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Environmental Regulations, Outward FDI and Heterogeneous Firms: Are Countries Used as Pollution Havens?

By

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Abstract

We consider whether pollution-intensive FDI tends to outflow from a country which maintains stringent environmental regulations and into countries with weak environmental regulations. We consider this issue by incorporating the predictions from the recent heterogeneous firm models of international trade into an empirical model of outward FDI by UK firms. We find that environmental regulations are not a robustly significant determinant of the internationalisation decision, but a pollution-intensive multinational enterprise's location decision will be affected by the environmental regime in place in the host country. Any deterrent effect is however highly conditional upon other factors, notably corruption.

JEL classification: F18; F23; Q56

Keywords: Pollution haven; Foreign investment; Environmental regulation

Outline

Non-Technical Summary

The pollution haven hypothesis states that the production of pollution intensive goods will migrate from countries in which environmental standards are high to those in which they are low.

Providing robust empirical support for the pollution haven hypothesis has proved difficult. Focusing on FDI flows, the empirical evidence which looks at U.S. inward FDI and differences in pollution abatement among U.S. states has arguably had most success in establishing an effect. Studies which consider the relocation patterns of plants within the U.S. are also in favour of a statistically significant role for environmental regulations. For non-U.S. countries, the support for the pollution haven hypothesis has been more mixed.

Within the pollution haven literature less attention has been paid to the question of whether pollution-intensive FDI tends to outflow from a country which maintains stringent environmental regulations and into countries with weak environmental regulations (typically developing countries). The limited evidence suggests that environmental standards are only a minor consideration in investment decisions.

In this paper we add to this literature by incorporating the predictions from the recent heterogeneous firm models of international trade into our empirical model of outward FDI by UK firms. As these models make clear, differences in the underlying characteristics of firms mean that even when faced with the same set of choices about global engagement, only the best firms in the industry are sufficiently productive to cover the sunk costs associated with FDI. In addition to the standard industry level measures of environmental regulation it is therefore important to control for firm characteristics in the modelling of outward FDI. We also study the choice about which locations to host that production. If the sunk costs of becoming a multinational differ across countries and the weakest environmental regulations are in countries with the highest entry costs, then only a small fraction of multinational firms will able to take advantage of these differences in environment regulation. If potential pollution havens instead have lower entry costs, in comparison the pollution haven effect will encourage a greater proportion of multinationals to locate production there.

We test whether there is a significant pollution haven effect for the UK because it is subject to relatively stringent environmental regulations which are strongly enforced, whilst also being one of the largest outward investors of the world economy.

We find that, controlling for firm performance, environmental regulations are not a robustly significant determinant of the internationalisation decision made by a firm. On the other-hand, if it is costly for the multinational enterprise to comply with stringent environmental regulations, its location decision will be affected by the environmental regime in place in the host country. Any deterrent effect is however highly conditional upon other factors, notably how corrupt the host country is. Corruption significantly weakens the negative effect more stringent environmental regulation has on FDI flows to a given host country. In contrast to many previous studies, we establish results that are highly robust across a variety of different model specifications and estimation techniques.

1 Introduction

The pollution haven hypothesis states that the production of pollution intensive goods will migrate from countries in which environmental standards are high to those in which they are low. Given the strong correlation between environmental regulation and per capita income, for some this has the additional connotation that developed countries use developing countries as the location of pollution intensive production.

The early theoretical literature captures the idea of pollution havens as differences in the comparative advantage of countries in the production of pollution intensive goods (Pethig (1976), Siebert (1977) and Yohe (1979)). Copeland and Taylor (1994) extend the analysis by endogenising environmental policy such that it depends upon national income. In these models of environmental regulations and trade, a country's comparative advantage in pollution-intensive industries is weakened by strict environmental regulation, thereby reducing its net exports from such sectors. On the other-hand, those countries which do not maintain high environmental standards increase their specialisation in pollution-intensive industries. Models have also been developed to show that similar results hold for capital flows (McGuire (1982)). If any factor of production is freely mobile across frontiers, environmental regulation will drive out the regulated industry from the more to the less regulated economy. More recently, however, Eskeland and Harrison (2003) show that the effect of environmental regulation imposed at home on outward investment may be ambiguous due to a possible complementarity between capital and pollution abatement.

In comparison to the theoretical modelling of the pollution haven hypothesis, providing robust empirical support has proved more difficult. Focusing on FDI flows, the empirical evidence which looks at U.S. inward FDI and differences in pollution abatement among U.S. states has arguably had most success in establishing an effect. List and Co (2000) and Keller and Levinson (2002) both find evidence that increased environmental regulation is associated with lower FDI inflows into U.S. states. Typically, it is argued that this approach has the advantage that while environmental regulations are known to differ across states, other difficult to measure country and industry differences that matter for FDI do not, or at least differ relatively little (Keller and Levinson, 2002).[1] For non-U.S. countries, Waldkirch

[1] Related to this literature are studies which do not explicitly consider FDI but rather the relocation patterns of plants within the U.S., such as Levinson (1996), Henderson (1996) and List et al. (2003). Here the evidence points to a statistically

and Gopinath (2008) measure the stringency of environmental regulation and FDI inflows into Mexico, Dean et al. (2009) the case of China and Smarzynska and Wei (2004) FDI flows into Eastern and Central European countries. Here the support for the pollution haven hypothesis has been more mixed. Waldkirch and Gopinath (2008) find a positive correlation between FDI and one of their measures of pollution (sulphur dioxide) although only for a few industries (in particular, those with large firms). In the case of other pollutants, and for other industries, the results suggest that environmental regulations enforcing a lower emission intensity may not necessarily deter FDI flows, ceteris paribus. Smarzynska and Wei (2004) find that their results are not robust to different measures of environmental stringency, while Dean et al. (2009) find an effect only for joint ventures in pollution intensive industries funded through Hong Kong, Macao and Taiwan.

Within the pollution haven literature rather less attention has been paid to the question of whether pollution-intensive FDI tends to outflow from a country which maintains stringent environmental regulations and into countries with weak environmental regulations, including developing countries. Early studies for the U.S. include Duerksen and Leonard (1980), who examine both trade and investment data in an effort to uncover a pollution haven effect. They find that U.S. FDI in pollution-intensive industries has not increased significantly in developing countries relative to developed countries. Overall, they argue that environmental standards are only a minor consideration in investment decisions. Similar results are obtained by Walter (1982) in a study of FDI by firms located in the U.S., Europe and Japan for the period 1970 to 1978. Finally, Xing and Kolstad (2002) find some evidence for outward FDI from heavily polluting U.S. industries (chemicals and primary metals).

In this paper we add to this literature by incorporating the predictions from the recent heterogeneous firm models of international trade, pioneered amongst others by Melitz (2003) and Helpman, Melitz and Yeaple (2004), into our empirical model of outward FDI by UK firms. As these models make clear, differences in the underlying characteristics of firms, captured in theory as productivity differences, mean that even when faced with the same set of choices about global engagement, which presumably will include the incentives to avoid environmental regulation in the home market, only the best firms in the industry are sufficiently productive to cover the sunk costs associated with FDI. Empirically

significant role for environmental regulations.

this suggests that in addition to the standard industry level measures of environmental regulation it is therefore important to control for firm characteristics in the modelling of outward FDI and that changes in environmental regulation may only affect the choices of a relatively small number of firms. We also study a second extensive margin to outward FDI; the choice about which locations to host that production. If the sunk costs of becoming a multinational differ across countries and the weakest environmental regulations are in countries that are culturally and physically distant, i.e. those with the highest entry costs, then only a small fraction of multinational firms will able to take advantage of these differences in environment regulation. If potential pollution havens instead have greater proximity to the home country and therefore lower entry costs, in comparison the pollution haven effect will encourage a greater proportion of multinationals to locate production there. Across these two questions we therefore focus on the 'who' and the 'where' components of the pollution haven hypothesis.

In terms of the empirical methodology the paper is closest to that of Yeaple (forthcoming) who examines the location choices of U.S. multinationals, while from the environmental literature only Smarzynska and Wei (2004) have modelled the pollution haven hypothesis in this way. To the best of our knowledge, no previous studies have considered whether there is a pollution haven effect from environmental regulation for the UK. This is despite the fact that the UK is subject to relatively stringent environmental regulations which are strongly enforced,[2] whilst also being one of the major outward investors of the world economy. In fact, the UK was the second largest outward investor in 2007, with a stock of FDI outflows that exceeded $1.7 trillion (UN, 2008).

From the analysis we find that, controlling for firm performance, environmental regulations are not a robustly significant determinant of the internationalisation decision made by a firm. On the other-hand, there is strong evidence to suggest that if it is costly for the multinational enterprise (MNE) to comply with stringent environmental regulations, its location decision will be affected by the environmental regime in place in the host country. Any effect is however highly conditional upon other factors, notably how corrupt the host country is. Relaxing environmental regulations in an uncorrupt country has a significantly positive effect on the probability a MNE locates there, but there is no effect if the country

[2] The 2007 Executive Opinion Survey ranked the UK fourteenth out of 131 countries in terms of the overall stringency of its environmental regulations (World Economic Forum, 2007)

is highly corrupt. In contrast to many previous studies, we establish results that are highly robust across a variety of different model specifications and estimation techniques.

The rest of the paper is organised as follows. The next section describes the simple econometric framework employed. Section 3 then presents our data, focusing in particular on the environmental variables. In section 4 we present and discuss our results and perform a range of robustness checks. Finally, section 5 concludes.

2 Econometric Methodology

If the pollution haven effect from UK environmental regulation is an important determinant of the internationalisation decision made by firms we would anticipate that, controlling for all other firm and industry characteristics, UK firms in industries with high environmental compliance costs would be more likely to own affiliates abroad than those in industries with low environmental compliance costs. This is tested in this paper using a Probit regression equation of the following form:

$$Subsidiary_i = \beta_0 + \beta_1 EnvironmentalCosts_j + \beta_2 X_i + \beta_3 Y_j + \varepsilon_i \quad (1)$$

for firm i in industry j. *Subsidiary* is a binary variable which takes a value of 1 if the firm has one or more foreign subsidiaries and 0 if it does not. *EnvironmentalCosts* is a measure of environmental compliance costs in industry j. A positive and significant value for β_1 would indeed suggest that UK firms in industries for which it is costly to comply with the environmental regulations are more likely to be MNEs. Mindful of the possible correlation between our measure of environmental costs and other factors that influence the domestic return to investment (relative to abroad) within an industry we also include other industry factors thought to be important in determining outward FDI decisions, namely measures of the physical capital intensity, human capital intensity, and technological intensity (R&D expenditure). These are included in the vector Y. Caves (1982), Helpman (1984) and Brainard (1993) emphasise the importance of factor proportions to explaining the pattern of foreign direct investment. In addition, previous studies using U.S. data have shown that pollution intensive sectors, which will have high environmental compliance costs, are also generally physical capital intensive (e.g. Antweiler et al. (2001)). A possible explanation is that the greater use of machinery and equipment by industry may generate more pollution. Cole et al. (2005) find a relationship between human capital intensive manufacturing UK industries and pollution intensity. They suggest this could be because skilled labour is required to maintain complex industrial processes, which often generate more pollution. We also include R&D because its importance to FDI is stressed by the intangible asset theory of foreign investment (as developed by Horstmann and Markusen, 1989).

