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Environmental Regulation and French Firms Location Abroad: an Economic Geography Model in an International Comparative Study

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Environmental Regulation and French Firms Location Abroad: an Economic Geography Model in an International Comparative Study

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1 Abstract

2 In this study, we re-examine the pollution haven hypothesis by a fresh take on both its theoretical and empirical aspects.
3 The originality of our work is twofold. First, we apply an economic geography model with the aim of deriving a rigorous
4 specification for the impact of environmental regulation on firms' location choice. Second, we test a conditional logit
5 model using French firm-level data in an international comparative study. We confirm evidence of a strong pollution
6 haven effect for our pooled sample of countries receiving French direct investments. However, through a sensitivity
7 analysis, we validate this finding for developed countries and most of emerging economies and Central and Eastern
8 European countries, but not for most Commonwealth of Independent States and developing countries, where a more
9 stringent environmental regulation seems to attract investments. Furthermore, we highlight a forward looking behavior
10 of firms, in terms of when deciding to locate in a country.

11 **Keywords:** FDI; Economic geography; Environmental regulation; Pollution havens.

12 **JEL classification:** F12; F18; Q28.

13 **1. Introduction**

14 Environmental regulation has notably been put in evidence by Copeland and Taylor (2004) through a simple model of
15 specialization and trade, according to which the rich countries that protect their environment, should abandon their
16 polluting activities to developing countries, whose environmental legislation and enforcement are not severe. This
17 statement illustrates the commonly studied "pollution haven hypothesis (PHH)".

18 Generally, statistical studies show that the PHH cannot be clearly identified. Four potential problems in this literature
19 require more empirical tests. First of all, most studies lack theoretical foundations for the construction of the equations to
20 be tested, which often entails specification errors. Secondly, the absence of relative endowments of production factors in
21 the explanation of foreign direct investment (FDI) can lead to omitted variable bias (Zhang and Markusen, 1999; Cheng
22 and Kwan, 2000). Next, several studies use very aggregated data on FDI and proxies of the severity of the
23 environmental policy that are far off the real variable to be taken into account, which generally results in bias induced
24 from measurement-error (Smarzynska and Wei, 2004). Finally, Keller and Levinson (2002) and Levinson and Taylor
25 (2008) emphasize the empirical importance of controlling for the unobservable characteristics of industries and
26 locations.

27 In this study, we consider these various limits and try to remedy them. We present a classic theoretical model of
28 economic geography, which supplies us a log-linearized specification for the determinants of firms' location choice,
29 among which we distinguish the impact of the environmental regulation. As far as we know, at the moment, there is
30 broadly no international empirical study on the PHH based on a theoretical model of economic geography. An exception
31 is Jug and Mirza (2005), where authors derive a structural gravity equation to show that environmental regulation is a
32 determinant of trade flows. However, authors focus on European countries only. Otherwise, economic geography models
33 have been used in purely theoretical works (Conrad, 2005; Rauscher, 2005; Van Marrewijk, 2005), while the existing
34 empirical studies on the PHH are most often based on standard international trade models. For the empirical work, we
35 use firm-level data on French firms locating in heterogeneous countries. Most of studies in related literature focus on
36 FDI locating in a single country, mainly in the United States, while only a few have attempted to examine this
37 hypothesis for other countries (Smarzynska and Wei, 2004; Dean et al., 2009). However, the actual debate on the reality
38 of pollution havens mainly concerns international issues: the fear that less regulated, poorer countries become pollution
39 havens for polluting firms from more regulated, developed countries. Hence, the novelty of this study lies on its
40 relevancy in the international debate regarding pollution havens, since it assesses the impact of environmental regulation

41 on FDI in different countries. In order to take into account the specific characteristics of countries, the empirical
42 estimations are performed controlling for different country groups (high-income Developed countries, Emerging
43 countries, Transition CEEC, Transition countries of CIS, and Developing countries). As regards the specific
44 characteristics of industries, the estimation methods used control for firms and industry specific effects. We use the
45 conditional logit model, which is a proven estimation method in the literature on location choice, providing high
46 precision on estimated effects. Finally, to represent the environmental regulation's stringency, we create a complex and
47 dynamic index, which assesses the relative severity of the environmental policy across countries.

48 **2. Review of the literature**

49 One of the earliest articles on the PHH is Grossman and Krueger (1993) work, whose objective was to assess the
50 environmental impacts of the North American Free Trade Agreement. Examining the impact of American industries'
51 pollution abatement costs on the pattern of trade and investment between United States and Mexico, the authors show
52 that traditional economic determinants of trade and investment were very important, while cross-industry differences in
53 pollution abatement costs on U.S. imports from Mexico appeared to be small and statistically insignificant. They
54 conclude that differences in the abatement costs do not play a significant role due to the weak weight of environmental
55 costs comparatively to more considerable production costs.

56 Since then, articles on this subject followed without a consensus being established, while concerns abound over the
57 effects of environmental standards on trade flows and FDI. Series of scientific studies did not manage to validate the
58 assumption that environmental regulation affects trade or firms' investment decisions (e.g., Jaffe et al., 1995; Wheeler,
59 2001; Raspiller and Riedinger, 2008). To deal with the ambiguous results found in the literature, Jeppesen et al. (2003)
60 investigate, through a meta-analysis of 11 studies, how the characteristics of empirical studies (empirical specification,
61 data, definition of regulatory variable and other control variables) influence the empirical results of the environmental
62 regulation impact on firms' location decision. Their results show that foreign firms are more sensitive to environmental
63 regulations than domestic ones. They also indicate a larger impact of regulation when smaller geographical area is
64 considered in the study and highlight the importance of taking into account the heterogeneity of firms. Ederington et al.
65 (2005) also explain partially why previous studies did not confirm the PHH. They recall that international trade is
66 essentially made between developed countries, whose regulation is quite similar. Nevertheless, if one examines only the
67 flows between industrial nations and developing countries, the environmental standards have more pronounced effects
68 on the trade structure: with the strengthening of the environmental regulation of the United States (US), imports from

69 developing countries decrease. In fact, Ederington et al. (2005) notice that polluting industries are generally the least
70 mobile geographically and thus, it becomes more expensive to establish production in countries that apply a less
71 rigorous regulation. In another attempt to search for the PHH, Kahn (2003) tests whether the greatest dirty US trade
72 growth has taken place with poorer non-democratic countries. The author shows that poor nations and non-democratic
73 nations are not major exporters of pollution intensive goods to the United States.

74 Most of papers in this field use data on trade flows while studying PHH. Some relatively more recent papers examine
75 PHH by using data on FDI. Eskeland and Harrison (2003) study the effect of the abatement cost and pollution intensity
76 on FDI in Morocco, Cote d'Ivoire, Venezuela and Mexico, and find essentially no empirical support for the PHH.
77 Besides, they find that the US factories are more efficient in terms of energy use and employ "cleaner" types of energy
78 than the domestic plants. In a group of 24 transition countries, Smarzynska and Wei (2004) find a relatively weak
79 evidence for pollution havens. Dean et al. (2009) find that a less stringent regulation is a significant determinant for
80 Chinese villages' attractiveness for joint ventures in highly polluting industries and with partners from Hong-Kong,
81 Macao and Taiwan. On the contrary, investors from industrial nations are not affected by higher standards, regardless of
82 the industry pollution intensity. The authors suggest that this result could be explained by technological differences.

83 Other studies assert that environmental regulation influences the spatial allocation of capital. List and Co (2000),
84 employing a conditional logit model and using four measures of regulatory stringency, show that heterogeneous
85 environmental policies across states affect foreign multinational corporations' new plant location decisions. Another
86 seminal paper in this literature is that of Keller and Levinson (2002), which uses panel data on inward FDI flows in the
87 US over a long period of time and employ an innovative measure of the relative abatement costs across the States. By
88 applying standard parametric models on panel data, the authors find a robust result showing that abatement costs have
89 moderate dissuasive effects on FDI. However, List et al. (2003b), by using a semi-parametric propensity score matching
90 estimator allowing them to take advantage of the panel nature of data to control for time- and location-specific
91 unobservables, suggest that the existing literature based on parametric estimates understates the impact of pollution
92 regulations. Similarly, empirical results of List et al. (2003a) from models using both parametric and semi-
93 nonparametric specifications on US county level panel data show that air quality regulations influence the destination
94 choice of relocating plants. However, when using a semi-parametric propensity score matching estimator while
95 comparing the location decisions of foreign and domestic firms in the New York State, List et al (2004) find that only
96 domestic firms are sensitive to the stringency of environmental regulation. Moreover, their empirical results point out to

97 a double-dividend from foreign investments: foreign plants induce economic development and are not unreasonably
98 influenced by environmental regulation. More recently, the application to Keller and Levinson data of newly developed
99 non parametric techniques (Henderson and Millimet, 2007) reveals two results: first, some of the parametric results are
100 not robust, and second, the impact of relative abatement costs is generally of a smaller magnitude than previously
101 suggested. At the opposite, Wagner and Timmins (2009), using panel data on outward FDI flows of various industries in
102 the German manufacturing sector, accounting for externalities associated with the FDI agglomeration effect and
103 employing a GMM estimator to control for endogenous time-varying determinants of FDI flows, find robust evidence of
104 a pollution haven effect for polluting chemical industry.

105 Finally, Cole et al. (2006) show the existence of an inverse relationship between FDI and environmental regulation: it is
106 FDI that influences the environmental policy, but this effect is a function of the degree of corruption in the host country.

