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Green Havens and Pollution Havens

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GREEN HAVENS AND POLLUTION HAVENS*

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Abstract

We test for pollution haven effects in outward foreign direct investment (FDI) for different sectors using a comprehensive and exhaustive dataset for outward FDI from the Netherlands, one of the most environmentally stringent countries and a major source of global FDI. Our evidence suggests that in the sectors natural resources extraction and refining, construction, retail, food processing, beverages and tobacco, and utilities, a less stringent environmental policy in the host country significantly attracts FDI. What is important for these *pollution haven* effects is not only regulation but also enforcement of environmental policy. In contrast to earlier results, it is not only footloose industries that display pollution haven effects, but also the traditional pollution-intensive industries. But for the sectors machines, electronics and automotive and transportation and communication a more stringent and better enforced environmental policy attracts more FDI as this may help their reputation for sustainable management and CSR. These sectors display *green haven* effects. These findings have important implications for the sector distribution of FDI in destination countries.

Keywords: pollution haven, green haven, FDI, environmental policy, regulation, enforcement, strategic effects, footloose industries, CSR

JEL codes: F18, F23, F13, Q50

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1. Introduction

A much debated question is whether firms in countries with more stringent environmental policies shift production to countries with less stringent environmental policies. Such countries are often referred to as pollution havens. Yet, so far, the evidence on pollution haven effects has been at best mixed and such effects remain highly contentious in debates about environment, trade and foreign direct investment (FDI). One of the reasons for the intensity of the debates is that environmental policy is often seen as a latent trade policy, especially now tariffs and quotas are gradually phased out with each round of multilateral trade negotiations.

Most empirical work on pollution havens has been directed on outsourcing and net imports to the U.S. (e.g., Becker and Henderson, 2000; List and Co, 2000; Keller and Levinson, 2002; Eskeland and Harrison, 2003; Javorcik and Wei, 2004; Kahn and Yoshino, 2004; Ederington et al., 2004). Typically, exogenous abatement costs or pollution levels are used as proxies for environmental policy but these studies typically find statistically insignificant effects on trade flows or FDI and thus find no evidence of pollution haven effects (also Brunnermeier and Levinson, 2004; Copeland and Taylor, 2004). However, if environmental policy is instrumented, more substantial effects of U.S. abatement costs are found on U.S. inward FDI (Fredriksson et al., 2003) and on net imports into the U.S. (Ederington and Minier, 2003). None of these studies investigate the impact of environmental policy in a multi-country setting. Moreover, our data shows that the U.S. environmental policy has become less stringent over time and that it is less stringent than the average Western European country, which implies that the U.S. itself could be a pollution haven. The Netherlands however ranks 8th in the world for our measure of environmental policy.[1]

However, an innovative recent study does find robust evidence for substantial pollution haven effects at a sector level (Kellenberg, 2009). This cross-country study uses a new dataset on environmental policy stringency and enforcement based on questionnaires in many countries and that it allows for the endogenous determination of income and strategic environment and trade policies. To identify pollution haven effects, it is assumed that individual countries strategically compete with other countries when setting stringency and enforcement of environmental policies. In contrast to the majority of previous empirical studies but in line with earlier evidence given by Ederington et al. (2005), this study finds substantial pollution haven effects for U.S. multinational firms in foreign countries in those industries that are *footloose* such as electrical equipment, appliances and components and machinery but not for more traditional *capital-intensive, pollution-intensive* industries such as mining and utilities with high fixed

[1] The top-ten ranking for 2005 is Denmark, Germany, Switzerland, Finland, Sweden, Austria, Norway, The Netherlands, Japan and Luxembourg. The U.S. ranks 20th together with Taiwan and just above Tunisia.

costs in production and high trade costs. The most capital-intensive industries are thus not necessarily the most likely industries to react to changes in environmental policy.

