sector for lower regulations to protect jobs in the face of increased competition, and is expected to have a negative impact on the stringency of environmental regulations. Since Potters and Sloof (1996) suggest that the effect of lobby group size may be non-monotonic, we include a quadratic term also for *MANUFsh*.

While Equation (17) expresses environmental regulations as a function of FDI, the previous pollution haven literature assumes that the causality between these two variables runs in the opposite direction. To allow for this potential endogeneity, we instrument FDI using 2SLS. To be suitable for use as an instrument, a variable must be correlated with FDI, yet exogenous with regard to *REGS,* requirements which considerably limit the choice of variables. In the first instance we use two such instruments; (i) the growth rate of aggregate GDP (*AGG. GDPgr*.), a variable which is commonly used within the empirical FDI literature to capture the potential dynamism, and hence attractiveness, of a host economy (see, for example, Nigh, 1985; Singh and Jun, 1995) (ii) the economically active population, a variable which captures the size of the host country. It is a well-known empirical observation that small (large) countries tend to be more (less) open to both international trade and investment and hence typically have a greater (smaller) share of trade and FDI in GDP (see, for example, Streeten, 1993). Finally, the exogenous variables from equation (17) are also included as instruments. We use a Sargan test of over-identifying restrictions to assess the validity of our instruments. Note that our sensitivity analysis examines the robustness of our results to the choice of instruments.

Variable Definitions and Data We have data for 33 countries for the period 1982-1992; 13 are OECD and 20 are developing countries. Table A1 in Appendix I provides all data sources.

Our measure of environmental regulations is grams of lead-content per gallon of gasoline, previously used by, for example, Hilton and Levinson (1998) and Damania *et al*. (2003). This variable has a number of features that make it desirable as a measure of industry environmental regulations, although it applies primarily to the transportation sector. In particular, lead content in gasoline has both cross-section and time series coverage which makes it arguably unique amongst suitable measures of environmental regulations.[11] Since Damania *et al*. (2003) report that that lead-content regulation has a statistically significant negative correlation with three other (cross-sectional) measures of industry environmental regulations, we believe it is the most useful measure available for our purposes. We create the *REGS* variable by multiplying the lead content in gasoline variable by –1. Thus, an increase in *REGS* represents an increase in the stringency of regulations (i.e. a decrease in lead content).

While our theory discusses the effect of the number of foreign firms, empirical measures of this variable are unavailable (to our knowledge). We use two different measures of inward FDI: (i) FDI stocks, and (ii) FDI flows (UNCTAD, 2001). Both measures are scaled by aggregate GDP. In our view, our two measures adequately capture the political effects discussed in the theory. While the FDI flow variable captures the political economy effects on *REGS* of new investments made, the FDI stock variable may better capture the overall effect of foreign investment. The stock variable will also partially capture the effects of FDI flows if there is a lag between the investment made and its political effects.

Our measure of corruptibility is the 'government honesty' variable reported by the International Country Risk Guide (see Knack and Keefer, 1995). This variable measures the extent to which 'high government officials are likely to demand special payments' and takes the form of an index between 0 and 6, where 0 represents the least government honesty, and 6 the most. For ease of interpretation, we subtract this index from 6 so that it forms *CORRUPT,* a measure of the lack of honesty, i.e. the degree of corruptibility (corruption). Thus, a higher value of *CORRUPT* represents a higher level of corruptibility. The control variables are defined in Appendix I. Table 1 provides summary statistics.

[11] The attractive features include: (i) the content of lead in gasoline is (almost) entirely a policy decision and is unlikely to be influenced by other factors; (ii) lead emissions are a particularly damaging *local* air pollutant with significant health implications. As a result, the control of such emissions is often an early environmental objective during a country's development.