107 In conclusion to this section, we recall Taylor (2004) who suggested that empirical work on the PHH had for a time been
108 misleading because researchers were regularly considering a pollution haven effect (PHE) while analyzing the PHH. The
109 common view in the related literature is that the PHH is a stronger version of the PHE. According to Copeland and
110 Taylor (2004), the PHE states that differences in environmental regulation affect, at the margin, plant location decisions
111 and trade flows. The PHH, on the other hand, predicts that under free trade, relocation of pollution-intensive production
112 from countries with stringent environmental regulation, usually developed countries, to countries with lax regulation,
113 usually developing countries, takes place because environmental regulation acts as the prevailing determinant factor in
114 the location decision of polluting firms. The theoretical support for PHH is quite weak compared to PHE, since trade and
115 FDI theory suggests that many other factors, in addition to environmental regulation, affect trade and FDI flows. Making
116 a distinction between these two notions and using an empirical model applied to cross-sectional data on 16
117 manufacturing industries from 13 European countries, Mulatu et al. (2010) find support for a PHE but fail to validate the
118 PHH. The authors show, however, that when the most polluting industry is considered, increased environmental
119 regulatory laxity of a country does result in a higher proportion of this dirty industry locating in that country. Mulatu et
120 al. (2010) also suggest that their results should be further explored by examining the endogeneity of environmental
121 policy in their framework and using panel data for more robust estimations. Kellenberg (2009) is one of the few
122 researchers who find robust and consistent evidence of the PHE once the endogeneity of environmental stringency is
123 taken into account. Moreover, Kellenberg (2009) shows evidence that enforcement of environmental policies is a more
124 deterrent factor than the stringency of the environmental regulation.

3. Theoretical background and empirical strategy

3.1. Theoretical assumptions

The theoretical frame of our model is based on the classic hypotheses of the New Economic Geography. We use as theoretical background the model developed by Head and Mayer (2004) that we extend by considering pollution as a third production factor, together with labor and capital, and assuming that firms' marginal costs of production have two components: one "internal" and another "external".

General assumptions of this economic geography model are: small open economies with two sectors - agriculture and industry; the first sector produces under Walrasian conditions a homogeneous good that is traded costless, and the second produces a continuum of differentiated goods, called varieties h , under increasing returns to scale in an environment of monopolistic competition; each firm produces a distinct variety, with $\sigma > 1$ the elasticity of substitution between two varieties; the shipping of these varieties towards another country implies "iceberg" transport costs, τ .

Following Head and Mayer (2004), we can write the gross profitability U of a firm h located in country i and trading with any country j :

$$U_i(h) \equiv \ln MP_i - (\sigma - 1) \ln c_i(h) \quad (1)$$

with $MP_i = \sum_j \varphi_{ij} (\mu E_j / G_j)$ - the Krugman Market Potential (see next sub-section for details), $\varphi_{ij} = \tau_{ij}^{1-\sigma}$ - a measure of "freeness of trade", $G_j = \sum_i n_i (c_i(h) \tau_{ij})^{1-\sigma}$ - expresses competition from firms located in other countries, E_i is the total expenditure in any country j , μ is the share of E that is spent for the consumption of differentiated goods, and $c_i(h)$ is the marginal cost of producing a variety h in the country i .

The location decision is thus determined by the comparison of locations' market potentials and the firm's marginal costs of production in these locations.

In our model, there are three production factors: labor, capital and pollution. One of the most common forms used to represent the cost function is that of Cobb-Douglas with constant returns: $c = (1/A) w^\alpha r^\beta t^\theta$, where $\theta = 1 - (\alpha + \beta)$ and w , r and t are costs of labor, capital and pollution, respectively. The share of labor in the firm's production process is denoted α , the share of capital β and finally that of pollution is θ , whereas A represents the total factor productivity. Moreover, a number of external factors can affect marginal cost and its applicability to real world

150 problems. These may include social norms, judicial corruption, information asymmetries, presence of negative
 151 externalities, transaction costs, price discrimination and other market failures. Consequently, we can rewrite the firm's
 152 marginal cost as follows:

$$153 \quad c = \frac{1}{A} w^\alpha r^\beta t^\theta \Omega \quad (2)$$

154 with the positive parameter $\Omega \geq 1$; $\Omega > 1$ implies an "external" cost to the firm in the presence of market failures
 155 affecting the firm's "internal" (theoretical) marginal cost associated to production $((1/A) w^\alpha r^\beta t^\theta)$. With $\Omega = 1$, the
 156 firm doesn't face any external factor influencing its "internal" marginal cost.

157 With these last assumptions we can rewrite equation (1) in the following way:

$$158 \quad U_i(h) \equiv \ln MP_i + (\sigma - 1) \ln A_i - \alpha(h) (\sigma - 1) \ln w_i - \beta(h) (\sigma - 1) \ln r_i - \theta(h) (\sigma - 1) \ln t_i - (\sigma - 1) \ln \Omega_i \quad (3)$$

159 The equation (3) predicts that the profitability of a firm h settled in a country i is an increasing function with regard to
 160 the market potential and the global factor productivity in country i , and decreasing with regard to production factor costs
 161 and market failures. This specification represents the theoretical background for our following empirical work.

162 **3.2. Empirical strategy**

163 **3.2.1. A location choice model: the conditional logit**

164 In this paper, we seek to study the factors determining a specific firm single location choice between some unordered
 165 alternatives. Each subsidiary h chooses country i where it will locate. An unordered choice model particularly well
 166 adapted to our theoretical framework is the model developed by McFadden in 1974, i.e., the conditional logit (firm
 167 fixed-effects logit model).

168 The conditional logit is a discrete choice model based on profit maximization. In such a model, each firm compares the
 169 profits related to different location alternatives, and selects, among the N alternatives, the location i that will maximize
 170 its profit $\pi_i(h)$.

171 In our example, for a French firm h facing N alternatives, the profitability of choosing i , $i \in N$, can be written:

$$172 \quad \pi_i(h) = \beta' Z_i + \varepsilon_i(h) \quad (4)$$

173 with Z_i a vector of independent variables that vary between location alternatives, β the vector of estimated parameters
 174 and $\varepsilon_i(h)$ a random error term, which corresponds to unobserved variables related to location i and affecting the choice
 175 of firm h .

176 Each French subsidiary h , faced with N alternatives, will choose to locate in country i if the expected profit $\pi_i(h)$
 177 exceeds the expected profits $\pi_j(h)$, for all $j \in N$ alternative locations.

178 The model is made operational for a particular choice of distribution for the disturbances. Let Y_h be a random variable
 179 that indicates the choice made. Following McFadden, if and only if the N disturbances are independent and identically
 180 distributed with Weibull distribution, the probability that firm h chooses location i is given by:

$$181 \quad Pr(Y_h = i) = \frac{\exp(\beta' Z_i)}{\sum_{j=1}^N \exp(\beta' Z_j)} \quad (5)$$

182 This intuitive formulation of the conditional logit model presents nevertheless some limits due to the assumption
 183 concerning the disturbances, which implies the property of Independence from Irrelevant Alternatives (IIA). According
 184 to the IIA property, the likelihood of making a choice is independent of the other alternatives. In practice, this
 185 assumption could be problematic. In order to mitigate this problem, in addition to the explanatory variables, we
 186 introduce in our econometric specification dummy variables representing five different country groups forming our
 187 sample. With the assumption that the error terms are correlated only within country groups and not across groups, the
 188 dummy variables (defined in section 4) should capture this correlation and reduce the IIA problem (see Head et al.,
 189 1995, for a similar technique).

190 **3.2.2. Data description**

191 Dependent variable: the location choice

192 Data concerning French firms location choice have been gathered from the Subsidiaries-Survey, conducted by the
 193 French Directorate of Treasury and Economic Policy in 2002. This Department collects the census of French
 194 subsidiaries, defined as units whose capital is owned by a French parent company by at least 10%. The best records in
 195 this survey, with no missing points, concern for each subsidiary three variables used in our study: the French
 196 classification NAF93 code of the subsidiary's sector, the host country and the year the location choice was undertaken.

197 Since we estimate our location model through a conditional logit, other characteristics of firms (e.g. size, age, etc.) for
 198 which we do not have sufficient information will be captured by the firm-fixed effects implied by such kind of models.

199 We concentrate on the manufacturing industry, excluding the two-level NAF93 code DF "Coke, Petroleum Refining and
 200 Nuclear Industry" that corresponds to specific sectors whose location determinants are beyond the scope of this study.
 201 Our empirical sample covers 1374 French investments in 74 countries from 1996 to 2002¹.

202 Explanatory variables

203 As shown by our theoretical model, the profitability of a location for a firm depends on the market potential of the
 204 location and the firm's marginal cost of production, the latter being a function of the total factor productivity, the
 205 production factor costs and market failures.

206 The **market potential** is a general concept regarding the impact of demand on firms' location. GDP of the host country
 207 and its population are the most commonly used proxies for demand variables, but they are very partial. In this study we
 208 use the concept of market potential of a location, introduced by Harris (1954) and validated then by its deduction from
 209 the standard model of the new trade theory, such as presented in equation (1) (Krugman, 1992; Head and Mayer, 2004).
 210 Analyzing the determinants of French firms' location choice, it seems essential to consider, besides the distance,
 211 additional trade costs induced by crossing borders and sharing or not a common language, while estimating the market
 212 potential of all possible destinations. Following Redding and Venables (2004) and Head and Mayer (2004), we build a
 213 measure of market potential (*MP*) that aggregates the local demand and the demands emanating from nearby markets,
 214 while taking into account the effect of demand's depreciation due to obstacles related to shipping goods in space and
 215 across borders.

216 Since there is no available data on the **total factor productivity (TFP)** across countries, we use two proxies: per capita
 217 GDP (*GDPcap*), which is a commonly used variable for productivity approximation, and the estimated TFP growth
 218 (*TFP_growth*), capturing hence simultaneously cross country differences in TFP levels and growth, respectively. For
 219 *TFP_growth* construction, we apply a "Growth Accounting" calculation method, following the technique developed by
 220 Solow (1956) to calculate the rate of technological progress.

221 Following our theoretical model, the **marginal cost** of production faced by a firm is a function of *labor*, *capital* and
 222 *environmental* costs.

¹ List of countries in Appendix A.

223 In our study, we capture *labor* and *capital costs* through the often used "countries' relative endowments in production
 224 factors" proxy, represented by the variable *KL*. *KL* is the ratio K/L, with K the capital stock and L the total labor force.