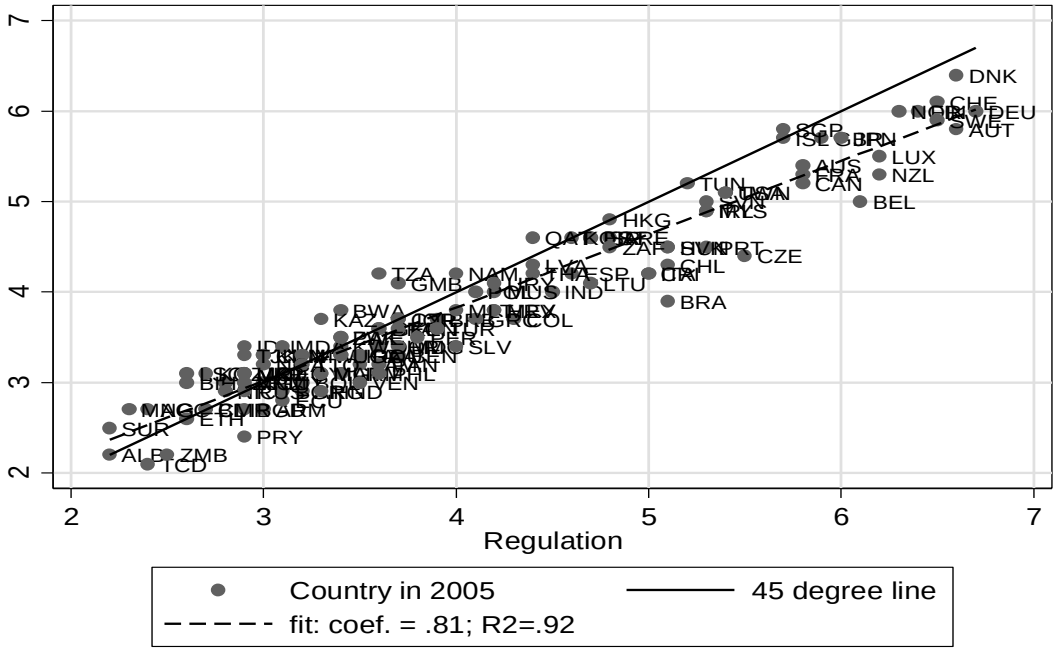
Our prime objective is to reconsider the results of Kellenberg (2009) by testing for a different hypothesis. We put forward the idea that in some sectors a reputation for sustainable management and corporate social responsibility (CSR) may be more important than avoiding stringent and strictly enforced environmental policy, especially for those sectors which are relatively footloose. In many developed countries translating the ideas of the triple bottom line, also known as 'people, profit, and planet', and 'cradle to grave' concepts into real business practice and CSR are gaining ground (Kitzmueller and Shimshack, 2011). Indeed, many firms find it important for their reputation to report in their annual account what they have done about the triple bottom line and want to be seen to be doing something about these issues. Such firms thus want to minimize their ecological footprint, have a reciprocal social structure and wish to comply with the Global Reporting Initiative (e.g., Willis, 2003; Herzig and Schaltegger, 2006). Such firms might undertake FDI in countries with stricter and better enforced environmental standards to avoid having to deal with issues such as how to deal with waste products. Many of these firms already send waste products to countries such as India or China to be processed. This argument will turn out to be especially relevant for relatively footloose industries such as machines, electronics and automotive, and ICT and communication. However, other industries such as refineries with relatively high fixed costs cannot so easily take care of their waste, which tends to end up in the soil. The public, shareholders, etc. only find out about this afterwards.

We thus put forward our alternative hypothesis that firms in traditional *capital-intensive, pollution-intensive* industries with high setup and trade costs *shy away* from countries with stringent and strictly enforced environmental policies and thus display pollution haven effects whilst relatively *footloose, CSR-minded* industries concerned with the triple bottom line and their green reputation are *attracted* to such countries. We are thus putting up the *pollution haven* hypothesis against the *green haven* hypothesis.

We examine the robustness of the results obtained by Kellenberg (2009) to a more comprehensive FDI data set with country dummies rather than regional dummies and with an alternative set of instruments for the regulation stringency and enforcement of environmental policy. We use data on Dutch outward FDI from the central bank of The Netherlands, which does not contain any gaps (in contrast to public data which does have gaps for confidentiality reasons) and allows for more sectors, more countries and more years. We make use of the data of regulation and enforcement of environmental policy derived from the questionnaires reported in the Global Competitiveness Reports (GCR) of the World Economic Forum and used for the first time by Kellenberg (2009).

Table 1 plots enforcement against stringency of environmental policy for the countries in our dataset. This suggests that on average enforcement is less strong than stringency of environmental policy in a given country. This is why we follow Kellenberg (2009) and allow for both enforcement and stringency of policy when testing for *pollution haven* and *green haven* effects.

Figure 1: Enforcement and regulation of environmental policy



Our empirical evidence suggests that countries with a more stringent and better enforced environmental policy deter FDI going to the more traditional *capital-intensive, pollution-intensive* industries such as natural resources extraction and refining, and utilities. We also find statistically significant pollution haven effects for agriculture and food processing, beverages and tobacco. We find that countries with a more stringent and better enforced environmental policy *attract* FDI to the sectors machines, electrical and automotive industries. We interpret these as *green haven* effects: Dutch firms in these sectors preferring for reasons of a good reputation for the triple bottom line, people profit and planet, CSR and sustainable governance to locate in those countries where environmental policy is more stringent and better enforced.