We control for differences in the characteristics of firms within the vector X. Multinational firms have been consistently found to have superior performance characteristics compared to non-exporters (Helpman et al., 2004). We would therefore anticipate that the better firms within an industry are more likely to be multinationals. As specified above, equation (1) assumes that all firms in the sample are affected in the same way by $EnvironmentalCosts$ and the control variables. However, we expect the coefficients to vary over the sample. For example, a relatively unproductive firm might not become a MNE regardless of the extent stringent UK environmental regulations increase that industry's costs. On the other-hand, highly productive firms may be significantly affected. We therefore introduce interaction terms to account for such possible firm behaviour. Finally ε is an error term.

A second component of the pollution haven hypothesis is where firms choose to locate. The stringency of the environmental regulations in the destination countries is an important element of the pollution haven hypothesis. Even if regression (1) reveals that firms in industries with high environmental costs are more likely to become MNEs, it could be that these firms are locating their subsidiaries in countries with equally or more stringent environmental regulations than the UK. This would suggest other country factors are more important in the location decision.

We consider the factors that determine where UK MNEs locate their foreign subsidiaries by estimating a Probit estimation of the form:

$$\begin{aligned} SubsidiaryLocation_{i,m} &= \beta_0 + \beta_1 X_i + \beta_2 Industry_j + \beta_3 EnvironmentalReg_m \\ &\quad + \beta_4 EnvironmentalReg_m \times MediumCosts_j \\ &\quad + \beta_5 EnvironmentalReg_m \times HighCosts_j + \beta_5 Z_m + \varepsilon_{i,m} \qquad (2) \end{aligned}$$

for firm i and country m. $SubsidiaryLocation$ takes a value of 1 if the MNE has one or more subsidiaries in a given destination country and 0 otherwise. Hence for each MNE we now have one observation for every country included in the dataset. This gives a total of $i \times m$ observations. X as before is a vector of firm-level control variables. Here we anticipate that even amongst multinational firms, those with better performance characteristics are more likely to operate subsidiaries in more locations. As the pollution haven hypothesis does not provide definite predictions regarding the effect an industry's environmental costs has on the probability that a MNE in that industry will locate in a given country, we control for any industry wide factors using $Industry$ which is a vector of time invariant (two-digit) industry effects. $EnvironmentalReg$ is the stringency of environmental regulation in the destination country m. $MediumCosts$ is a dummy variable for firms in medium environmental cost industries, and $HighCosts$ is a dummy variable for firms in high environmental cost industries. Finally, Z is a vector of country-level controls.

Equation (2) includes interaction terms between our measure of a country's environmental standards and dummy variables categorising the costs of complying with UK environmental regulation in the firms' industry as medium or high. Low environmental compliance cost industries are the reference (omitted) category. These slope dummies allow for the possibility that UK FDI with high domestic environmental expenditures become relatively more attracted to host countries with weak environmental regulation. This is a direct corollary of the pollution haven hypothesis. Hence if this is the case, β_4 and β_5 should both be negative and significant, with $\beta_4 < \beta_5$. On the other-hand, β_3 should be insignificant because firms with low environmental costs should not be affected by the stringency of environmental regulations in host countries when choosing where to locate subsidiaries.

3 Data

The primary source of the firm-level data is the FAME (Financial Analysis Made Easy) dataset, published by Bureau van Dijk. From this database, we focus our analysis on UK manufacturing firms, which have a UK SIC(1992) code of 15-36 and are classified at the four-digit UK SIC(1992) level. Information is available on whether or not each firm has foreign subsidiaries and, if the firm does, in which countries they are located. Although the firms are observed within a 10 year window (1996 to 2005), information on foreign subsidiaries is however only observed in the last year. Hence our firm data are for the year 2005. This is a weakness of the available data, although one common to that found elsewhere in the literature

(Smarzynska and Wei, 2004). We accordingly assume that the stock of FDI in 2005 is determined by a set of exogenous variables measured at that point in time. If the cross-industry differences in pollution abatement are persistent across industries, this may mean we capture the long-run effects of the pollution abatement hypothesis in using the stock of FDI. If they are not then this may make it less likely we find evidence in support of the pollution haven hypothesis. Mindful of this issue we explore the sensitivity of our findings to measures of the pollution variables at different points in time.

Figure 1 displays the aggregate outward FDI flows of the UK manufacturing sector between 1990 and 2005.[3] This shows that outward FDI flows in manufacturing peaked in the late 1990s. In fact, total outward manufacturing FDI over 1990 to 1997 was exceeded by the following three years alone (1998, 1999 and 2000), before falling away again over 2001, 2002 and 2003. Hence it is likely that a large proportion of the MNEs in our dataset made their location decisions, and invested in a sunk start-up cost, in 1998, 1999 and 2000. In this case, changes in the characteristics of countries after this time might have had relatively little influence on the decision of many of the MNEs regarding where they should locate their affiliates. Similarly, the period is sufficiently long that any disinvestments are likely to have been completed. We therefore perform robustness checks of regression (2) in which country variables ($EnvironmentalReg$ and Z) are measured in the year 2000.

3.1 Environmental variables

To estimate regression equations (1) and (2) we wish to find a measure of the costs that firms must undertake to meet the requirements of the environmental legislation ($EnvironmentalCosts$). We follow the approach established by the existing literature by using pollution abatement costs (scaled by value added) as a measure of environmental compliance costs.

The 2005 pollution abatement operating cost data we use are collected by the UK Environmental Protection Expenditure Survey, which has run over the period 2001-2006. We refer to this measure as $EnvironmentalCosts$. These data are defined as all in-house expenditure in 2005 associated with the operation of pollution control abatement equipment and payments to external organisations for environmental services. This includes labour costs, leasing payments and maintenance costs for equipment

[3] Data displayed are obtained from the OECD.Stat database.

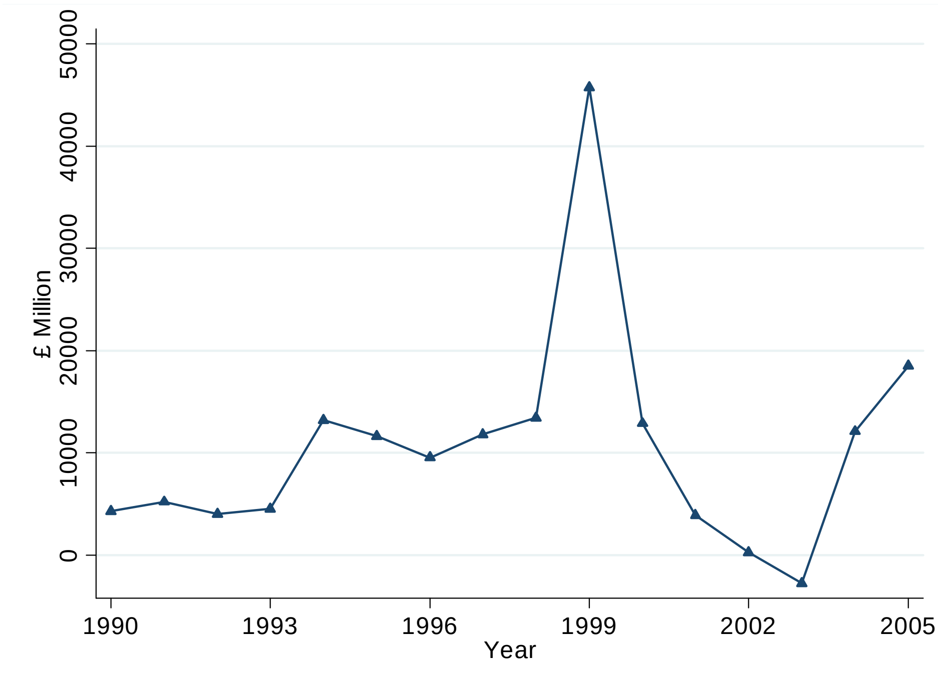

Figure 1: UK Outward FDI Flow

and payments made to others for the treatment and disposal of waste. Although this is the most detailed data available for the UK, it is available only at the two-digit SIC level. We also explore the robustness of our findings to more detailed pollution abatement cost data for the year 2005 for the U.S. (PACE 2005).[4] The PACE data have been published at the six-digit NAICS level (equivalent to four-digit SIC).[5] This data makes clear that there is a large spread in abatement costs within many five-digit NAICS industries, let alone the three-digit NAICS (which is equivalent to the two-digit SIC).

Although pollution abatement costs have become a widely used measure of the $EnvironmentalCosts$ variable, there are criticisms of this approach. Firstly, using a single measure of abatement costs for all firms within a particular industry overlooks the fact that in the UK the stringency of environmental regulation is determined to some extent at the local level. In the case of the UK, Cole et al. (2005) explain how this is the result of informal as well as formal regulation. Therefore although a firm may be in a particularly dirty industry, if it is also located in a region with relatively lax environmental regulations,

[4] The PACE survey was originally conducted annually between 1973 and 1994 (with the exception of 1987), but was discontinued after 1994 by the US Census Bureau for budgetary reasons.

[5] The 2005 PACE data are classified according to NAICS(2002). Nonetheless, importing these pollution abatement costs into the FAME dataset is not problematic because NAICS(2007) codes are available for each firm in FAME, and the NAICS(2007) and NAICS(2002) classification codes are very similar (only a few six-digit manufacturing sectors change). More detail on the treatment of the U.S. pollution abatement cost data is provided in the Appendix.

it could have far lower abatement costs than the industry average. One potential method for overcoming this caveat is to adjust the industry level measure of abatement costs according to the region in which the firm is located, and how stringent environmental regulations are in that region. Unfortunately, data are not available to allow us to weight the $EnvironmentalCosts$ variable in this way and we must accept we therefore capture an industry average effect, although it is only likely to affect the question of the decision to become a MNE (not the location of affiliates).

Secondly, if many plants with high environmental costs within a particular industry have already offshored pollution intensive production this will tend to lower the measure of domestic pollution abatement expenditure for the industry. While the use of firm-level FDI data might be seen to reduce the usual concern of endogeneity between abatement expenditure and industry FDI flows, we remain concerned by this point. This again motivates us to establish the robustness of our findings to the use of abatement cost data from an earlier time period. If at this earlier time, fewer firms have offshored their dirty production then the current stock of FDI is less likely to have affected the environmental costs variable in that earlier year. In fact, using past pollution abatement cost data could overestimate the effect of industry-level endogeneity. This is because abatement costs (scaled by value added) of dirty industries tended to be higher in the past relative to other industries not simply because they had not offshored their production, but also because they had not invested as much in newer and greener technologies. Thus if we find using this data that the results remain robust, we can be reasonably sure that the endogeneity of abatement expenditure is not a problem.