225 The most complex cost to be represented is the *environmental cost*, for which a direct measure does not exist.
 226 Researchers make use of a large set of indicators to address the environmental cost: GNI/cap (Antweiler et al., 2001),
 227 multilateral environmental agreements (MEAs)' ratification (Smarzynska and Wei, 2004), INGOs density and
 228 stringency of air pollution standards (Esty and Porter, 2001), etc. These variables are supposed to capture the
 229 environmental regulation stringency of a location. However, some of them are too narrow and don't encompass all
 230 environmental areas (e.g. stringency of air pollution standards), whereas others are too broad and capture many other
 231 development dimensions (e.g. GNI/cap). These two limits point out to a more general shortcoming of using one or
 232 several of those variables separately. For instance, some countries may have a small number of MEAs, but strict air
 233 pollution standards. The use of one variable rather than the other in the regression would give an incomplete vision of
 234 the local environmental regulation. Similarly, if variables are not grouped together in an aggregate indicator, even their
 235 simultaneous introduction in one regression may conduct to misled interpretations, due to the specific meaning of each
 236 one. Hence, while mentioned studies use a single proxy variable to represent the stringency of environmental regulation,
 237 we adopt a different approach and construct an index comprising a set of most used proxies in order to encompass the
 238 general environmental policy context of countries. Our approach is consistent with a number of studies, which, for
 239 similar concerns, make use of specific aggregate indicators for environmental regulation stringency. For example,
 240 Mulatu et al. (2010) use a new variable computed as "one minus the WEF's *Environmental Sustainability Index*";
 241 Damania et al. (2004) use the *2001 Stringency of Environmental Regulation Index* developed by the WEF based on a
 242 questionnaire addressed to approximately 2000 businessmen of about sixty countries; Dasgupta et al. (2001) evaluate the
 243 environmental policy in the agricultural sector of 31 countries for the year 1990, using a quantified analysis of reports
 244 prepared for the United Nations Conference on Environment and Development; Cagatay and Mihci (2003) use the
 245 *Environmental Sensitivity Performance Index* built on the basis of OECD's pressure, state and response indicators, etc.

246 We thus compute for each country in our sample a global *Environmental Regulation (ER)* index following the
 247 techniques of Z-score² and Principal Component Analysis (PCA). Since the Z-score method is commonly used for

² We first calculate for each variable and year, the distance between each country's value and the mean of the group expressed in standard-errors, following the formula: $z = \left(X_{jt} - \bar{X}_t \right) / \sigma_t$. We obtain values that allow classifying the countries below or above

248 computing aggregate indexes, while PCA analysis is rather used in data description and for a reduction of data
 249 dimensionality, we retain Z-score *ER* index for our core analysis and use PCA *ER* index in a robustness test. Our *ER*
 250 index integrates three variables, which have the advantage of permitting cross national comparisons in a systematic and
 251 quantitative fashion:

- 252 • *MEAs ratified*: this variable distinguishes countries that ratified several international environmental agreements,
 253 proving this way their governments' concern about environmental protection.

254 However, if we only use the MEAs variable as the environmental proxy without controlling for other aspects of
 255 the environmental policy, it might capture in this case the state's willingness to keep reliable relationships on
 256 the international arena, which is usually favorable for FDI, rather than the country's direct concern on
 257 international, and much less domestic, environmental compliance.

- 258 • *International NGOs (INGOs' members per million of population)*: as mentioned by Dasgupta et al. (2001) and
 259 Smarzynska and Wei (2004), international NGOs make local population sensitive to environmental problems,
 260 and also put pressure on governments to respect laws. Despite some particular cases where specific firms
 261 benefit from INGOs, which provide them a support to face environmental costs, a large presence of INGOs is
 262 supposed to be associated with high environmental cost. Indeed, anecdotal evidence suggests that INGOs
 263 contribute to the enforcement of regulation or even substitute for governments when they fail in addressing
 264 environmental problems in an effective way. For illustration, we can cite the examples of the Environmental
 265 Control Agency (Bapedal) established in 1990 in Jakarta (Indonesia) to enforce industrial pollution regulations,
 266 and, at the international level, the founding in 1993 of the Forest Stewardship Council scheme for an
 267 environmentally and socially sustainable harvesting.

- 268 • *Energy efficiency (GDP/ unit of energy used)*: we use this output indicator variable to assess the environmental
 269 regulation effectiveness, following Cagatay and Mihci (2003) who use similar quantitative indicators. Our
 270 variable is based on physical unit of energy used to net out the effect of the relative energy prices due to
 271 geographical advantages and abundance of some fossil energies. We also control for latitude when constructing
 272 this variable, since relative energy use may be influenced by cross-country differences in average temperatures.

273 One can suggest using the energy costs across countries as a direct measure of environmental costs faced by

the mean. Then, we calculate the unweighted average of all variables' Z-scores, before applying the standard normal percentile technique which gives the value "0" to the least average Z-score and "100" to the highest.

274 firms. However, despite the fact that considering this variable would restrict environmental costs to energy
 275 issues, the weak availability of related data provided by a few databases (IEA or Enerdata) prevents us from
 276 focusing on energy costs. Nevertheless, we perform in Section 5 a robustness test considering energy costs.

277 Table 1 presents correlations between the three component variables of the ER index, the ER index and the per capita
 278 GDP. Some component variables are well correlated, while others have a smaller correlation coefficient. This lends
 279 support to our argument that the ER component variables measure each one a distinct aspect of the environmental
 280 regulation, and taken together they represent the overall environmental policy stringency. Moreover, the correlation
 281 between per capita GDP and the ER index indicates that the two variables are correlated, but not in such a way that
 282 would prevent ER index of capturing the proper effect of the environmental regulation stringency.

283 *- Table 1 here -*

284 It is a common view to consider that the stringency of the environmental regulation could be correlated with countries'
 285 development level. Indeed, Figure 1 shows a positive correlation between per capita GDP and our ER index. However,
 286 we observe that a level of economic development could be consistent with disparate levels of environmental regulation.
 287 Hence, this confirms that our ER index should capture in the regressions a proper environmental effect distinct from the
 288 effect of economic development, especially as the latter should also be controlled by the per capita GDP introduced
 289 above as a proxy for TFP.

290 *- Figure 1 here -*

291 Another theoretical assumption of our model is the existence of **market failures** that may affect the marginal production
 292 cost, e.g. judicial corruption and malpractice, deficient social norms, high transaction costs, information asymmetries.
 293 These are usually associated to the quality of governance in a country. Indeed, bad governance generates additional costs
 294 and creates a feeling of insecurity among investors, especially in developing countries or transition economies where
 295 governance failings are rather frequent. We use two governance indicators developed by Kaufmann et al. (2005): the
 296 corruption level (*CORRUP*)³ and the government regulatory quality (*REGULQUAL*). Moreover, we include a third
 297 variable capturing quality of doing business in a country, a variable *FREE* taking value "1" for countries considered by
 298 the Freedom House Organization as to be free according to their political rights and civil liberties of citizens, and "0"

³ *CORRUP* is the inverse of the original Kaufmann index which reflects the control of corruption in states. A higher value means a worse governance outcome.

299 otherwise.

300 We also add to the base variables defined by the theoretical model, a dummy variable controlling for the existence of a
 301 preferential trade agreement between host countries and France (*PTA*) and a dummy (*COL45*) controlling for ex-colonial
 302 relationships between France and potential FDI locations.

303 Appendix C presents descriptive statistics for the independent variables and information about the data.

304 4. Empirical results

305 4.1. Pooled sample estimations

306 Column (1) of Table 2 shows results from conditional logit estimation for our global sample of countries. Besides the
 307 variables presented above, our estimations include dummy variables grouping countries in five homogeneous clusters:
 308 *Developed* for high-income countries, *Emerging* for emerging countries⁴, *TrCEEC* for transition CEEC, *TrCIS* for
 309 transition countries of CIS, and *Developing* for other developing (low and middle income) countries⁵. Variables are log-
 310 linearized, and *KL* and *ER* variables have been lagged one-year in order to control for endogeneity with the dependent
 311 variable⁶.

312 - Table 2 here -

313 We observe that results are consistent with theory and our predictions. Concerning our core variable, the environmental
 314 regulation, it seems to be an important factor for French manufacturing firms' location decision. The estimated
 315 coefficient of the ER index is negative and consistently significant at the 1% level, indicating that a more stringent
 316 environmental regulation deters French manufacturing investments. Also market potential, total factor productivity,
 317 existence of a preferential trade agreement and ex-colonial relationships appear to be important attractive factors for
 318 French direct investments abroad. Moreover, French firms seem to be attracted by labor-abundant countries, an increase

⁴ An emerging country is a country, up to there under developed, which undertook measures and accumulated means, in particular legal and cultural, in order to begin a phase of fast growth of the production and social welfare (see Table 6 in Appendix A for countries classified as emerging by Morgan Stanley Capital International, as for July 2006). Czech Republic, Hungary, Poland and Russia are also classified by MCSI as emerging economies, but we include these countries in their respective transition country group.

⁵ According to the World Bank classification, countries with per capita GNI superior to \$11,456 are considered as high-income countries. We use this classification excluding from this list countries considered in our study as transition or emerging economies. All other countries, not included in our Transition, Emerging, or Developed (high-income) country groups, have been included in the Developing country group (see Appendix A for the list of countries included in our sample).

⁶ Furthermore, always aiming at verifying endogeneity between FDI and ER, we run more regressions with additional lagged measures of environmental regulation as robustness tests in the next section (Table 5).

319 in the K/L ratio having a negative and significant effect on the location decision. Finally, host countries' governance and
 320 democracy influence French firms' decision to settle or not in a country, since *CORRUP* and *FREE* variables have
 321 significant coefficients with the expected signs. Thus, democratic societies attract French FDIs, while a high level of
 322 corruption discourages them. *REGULQUAL* is not significant, may be due to multicollinearity between Kaufmann's
 323 variables. The dummy variables *Emerging* and *Developing* are significant at the 1% level and indicate that between 1996
 324 and 2002, French firms preferred to establish predominantly in emerging economies compared to transition and
 325 developed countries, but with much less preference for developing countries.