Results Table 2 reports our fixed-effects (FE) estimates using both stock and flow measures of FDI. While Models (1) and (3) report the OLS results, Models (2) and (4) report the IV (2SLS) estimates. A Hausman specification test indicated that the effects are correlated with the independent variables implying that the random effects results are inconsistent. For this reason, as well as for space considerations, we do not report the random effects results (they are available from the authors upon request). We found no evidence of first-order autocorrelation. A DWH test indicates that OLS yields inconsistent estimates. Thus, our focus will be on the IV results, but we report OLS estimates for completeness. A Sargan test of over-identifying restrictions fails to reject the null that our IV equations are properly specified for the FE results. This would suggest that our instruments are valid. Appendix II reports the first-stage results.[12]

The empirical findings in Table 2 lend support to our theory's predictions. *FDI* has a positive effect on *REGS* in all models, with statistical significance at conventional levels in three of them. Moreover, the interaction variable *FDI*×*CORRUPT* is significant and negative in all models, suggesting that the effect of *FDI* on *REGS* is *conditional* on *CORRUPT*. The F-test on the two FDI terms (which restricts their coefficients to zero) is highly significant in all four models. In order to study the economic and environmental significance of *FDI*, Table 2 also reports the estimated marginal effect of FDI on *REGS* at the mean level of *CORRUPT* for all four models. In particular, estimates are provided for (i) a one unit increase in the FDI stock or flow, and (ii) a one standard deviation increase in FDI. These indicate that the effect of *FDI* on *REGS* is consistently positive at the mean of *CORRUPT*, i.e. the "welfare effect" dominates the "bribery effect." For instance, Model (2) indicates that a unit increase in *FDI* results in a decline of 0.10 (=0.16-(0.025×2.55)) grams of lead per gallon, evaluated at the mean of *CORRUPT*.[13]

Figure 1 illustrates these declining marginal effects for the four models in Table 2. Models (1), (3) and (4) all suggest that the marginal effect of *FDI* on *REGS* becomes negative at within-sample levels of *CORRUPT* of between 2.9 and 4.1. Thus, 3 out of the 4 models produce

[12] First stage Models (A1) and (A4) in Appendix II indicate that *AGG GDPgr* and *GDP* are positive, significant determinant of both FDI stocks and flows, whilst *ECON.ACT.POP., URBANPOPsh* and *MANUFsh* are found to be negative and significant determinants. *CORRUPT* is not statistically significant.

[13] Model (1) indicates that a unit increase in *FDI* results in a decline of 0.011 (=0.029-(0.0071×2.55)) grams of lead per gallon, evaluated at the mean of *CORRUPT*. The effect differs sharply at high levels of *CORRUPT*. At one standard deviation above the mean of *CORRUPT*, the effect equals an *increase* of 0.00025 [=0.029-(0.0071× (2.55+1.57)] grams of lead per gallon of gasoline. Thus, for sufficiently high levels of corruptibility, the "bribery effect" dominates the "welfare effect", consistent with our theory.

a within-sample reversal of signs, as predicted by Proposition 1. To put these values in context, the average level of *CORRUPT* over the period 1982-92 was 2.1 in Italy, 3.2 in Venezuela, 4.2 in Nigeria and 5.7 in Bangladesh. Model (2) (with all relevant coefficients being significant) estimates that the marginal effect becomes negative at an out-of-sample value of 6.4. Thus, Model (2) suggests that FDI raises environmental policy stringency in all countries. In sum, all four models in Table 2 suggest that the effect of *FDI* is lower the greater the level of *CORRUPT*.

The positive marginal effects reported in Table 2 reflect a decline in lead content in gasoline as a result of FDI. The IV analysis for FDI stock suggests a significantly larger effect of *FDI* on *REGS* than do the other three models (although the marginal effect from Model (4) should be interpreted with caution since the *FDI* term is not significant). Model (2) suggests that a one standard deviation increase in the FDI stock raises *REGS* by 0.70, equivalent to a reduction of the lead content in gasoline of 0.70 grams per gallon. This reduction in lead content is equivalent to a decline of 0.71 of a standard deviation. Model (3), on the other hand, suggests that a one standard deviation increase in FDI flows raises *REGS* by only 0.051, equivalent to only 0.052 of a standard deviation.