The earliest year in which the Environmental Protection Expenditure survey data are available for the UK is 2001. However, from Figure 1 we can see that large outward FDI flows had already taken place by this time. Hence the same problem could remain for this data. We therefore focus on the sensitivity of our findings to U.S. PACE survey data for 1994.

For equation (2) we require a country-level measure of the stringency of environmental regulations ($EnvironmentalReg$). For this task we employ a qualitative measure of environmental regulations using a variable taken from the Executive Opinion Survey (World Economic Forum, 2006), which featured 125 developed and developing countries. This survey, conducted in the early months of 2006, asked business executives to assess the "overall stringency of environmental regulation and enforcement" in their country on a scale of 1 to 7. Here 1 is defined as "lax compared to most countries" and 7 as "among the world's most stringent". In total, 11,232 responses were used for the 2006 survey. This variable has been used only by two previous studies which we are aware of; Wagner and Timmins (forthcoming) and Kellenberg (2009). As pointed out by Wager and Timmins (forthcoming), it has the advantage of avoiding the aforementioned endogeneity problems associated with pollution abatement cost variables, and it is also available for a far wider range of countries than measures used in previous studies. In addition, unlike other qualitative measures, it accounts not only for the stringency of environmental regulation but also the extent to which it is being enforced.

A common criticism of such survey data is that it may exhibit a "perceptions bias", i.e. respondents in a given economy systematically provide overly optimistic or pessimistic responses. The Executive Opinion Survey aims to minimise any such bias in three ways. Firstly, the raw data are subjected to rigorous quality control processes. Outliers are excluded, in particular answers which are clearly too positive or negative in their outlook. Secondly, the questions are worded in a way that encourages respondents to compare the situation in their economy against the best-performing economies in the world, rather than considering the absolute performance of their economy. Thirdly, companies are selected whose size and scope guarantee that their business executives are not only familiar with the current conditions in their country, but also have knowledge and experience of the global environment. Hence it is argued that they are well positioned to judge their economy's position relative to that prevailing in others. Every effort is made to ensure that the sample of respondents is representative of the national business sector in each country. In order to achieve this, the World Economic Forum has established collaborative partnerships with a network of over 130 institutions around the world.

3.2 Control variables

We include firm and industry characteristics in regression (1), and firm and country characteristics in regression (2). The firm-level control variables include firm size measured in terms of the log of the number of employees ($Employees$), labour productivity ($LabourProductivty$), and firm export participation and intensity ($Exporter$ and $ExportShare$ respectively). The industry-level control variables (all measured at the two-digit SIC level) include physical capital intensity ($PhysicalCapital$), human capital intensity ($HumanCapital$) and the R&D intensity ($R\&D$) of an industry. $R\&D$ is likely to be correlated with $EnvironmentalCosts$ as a high level of R&D intensity is likely to reduce the resource intensity of the production process. There may be further linkages if environmental regulations have a significant impact on firm behaviour. Firms may respond by investing in green technologies rather than offshoring dirty production. Hence R&D may have become a substitute for establishing foreign subsidiaries. The final industry-level variable is a measure of industry scale economies, defined in terms of value added divided by the number of firms ($ScaleEconomies$). Large scale economies would suggest greater benefits to concentrating production, and thus again by Brainard's (1997) proximity-concentration trade-off, less FDI might be expected. Likewise, greater economies of scale in resource use should reduce the environmental costs of production.

Country controls Y are included in regression (2) as these factors may co-vary with the environmental regulations in place. Again following Brainard's (1997) the proximity-concentration trade-off theory, we include in the regression a measure of market size (measured by GDP) and distance from the UK ($Distance$). As is standard in the FDI literature, we also include a proxy for labour costs in the form of per capita income ($GDPpercapita$). The stock of FDI in the country ($FDIStock$) is included to capture agglomeration/congestion externalities to FDI. The importance of agglomeration/congestion externalities to foreign investment has been extensively developed in the international economics literature (see for example Goldstein and Gronberg (1984) and Wheeler and Mody (1992)). In addition, following the factor proportions explanation for FDI we include the average years of schooling to capture human capital ($Education$). A large endowment of human capital in a country has been shown to facilitate the adaptation of foreign technologies (Nelson and Phelps (1966), Benhabib and Spiegel (1994)) and hence has been found to attract foreign investment (see for example Noorbakhsh and Paloni (2001)). Finally, we control for the effect of being a member of the OECD ($OECD$). The Appendix provides full details regarding the definitions and sources of all variables.

We then extend the range of country-level control variables by introducing a variety of indices which intend to capture the general policy environment and institutional infrastructure of the destination country. To be consistent with the intangible asset theory of investment we introduce an index which captures the protection offered by the legal system and the quality of property rights (*LegalSystem*). We also control for the freedom to trade internationally in the host country (*Openness*) and for the size of government (*GovernmentSize*). *LegalSystem*, *Openness* and *GovernmentSize* are all obtained from the Fraser Institute, and rated on the basis of a 1-10 index where 10 denotes greater economic freedom.

Finally, we follow Fredriksson et al. (2003) and Cole et al. (2006) by investigating the role of corruption (*Corruption*) in the context of pollution havens. The measure of corruption considered is the Corruption Perceptions Index published by Transparency International. It relates to perceptions of the degree of corruption as seen by business people and country analysts and ranges between 0 (highly clean) and 10 (highly corrupt). The impact of corruption on FDI has been the subject of much debate. On the one-hand it may increase the risk associated with foreign investment, although on the other-hand it may offer firms the opportunity to receive special treatment from government officials seeking bribes. In particular, firms may avoid fulfilling environmental regulatory requirements in corrupt states. Hence the impact of *EnvironmentalReg* may be conditional upon the level of corruption, which is reflected by the introduction of an interaction term between *Corruption* and *EnvironmentalReg*.

3.3 Descriptive statistics

In total, there are 6,762 UK owned manufacturing firms in the sample,[6] which includes 715 MNEs. MNEs are therefore only a small proportion of the total number of firms (10.6%). The two-digit UK pollution abatement cost data are available for all of these firms. Only 5,130 firms in our sample are located in industries in which U.S. pollution abatement cost data are available however, which includes 571 MNEs. Hence when testing the robustness of the results using the U.S. data, the sample size will fall. Regarding the U.S. data, in 2005 pollution abatement costs totalled $20.7 billion, which for the same industries compares to $24.7 billion in 1994 (2005 dollars). Hence there has been a substantial fall in pollution abatement costs over recent years. This is consistent with the possibility that firms have been investing in green technologies, but it is also consistent with the possibility that by 2005 many dirty firms had offshored their production, thereby lowering their domestic abatement cost expenditure.

[6] Here UK ownership is defined in terms of the global ultimate owner being based in the UK.

Descriptive statistics for the *EnvironmentalCosts* and the firm-level and industry-level control variables, are included in Table 1 below.[7]

Table 1: Summary statistics of firm data

Variable	Mean	Standard Deviation	Minimum	Maximum	Observations
EnvironmentalCostsUK	0.0121317	0.0082307	0.0016572	0.0377358	6762
Employees	537.4583	4135.43	1	212000	6762
LabourProductivity	739.4788	20076.86	0.1578947	1307333	6762
Exporter	0.4695356	0.499108	0	1	6762
ExportShare	0.1524958	0.2626586	0	1	6762
PhysicalCapital	13395.9	8247.197	5946.743	60060.73	6762
HumanCapital	0.4032324	0.0636095	0.0861908	0.7138127	6762
R&D	0.0431938	0.081909	0.0023249	0.4167822	6762
ScaleEconomies	1516465	2071231	323795.5	1.41e+07	6762

Note: Descriptive statistics are given for variables in levels, although in the estimated regressions all quantitative variables enter in logarithmic form

Further descriptive statistics can be used to provide useful information regarding the relationship between *EnvironmentalCosts* and the FDI behaviour of firms. Firstly, it should be noted that the mean *EnvironmentalCosts* for MNEs is 1.22% whilst for non-MNEs it is 1.16%. Hence MNEs spend fractionally more on pollution abatement operating costs, although the difference is not significant at the 5% significance level (the t-statistic is 1.825). Secondly, we consider the distribution of MNEs across the industries with the highest and lowest pollution abatement costs. This is summarised by Table 2. If there is a significant pollution haven effect in the UK, the dirty industry firms are likely to have offshored their production and therefore a large proportion should have foreign subsidiaries. However, it is clear from Table 2 that MNEs represent a greater proportion of the total number of firms in the cleanest industries (11.24%) than the dirtiest (9.53%). Hence the pollution haven effect does not appear to be strong enough to dominate other factors in determining firms' FDI decisions.

In the estimation of equation (2), we consider a sample of up to 109 developed and developing countries. A full list of these countries is given in Table A1 in the Appendix. MNEs tend to locate their subsidiaries in a small number of locations. On average the total number of 715 MNEs have subsidiaries in only 3.6

[7] Although environmental costs are observed at the industry level, Table 1 summarises each firm's observed value for *EnvironmentalCostsUK*, and hence there are 6,762 observations.

Table 2: Proportion of MNEs in each industry, by pollution abatement costs

Dirtiest manufacturing industries	pac	n	MNEs	Cleanest manufacturing industries	pac	n	MNEs
Leather products	3.7736	40	1	Furniture	1.0760	665	51
Pulp and paper	3.3926	176	18	Apparel	1.0665	146	19
Chemicals excluding pharmaceuticals	3.2015	383	52	Motor vehicles	0.9073	126	15
Coke, petroleum and nuclear fuel	3.0684	23	5	Fabricated metal products	0.8640	834	77
Basic metals	1.8956	207	12	Other transport equipment	0.7318	159	14
Rubber and plastics	1.8881	352	29	Machinery	0.7305	471	66
Textiles and textile products	1.8160	233	20	Office machinery and equipment	0.6569	111	25
Wood and wood products	1.5793	171	7	Electrical apparatus	0.5518	311	40
Food products; beverages and tobacco	1.5701	747	68	Radio, TV and communications	0.5152	187	38
Non-metallic mineral products	1.2613	194	17	Publishing and printing	0.3628	872	68
Pharmaceuticals	1.0835	118	23	Medical and optical products	0.1657	236	50
Total MNEs as a percentage of total n			9.53	Total MNEs as a percentage of total n			11.24

countries. In addition, subsidiaries are most commonly located in other OECD countries, with 96% of the 715 MNEs having at least one subsidiary located within an OECD member. In contrast, 76% have subsidiaries in non-OECD countries. Table 3 provides summary statistics of the country-level variables included in equation (2). Note that due to missing data the inclusion of *Education* and/or the policy variables will lead to a fall in the number of countries included in the sample.