326 To go further in our analysis, we intend to perform a Chow-type test in order to check for a specific behavior from
 327 polluting firms. Given that this Chow test must be run on a logit specification, we present in Model (2) the results of the
 328 estimation of Model (1) with a Logit model with adjusted standard-errors for intragroup correlation. Observing similar
 329 coefficients and significance levels in Conditional logit and Logit models, we can perform the Chow test. We create a
 330 dummy variable *HPoll* indicating when firms belong to the common most polluting sectors *Basic metal industries* (NAF
 331 3-digit codes 27.1-27.5), *Chemical and para-chemical industry* (NAF codes 24.1–24.3 and 24.5–24.7), or *Manufacture*
 332 *of pulp, paper and paperboard* (NAF code 21.1). The last column of Table 2 shows a different effect of *ER* index on
 333 high-polluting firms compared to less polluting firms (interaction term $ER_{t-1} * HPoll$): the location choice of the most
 334 polluting firms appears to be more sensitive to the stringency of the host country's environmental regulation. However,
 335 we should note that this difference is only significant at the 10% level⁷. Everything else equal, all industries have interest
 336 to avoid additional costs induced by a stricter environmental regulation since there is generally no totally "clean"
 337 manufacturing sector, but this effect is a little stronger for the most polluting sectors. This result is in line with previous
 338 studies which do not find a large difference between most polluting and less polluting sectors (Jug and Mirza, 2005).

339 To draw more precise conclusions, we aim to interpret the magnitude of the environmental regulation's effect on French
 340 firms' location. If one needs a regression coefficient to express the effect of units of X on the probability of Y, the
 341 "elasticity" is suggested. Nevertheless, conditional logit estimates allow only calculation of individual elasticities for
 342 each alternative and we cannot have a uniform effect for all of them. However, we can first calculate the predicted
 343 probability P^1 of getting FDI when *ER* value is fixed at its sample mean. Then, we change *ER* variable by one standard
 344 deviation, and recalculate the probability P^2 of getting FDI. The difference in the predicted probabilities

⁷ While testing for the null hypothesis $H_0: \ln ER_{t-1} * HPoll = 0$ and $HPoll = 0$, the chi2 value of 5.60 with Prob > chi2 of 0.0607 allows us to reject the null hypothesis of an identical behavior between high-polluting and less-polluting sectors at the 10% level.

345 $P^2/P^1 = [1 + st. dev(ER)/mean(ER)]^{\beta}$ can be interpreted as the effect of a one-standard deviation change in *ER* on
 346 the probability of attracting FDI, when all other variables are held constant at the sample mean values. We find for the
 347 global sample in Model (2)⁸ that a 1-standard deviation shock on *ER* index would decrease the attractiveness of the
 348 "average country" (in terms of *ER* value) by 18.2%. For illustration, considering *ER* values reported in Table 6, and with
 349 all other variables kept constant at the sample mean values, Romania (the "average country") would have 18.6% more
 350 chances than Australia to receive French FDI, and as much less chances than Bulgaria. For most and less polluting firms
 351 this effect represents 21.2% and 11.8%, respectively.

352 Given that a significant *ER* effect was found for the global sample, with a weak difference between most and less
 353 polluting firms, we extend our further empirical analysis on the full sample of firms in order to assess behavior of all
 354 manufacturing sector firms and to consider the largest number of observations.

355 4.2. Country group analysis

356 Based on the previous results providing evidence of a strong pollution haven effect, we intend to distinguish which
 357 countries are more likely to constitute pollution havens. To this goal, we need to introduce interaction terms between the
 358 *ER* index and the country group dummies. However, as noted by Ai and Norton (2003), the marginal impact of an
 359 interaction effect in a non-linear model is not simply the coefficient for this interaction. Because there are two additive
 360 terms and each can be positive or negative, the interaction effect may have different signs for different values of
 361 covariates. We thus apply a procedure developed by Ai and Norton (2003) that computes correct magnitudes and
 362 standard errors of the interaction effect for each of the observations in a logit model. Given that interaction terms cannot
 363 be correctly interpreted from our conditional logit model results, and since we checked in Table 1 that the results
 364 obtained with a logit model with adjusted standard errors for intragroup correlation are consistent with those found with
 365 the conditional logit, we use the Norton's et al. (2004) methodology recommended for computing the marginal effects of
 366 the interaction terms in logit models⁹.

367 Table 3 displays marginal effects of Model (1) variables as well as *ER* interaction terms with *Developed*, *Emerging*,
 368 *CEEC*, *CIS*, and *Developing* dummies in the respective columns. Almost all explanatory variables maintain their sign
 369 and significance across all country group models. Concerning the effect of the environmental regulation for specific

⁸ We consider here Model (2) presenting Logit model results, in order to be able to compare interpretations with those based on the Logit results of Model (3) related to most and less polluting firms.

⁹ This procedure has been implemented in Stata through the *inteff* module.

370 country groups, looking at Table 3 results, we observe positive and significant interaction terms, which seem to offset
 371 the negative *ER* variable's marginal effect for *Emerging*, *CIS* and *Developing* countries in columns (5), (7) and (8),
 372 meaning that a more stringent environmental regulation in these countries attracts FDI. On the contrary, the insignificant
 373 interaction term for *CEEC* and the negative strongly significant interaction term for *Developed* countries confirm a
 374 pollution haven effect for these country groups.

375 *- Table 3 here -*

376 However, as previously mentioned, the interaction effect's magnitude and significance may vary across the range of
 377 predicted values, and these early conclusions can be misleading. The methodology recommended by Norton et al. (2004)
 378 allows us to visualize the correct interaction effect through two figures: one for the amplitude of the interaction term's
 379 marginal effect, and the other for its statistical significance. Consequently, we obtained the respective figures for our
 380 five country groups, displayed in the Appendix B.

381 For *Developed* countries, in Figure 2, the negative and strongly significant interaction effect offsets the baseline positive
 382 and weakly significant *ER* marginal effect in Model (4), i.e. 0.007.

383 Figure 3 presented for *Emerging* economies shows a positive interaction term which offsets the baseline negative *ER*
 384 marginal effect of -0.018 in Model (5) for most of the observations but is only significant for a minor part of them.
 385 Indeed, the major part of the observations have z-statistics lying between the critical values (± 1.96) represented by the
 386 upper and bottom horizontal lines on the Y-axis and corresponding to the 5% level of significance. Therefore, apart from
 387 the few observations which are significant and for which the interaction term offsets the baseline negative *ER* marginal
 388 effect in Model (5), the *ER* marginal effect for *Emerging* economies is negative.

389 Examining the figure corresponding to *CEEC* (Figure 4), we observe that the interaction effect is negative but
 390 statistically insignificant across the entire range of predicted probabilities of choosing a CEE country (X-axis). Hence,
 391 the environmental regulation's effect for *CEEC* is not statistically different from the baseline *ER* variable's marginal
 392 effect reported in the Model (6) of Table 3, i.e. - 0.012.

393 Finally, the opposite of the pollution haven effect is found for most of *CIS* and nearly the entire group of *Developing*
 394 countries. In Figure 5 regarding *CIS* countries, we observe a positive interaction effect, statistically significant for
 395 almost all the observations, and taking values that generally offset the baseline negative *ER* marginal effect of -0.017 in
 396 Model (7). Similarly, examining Figure 6, we underline a highly significant positive marginal effect for the interaction

397 term $ER_{t-1} * Developing$, offsetting the baseline negative ER marginal effect of -0.015 in Model (8) until reaching
 398 positive values up to 0.19. That means French firms are attracted by a more rigorous environmental regulation in these
 399 two country groups. These final interesting results support findings of Dam and Scholtens (2008) suggesting that
 400 polluting firms prefer locating in countries with lax environmental regulation, which are not necessarily the poorest or
 401 most corrupt countries. As mentioned by these authors, multinational firms with strong social responsibility seem to
 402 avoid locating in countries with too weak environmental regulation.

403 5. Robustness checks

404 Tables 4 and 5 present results from some robustness checks. Table 4 reports results of regressions testing alternative
 405 proxies for the central variables in our model, while Table 5 presents robustness checks of our main results obtained
 406 through alternative estimation techniques.

407 In Models (9) to (13) of Table 4, we assess the sensitivity of Model (1) results to the environmental regulation variable
 408 used. In Model (9) we introduce energy costs in industry (tax inclusive prices) for fuel ($lnPfuel$), electricity ($lnPelec$) and
 409 natural gas ($lnPgas$), in order to control for fossil energy endowments and capture in some extent the stringency of the
 410 environmental regulation. These variables have been extracted from the Enerdata database, which is, to the best of our
 411 knowledge, the international database providing figures on energy in a more complete way (energy considered, country
 412 coverage, time dimension, etc.). However, this database suffers from some shortcomings in terms of data availability,
 413 which prevents researchers from conducting large estimations. Despite the sharp reduction of the number of
 414 observations due to the several missing values in the Enerdata database, we observe in Model (9) that most of variables
 415 keep sign and significance as compared to Model (1), and especially the ER index¹⁰. However, the electricity and the
 416 natural gas price variables are insignificant, probably due to multicollinearity between energy price variables or the
 417 shortcomings of the database, while the coefficient of the fuel price variable is negative and significant at the 5% level.
 418 In Model (10), we only keep the fuel price, which is the energy price variable the best reported across time and
 419 countries. The purpose is thus to enlarge the scope of the estimation as compared to Model (9) and to further control for
 420 geographical advantages, i.e. fossil energy abundance. All country groups being represented in the estimation, results are

¹⁰ For illustration of these missing values, we note that the regression in Model (9) does not include any CIS country since the information about those countries is very poor and data is usually reported in tax excluded prices. The absence of CIS countries in the sample is a credible explanation of the insignificance of corruption and the stronger negative effect of the ER index (we saw in the previous section that this variable has a positive effect on location in the CIS countries).