The estimated overall effect of *CORRUPT* on *REGS* is consistently *negative* in the models reported in Table 2 (as may be expected - see, e.g., Damania *et al*., 2003). Using Model (2) as an example, at the mean level of *FDI*, the effect of a one unit change in *CORRUPT* equals –0.016 (=0.20-(0.025×8.64)), representing an increase in the lead content per gallon of gasoline of 0.016 grams. The FDI flow models yield somewhat greater increases.[14]

With regard to our control variables, *GDP* and GDP^2 exhibit little consistency across models. In contrast, *URBANPOPsh* displays a consistently negative and significant relationship with *REGS*, albeit decreasing at the margin. A closer examination reveals that the (minimum) turning point level of *URBANPOPsh* is 66.6, roughly equivalent to South Korea or Columbia. Thus, for many countries in our sample, our estimates suggest that *REGS* increases with the urban population share in accordance with our prior expectations. *MANUFsh* exhibits a generally positive relationship with *REGS*, which is decreasing at the margin. The (maximum) turning point level of *MANUFsh* is 17.2, broadly equivalent to India or Pakistan. Thus, for many

[14] Note also the effect of *CORRUPT* on *REGS* rises at higher levels of *FDI*. For example, again using Model (2), at one standard deviation above the mean of *FDI*, a unit change in *CORRUPT* yields an effect on *REGS* equal to –0.19 [=0.20-(0.025×(8.64+7.25))]. This is a twelve-fold increase compared to the effect at the mean.

countries in our sample an increase in *MANUFsh* is associated with a decrease in *REGS,* in accordance with expectations.

Sensitivity Analysis To assess the robustness of our results, Table 3 reports eight alternative specifications of equation (17), with Models (5)-(8) relating to FDI stocks and Models (9)-(12) to FDI flows. Models (5) and (9) drop the *URBANPOPsh* and *MANUFsh* variables to ensure that they are not unduly influencing the results.[15] Models (6), (7), (10) and (11) then include these variables individually. The sign and significance of our variables of interest remain consistent with those from our 'full' models in Table 2. Table 3 also reports the effect of a one standard deviation increase in FDI on *REGS*. For FDI stocks (Models (5)-(8)) these marginal effects are broadly consistent in size across models. While for FDI flows (Models (9)-(12)) we see some variation across models, this also reflects the fact that the *FDI* term within these models is not always statistically significant.

Models (8) and (12) assess the sensitivity of our results to our chosen instruments. In these models we use one altogether different instrument, together with alternative measures of the two instruments used previously. Our first new instrument is the rate of inflation, a variable shown to be a deterrent to inward FDI (see, for example, Schneider and Frey, 1985; Singh and Jun, 1995). As an alternative measure of the dynamism of an economy we now use the growth of *per capita* GDP, and as a new measure of the size of a country we use the *total* population.[16] Again, a Sargan test fails to reject the null that our equation is properly specified for both models. Our results reveal little sensitivity to this change of instruments and are similar to the results in Table 2.

As a final check on the robustness of our results, we estimate *dfbetas*. *Dfbetas* measure the difference between each regression coefficient when the *i*th observation is included and excluded, the difference being scaled by the estimated standard error of the coefficient. Bollen and Jackman (1990) argue that an observation is deserving of special attention if $|dfbeta| > 1$, implying that the observation shifted the estimated coefficient by at least one standard error. Across all independent variables, including those within our first stage regressions, we find no

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[15] Appendix II Models (A2) and (A5) provide the first stage results for Models (5) and (9), respectively.

[16] Appendix II Models (A3) and (A6) provide the first stage results for Models (8) and (12), respectively. Of the new instruments, *TOT. POP.* is found to be a negative, significant determinant of FDI stocks and flows, whilst *PC GDP gr.* is found to be a positive determinant. *INFLATION* is of mixed sign and is not statistically significant.

dfbetas that exceed 1. In fact, no *dfbetas* exceed 0.5. We therefore have no evidence to suggest that outliers are exerting undue influence on our estimated coefficients.

V. CONCLUSION

Whereas the theoretical and empirical literature investigates the effects of variations in the stringency of local environmental policies on foreign direct investment, the effects of foreign investment on environmental policy have been ignored. In this paper we take a first step to remedy these deficiencies.

We employ a political economy model of local environmental policymaking. The environmental policy effects of foreign direct investment are found to be conditional on the government's degree of corruptibility. Foreign direct investment leads to a higher (lower) stringency of environmental policy when the degree of local government corruptibility is low (high). Our empirical findings are fully consistent with the predictions of the model.