Table 3: Summary statistics of country-level data

Variable	Mean	Standard Deviation	Minimum	Maximum	Observations
EnviromentalReg	4.19	1.17	2.4	6.7	109
GDP	1256074	8503543	3456	8.82e+07	109
GDPpercapita	15503	14024	706	80471	109
Distance	5829	3863	324	19147	109
OECD	0.26	0.44	0	1	109
FDIStock	83149	194002	75	1634121	109
Education	6.25	3.19	0	12.25	85
Corruption	5.40	2.30	0.30	8.30	107
GovernmentSize	6.05	1.44	2.54	9.18	97
LegalSystem	5.62	1.99	1.79	9.17	97
Openness	7.03	1.12	1.88	9.48	97

Note: Descriptive statistics are given for variables in levels, although in the estimated regressions all quantitative variables enter in logarithmic form

4 Empirical Results

4.1 Environmental Regulations and the Internationalisation Decision

Table 4 provides the results for the Probit estimation of equation (1). Four different specifications are estimated. Specification (a) is equation (1), but without the industry-level control variables. Specification (b) then includes the four industry-level controls. Both (a) and (b) assume that the effect of $EnvironmentalCosts$ on MNE decisions is continuous. For an alternative assumption that environmental costs must reach a threshold level before they trigger outflows of FDI, specification (c) introduces interaction terms between dummy variables for medium and high environmental cost sectors ($MediumCosts$ and $HighCosts$ respectively), and $EnvironmentalCosts$. Low environmental cost industries are therefore the reference category. We consider high environmental cost sectors as the four sectors with the highest pollution abatement expenditure. These include leather products (SIC 19), pulp and paper (SIC 21), the manufacture of coke, petroleum and nuclear fuel (SIC 23) and chemicals excluding pharmaceuticals (SIC 24 other). Each of these sectors spent more than 3% of their value added on pollution abatement. For the total sample of 6,762 firms, there are 622 firms in these sectors. For comparison, the industry with the next highest spending on pollution abatement, basic metals, spent 1.9% of value added on abatement. We consider low environmental cost sectors as the four sectors with the lowest pollution abatement expenditure. These industries are publishing and printing (SIC 22), electrical apparatus (SIC 31), radio, TV and communications (SIC 32), and medical and optical products (SIC 33). Each of these sectors spent less than 0.6% of their value added on pollution abatement. This amounts to 845 firms. The remaining 5,295 firms are classified as having medium environmental costs. Finally, specification (d) considers whether there is a difference in response to environmental costs across firms according to their productivity level, which we capture using an interaction term between $EnvironmentalCosts$ and $LabourProductivity$.

As suspected, omitted industry specific factors have a strong bearing on the correlation between environmental costs and the decision to become a multinational. In regression (a) $EnvironmentalCosts$ has a negative effect on the probability of becoming a MNE, the opposite effect to that predicted by the pollution haven hypothesis. This result alters in specification (b), $EnvironmentalCosts$ becomes insignificant, once we introduce other industry variables. We conclude from these results that if there is any evidence that environmental considerations are a significant determinant of the outward FDI decision of UK firms, it is not as predicted by the pollution haven hypothesis. This might occur because pollution abatement costs are too small a proportion of total costs to affect a firm's internationalisation decision. It might alternatively be argued that the pollution haven hypothesis reflects to a larger extent a vertical rather than horizontal FDI motive. If for the UK host countries with substantially weaker environmental standards are geographically distant then the trade costs associated with locating stages of the production chain in these countries may be prohibitive. Furthermore, there is evidence to suggest that the most highly polluting industries are not very geographically mobile, or footloose (Ederington et al., 2005). Hence a globalisation strategy designed purely to exploit lax environmental standards abroad

Table 4: Probit estimation of decision to become a MNE

	Specification							
Variables	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
EnvironmentalCosts	-.0199309	-.0008707	.0004516	.0054848				
	(-4.35)***	(-0.15)	(0.04)	(0.23)				
USEnvironmentalCosts94					-.0099751	-.0068964	-.0072232	.0262846
					(-2.95)***	(-1.79)*	(-1.74)*	(1.50)
MediumCosts*EnvironmentalCosts			.001153				-.0004649	
			(0.39)				(-0.27)	
HighCosts*EnvironmentalCosts			.000455				-.0014167	
			(0.06)				(-0.35)	
Employees	.0483651	.0487924	.0488339	.0487792	.0519651	.0528174	.0528204	.0527023
	(20.86)***	(20.85)***	(20.85)***	(20.85)***	(18.89)***	(18.96)***	(18.96)***	(18.95)***
LabourProductivity	.0250695	.0246192	.0246009	.0186786	.0244792	.0253669	.0253153	-.0093199
	(7.25)***	(7.09)***	(7.08)***	(0.85)	(5.96)***	(6.13)***	(6.11)***	(-0.50)
LabourProductivity*EnvironmentalCosts				-.0013096				-.0065855
				(-0.28)				(-1.93)*
Exporter	-.0410671	-.041308	-.0413659	-.0414206	-.0474197	-.0459555	-.0460988	-.0467799
	(-4.69)***	(-4.76)***	(-4.76)***	(-4.76)***	(-4.53)***	(-4.45)***	(-4.46)***	(-4.53)***
ExportShare	.1712784	.1570156	.1566875	.1571176	.1885217	.1632296	.1633735	.1638891
	(11.74)***	(10.78)***	(10.75)***	(10.79)***	(11.02)***	(9.55)***	(9.55)***	(9.59)***
PhysicalCapital		.0471687	.0453301	.0473029		.0432162	.0435639	.0447593
		(4.30)***	(3.53)***	(4.30)***		(3.43)***	(3.09)***	(3.55)***
HumanCapital		.0798845	.0824364	.0802658		.0881708	.0863875	.0932444
		(3.24)***	(2.78)***	(3.25)***		(3.03)***	(2.95)***	(3.18)***
R&D		.0155086	.0153963	.0155217		.0183713	.0186888	.018087
		(4.87)***	(4.59)***	(4.87)***		(5.48)***	(5.36)***	(5.40)***
ScaleEconomies		-.0422465	-.0420202	-.0422488		-.0404025	-.0410986	-.0409651
		(-4.86)***	(-4.24)***	(-4.86)***		(-4.44)***	(-4.24)***	(-4.50)***
Observations	6762	6762	6762	6762	5484	5484	5484	5484
R-squared	0.1615	0.1705	0.1706	0.1705	0.1523	0.1656	0.1656	0.1666

Note: Reported coefficients are marginal effects calculated at the mean of the right-hand side variables. Z-statistics from a test of the significance are given in parenthesis. *** indicates statistical significance at the 1% significance level, ** at the 5% level, and * at the 10% level. All quantitative variables are in logs.

may simply not be economically worthwhile for UK firms in comparison to say, being located close to markets (Brainard, 1987).

These conclusions are robust to treating the environmental costs variable as a threshold variable. There is no evidence of a threshold level to the effects of abatement costs in specification (c). High or medium cost firms do not behave differently in this respect to low polluters, or to each other, for both sets of pollution abatement data.[8] In addition, specification (d) suggests there is no evidence for our sample that the firms' response to changes in *EnvironmentalCosts* of the industry is conditional upon the productivity of their labour. We find similar results if we interact *EnvironmentalCosts* with firm size (not reported).

The control variables are highly significant across the regressions. As expected larger firms with higher labour productivity are more likely to become MNEs, as are those which are more globally engaged in terms of a greater export share. These results confirm those found elsewhere in the international trade literature on firm characteristics and the mode of global engagement (see Greenaway and Kneller, 2007 for a review). Exporting per se however lowers the likelihood that a firm engages in FDI, as indicated by the variable *Exporter* which is negative and significant. This suggests that firms decide to export as a substitute for establishing foreign subsidiaries, supporting Brainard's (1997) proximity-concentration trade-off hypothesis. Firms located in industries that are more physical capital intensive and human capital intensive are more likely to become MNEs. This suggests that there are countries abroad where physical and human capital are cheaper, and thus firms in industries which use these factors intensively in general have more to gain in terms of cost reductions by relocating abroad. In addition, firms in more research intensive industries are more likely to establish MNEs (*R&D* is positive and significant). Hence R&D appears to be a complement, rather than a substitute, for becoming multinational. Finally, the *ScaleEconomies* variable has a negative and significant relationship with outward FDI: a lower average market share within an industry increases the tendency to conduct FDI.

In the remaining regressions in Table 4 we test the robustness of these results to the use of U.S. pollution abatement cost data. As discussed, the U.S. data has the advantage that it is more disag-

[8] This result is also robust to modelling the variable effect of *EnvironmentalCosts* across firms by adding an *EnvironmentalCosts* squared term to model (c), rather than using slope dummies.

gregated.[9] The 1994 PACE data is of additional interest because the offshoring of dirty production by pollution intensive industry prior to 2005 may have affected the distribution of abatement costs across industries. Nonetheless, we again find that the results are broadly unchanged. $USEnvironmentalCosts94$ is now weakly significant for specifications (f) and (g), although of the wrong sign. However, similar to before it becomes insignificant in specification (h), and is also insignificant if we include the apparel sector firms (again this is not reported to conserve space). The significance of the control variables is also unaffected. The only minor difference is that the interaction term between *LabourProductivity* and *EnvironmentalCosts* becomes weakly significant, although again it has an unexpected negative relationship. We therefore conclude that the lack of support for the predictions of the pollution haven hypothesis is robust.

4.2 Environmental Regulations and the Location Decision of MNEs

We use Table 5 to report on a second aspect of the pollution haven hypothesis; where firms that choose to become multinationals locate their affiliates. Model (a) is a simplified version of equation (2), which excludes policy variables and the slope dummies. We use controls for the general policy environment - government size (*GovernmentSize*), protection offered by the legal system and property rights (*LegalSystem*), and openness to trade (*Openness*) - in regression (b).[10] Due to missing data the sample falls from 109 to 97 countries. Specification (c) adds the *Corruption* measure, and also interacts this term with the environmental stringency of the destination country (*EnvironmentalReg*). There are 96 countries in these regressions. Fourthly, we introduce interaction terms to allow for differences between firms in high, medium and low environmental costs industries in their response to changes in *EnvironmentalReg* (specification d). Again, low environmental cost industries are the reference category. 196 MNEs are classified as low cost, 443 are medium and 76 are high. Finally, specification (e) also includes *Education*. Including this variable results in a further drop in the number of countries to just 76. The firm-level control variables (*Employees*, *LabourProductivity*, *Exporter* and *ExportShare*) and industry dummies are all not reported to conserve space.

[9] Using the 2005 PACE survey data we find no effect on the conclusions drawn. These results are available from the authors on request.