421 similar to those of our core Model (1) and the coefficients of *ER* index and *lnPfuel* are still significantly negative. In
 422 Models (11), (12) and (13), we successively replace *ER* by three alternative environmental regulation variables: *ER*
 423 (*PCA*), *GASUNLEAD* and *ENVTAX*, respectively. *ER* (*PCA*) is an *Environmental Regulation* index including the same
 424 component variables as *ER*, but computed through the *PCA* method (Model 11). *GASUNLEAD* variable represents the
 425 market share of unleaded versus leaded gasoline. Damania et al. (2003) have previously used the lead content in gasoline
 426 to represent the stringency of environmental policy, and they recall that this variable had also been used by Deacon
 427 (1999) and Hilton and Levinson (1998) to proxy the environmental regulation in other kinds of studies. Since lead
 428 constitutes a harmful air pollutant, relatively strict countries should allow a lower lead content in gasoline. Data
 429 concerning lead contents being not available for several observations in our sample, we rather include the market share
 430 of unleaded gasoline, which is a closely related measure (Model 12). Finally, in Model (13), *ENVTAX* represents the
 431 total environmental tax revenues in the European countries, expressed as a share of their GDP. Although our sample is
 432 restricted to European countries in this case, this variable has the twofold advantage of being directly observed in those
 433 countries, as well as being the most close to our theoretical model. In all of these models, the environmental regulation
 434 variable keeps its negative and significant effect on firms' location choice, even if Models (12) and (13) show some
 435 different results for the other explanatory variables, mainly explained by the different sample composition and size as
 436 compared with Model (1).

437 *- Table 4 here -*

438 The common use of the *KL* variable, that is proportional to the ratio of wages to capital cost under the assumption that
 439 all countries have a common production function, could be too restrictive. Errors in this variable may be correlated with
 440 environmental regulation, which would result in bias. To check the potential bias induced, we perform a robustness test
 441 by introducing two alternative variables, i.e. the real exchange rate *RER* and the real interest rate *RIR* (Model 14, Table
 442 4). *RER* is used as a proxy for differences in real wage levels and *RIR* is a proxy for differences in capital cost. Our
 443 empirical results show that *RER* is significantly negative and *RIR* is significantly positive. The negative impact of *RER*
 444 is consistent with the fact that French investors are seeking for a cheaper workforce. As regards *RIR*, we could explain
 445 its positive sign following two judgments. First, French investors, originates from a developed country (capital
 446 abundant), seem to be more likely to seek for another comparative advantage than the capital cost, i.e. a cheap labor
 447 force. Given that these two variables are interdependent, as labor force is cheaper in labor abundant countries, which
 448 have usually higher capital costs, it appears that seeking for a cheaper labor force prevails on seeking for a cheaper

449 capital in our case, since French investors could come with their own cheaper capital. Second, since access to capital is
 450 an important factor for per capita GDP, there may also be multicollinearity between these two variables. Indeed, our
 451 results indicate for such a bias, as *GDPcap* effect turns to be negative. Nevertheless, all other variables are rather robust,
 452 and especially the *ER* effect.

453 Next, we test for the robustness of our *Market Potential* variable in Model (15), where we introduce the most common
 454 measures of market size and its accessibility, namely the variables *GDPdist* (GDP of host country normalized by its
 455 distance from France), *Adjacency* (sharing a common border), and *LangEthn* (sharing a common, ethnic groups'
 456 language). Since all variables have the expected sign and keep significance, our results are robust to different market
 457 size variables used.

458 In Table 5 we report alternative estimations to the Model (1). In Models (16) to (18) we explore more deeply the time
 459 dimension of our data in order to address two issues: endogeneity and forward looking behaviour of firms. In Models
 460 (16) and (17), we lag the environmental regulation variable two years ($\ln ER_{t-2}$) and three years ($\ln ER_{t-3}$), respectively.
 461 We observe that the coefficient of the environmental regulation is still negative and significant at the 1% level, but its
 462 magnitude declines for most lagged measure. Hence, although more concerned with the recent environmental regulation
 463 stringency, firms appear to be also sensitive to the former regulation characteristics. In Model (18), we introduce the
 464 environmental regulation stringency observed in the year the firm decides to locate ($\ln ER$) and the difference between
 465 this measure and the environmental regulation stringency reported three years earlier ($\ln ER_diff3$, representing the
 466 evolution of the environmental regulation over the last three years). We note that both variables have a deterrent effect
 467 on firms' location choice, and that the evolution of the environmental regulation even has a larger marginal impact than
 468 the current level of the environmental regulation¹¹. Resuming the results depicted by the three Models (16), (17 and (18),
 469 we can say that firms, when they take the decision of locating in a country, not only are sensitive to most recent levels
 470 of environmental regulations, but are also very sensitive to the recent evolution of environmental regulations in that
 471 country. Indeed, in countries that started strengthening their regulations, firms may anticipate and be reluctant to a
 472 similar trend for the next years. All these findings indicate a forward looking behavior of French firms while deciding to
 473 locate abroad.

474 Finally, Models (16) to (18) confirm the robustness of our results for the ER index since they also address some of the

¹¹ We find a similar result if we include in the regression ER_{t-1} and its difference with ER_{t-3} .

475 endogeneity concerns suggested by the well-known race to the bottom hypothesis.

476 Models (19) and (20) control for fixed effects. Model (19) corresponds to a logit estimation including dummies for each
477 4-digit NAF Codes of subsidiaries' sectors, thus controlling for industry fixed-effects. Results are strongly similar to
478 those of Model (1), since in our study the conditional logit is by construction a firm fixed-effects model. In Model (20),
479 we control for time-invariant factors and present estimation results of regressions including country fixed-effects.
480 Moreover, following Train (1986), we are supposed to correct the biases induced by the IIA while integrating country
481 fixed effects. The results confirm the significant and negative effect of environmental regulation on firms' location
482 choice, while controlling for all other country specific-effects.

483 *- Table 5 here -*

484 **6. Conclusion**

485 In this study, we have tested the pollution haven hypothesis through an analysis of the impact of the environmental
486 regulation on French manufacturing firms' location choice. Using firm-level data on French firms' location in the world,
487 we have first tested this hypothesis for a pooled sample of countries, and then by making a distinction between
488 *Developed* countries, *Emerging* economies, *Transition CEEC*, *Transition* countries of *CIS*, and *Developing* countries. By
489 applying an economic geography model, which has the advantage of considering a complete set of FDI determinants,
490 and by developing a complex index expressing the stringency of environmental regulation in a satisfying way, we have
491 succeeded in revealing the existence of a strong pollution haven effect.

492 Empirical results of the base model show that in presence of heterogeneous countries, French manufacturing industries
493 prefer to locate in countries with more lenient environmental regulations. In an attempt to identify countries that are
494 more likely to constitute pollution havens, we validate existence of a pollution haven effect for developed, most of
495 emerging and CEE countries included in our sample, but not for most of CIS and developing countries where a more
496 stringent environmental regulation seems rather to attract investments. Thus, manufacturing French firms locate
497 preferably in countries with less stringent environmental policy, provided that regulation is not more lenient than an
498 accepted level ensuring wealthy business environment. Robustness tests finally confirm the stability of our results across
499 different specifications, including alternative proxies for our core variables and alternative estimation techniques.
500 Furthermore, tests using lagged measures of environmental regulation show that firms are forward looking while taking

501 decision of moving or investing.

502 The only approval or rejection of the pollution haven hypothesis is not sufficient to respond to fears related to the impact
 503 on firms' location of heterogeneous environmental regulations across countries. Research examining to which extent
 504 pollution havens imply a real threat to the environment in the less developed countries or at the opposite could be
 505 beneficial to it thanks to technological improvements for example, or the 'pollution halo effect', would be of a great
 506 interest.

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Appendices

A. List of countries

The last two columns show the number of French subsidiaries hosted: total number, and in the three common most polluting sectors (i.e. Basic metal industries, Chemical and Para-chemical industry, Manufacture of pulp, paper and paperboard).

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Figure 6 Interaction effect for Developing countries

Figures:

Figure 1 Relationship between ER index and GDP per capita

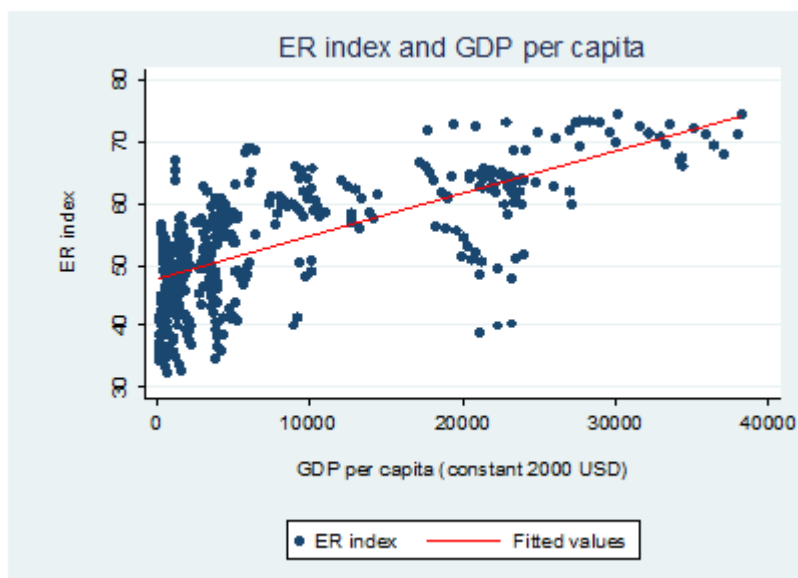


Figure 2 Interaction effect for Developed countries

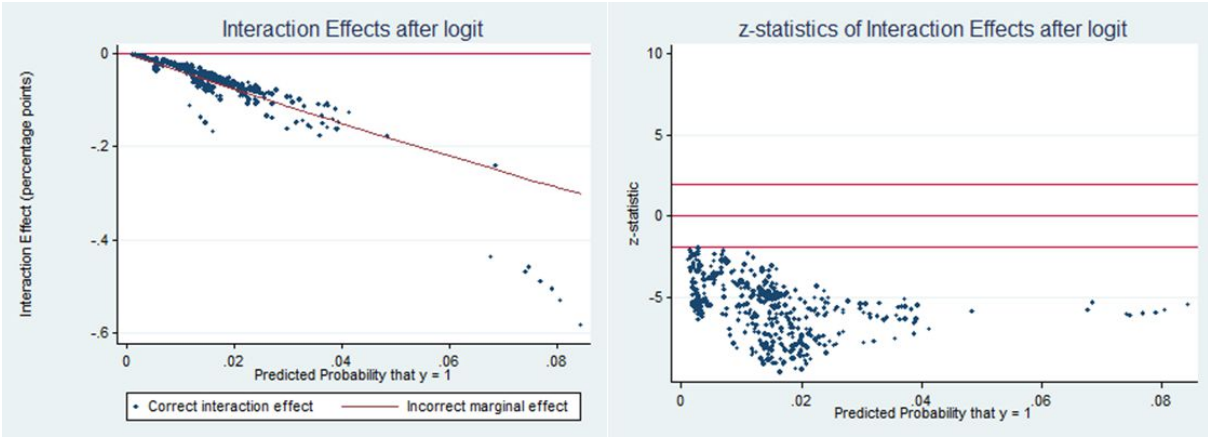


Figure 3 Interaction effect for Emerging economies

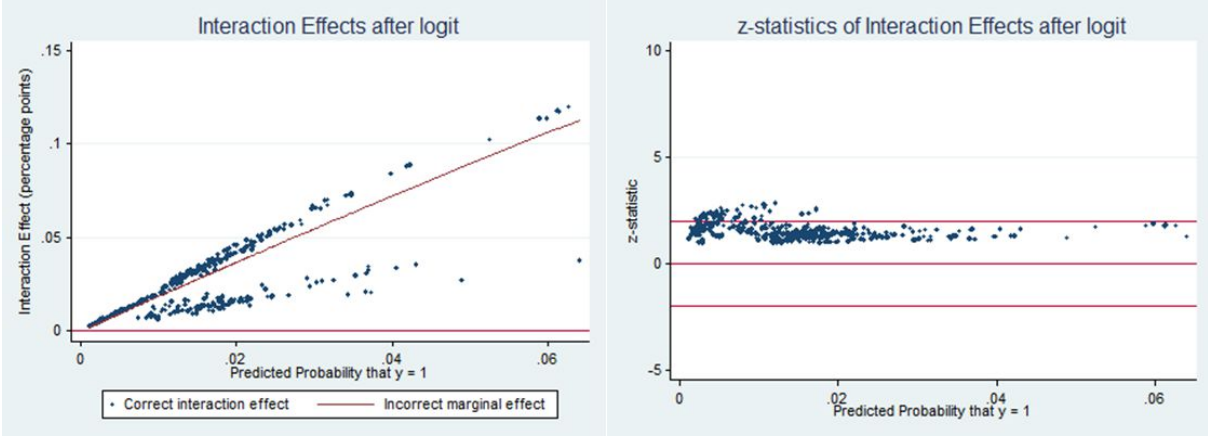


Figure 4 Interaction effect for CEEC

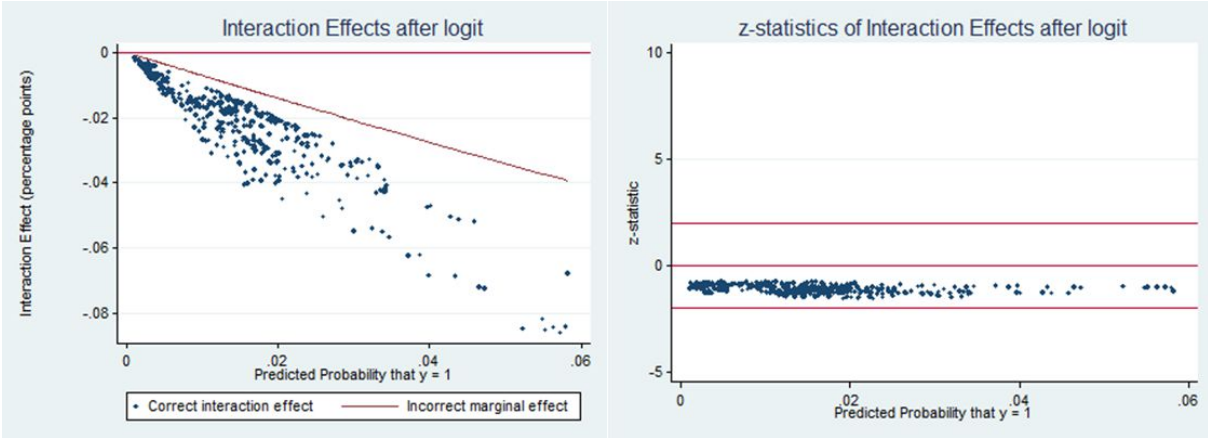


Figure 5 Interaction effect for CIS

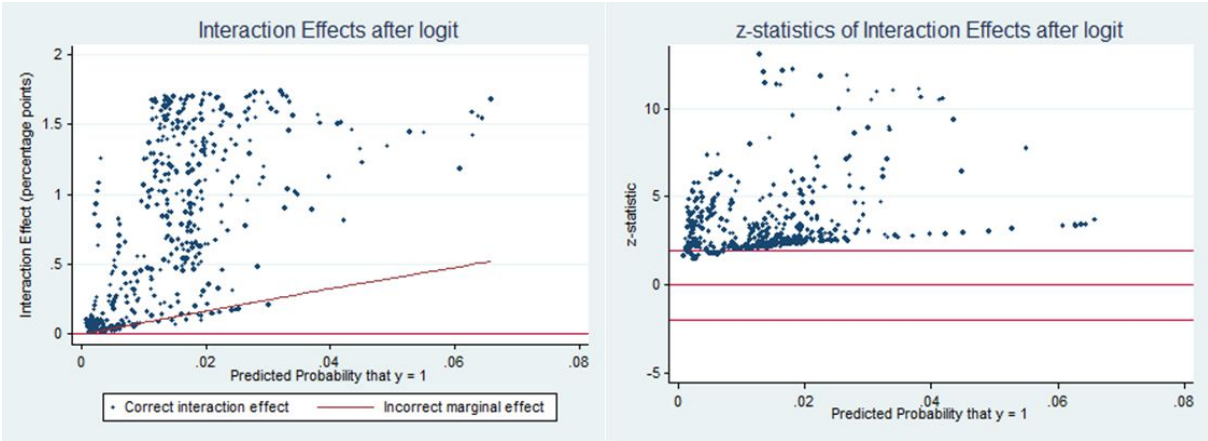
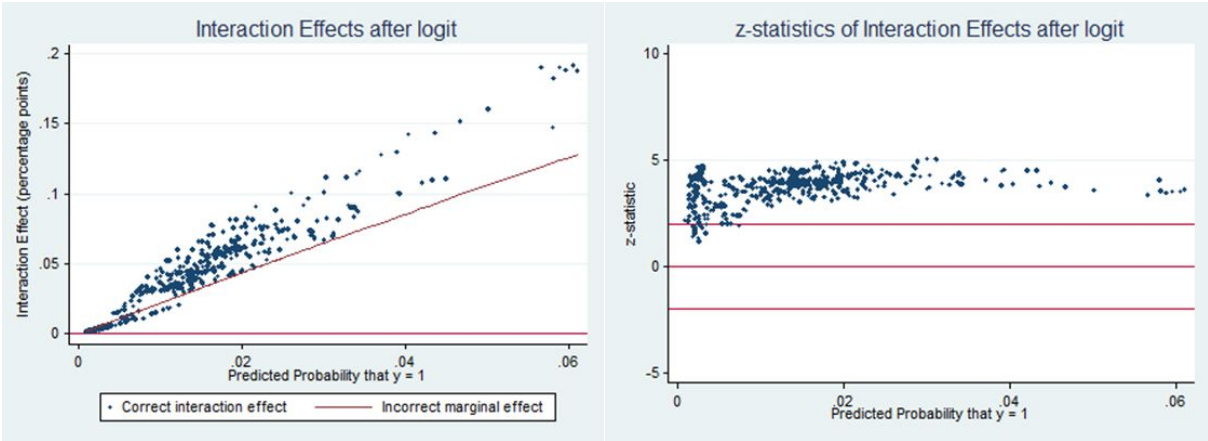


Figure 6 Interaction effect for Developing countries



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Variables	<i>GDPcap</i>	<i>ERindex</i>	<i>MEAs</i>	<i>INGOs</i>	<i>Energy efficiency</i>
<i>GDPcap</i>	1.0000				
<i>ERindex</i>	0.6647	1.0000			
<i>MEAs</i>	0.3020	0.7202	1.0000		
<i>INGOs</i>	0.6192	0.6198	0.2459	1.0000	
<i>Energy efficiency</i>	0.6762	0.9082	0.4962	0.5214	1.0000

Table 2 Conditional logit and logit estimates (coefficients)

	(1) Conditional logit	(2) logit	(3) Chow-type test
<i>lnMP</i>	0.607*** (0.051)	0.605*** (0.058)	0.628*** (0.059)
<i>lnGDPcap</i>	0.523*** (0.125)	0.408*** (0.116)	0.414*** (0.115)
<i>TFP_growth</i>	0.012*** (0.004)	0.012*** (0.004)	0.012*** (0.004)
<i>lnKL_{t-1}</i>	-0.677*** (0.111)	-0.562*** (0.102)	-0.532*** (0.100)
<i>lnER_{t-1}</i>	-1.094*** (0.255)	-1.226*** (0.245)	-0.768*** (0.177)
<i>lnER_{t-1} *HPoll</i>			-0.689* (0.373)
<i>HPoll</i>			2.742* (1.491)
<i>lnCORRUP</i>	-0.918*** (0.264)	-0.889*** (0.264)	-0.441*** (0.152)
<i>lnREGULQUAL</i>	-0.486 (0.329)	-0.425 (0.265)	-0.137 (0.251)
<i>FREE</i>	0.325*** (0.098)	0.355*** (0.097)	0.351*** (0.097)
<i>PTA</i>	0.436*** (0.121)	0.511*** (0.131)	0.475*** (0.132)
<i>COL45</i>	0.834*** (0.143)	0.826*** (0.140)	0.798*** (0.140)
<i>Emerging</i>	0.995*** (0.167)	1.022*** (0.189)	1.019*** (0.191)
<i>TrCEEC</i>	0.286* (0.162)	0.350** (0.167)	0.300* (0.170)
<i>TrCIS</i>	0.468* (0.249)	0.411 (0.269)	0.466* (0.262)
<i>Developing</i>	-0.857*** (0.222)	-0.860*** (0.242)	-0.836*** (0.240)
LR chi2 (H ₀ : <i>lnER_{t-1} *HPoll=0</i> and <i>HPoll=0</i>)			5.60
Prob > chi2			0.0607
Pseudo R ²	0.0632	0.0522	0.0523
N. of obs.	96054	96054	96054