The results of the paper raise some concerns about the previous empirical literature seeking to uncover "pollution haven" effects, i.e. that foreign firms locate where environmental policies are relatively weak. This literature has largely ignored the fact that environmental policies are endogenously determined, and in particular has not incorporated the environmental policy effects of foreign direct investment discussed in this paper. The present paper may consequently provide some guidance for future empirical efforts in this area.

The policy implications that emerge are that warnings of negative effects of foreign direct investment need to be taken seriously, in particular where the degree of government corruptibility (corruption) among policymakers is high. In such countries, foreign direct investment contributes to the creation of the feared pollution havens. On the other hand, the results are encouraging for countries with relatively low degrees of corruptibility among policy makers. Foreign direct investment may even result in an improved environmental quality in such countries. Our results further reinforce the need for reforms that reduce the level of government corruption (corruptibility) in many countries.

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APPENDIX I

Table A1. Data Definitions and Sources

Variable	Definition	Source
REGS	Lead content of gasoline, multiplied by –1 to form an index of environmental regulations	Octel's Worldwide Gasoline Survey (various years)
CORRUPT	'Government honesty' subtracted from 6 to form an index of corruption from 0 to 6	Knack and Keefer (1995)
FDI	Inward FDI stocks and flows, divided by aggregate GDP	UNCTAD FDI Database (2001)
GDP	Per capita income	World Development Indicators (2002)
URBANPOPsh	Share of the population living in urban areas	World Development Indicators (2002)
MANUFsh	Manufacturing value added as a share of GDP	World Development Indicators (2002)
AGG.GDP gr.	Aggregate GDP growth rate	World Development Indicators (2002)
PC.GDP gr.	Per capita GDP growth rate	World Development Indicators (2002)
INFLATION	Inflation rate	World Development Indicators (2002)
ECON.ACT.POP.	Economically active population	World Development Indicators (2002)
POP	Total population	World Development Indicators (2002)