[10] Two further controls of the policy environment were also considered (macroeconomic stability and the extent of regulation of credit, labour and business). However, these variables were generally found to be insignificant, and at the same time introduced multicollinearity problems. Hence they are excluded from the analysis presented here.

Table 5: Probit estimation of the location decision of MNEs

Variables	(a)	(b)	(c)	(d)	(e)
EnvironmentalReg	.0006247	-.0007761	-.0021464	-.0016573	-.0015061
	(5.36)***	(-3.83)***	(-5.84)***	(-4.41)***	(-3.21)***
MediumCosts*EnvironmentalReg				-.0006104	-.0009059
				(-3.04)***	(-3.57)***
HighCosts*EnvironmentalReg				-.0007948	-.0011753
				(-3.69)***	(-4.32)***
GDP	.0006497	.0010176	.0008359	.0008211	.0009886
	(7.34)***	(7.57)***	(5.93)***	(5.93)***	(5.51)***
GDPpercapita	.0000932	-.0006137	-.0011635	-.0011329	-.0013734
	(0.53)	(-2.47)**	(-3.75)***	(-3.72)***	(-2.64)***
Distance	-.000506	-.0013613	-.0011354	-.0011091	-.0013147
	(-6.11)***	(-8.83)***	(-7.13)***	(-7.08)***	(-6.32)***
FDIStock	.0020183	.0026464	.00253	.0024868	.0027857
	(12.41)***	(12.20)***	(11.94)***	(11.86)***	(9.30)***
OECD	.000962	.0003856	.0005369	.0005174	.0002763
	(3.27)***	(1.09)	(1.54)	(1.51)	(0.67)
GovernmentSize		.00077	.00051	.0004962	.0005843
		(6.97)***	(4.92)***	(4.88)***	(4.78)***
LegalSystem		.0018184	.0020016	.0019692	.0025518
		(10.20)***	(10.73)***	(10.69)***	(9.83)***
Openness		-.0010414	-.0009861	-.0009693	-.0006661
		(-5.97)***	(-6.21)***	(-6.21)***	(-2.70)***
Corruption			-.0016044	-.0016063	-.0009703
			(-4.25)***	(-4.32)***	(-1.85)*
Corruption*EnvironmentalReg			.0003569	.0003575	.0002961
			(6.21)***	(6.31)***	(3.78)***
Education					.0014539
					(1.87)*
Observations	77935	69355	68640	68640	54340
R-squared	0.3771	0.3777	0.3821	0.3828	0.3789

Note: Reported coefficients are marginal effects calculated at the mean of the right-hand side variables. Z-statistics from a test of significance are given in parenthesis. *** indicates statistical significance at the 1% significance level, ** at the 5% level, and * at the 10% level. Firm controls and industry dummies are not reported to conserve space. All quantitative variables are in logs.

Before moving to discuss the results for the effect of environmental regulations on outward FDI we briefly discuss the results for the other variables included in the regressions. The control variables reassuringly have the expected signs. Market size as measured by *GDP* attracts FDI. MNEs also locate subsidiaries in countries with a low income per head (*GDPpercapita* is negative and significant), indicating that labour costs are important. Again we find evidence that multinational location decisions reflect a trade-off between achieving proximity to consumers and scale economies. In particular, higher transport costs and tariff barriers (as captured by *Distance* and *Openness* respectively) make it desirable to conduct FDI in the target market.[11] In common with Wagner and Timmins (forthcoming), we find a statistically significant role for FDI agglomeration effects. In fact, there are strong positive externalities associated with FDI agglomeration. *GovernmentSize* and *LegalSystem* both have positive and strongly significant effects, suggesting that countries with small governments and strong legal protection are preferable to MNEs. Finally, there is some support for the theory that factor proportions are important for direct investment, with countries that are skill intensive attracting FDI (*Education* is positive and significant at the 10% level).

From regression (a) we find there is no evidence in favour of the pollution haven hypothesis. In fact, conversely it appears as though countries with stringent environmental regulations are more likely to attract UK MNEs. However, this would appear to be a consequence of other important control variables omitted from the regression, in particular the policy control variables. If we introduce government size, protection offered by the legal system, and openness to trade, we now find that *EnvironmentalReg* has a negative and significant effect on the probability of firm location. Conditional on a range of other aspects of policy we find the first evidence that multinational firms are attracted to locations that have lower environmental regulations.

With the further addition of the corruption variable in regression (c) the magnitude of the deterrent effect from environmental regulation even increases. Hence it appears as though even with the inclusion of other policy variables, *EnvironmentalReg* to a large extent picks up the positive effect of lower corruption. Corruption itself is found to deter UK foreign investment. From regression (d) we also find

[11] In addition, the possible trade-off is supported by the result that *Exporter* (not reported in Table 5) is negative and significant, suggesting that firms decide to export to a destination as a substitute for establishing foreign subsidiaries there.

that the more corrupt the country, the less the deterrent effect from stringent environmental regulations (*Corruption***EnvironmentalReg* is positive and significant). Again this would tend to support the pollution haven hypothesis. From specification (e) there is a possibility that the direct effect of corruption arises in part because it is acting as a proxy for human capital (*Corruption* becomes only weakly significant), but both the direct and interaction effects for *EnvironmentalReg* are robust.

For specification (c), the predicted probabilities of establishing subsidiaries in a country range from 0.000 to 0.982 across the 68,640 firm-country combinations, although the mean predicted probability is just 0.034 (or 3.4%). Hence for the vast majority of observations there is a low probability that the dependent variable *SubsidiaryLocation* takes a value of 1. This reflects the data, where most multinationals have affiliates located in only a small number of countries. Although the results support the pollution haven hypothesis with the inclusion of the policy variables, even with corruption included the magnitude of the effect of *EnvironmentalReg* is not particularly large. A 1 unit increase in the environmental index of an average country reduces the chances of an average MNE locating one or more subsidiaries there by 0.21% for specification (c). Considering that *EnvironmentalReg* only ranges from 2.4 to 6.7 for all the countries in the sample, a 1 unit rise in the index would represent a substantial tightening of environmental policy. On the other-hand, this effect is larger than the marginal effects of the other variables included in the model which are measured on a similar scale (*Corruption*, *GovernmentSize*, *LegalSystem* and *Openness*). Of these variables, only strong protection offered by the legal system and high quality property rights (as measured by *LegalSystem*) has a marginal effect of a similar magnitude.

When reporting the impact of environmental regulations in the host country on the predicted probability of a MNE locating there, one should emphasise however, that it is highly conditional upon the level of corruption. We can depict this using Figure 2, which is based on the estimates of specification (c). The diagram plots the variable *EnvironmentalReg* against the predicted probability of location for three different types of countries; a country with a corruption index equal to the lowest value in our sample (low corruption), the sample average (average corruption), and the highest value in our sample (high corruption). All other variables are held at their sample means. It is clear from the diagram that the predicted probability of firm location is almost independent of environmental standards for highly corrupt countries, and even for countries with an average level of corruption. On the other-hand, the relative impact of environmental regulations for a country with a low level of corruption is substantial, with the probability of location more than ten times greater if $EnvironmentalReg$ takes a value of 2 rather than 7.

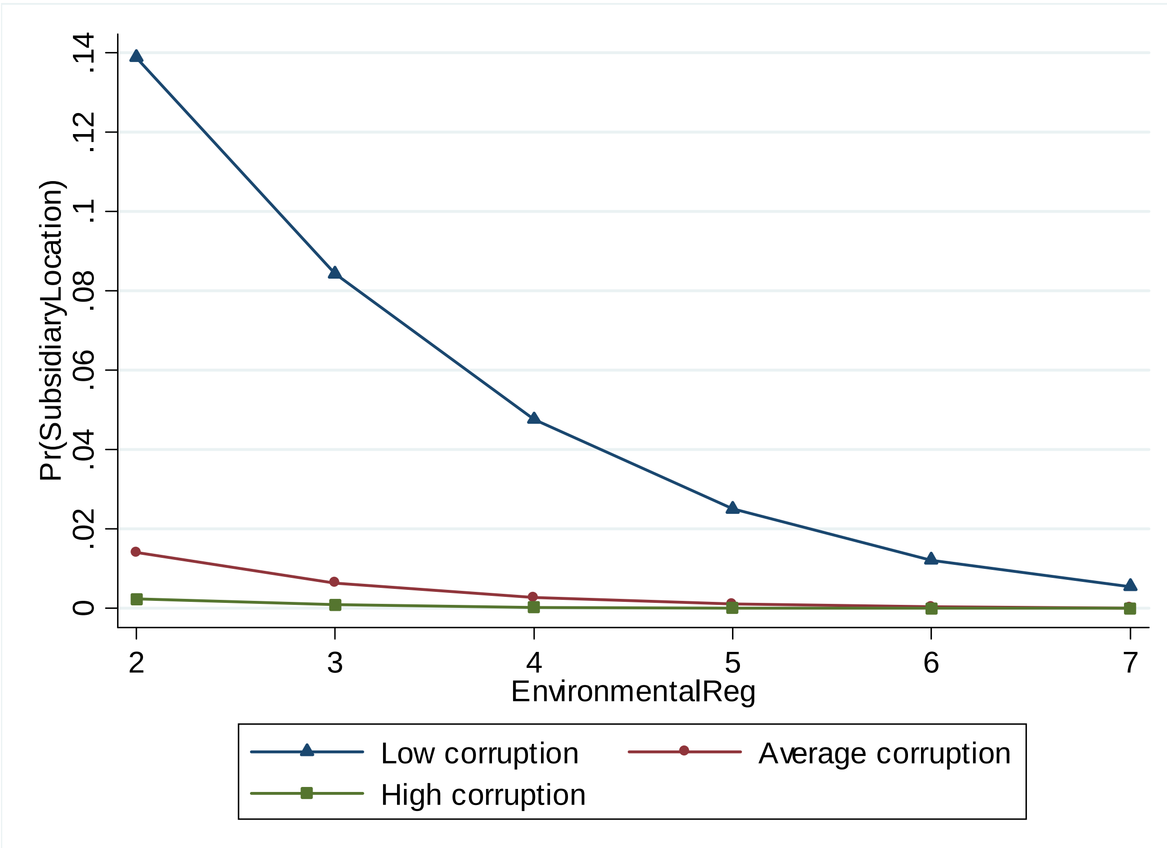

Figure 2: Role of corruption

Focusing now on specifications (d) and (e), we find that firms in high, medium and low environmental cost sectors are heterogeneous in their response to $EnvironmentalReg$. High cost sector firms are more strongly deterred from establishing subsidiaries in a country with stringent environmental regulations than low and also medium cost firms (for specification (d) the null hypothesis that the coefficients on $MediumCosts * EnvironmentalReg$ and $HighCosts * EnvironmentalReg$ are equal gives a χ^2 statistic of 3.97, which is rejected at the 5% level). Hence the more costly it is to comply with UK environmental regulations, the more attractive countries with weak environmental regulations become. It is perhaps surprising to find that even for the low cost sector there is a statistically significant deterrent effect from

EnvironmentalReg. However, it is arguably not economically significant, and is not found to be robust in some specifications reported later, in which we estimate separate regressions for the high, medium and low cost sectors.[12]

A further robustness check is provided by Table A2 in the Appendix, which repeats the estimations reported by Table 7 using year 2000 country variables. Recall that Figure 1 suggests a large proportion of the MNEs in our sample may have made their decision to establish foreign subsidiaries in the late 1990s. Hence it might be more relevant to measure the country variables at this time, rather than in 2005.[13] However, in 2000 the Executive Opinion Survey had a smaller country coverage, and hence the regressions in Table A2 include fewer countries (57 countries for specifications (a), 56 for (b) and (c) and 50 for (d)). Year 2000 country variables *Distance* and *OECD* are no different to 2005, whilst *Education* also takes the same values as in the previous regressions as it was previously being measured for the year 2000.