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01

Table 3 Logit estimates with country-groups interaction terms (marginal effects)

	(4)	(5)	(6)	(7)	(8)
	Developed	Emerging	CEEC	CIS	Developing
<i>lnMP</i>	0.006*** (0.001)	0.006*** (0.001)	0.006*** (0.001)	0.006*** (0.001)	0.006*** (0.001)
<i>lnGDPcap</i>	0.002* (0.001)	0.003*** (0.001)	0.004*** (0.001)	0.005*** (0.001)	0.004*** (0.001)
<i>TFP_growth</i>	0.0001*** (0.000)	0.0001*** (0.000)	0.0001*** (0.000)	0.0001*** (0.000)	0.0001*** (0.000)
<i>lnKL_{t-1}</i>	-0.004*** (0.001)	-0.004*** (0.001)	-0.006*** (0.001)	-0.007*** (0.001)	-0.006*** (0.001)
<i>lnER_{t-1}</i>	0.007* (0.004)	-0.018*** (0.003)	-0.012*** (0.003)	-0.017*** (0.002)	-0.015*** (0.003)
<i>lnER_{t-1}*Developed</i>	-0.040*** (0.005)				
<i>lnER_{t-1}*Emerging</i>		0.019*** (0.006)			
<i>lnER_{t-1}*TrCEEC</i>			-0.007 (0.009)		
<i>lnER_{t-1}*TrCIS</i>				0.084*** (0.014)	
<i>lnE_{t-1}*Developing</i>					0.023*** (0.006)
<i>lnCORRUP</i>	-0.006** (0.003)	-0.009*** (0.003)	-0.009*** (0.003)	-0.009*** (0.003)	-0.009*** (0.003)
<i>lnREGULQUAL</i>	-0.003 (0.003)	-0.005* (0.003)	-0.004 (0.003)	-0.002 (0.003)	-0.004 (0.003)
<i>FREE</i>	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.001)	0.004*** (0.001)	0.004*** (0.001)
<i>PTA</i>	0.007*** (0.002)	0.007*** (0.002)	0.006*** (0.002)	0.005*** (0.002)	0.006*** (0.002)
<i>COL45</i>	0.005** (0.002)	0.007*** (0.003)	0.012*** (0.003)	0.015*** (0.003)	0.013*** (0.003)
Country_group dummies	Yes	Yes	Yes	Yes	Yes
Pseudo R ²	0.0563	0.0528	0.0522	0.0560	0.0528
N. of obs.	96054	96054	96054	96054	96054

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01

Table 4 Robustness tests with alternative variables (coefficients)

	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Energy price	Geo. advantage	<i>ER</i>	<i>ER</i>	<i>ER</i>	<i>KL</i>	<i>MP</i>
<i>lnMP</i>	0.219** (0.093)	0.597*** (0.064)	0.608*** (0.051)	0.437*** (0.065)	0.540*** (0.107)	0.400*** (0.054)	
<i>lnGDPdist</i>							0.815*** (0.087)
<i>Adjacency</i>							0.583*** (0.120)
<i>LangEthn</i>							0.204 (0.126)
<i>lnGDPcap</i>	0.849*** (0.214)	0.746*** (0.166)	0.536*** (0.125)	0.584*** (0.179)	-0.054 (0.344)	-0.241*** (0.076)	0.674*** (0.135)
<i>TFP_growth</i>	-0.009 (0.006)	0.002 (0.006)	0.012*** (0.004)	0.007 (0.005)	0.035** (0.014)	0.019*** (0.006)	0.013*** (0.004)
<i>lnKL_{t-1}</i>	-0.435** (0.217)	-0.952*** (0.147)	-0.684*** (0.111)	-0.347** (0.165)	-0.409 (0.287)		-0.879*** (0.124)
<i>lnRER</i>						-1.820*** (0.372)	
<i>lnRIR</i>						0.989*** (0.331)	
<i>lnER_{t-1}</i>	-2.682*** (0.564)	-0.773** (0.338)				-1.631*** (0.324)	-2.121*** (0.294)
<i>lnPfuel</i>	-0.411** (0.177)	-0.219** (0.101)					
<i>lnPelec</i>	-0.005 (0.151)						
<i>lnPgas</i>	0.172 (0.138)						
<i>lnER_{t-1} (PCA)</i>			-1.313*** (0.284)				
<i>GASUNLEAD_{t-1}</i>				-0.005*** (0.002)			
<i>lnENVTAX_{t-1}</i>					-1.367*** (0.219)		
<i>lnCORRUP</i>	0.194 (0.462)	-0.896** (0.363)	-0.903*** (0.263)	0.545 (0.381)	-1.807** (0.880)	-1.269*** (0.360)	-1.701*** (0.267)
<i>lnREGULQUAL</i>	-0.270 (0.872)	-3.206*** (0.583)	-0.466 (0.329)	0.253 (0.636)	-3.352*** (1.214)	-1.724*** (0.607)	-0.234 (0.332)
<i>FREE</i>	0.717*** (0.181)	0.516*** (0.119)	0.323*** (0.098)	0.659*** (0.168)	-0.033 (0.465)	-0.044 (0.131)	0.149 (0.096)
<i>PTA</i>	0.378* (0.223)	0.278 (0.190)	0.454*** (0.122)	-0.595*** (0.190)	0.954*** (0.322)	0.450*** (0.150)	0.508*** (0.119)
<i>COL45</i>	4.050*** (0.649)	1.201*** (0.293)	0.870*** (0.145)	1.033*** (0.233)	no obs.	0.453** (0.186)	0.758*** (0.194)
<i>Emerging</i>	0.460* (0.273)	0.440* (0.235)	0.990*** (0.166)	-0.122 (0.257)	no obs.	0.326 (0.207)	1.263*** (0.166)
<i>TrCEEC</i>	0.925** (0.381)	0.159 (0.235)	0.282* (0.162)	-0.534** (0.256)	no obs.	0.089 (0.188)	0.847*** (0.160)
<i>TrCIS</i>	no obs.	1.336*** (0.427)	0.477* (0.248)	0.500 (0.401)	no obs.	-0.627** (0.317)	0.695*** (0.248)
<i>Developing</i>	-2.394*** (0.510)	-1.759*** (0.322)	-0.883*** (0.223)	-1.418*** (0.467)	no obs.	-1.932*** (0.280)	-0.699*** (0.226)
Pseudo R ²	0.0570	0.0808	0.0634	0.0354	0.0355	0.0768	0.0665
N. of obs.	24352	40806	96054	37698	9642	39443	96054

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01

Table 5 Robustness tests with alternatives specifications (coefficients)

	(16)	(17)	(18)	(19)	(20)
	Lagged ER (t-2)	Lagged ER (t-3)	Evolution of ER (diff.)	Industry FE	Country FE
<i>lnMP</i>	0.559*** (0.053)	0.539*** (0.055)	0.500*** (0.057)	0.610*** (0.052)	1.856** (0.774)
<i>lnGDPcap</i>	0.446*** (0.129)	0.370*** (0.134)	0.398*** (0.136)	0.429*** (0.117)	-0.058 (0.787)
<i>TFP_growth</i>	0.010** (0.004)	0.006 (0.004)	0.004 (0.004)	0.012*** (0.004)	0.007 (0.005)
<i>lnKL_{t-1}</i>	-0.550*** (0.117)	-0.432*** (0.123)	-0.451*** (0.126)	-0.583*** (0.103)	-1.747*** (0.456)
<i>lnER</i>			-1.080*** (0.287)		
<i>lnER_{t-1}</i>				-1.197*** (0.260)	-3.051** (1.247)
<i>lnER_{t-2}</i>	-0.946*** (0.264)				
<i>lnER_{t-3}</i>		-0.629** (0.277)			
<i>lnER_diff3</i>			-3.528*** (0.697)		
<i>lnCORRUP</i>	-0.742*** (0.276)	-0.626** (0.285)	-0.568* (0.300)	-0.898*** (0.264)	0.229 (0.708)
<i>lnREGULQUAL</i>	-0.691** (0.347)	-1.029*** (0.365)	-1.045*** (0.401)	-0.451 (0.329)	2.174*** (0.699)
<i>FREE</i>	0.409*** (0.102)	0.510*** (0.107)	0.609*** (0.112)	0.351*** (0.098)	0.137 (0.168)
<i>PTA</i>	0.432*** (0.123)	0.343*** (0.130)	0.407*** (0.143)	0.499*** (0.120)	-0.093 (0.204)
<i>COL45</i>	0.808*** (0.154)	0.755*** (0.167)	1.124*** (0.179)	0.819*** (0.146)	-0.787 (1.687)
<i>Emerging</i>	0.938*** (0.169)	0.894*** (0.175)	0.838*** (0.191)	1.025*** (0.167)	0.692 (2.504)
<i>TrCEEC</i>	0.242 (0.166)	0.161 (0.174)	0.417** (0.190)	0.340** (0.161)	-1.206 (1.872)
<i>TrCIS</i>	0.209 (0.260)	0.007 (0.276)	-0.007 (0.295)	0.425* (0.250)	-2.664 (3.143)
<i>Developing</i>	-0.830*** (0.225)	-0.809*** (0.232)	-1.008*** (0.249)	-0.862*** (0.223)	1.561 (2.307)
Industry fixed-effects	No	No	No	Yes	No
Country fixed-effects	No	No	No	No	Yes
Pseudo R ²	0.0590	0.0573	0.0602	0.0527	0.1399
N. of obs.	87647	79355	69704	95981	96054