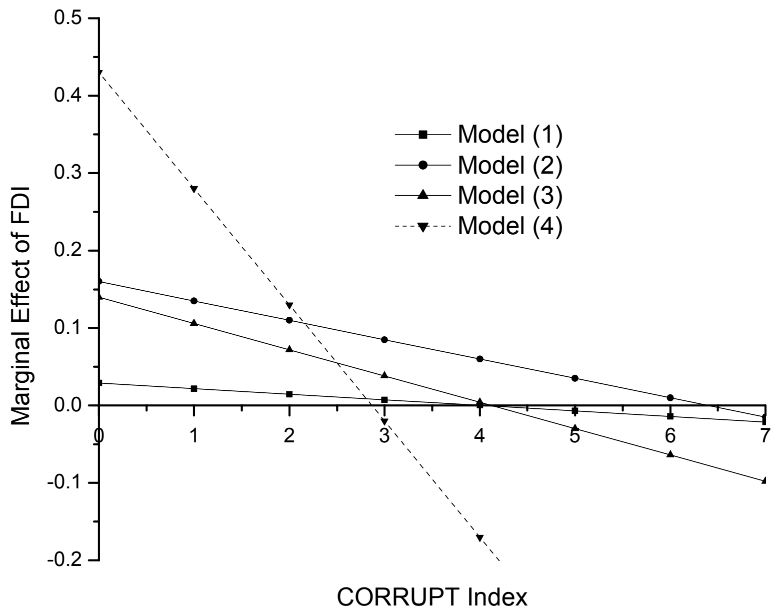
APPENDIX II

Table A2. First Stage FDI Equations

	(A1) FDI STOCK Used in Model (2)	**(A2) FDI STOCK** Used in Model (5)	**(A3) FDI STOCK** Used in Model (8)	**(A4) FDI FLOW** Used in Model (4)	**(A5) FDI FLOW** Used in Model (9)	**(A6) FDI FLOW** Used in Model (12)
AGG. GDP gr.	0.043*	0.060**		0.018**	0.014*	
	(1.7)	(2.3)		(2.3)	(1.8)	
ECON.ACT.POP.	-0.42***	-0.46***		-0.071***	-0.061***	
	(6.1)	(7.2)		(3.5)	(2.8)	
PC GDP gr.			0.038			0.020**
			(1.4)			(2.4)
INFLATION			-0.00011			0.00038
			(0.4)			(0.3)
TOT. POP.			-0.28***			-0.49***
			(4.9)			(3.5)
CORRUPT	0.21	0.76***	0.19	0.044	0.060*	0.040
	(1.1)	(4.2)	(1.0)	(1.2)	(1.6)	(1.1)
GDP	0.62**	0.22	0.60**	0.14**	0.12**	0.15**
	(2.6)	(0.9)	(2.4)	(2.2)	(2.0)	(2.3)
GDP^2	-0.013***	-0.0079**	-0.012***	-0.0026	-0.0024***	-0.0027***
	(3.7)	(2.1)	(3.5)	(-2.9)	(2.9)	(3.0)
URBANPOPsh	-0.64***		-0.65***	0.16***		0.16***
	(4.3)		(4.2)	(3.4)		(3.5)
$URBANPOPsh^2$	0.0033**		0.0033**	-0.0014***		-0.0014***
	(2.6)		(2.5)	(3.7)		(3.8)
MANUFsh	-1.11***		-1.10***	-0.13***		-0.13***
	(5.9)		(5.8)	(3.2)		(3.2)
$MANUFsh^2$	0.031***		0.030***	0.0031***		0.0030***
	(7.3)		(7.2)	(3.2)		(3.2)
Observations	353	353	353	353	353	353
R^2	0.35	0.25	0.36	0.31	0.25	0.31

Notes: Absolute value of t-statistics in parentheses. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level. Models with *URBANPOPsh* and *MANUFsh* omitted individually, which were used to estimate models (6), (7), (10) and (11), are not reported for reasons of space.

Figure 1. The Marginal Effect of *FDI* on *REGS* conditional on *CORRUPT*



Notes: Marginal effects are calculated using Models (1)-(4), Table 2.

Table 1. Summary Statistics

	Mean	S.D.	Minimum	Maximum
CORRUPT	2.55	1.57	0	6
REGS	-1.78	0.98	-3.98	0
FDI Stock	8.64	7.25	0.31	33.2
FDI Flow	0.82	0.95	-1.29	7.92
GDP	7.83	9.65	0	41.35
URBANPOPsh (%)	55.28	25.30	11	97
MANUFsh (%)	19.61	7.15	3.61	34.56
TOTAL POP. (mn)	67.48	134.40	8.41	882.30
ECON. ACTIVE POP. (mn)	40.09	79.04	4.52	525.00
AGG. GDP growth	3.19	3.93	-13.13	13.29
PC GDP growth	1.51	3.94	-15.80	11.41
INFLATION	57.44	275.24	-9.81	3079.81

Table 2. Fixed Effects Results for FDI Stocks and Flows

	(1) FDI STOCK FE, OLS	(2) FDI STOCK FE, IV	(3) FDI FLOW FE, OLS	(4) FDI FLOW FE, IV
FDI	0.029***	0.16*	0.14**	0.43
	(3.1)	(1.8)	(2.2)	(1.4)
CORRUPT	0.0087	0.20***	-0.029	0.056*
	(0.3)	(3.2)	(1.1)	(1.6)
*FDI*CORRUPT*	-0.0072**	-0.025***	-0.034*	-0.15***
	(2.6)	(4.1)	(1.8)	(3.9)
GDP	-0.038	-0.11	-0.020	-0.067
	(0.7)	(1.3)	(0.4)	(0.9)
GDP^2	-0.00093	0.00021	-0.0012*	-0.0062
	(1.3)	(0.1)	(1.6)	(0.6)
URBANPOPsh	-0.16***	-0.14**	-0.18***	-0.23***
	(5.3)	(2.2)	(6.1)	(3.6)
$URBANPOPsh^2$	0.0012***	0.0013***	0.0014***	0.0018***
	(4.9)	(3.1)	(5.2)	(3.3)
MANUFsh	0.10**	0.14	0.090**	-0.0068
	(4.9)	(1.3)	(2.1)	(0.1)
$MANUFsh^2$	-0.0029***	-0.0041	-0.0025***	-0.00036
	(3.0)	(1.5)	(2.7)	(0.3)
Observations	353	353	353	353
R^2	0.40	0.48	0.39	0.47
F-test FDI	9.6	21.1	4.8	15.5
(*p* value)	(0.008)	(0.000)	(0.09)	(0.000)
Sargan test		0.34		0.041
(*p* value)		(0.56)		(0.84)
DWH endog. test	94.8		63.6	
(*p* value)	(0.00)		(0.02)	
$\frac{\partial REGS}{\partial FDI}$	0.011^{+}	0.10^{+}	0.053^{+}	0.047
$\frac{\partial REGS}{\partial FDI} * s.d.$	0.080^{+}	0.70^{+}	0.051^{+}	0.045