The estimation results given by Table A2 suggest that environmental regulations have a stronger role to play in determining the location in which UK MNEs establish foreign affiliates than previously estimated. For example, for specification (c), a 1 unit increase in *EnvironmentalReg* now decreases the probability of location by 0.58%, evaluated at sample means. This marginal effect is nearly three times that estimated by the corresponding regression in Table 5. To put this into context, the average predicted probability of a MNE locating in a destination country is 5.5%, which is higher than before as there are fewer countries in which MNEs only very rarely establish subsidiaries. Furthermore, specifications (d) and (e) tell us that the threshold effects of being a firm in a medium or high environmental cost sector are also stronger than before. For instance, (e) tells us that increasing *EnvironmentalReg* by 1 unit reduces the probability that firms in the high environmental cost sector establish foreign subsidiaries in that destination by 0.46% more than low cost sector firms. The corresponding percentage in Table 5 was

[12] Table 5 models the heterogeneity between firms of different environmental costs by introducing dummy variable interaction terms. This implies the existence of thresholds in *EnvironmentalCosts* beyond which firms behave differently. To test whether this relationship is more appropriately modelled as a continuous change between firms we tried interacting *EnvironmentalCosts* with *EnvironmentalReg*. The results generally remain robust. In fact, the magnitude of the direct deterrent effect from *EnvironmentalReg* is now much greater than in Table 5.

[13] In the Executive Opinion Survey 2000, business executives were separately asked to assess the stringency of the "overall pollution regulations" in their country, and to assess whether "environmental regulations are enforced consistently and fairly", rather than incorporating both aspects into a single question. Both questions were again on a scale of 1 to 7. We therefore take the average of these two indices to form our single index *EnvironmentalReg*.

just 0.12%.

Overall, there is strong evidence that the impact of *EnvironmentalReg* on the location decision of a MNE varies according to environmental compliance costs. This may also apply to the control variables. To further investigate heterogeneity in the behaviour of the firms in this respect, Table 6 reports separate regressions for high, medium and low environmental cost sectors. There are also other advantages to separating the sample in this way. For instance, it is now possible to calculate the marginal effects of changes in the right-hand side variables separately for each group of firms.

Table 6 reveals differences in the behaviour of each group of firms. For the high compliance cost sector, the bias from omitting corruption is particularly evident; *EnvironmentalReg* is insignificant for specification (a) but significant and negative at the 5% level for specification (b). Moreover, in the case of the latter, the magnitude of the coefficient is nearly double that estimated by the equivalent pooled regression (specification (c) in Table 6). A 1 unit increase in the environmental index now reduces the probability that a MNE in a high environmental cost sector will establish subsidiaries in a country by 0.37% with corruption included. Although the deterrent effect from environmental regulations is also significant for the medium and the low cost sector for specification (b), the magnitude of this effect is lower than that for the high cost sector. For medium cost polluters, the marginal impact of a 1 unit increase in the environmental index reduces the probability of location by 0.26%, and for low polluters by just 0.10%. These marginal effects imply that the probability of location compare to a mean predicted probability of 4.7%, 3.3% and 3.1% for high, medium and low environmental cost firms, respectively.

The estimation results discussed suggest that firms are less likely to locate subsidiaries in a country with stringent environmental regulations. Hence maintaining tough environmental standards may lead to a loss of jobs and production which would otherwise have been attracted to the country if environmental standards were weaker. In this respect, there is evidence of a pollution haven effect. It implies that governments can use environmental regulations as a policy tool to attract or discourage pollution intensive FDI. However, this result does not necessarily imply that there are countries that have become pollution havens, because it is conditional upon many other country variables. For instance, UK MNEs in high (as well as medium and low) environmental cost sectors are attracted to countries which offer strong legal

Table 6: Probit estimation of the location decision of MNEs for high, medium and low environmental cost industries

	High Environmental Costs		Medium Environmental Costs		Low Environmental Costs	
Variables	(a)	(b)	(a)	(b)	(a)	(b)
Employees	0.0050672	0.0044094	0.0022868	0.0021197	0.0014545	0.001345
	(7.28)***	(6.55)***	(12.27)***	(11.48)***	(6.38)***	(5.85)***
LabourProductivity	-0.0016611	-0.0014718	0.000223	0.000205	0.0001094	0.0000756
	(-2.44)**	(-2.45)**	(1.56)	(1.54)	(0.71)	(0.53)
Exporter	-0.0091178	-0.0081376	-0.0031038	-0.0028543	-0.0043855	-0.0040099
	(-3.10)***	(-3.05)***	(-5.38)***	(-5.25)***	(-4.18)***	(-3.99)***
ExportShare	0.0000448	-0.0000366	0.0068407	0.0063486	0.0038326	0.0034533
	(0.02)	(-0.01)	(8.80)***	(8.47)***	(4.83)***	(4.53)***
EnvironmentalReg	-0.0007038	-0.003715	-0.0011017	-0.0025779	-0.0001837	-0.0009808
	(-0.68)	(-2.01)**	(-4.10)***	(-5.22)***	(-0.71)	(-2.09)**
GDP	0.0016669	0.000835	0.0008899	0.0007551	0.0009308	0.0008674
	(2.53)**	(1.32)	(5.21)***	(4.15)***	(4.55)***	(3.81)***
GDPpercapita	-0.0023958	-0.0030769	-0.0007414	-0.0013579	0.0001806	-0.0002232
	(-1.94)*	(-2.15)**	(-2.31)**	(-3.35)***	(0.54)	(-0.52)
Distance	-0.0017113	-0.0009578	-0.0015834	-0.0013874	-0.0007577	-0.0006901
	(-2.35)**	(-1.40)	(-7.52)***	(-6.29)***	(-3.87)***	(-3.18)***
FDIStock	0.0053291	0.0054066	0.002669	0.0025689	0.001726	0.0015882
	(5.22)***	(5.37)***	(9.56)***	(9.35)***	(5.49)***	(5.22)***
OECD	0.0029749	0.0032537	0.0010679	0.001121	-0.0010261	-0.0008419
	(1.39)	(1.60)	(2.08)**	(2.20)**	(-2.89)***	(-2.38)**
GovernmentSize	0.0014245	0.0007499	0.0007778	0.0005321	0.0004889	0.0003651
	(2.58)***	(1.53)	(5.42)***	(3.89)***	(3.28)***	(2.51)**
LegalSystem	0.0022373	0.0033746	0.0018304	0.0020222	0.0014161	0.0014076
	(2.91)***	(4.06)***	(8.04)***	(8.39)***	(5.03)***	(5.03)***
Openness	-0.0008535	-0.0009393	-0.0009562	-0.0009381	-0.0010672	-0.0009818
	(-0.99)	(-1.27)	(-4.27)***	(-4.55)***	(-4.14)***	(-3.98)***
Corruption		-0.0029135		-0.0017765		-0.0009565
		(-1.57)		(-3.58)***		(-1.85)*
Corruption*Environ.		0.0008654		0.0003813		0.0001835
		(2.93)***		(5.03)***		(2.45)**
Observations	7372	7296	42971	42528	19012	18816
R-squared	0.3743	0.3836	0.3742	0.3782	0.3766	0.3803

Note: Reported coefficients are marginal effects calculated at the mean of the right-hand side variables. Z-statistics from a test of significance are given in parenthesis. *** indicates statistical significance at the 1% significance level, ** at the 5% level, and * at the 10% level. All quantitative variables are in logs.

system protection and high quality of property rights. These countries are characterised by stringent environmental regulations (the correlation between *EnvironmentalReg* and *LegalSystem* for the 96 countries included in the sample is 0.79, which is significant at the 1% level). On the other-hand, countries with weak environmental standards also have a lower per capita income (the correlation between *EnvironmentalReg* and *GDPpercapita* is 0.76, again significant at the 1% level), and firms in the high environmental cost sector tend to invest in such countries due to lower labour costs. In fact, for specification (b), just a 1% fall in *GDPpercapita* of an average country leads to a 0.31% rise in the chances of an average MNE in the high cost sector locating subsidiaries there. Arguably this is far more economically significant than the impact of *EnvironmentalReg*. Hence developing countries might be more likely to become pollution havens to dirty industry because they have lower labour costs rather than because they have weak environmental regulations. For some this might be seen as semantics. Put simply, the results suggest that developing countries may become dirtier due to UK FDI, although principally in order to take advantage of lower production costs rather than weak environmental standards. Meanwhile, for low environmental compliance cost industry we find that *GDPpercapita* is insignificant, despite the fact that clean firms are often thought of as labour intensive (see for example Cole and Elliot, 2005).

In contrast to *GDPpercapita*, the measure of market size (*GDP*) is a robustly significant determinant of MNE location for the low environmental cost firms, while it becomes insignificant for the high cost sector firms once we introduce *Corruption*. This suggests that when low cost firms locate abroad they do so with the aim of expanding into new markets, thereby strengthening their position in a global context. This possibility is supported by the result that low cost industry is more likely to locate subsidiaries in destination countries that are less open to free trade (*Openness* is negative and significant). Hence low cost sector firms are establishing subsidiaries in order to access closed markets which cannot be easily served by exporting. This is not the case for the high cost industry, for which *Openness* is insignificant. Moreover, it is more globally engaged low cost sector firms that are more likely to locate subsidiaries in a foreign country (i.e. they have a greater export share). In contrast, for high cost sector firms *ExportShare* is insignificant.

Other differences between the low and high environmental cost sectors include that a smaller size of government in the destination country's economy attracts low cost sector firms (*GovernmentSize* is positive and significant). We interpret this result as showing that firms in low cost sectors are attracted to countries with more market-friendly policy environments. That *GovernmentSize* is insignificant for high cost sector firms for specification (b) might therefore again indicate that they are more concerned with offshoring production rather than accessing new markets.[14,15]

4.3 Methodological Robustness Check: Conditional Logit Model Estimation

Thus far we have conducted Probit estimations of the location decision. This implicitly assumes that a given MNE makes an independent decision about whether or not to establish subsidiaries in each individual host country. It may be more appropriate, however, to model the firm's location decision as a choice among the M alternative countries in the dataset. The conditional Logit model (CLM) allows us to model the location choice of MNEs in this way.