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01

Table 6 List of countries, by 1996 - 2002 average ER (Z-score) index

Country	Country-group	ER index	Total FDIs	HPoll FDIs
Denmak	<i>Developed</i>	72.51927	9	1
Ireland	<i>Developed</i>	72.22519	11	1
Norway	<i>Developed</i>	71.28683	7	0
Switzerland	<i>Developed</i>	69.25587	20	1
Uruguay	<i>Developing</i>	66.62847	5	1
Morocco	<i>Emerging</i>	65.34323	36	2
Austria	<i>Developed</i>	64.42762	13	0
Netherlands	<i>Developed</i>	64.35733	19	3
United Kingdom	<i>Developed</i>	64.28305	54	2
Sweden	<i>Developed</i>	63.53307	16	1
Italy	<i>Developed</i>	63.50548	23	2
Finland	<i>Developed</i>	63.06514	28	0
Portugal	<i>Developed</i>	62.47086	26	4
Slovenia	<i>Tr. CEEC</i>	61.68478	5	0
Germany	<i>Developed</i>	61.4548	88	13
Spain	<i>Developed</i>	61.05751	57	4
Latvia	<i>Tr. CEEC</i>	59.47469	14	3
Hungary	<i>Tr. CEEC</i>	59.41331	23	2
Argentina	<i>Emerging</i>	58.98042	42	6
Greece	<i>Developed</i>	58.94014	7	0
Czech Republic	<i>Tr. CEEC</i>	57.7374	40	4
Croatia	<i>Tr. CEEC</i>	57.63725	12	1
New Zealand	<i>Developed</i>	57.09515	6	1
Poland	<i>Tr. CEEC</i>	56.15657	60	8
Slovakia	<i>Tr. CEEC</i>	56.06921	56	8
Estonia	<i>Tr. CEEC</i>	56.05787	3	0
Chile	<i>Emerging</i>	55.9077	21	3
Bangladesh	<i>Developing</i>	54.18826	1	0
Paraguay	<i>Developing</i>	54.11656	1	0
Australia	<i>Developed</i>	53.66515	34	4
Romania	<i>Tr. CEEC</i>	53.1874	34	1
Bulgaria	<i>Tr. CEEC</i>	52.03762	9	1
Egypt	<i>Emerging</i>	51.8987	8	0
Lithuania	<i>Tr. CEEC</i>	51.8107	4	0
India	<i>Emerging</i>	51.68941	54	4
Pakistan	<i>Emerging</i>	51.48463	5	1
South Africa	<i>Emerging</i>	51.33337	31	6
Peru	<i>Emerging</i>	50.99601	9	0
Canada	<i>Developed</i>	50.4206	67	7
Algeria	<i>Developing</i>	50.20105	35	0

Country	Country-group	ER index	Total FDIs	HPoll FDIs
Philippines	<i>Emerging</i>	49.9314	13	2
China	<i>Emerging</i>	49.85776	124	25
Senegal	<i>Developing</i>	49.75875	3	0
Korea(Republic)	<i>Emerging</i>	49.55011	23	3
Sri Lanka	<i>Developing</i>	49.45883	2	1
Trinidad and Tobago	<i>Developing</i>	48.90398	1	0
Jordan	<i>Emerging</i>	48.72429	7	3
Iran	<i>Emerging</i>	48.69851	3	0
Mexico	<i>Emerging</i>	48.39274	38	4
Guatemala	<i>Developing</i>	48.17775	3	1
Bolivia	<i>Developing</i>	48.12107	1	0
Turkey	<i>Emerging</i>	47.99641	13	2
Brazil	<i>Emerging</i>	47.79189	1	1
Russia	<i>Tr. CIS</i>	46.87081	45	7
Lebanon	<i>Developing</i>	46.79508	8	1
Honduras	<i>Developing</i>	46.71982	1	0
Ukraine	<i>Tr. CIS</i>	45.16016	7	0
Côte d'Ivoire	<i>Developing</i>	43.97885	8	0
Uzbekistan	<i>Tr. CIS</i>	43.81619	1	0
Indonesia	<i>Emerging</i>	43.73818	2	0
Ecuador	<i>Developing</i>	42.92884	2	0
Malaysia	<i>Emerging</i>	42.1367	31	3
Ghana	<i>Developing</i>	42.09168	3	0
Saudi Arabia	<i>Developing</i>	41.74575	2	1
Venezuela	<i>Developing</i>	41.6977	5	0
United Arab Emirates	<i>Developed</i>	39.75076	9	2
Dominican Republic	<i>Developing</i>	39.72932	1	0
Cameroon	<i>Developing</i>	39.37199	3	1
Mozambique	<i>Developing</i>	39.29367	1	0
Thailand	<i>Emerging</i>	39.14275	4	0
Gabon	<i>Developing</i>	37.90731	3	0
Azerbaijan	<i>Tr. CIS</i>	37.81756	3	0
Ethiopia	<i>Developing</i>	35.66262	2	0
Kazakhstan	<i>Tr. CIS</i>	35.26333	8	0
Total			1374	152

Table 7 Descriptive statistics for interaction effects

Interaction term	Mean	Std. Dev.	Min.	Max.
$\ln ER_{t-1} * \textit{Developed}$	-0.0543	0.0650	-0.5824	-0.0030
$\ln ER_{t-1} * \textit{Emerging}$	0.0238	0.0207	0.0024	0.1199
$\ln ER_{t-1} * \textit{TrCEEC}$	-0.0207	0.0148	-0.0862	-0.0015
$\ln ER_{t-1} * \textit{TrCIS}$	0.7352	0.6083	0.0125	1.7364
$\ln ER_{t-1} * \textit{Developing}$	0.0427	0.0342	0.0012	0.1913

Table 8 Descriptive statistics for variables used in estimations

Variable	Mean	Std. Dev.	Min.	Max.	N
<i>MP</i>	11.1613	12.3426	1.8357	68.4638	96054
<i>GDPcap</i>	7289.2386	9013.7306	95.4479	38302.6094	96054
<i>TFP_growth</i>	-2.0331	9.9872	-95.3050	28.888	96054
<i>KL_{t-1}</i>	22334.8144	28264.9816	224.6915	150149.625	96054
<i>RER</i>	103.9837	13.08053	53.46917	159.2242	50401
<i>RIR</i>	10.325	13.672	-82.46	84.05	72609
<i>ER_{t-1} (Z-score)</i>	52.9100	9.4188	32.2522	74.1721	96054
<i>ER_{t-1} (PCA)</i>	52.4092	6.6362	34.2623	74.7474	96054
<i>Pfuel</i>	232.2179	121.2678	11	1089	40806
<i>Pelec</i>	897.3539	584.9564	153	6011	53901
<i>Pgas</i>	186.7169	107.4092	5	727	30360
<i>GASUNLEAD_{t-1}</i>	65.3025	34.7952	0	100	55884
<i>ENVTAX_{t-1}</i>	2.8921	0.8439	1.47	5.39	23271
<i>CORRUP</i>	33.4696	9.7613	17.9116	56.7732	96054
<i>REGULQUAL</i>	4.4413	0.7789	2.1764	5.9688	96054
<i>FREE</i>	0.5408	0.4983	0	1	96054
<i>PTA</i>	0.2604	0.4389	0	1	96054
<i>COL45</i>	0.0811	0.273	0	1	96054
<i>GDPdist</i>	1.80E+08	6.68E+08	3.59E+05	4.37E+09	96054
<i>Adjacency</i>	0.0572	0.2323	0	1	96054
<i>LangEthn</i>	0.1224	0.3278	0	1	96054

Table 9 Data definition and sources

Variable	Definition	Sources
<i>Dependent variable</i>	Location choice	Subsidiaries-Survey 2002, French Directorate of Treasury and Economic Policy
<i>MP</i>	Market potential	Data on international trade: R. Feenstra and R. Lipsey, NBER 1990-2000;
<i>Adjacency and LangEthn</i>	Dummy variables for sharing common border and language, respectively	Chelem, CEPII, 2000-2004; Geographic data: CEPII
<i>GDPdist</i>	Gross Domestic Product (of the host country) divided by the distance between France and the host country	GDP: World Development Indicators, World Bank. Distance : DISTANCES database of CEPII
<i>GDPcap</i>	Per capita Gross Domestic Product at constant 2000 prices	World Development Indicators, World Bank
<i>TFP growth</i>	Total factor productivity growth	Authors calculation; World Bank & International Energy Agency data
<i>KL</i>	Country relative endowments in production factors (capital versus labor) Construction of capital stock series using perpetual inventory method	World Development Indicators, World Bank + authors calculation
<i>RER</i>	Real effective exchange rate	World Development Indicators, World Bank
<i>RIR</i>	Real interest rate	World Development Indicators, World Bank
<i>ER</i>	Environmental regulation index: Multilateral Environmental Agreements (MEA) International NGOs Energy efficiency (GDP/unit of energy used), controlled for latitude	Authors calculation Earthtrends, World Resources Institute Center for the Study of Global Governance World Bank; DISTANCES (GEO) database of CEPII (for latitude)
<i>Pfuel</i>	Constant price in US\$ per toe of heavy fuel oil (tax incl., \$05/toe)	Enerdata database
<i>Pelec</i>	Constant price in US\$ per toe of electricity in industry (tax incl., \$05/toe)	Enerdata database
<i>Pgas</i>	Constant price in US\$ per toe of natural gas in industry (tax incl., \$05/toe)	Enerdata database
<i>GASUNLEAD</i>	Market share of unleaded versus leaded gasoline	United Nations Environment Programme (UNEP)
<i>ENVTAX</i>	Total environmental tax revenues, % GDP	EUROSTAT.
<i>CORRUP</i>	Corruption	Governance Indicators 1996-2004, D. Kaufmann, A. Kray and M. Mastruzzi
<i>REGULQUAL</i>	Regulations improving firms' general environment	Governance Indicators 1996-2004, D. Kaufmann, A. Kray and M. Mastruzzi
<i>PTA</i>	Preferential trade agreements with EU, hence with France	Preferential trade agreements database (PTAs)
<i>COL45</i>	Colonial relationship with France post 1945	DISTANCES database of CEPII
<i>FREE</i>	Dummy taking value 1 if the country is considered democratic (average of Political Rights and Civil Liberties lying between 1.0 and 2.5)	Freedom House.
<i>Developed</i>	High-income countries	World Bank Country Classification, excluding CEEC and Emerging economies
<i>Emerging</i>	Emerging countries	Morgan Stanley Capital International (MSCI) classification
<i>TrCEEC</i>	Central and Eastern European Countries	Multiple sources
<i>TrCIS</i>	Commonwealth of Independent States	Multiple sources
<i>Developing</i>	Other developing (low and middle income) countries	World Bank Country Classification, excluding CEEC, CIS and Emerging economies