Notes: Absolute value of t-statistics in parentheses. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level. Marginal effects are calculated at the sample means of *CORRUPT*. s.d. = standard deviation. $^{+}$ indicates a marginal effect stemming from a model in which both FDI terms are significant at the 10% level.

Table 3. Sensitivity Analysis

	(5) FDI STOCK FE, IV	(6) FDI STOCK FE, IV	(7) FDI STOCK FE, IV	(8) FDI STOCK FE, Alt. IV	(9) FDI FLOW FE, IV	(10) FDI FLOW FE, IV	(11) FDI FLOW FE, IV	(12) FDI FLOW FE, Alt. IV
FDI	0.14*	0.16**	0.15*	0.18**	0.28	0.60	0.010	0.58*
	(1.7)	(2.2)	(1.7)	(2.1)	(0.6)	(1.5)	(0.3)	(1.7)
CORRUPT	0.13	0.15**	0.21***	0.20***	0.073*	0.052	0.091***	0.051
	(1.6)	(2.3)	(3.2)	(3.2)	(1.7)	(1.1)	(2.5)	(1.4)
*FDI*CORRUPT*	-0.019***	-0.023***	-0.024***	-0.025***	-0.11***	-0.16***	-0.11***	-0.16***
	(3.3)	(4.2)	(4.0)	(4.1)	(2.6)	(3.8)	(2.6)	(3.7)
GDP	-0.00089	-0.10	-0.034	-0.13	0.017	-0.087	0.059	-0.093
	(0.1)	(1.3)	(0.4)	(1.5)	(0.3)	(0.9)	(1.2)	(1.2
GDP^2	-0.0010	0.00042	-0.00082	0.00056	-0.0016	-0.00027	-0.0023***	-0.00019
	(0.9)	(0.3)	(0.6)	(0.4)	(1.3)	(0.2)	(2.9)	(0.2
URBANPOPsh		-0.16***		-0.12*		-0.25***		-0.25**
		(3.8)		(1.8)		(3.0)		(3.8)
$URBANPOPsh^2$		0.0016***		0.0012***		0.0020***		0.0019***
		(4.6)		(2.8)		(2.8)		(3.4
MANUFsh			0.15	0.16			0.033	0.014
			(1.6)	(1.5)			(0.5)	(0.2
$MANUFsh^2$			-0.0045*	-0.0048*			-0.0013	-0.00081
			(1.8)	(1.7			(0.7)	(0.6
Observations	353	353	353	353	353	353	353	353
R^2	0.44	0.48	0.46	0.48	0.43	0.46	0.44	0.42
F-test FDI vars.	16.3	22.7	19.7	21.3	7.75	17.0	8.2	16.2
(*p* value)	(0.000)	(0.000)	(0.000)	(0.000)	(0.02)	(0.000)	(0.02)	(0.000)
Sargan Test	0.57	1.24	0.086	3.2	0.0020	0.055	0.22	4.3
(*p* value)	(0.45)	(0.27)	(0.77)	(0.19)	(0.96)	(0.81)	(0.63)	(0.11)
$\frac{\partial REGS}{\partial FDI} * s.d.$	0.66^{+}	0.73^{+}	0.64^{+}	0.84^{+}	-0.00048	0.18	-0.26	0.17^{+}

Notes: Absolute value of t-statistics in parentheses. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.
The F-test is a test of the joint significance of the FDI variables. Marginal effects are calculated at the sample means of *CORRUPT*. s.d. = standard deviation. $^{+}$ indicates a marginal effect stemming from a model in which both FDI terms are significant at the 10% level. Models (8) and (9) use alternative instruments.