Typically, in a CLM the individual makes only a single choice, assumed to be that which maximises utility. However, the nature of our dataset is such that a number of choices may be observed, i.e. MNEs often establish subsidiaries in more than one destination country. We therefore follow the location choice literature (for example, Becker et al., 2005) by assuming that the management of each MNE delegates the location decision to a number of decision makers who individually select a single location for investment out of the M alternative countries. Clearly these individual location decisions are likely to be correlated for each MNE. We therefore allow for clustering, such that observed location choices are assumed to be independent between MNEs, but not necessarily independent within an individual MNE's location decisions.

The CLM assumes that decisions regarding firm i's location are driven by a stochastic utility function U^*_{im}, where:

$$U^*_{im} = V_{im} + \varepsilon_{im}$$

for countries $m = 1, ..., M$. Here, V_{im} is the deterministic component of the utility that firm i derives

[14] As before, we test the robustness of the results reported in Table 6 to using country variables measured in the year 2000. As was the case for the pooled regression, we find that the magnitude of the effect *EnvironmentalReg* has on the probability of MNE location increases using 2000 data.

[15] An additional robustness check was also performed by introducing the measure of education in the destination country into specification (b). The results are not reported due to reasons of space, but for high, medium and low environmental cost firms this measure of human capital was found to be insignificant at the 10% level, and did notably affect the estimation results.

when choosing to establish subsidiaries in country m, and ε_{im} is the random component. The general form of the utility function V_{im} can be given as:

$$V_{im} = \mathbf{z}_m\gamma + \mathbf{x}_i\beta_m + \mu_m \tag{3}$$

where $\mathbf{z}_m$ contains values of the independent variables for country m, and γ contains the effects of the country-specific variables. μ_m is a country-specific fixed effect. One approach to including firm characteristics would be to create a characteristics variable which varies across countries. This would be achieved by defining a series of dummy variables $d_{im} = 1$ if country $= m$, and 0 otherwise. A series of pseudo-attributes x_{im} is then generated from the individual characteristics x_i in the following way:

$$x_{im} = d_{im}.x_i \text{ for all } m = 1, ..., M$$

The set $\mathbf{x}_i = \{x_{im}, m = 2, ..., M\}$ is then included, alongside the genuine attributes $\mathbf{z}_m$, in the utility specification V_{im}. x_{i1} is dropped to avoid collinearity. Hence in formula (3), $\mathbf{x}_i$ contains the firm-specific independent variables for firm i, and β_m contains the coefficients for the effects on country m relative to the base country $m = 1$. Further details can be obtained in Long (1997).

In the case of our sample, there are up to 109 countries included in the estimation equation. We therefore need 108 interaction terms for each of the firm-level and industry-level variables. Clearly this would generate far too many explanatory variables. To simplify the model, we therefore group the destination countries into 10 regions; North America, Western Europe, Central and Eastern Europe, Australasia, Africa, East Asia, South Asia, Central and South America, the Caribbean, and the Middle East. We then generate pseudo-attributes x_{ir} for regions $r = 1, ..., 10$, rather than the M countries. Hence we redefine the set $\mathbf{x}_i = \{x_{ir}, r = 2, ..., 10\}$, and include this in formula (3), which now takes the form:

$$V_{im} = \mathbf{z}_m\gamma + \mathbf{x}_i\beta_r + \mu_r$$

such that μ_r is now a region-specific fixed effect, and β_r contains the coefficients for the effects of firm characteristics $\mathbf{x}_i$ on region r relative to the base region $r = 1$. In this way, the CLM allows us to judge how firm characteristics influence the region the firm decides to invest in, rather than the specific country within that region. Clearly, country characteristics are still included as determinants of the location choices made within regions.

It is assumed that the location choices $y_i \in \{1,...,M\}$ relate to stochastic utilities U^*_{im} through an observability criterion which states that:

$$y_i = m \text{ if } U^*_{im} = \max U^*_{ij} \text{ for } j = 1,...,M$$

This leads to the following general expression for the probability $\Pr(y_i = m|\mathbf{x}_i, \mathbf{z}_i)$ of the ith decision maker choosing country m:

$$\Pr(y_i = m|\mathbf{x}_i, \mathbf{z}_i) = \Pr(U^*_{im} = \max U^*_{ij}|\mathbf{x}_i, \mathbf{z}_i)$$

To derive expressions for each $\Pr(y_i = m|\mathbf{x}_i, \mathbf{z}_i)$, and consequently estimate the parameters of V_{im}, it is assumed that each ε_{im} is distributed as an independent extreme value. In this case, McFadden (1974) showed that the predicted probability of a decision maker choosing to locate in country m is:

$$\Pr(y_i = m|\mathbf{x}_i, \mathbf{z}_i) = \frac{\exp(\mathbf{z}_m\gamma + \mathbf{x}_i\beta_r)}{\sum_{j=1}^{18}\exp(\mathbf{z}_j\gamma + \mathbf{x}_i\beta_1) + \sum_{j=19}^{21}\exp(\mathbf{z}_j\gamma + \mathbf{x}_i\beta_2) + ...}$$

where $\beta_1 = 0$. $j = 1,...,18$ for the first region (Western Europe) as there are 18 countries in this region, $j = 19,...21$ for the second region as there are 3 countries in this region (North America), and so on for all regions.

The estimation results for the conditional Logit model are provided by Table 7. Specifications (c) and (d) allow the impact of environmental regulations in the host country to vary according to the environmental compliance costs of the MNE's industry. As noted above, the firm-level control variables (*Employees*, *LabourProductivity*, *Exporter* and *ExportShare*) are included as interaction terms with dummy variables for 9 regions. The base (omitted) region is Western Europe. However, these interaction terms are not reported in Table 7 in order to conserve space. In addition, specifications (b), (c) and (d) include the industry control variables (*PhysicalCapital*, *HumanCapital*, *R&D*, *ScaleEconomies*), again as a set of interaction terms, but again omitted to conserve space. Finally, all four specifications also include region-specific constant terms (again not reported).

The CLM provides evidence which is supportive of the conclusions derived from the Probit estimations. *EnvironmentalReg* has a statistically significant deterrent effect across all four specifications, which

Table 7: Conditional Logit estimation of the location decision of MNEs

Variables	(a)	(b)	(c)	(d)
EnvironmentalReg	.5591913	.5557851	.1687808	.1254678
	(-5.19)***	(-5.21)***	(-6.84)***	(-7.60)***
EnvironmentalReg*EnvironmentalCosts			.7786982	.7451874
			(-4.88)***	(-5.53)***
GDP	1.32813	1.326092	1.335186	1.438009
	(5.82)***	(5.76)***	(5.85)***	(6.10)***
GDPpercapita	.973944	.9651558	.9590622	.8632405
	(-0.20)	(-0.26)	(-0.31)	(-0.83)
Distance	.6771946	.6798619	.677786	.6877399
	(-4.67)***	(-4.57)***	(-4.57)***	(-4.17)***
FDIStock	2.024151	2.046796	2.043366	1.889841
	(10.26)***	(10.37)***	(10.18)***	(7.37)***
OECD	.9637939	.956307	.9520774	.9757893
	(-0.29)	(-0.35)	(-0.39)	(-0.17)
GovernmentSize	1.176013	1.176698	1.170883	1.158484
	(4.38)***	(4.32)***	(4.18)***	(3.70)***
LegalSystem	1.999444	2.025347	2.032542	2.391964
	(9.00)***	(9.15)***	(9.14)***	(11.45)***
Openness	.8237648	.8195388	.8239058	1.07926
	(-3.06)***	(-3.12)***	(-3.01)***	(1.00)
Corruption	.7352564	.7336644	.7049015	.8250329
	(-2.78)***	(-2.75)***	(-3.10)***	(-1.41)
Corruption*EnvironmentalReg	1.118411	1.120587	1.128947	1.1137
	(6.27)***	(6.30)***	(6.83)***	(4.81)***
Education				1.550995
				(2.00)**
Impact of EnvironmentalCosts on location in following regions				
North America	.841105	1.006087	.9082606	.8918387
	(-1.68)*	(0.04)	(-0.70)	-0.81
Central and Eastern Europe	1.265116	1.261869	.8254111	1.049146
	(1.45)	(1.00)	(-0.81)	(0.20)
Australasia	.6915465	.7411033	.7454333	.737837
	(-1.80)*	(-1.18)	(-1.15)	(-1.20)
Africa	1.46433	1.472592	.9719772	1.18079
	(1.56)	(1.28)	(-0.10)	(0.52)
East Asia	.8891209	1.488568	1.113816	1.02403
	(-0.85)	(2.05)**	(0.55)	(0.11)
South Asia	.8468182	.8217915	.5667906	.522709
	(-0.62)	(-0.52)	(-1.52)	(-1.63)
Central and South America	1.642703	2.127067	1.490025	1.40172
	(2.67)***	(2.94)***	(1.54)	(1.28)
Caribbean	3.952666	2.776004	1.538268	1.428723
	(1.30)	(0.86)	(0.36)	(0.29)
Middle East	.6713116	1.250259	.9447153	.2670305
	(-0.82)	(0.47)	(-0.12)	(-1.78)*
Industry variables	No	Yes	Yes	Yes
Observations	88608	88608	88608	68856
R-squared	0.4092	0.4147	0.4165	0.4196

Note: Coefficients are odds ratios. Z-statistics from a test of the significance are given in parenthesis. *** indicates statistical significance at the 1% significance level, ** at the 5% level, and * at the 10% level. Other firm and industry interaction terms omitted to conserve space. All quantitative variables are in logs. Western Europe is the base region.

regressions (c) and (d) suggest is stronger for MNEs in industries with higher environmental compliance costs. More specific interpretations can be provided by the odds ratios given in Table 7. The odds ratio associated with *EnvironmentalReg* is 0.56 for both (a) and (b). This has the following interpretation: increasing the environmental index by one unit for a given country decreases the odds that a MNE will establish subsidiaries there by 44%, holding the values for all other countries constant. This rises to 49% for both (a) and (b) if *Education* is added as a control variable to these regressions (not reported). Compared to the interpretation of the marginal effects provided by the Probit regressions based on the same data, the magnitude of this effect appears to be far more economically significant. However, it must be taken into account that this apparent large change in the odds only applies to a very small probability of location (the mean predicted probability of these models is around just 1%). Referring to specification (c), the results tells us that if the logarithm of the environmental costs of an industry is 1 unit higher, MNEs in this industry are deterred from investing in a country by an additional 22% following a 1 unit rise in *EnvironmentalReg*. This rises to 26% for once we also control for *Education* (specification (d)).

The interaction terms between *EnvironmentalCosts* and the various regions can be interpreted in the following way. For specifications (a) and (b), a 1 unit increase in the logarithm of the environmental costs of a sector increases the odds of a MNE in that sector locating in Central and South America over Western Europe by 64% and 113% respectively, holding all else constant. (Here the logarithm of environmental costs only ranges from -6.4 to -3.3 across all the manufacturing sectors and hence a 1 unit increase implies substantially more environmental costs.) This could suggest that Central and South American countries may have become pollution havens to UK MNEs. However, specifications (c) and (d) find no robustly significant role for *EnvironmentalCosts* in affecting region choice. Hence the results do not support the hypothesis that the environmental costs of a MNE's industry affects the region in which it invests. This is consistent with the evidence from Table 4 regarding this aspect of the pollution haven hypothesis.

5 Conclusion

In this study we have examined whether environmental standards influence UK firms' FDI behaviour. We have found some robust support for some aspects of the pollution haven hypothesis. No evidence has been uncovered to suggest that firms in industries with high environmental compliance costs are more likely to become MNEs, despite the possibility of taking advantage of environmental regulation that is relatively weak abroad compared to the UK. However, once the firm has decided to become a MNE, there is evidence of a statistically significant pollution haven effect. That is, firms are deterred from investing in potential host countries if they operate stringent environmental regulations, ceteris paribus. This deterrent effect is far stronger for firms in higher environmental compliance cost sectors, although falls dramatically the greater the level of corruption in the host country. Moreover, the magnitude of the pollution haven effect grows when we use year 2000 data, at which time many of the MNEs in our sample may have made their location decisions. This suggests that environmental regulations are indeed a useful policy tool to reduce the pollution intensity of UK FDI that a host country receives.

Although the estimation techniques used in this paper do overcome many caveats to previous empirical work, there are nonetheless further problems which might potentially remain. These include that we cannot control for unobservable plant fixed effects. In addition, there may be unobservable country characteristics that are correlated with both environmental regulation and investment which would bias the results. Another problem is that the offshoring of production is in practice a dynamic phenomenon. However, our finding that the results are robust to using country variables from the year 2000 suggests that this problem may not necessarily affect the conclusions drawn by this paper.

6 Appendix

Dependent variable

$SubsidiaryLocation$:Presence indicator by country and firm, which takes a value of 1 if the firm has at least one foreign manufacturing affiliate in the respective host country.

Environmental variables

$EnvironmentalCosts$:Logarithm of pollution abatement operating costs (PAOCs) per unit of value added. This is taken from the UK Environmental Protection Expenditure survey, with value added data from the OECD Structural Analysis (STAN) database. The survey defines PAOCs as all in-house expenditure in 2005 associated with the operation of pollution control abatement equipment and payments to external organisations for environmental services. This includes labour costs, leasing payments and maintenance costs for equipment and payments made to others for the treatment and disposal of waste. Environmental spending also does not include spending on health and safety. It does not include any spending where the primary purpose is other than environmental protection.

The data are based on a stratified random sample of 7,858 companies, drawn from the Inter Departmental Business Register (IDBR) held by the Office for National Statistics (ONS). Companies with 1 to 9 employees were excluded. The total number of validated responses was 1,466. By taking the ratio of PAOCs to value added, the data accounts for industry size. PAOCs are measured at (approximately) the two-digit SIC level.

EnvironmentalReg :This is a qualitative measure taken from the 2006 Executive Opinion Survey conducted by the World Economic Forum. It ranges from 1 to 7 where 1 is defined as "lax compared to most countries" and 7 as "among the world's most stringent". In total, 11,232 responses were used for the 2006 survey, which featured 125 developed and developing countries. The survey was conducted in the early months of 2006. The coverage of countries included in the Executive Opinion Survey increased in 2007. Therefore, in order to maintain as broad a sample as possible, and since the stringency of environmental regulations tends not to change substantially from year-to-year, observations were considered for countries which were not included in 2006 but added into the survey for 2007. Observations from 2007 are used for Oman, Saudi Arabia, Uzbekistan and Senegal.

Firm-level control variables

Employees :Logarithm of total employees.

LabourProducitivity :Logarithm of labour productivity, defined as turnover per employee.

Exporter :A 0/1 indicator which takes the value 1 if the firm exports and 0 otherwise.

ExportShare :Share of exports in total output.

Industry-level control variables

PhysicalCapital :Logarithm of physical capital intensity, measured as non-wage value added per worker, 2005:

(value added - total compensation of employees)/employees

Source of these data: OECD database.

HumanCapital :Logarithm of human capital intensity, measured as share of value added paid to skilled workers, 2005:

((total compensation of employees)/value added) - ((unskilled wage$\times$employment)/value added)

Source of these data: OECD database.

R&D :Logarithm of research and development expenditure divided by value added, 2005. Source: ONS, Business Monitor, MA14.

ScaleEconomies :Logarithm of value added per firm, 2005. Source: ONS, Annual Business Inquiry.

Country-level control variables

FDIStock :Logarithm of annual accumulated stock of total inward FDI in millions of U.S. dollars, 2005 Source: UNCTAD World Investment Report.

GDP :Logarithm of GDP measured in millions of U.S.$ at PPP exchange rates, 2005. Source: IMF.

GDPpercapita :Logarithm of GDP per capita measured in units of U.S.$ at PPP exchange rates, 2005. Source: IMF.

Distance :Logarithm of geodesic distance. This is calculated following the great circle formula, which uses the geographic coordinates of the capital cities. This variable also incorporates internal distances based on areas. Source: CEPII (http://www.cepii.fr/).

OECD :A 0/1 indicator which takes the value 1 if the country is in the OECD and 0 otherwise.

Education :Logarithm of the average schooling years in the total population over 25 years old in 2000. Source: updated version of Barro and Lee (2000).

Corruption :Transparency international Corruption Perceptions Index (CPI), 2005. The CPI score relates to perceptions of the degree of corruption as seen by business people and country analysts. The CPI is based on data gathered over 2003-2005. It ranges between 0 and 10, and has been rescaled for this study such that 0 is highly clean and 10 is highly corrupt.

GovernmentSize :Index measuring the size of the government in 2004. Rated on the basis of a 1-10 index where 10 denotes smaller government size. Source: the Fraser Institute (www.freetheworld.com).

LegalSystem :Index giving the protection offered by the legal system and the quality of property rights in 2004. Rated on the basis of a 1-10 index where 10 denotes greater protection. Source: the Fraser Institute (www.freetheworld.com).

Openness :Index giving the freedom of the country to trade internationally in 2004. Rated on the basis of a 1-10 index where 10 denotes greater openness. Source: the Fraser Institute (www.freetheworld.com).

Table A1: List of countries

Algeria	El Salvador	Madagascar	Senegal
Angola	Estonia	Malawi	Singapore
Argentina	Finland	Malaysia	Slovak Republic
Australia	France	Mali	Slovenia
Austria	Germany	Malta	South Africa
Bangladesh	Greece	Mauritania	Spain
Barbados	Guatemala	Mauritius	Sri Lanka
Belgium	Guyana	Mexico	Sweden
Bolivia	Honduras	Morocco	Switzerland
Bosnia and Herzegovina	Hong Kong	Mozambique	Taiwan
Botswana	Hungary	Namibia	Tanzania
Brazil	Iceland	Netherlands	Thailand
Bulgaria	India	New Zealand	Trinidad and Tobago
Burkina Faso	Indonesia	Nicaragua	Tunisia
Cambodia	Ireland	Nigeria	Turkey
Cameroon	Israel	Norway	USA
Canada	Italy	Oman	Uganda
Chile	Jamaica	Pakistan	Ukraine
China	Japan	Panama	United Arab Emirates
Colombia	Kazakhstan	Paraguay	Uruguay
Costa Rica	Kenya	Peru	Uzbekistan
Croatia	Korea Rep.	Phillipines	Vietnam
Cyprus	Kyrgyzstan	Poland	Venezuela
Czech Republic	Latvia	Portugal	Zambia
Denmark	Lesotho	Qatar	Zimbabwe
Dominican Republic	Lithuania	Romania	
Ecuador	Luxembourg	Russian Federation	
Egypt	Macedonia FYR.	Saudi Arabia	

Table A2: Probit estimation of the location decision of MNEs using 2000 country-level data

Variables	(a)	(b)	(c)	(d)	(e)
EnvironmentalReg	.0021609	-.0053533	-.0058385	-.0038478	-.0047136
	(3.37)***	(-5.71)***	(-5.24)***	(-3.17)***	(-3.26)***
MediumCosts*EnvironmentalReg				-.002609	-.0032485
				(-3.39)***	(-3.62)***
HighCosts*EnvironmentalReg				-.0036605	-.0045868
				(-4.38)***	(-4.70)***
GDP	.0021503	.0041064	.003086	.0030543	.003986
	(4.67)***	(6.23)***	(4.30)***	(4.30)***	(4.75)***
GDPpercapita	-.0024174	-.0045123	-.0054126	-.0054024	-.0083866
	(-3.58)***	(-5.88)***	(-5.60)***	(-5.64)***	(-6.80)***
Distance	-.0031757	-.0042211	-.0036159	-.0035787	-.0046033
	(-7.89)***	(-8.21)***	(-6.45)***	(-6.45)***	(-6.55)***
FDIStock	.0119278	.0094094	.0098199	.0097193	.010609
	(18.57)***	(12.08)***	(12.13)***	(12.10)***	(11.35)***
OECD	.007346	.003123	.0025517	.0025034	.0033739
	(5.32)***	(2.24)**	(1.87)*	(1.86)*	(1.94)*
GovernmentSize		.0007043	.0007484	.0007364	.001042
		(2.15)**	(2.22)**	(2.21)**	(2.66)***
LegalSystem		.007562	.0081744	.0081078	.0086914
		(11.52)***	(10.48)***	(10.48)***	(9.80)***
Openness		-.0007193	-.0011707	-.0011803	-.000815
		(-0.86)	(-1.41)	(-1.44)	(-0.84)
Corruption			-.0025893	-.0027251	-.0042547
			(-1.77)*	(-1.88)*	(-2.49)**
Corruption*EnvironmentalReg			.000809	.0008322	.001206
			(3.11)***	(3.23)***	(3.93)***
Education					.00915
					(3.10)***
Observations	40755	40040	40040	40040	35750
R-squared	0.3268	0.3352	0.3364	0.3376	0.3312

Note: Reported coefficients are marginal effects calculated at the mean of the right-hand side variables. Z-statistics from a test of significance are given in parenthesis. *** indicates statistical significance at the 1% significance level, ** at the 5% level, and * at the 10% level. Firm controls and industry dummies are not reported to conserve space. All quantitative variables are in logs.

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