Kellenberg (2009) uses public data on US outward FDI from the BEA whilst we use data on Dutch outward FDI. His BEA dataset covers only 5 years, 9 sectors and 50 countries whilst our dataset on Dutch outward FDI covers 7 years and 12 sectors for 188 countries. Furthermore, our dataset has comprehensive coverage and does not contain any gaps for confidentiality reasons. Our econometrics allows for the more detailed country fixed effects than regional fixed effects. Our analysis is also related to that of Wagner

and Timmins (2009) who use only a cross-sectional dataset of 76 countries and 6 manufacturing industries for the year 2003 of German data and do not distinguish regulation stringency from enforcement of environmental policy. Furthermore, their dependent variable is not outward FDI but estimates of country-sector fixed effects from first-differenced first-stage regression of FDI flows. They thus estimate the effect of regulation stringency of environmental policy on the time average *change* in FDI flows between 1996 and 2003 for each sector.

Section 2 discusses in some detail our FDI dataset and the data for regulation stringency and enforcement of environmental policy that we use. Section 3 offers a first shot at estimating the effects of environmental policy on aggregate FDI. It finds no evidence of pollution haven or green haven effects at the aggregate level. Section 4 presents the econometric specification of our tests for pollution havens and green havens at the sector level where we do find statistically significant effects. Section 5 discusses our instruments for regulation stringency and enforcement of environmental policy. Section 6 presents our main results for sectoral pollution haven and green haven effects at the sector level. Section 7 concludes.

2. FDI and environmental policy data

We test our hypotheses with outward FDI data on investments done by multinationals in as many countries as possible. Since available FDI data sets either have large gaps in them for reasons of confidentiality, we use a unique dataset on outward FDI from the Netherlands collected by De Nederlandsche Bank. This dataset benefits from *all* firms being legally required to report their current-account transactions, including foreign investment flows and positions collected via banks, stating the balance sheet current Euro value of FDI stocks and the value of new investment flows. In contrast, publicly available BEA data for US outward FDI is based on five-yearly censuses, but relies on surveys and interpolation for years in between (Mataloni, 1995). Aggregate FDI and disaggregated FDI data for several broad sectors and large countries are available through the central bank's website.[2] At the more detailed level of specific countries and sectors, the data is confidential and accessible by special permission. They cover 192 host countries for the years 1999 through 2005 for the whole population of affiliates of multinationals.[3] [4] A second important benefit of this data source is that we are able to exclude

[2] See http://www.statistics.dnb.nl/index.cgi?lang=uk&todo=Balans, Table T12.6.2.
[3] Following the standard definition an affiliate is counted as FDI if the parent company owns at least a 10% stake.
[4] A change in the way FDI was reported caused a break in 2003. Before this date, all data was reported through the banking system, since they collect balance sheet data for loan purposes and perform the actual transactions. After April 2003, a new system was introduced based on direct reporting by resident parent companies, although since then a sample is used based on gathering about 95% of the total value of capital stocks and flows.

financial holding companies, many of which are so called 'letterbox companies' which only reside in The Netherlands for tax reasons.

After excluding banks, financial holding companies, insurance companies, pension funds and private agents, we are left with 188 countries for 7 years and 12 sectors, yielding 5,797 non-zero observations.[5] Five of these firms were among the 100 largest non-financial multinationals in the world in 2002 by foreign assets.[6] In 2007 Dutch FDI represented 5.5 percent of World FDI while US FDI represented 18 percent (UNCTAD, 2008). Following the Eurostat classification of FDI, outward stocks are classified according to the activity of the non-resident enterprise.

We measure FDI by the value to the parent firm of investments made abroad. It makes more sense to measure FDI by sales volume of affiliate sales if FDI is horizontal, i.e., if multinationals invest locally to sell in the local market, but evidence suggests that horizontal FDI is not very prevalent compared with vertical-fragmentation FDI (e.g., Blonigen, et al., 2007; Poelhekke and van der Ploeg, 2009).[7] For vertical FDI local sales may be zero, because the affiliate is a link in a longer product chain and sales are made in third or in home countries. Sales within a vertically integrated MNE are also not traded which makes it unclear how the price is determined. The stock of FDI (book value) seems a more accurate reflection of actual investment.

For our main variable of interest we follow Kellenberg (2009) and collect survey data from the Global Competitiveness Reports by the World Economic Forum. Two environmental survey questions measure the 'stringency of environmental regulation', which relates to official rules and regulations, and the 'consistency of environmental regulation', which asks about the enforcement of those rules and regulations, as it is experienced by business executives in each country.[8] We collect the scores on both variables for all available countries (128) and years (1999-2005). Because not every country was surveyed every year, we can use 662 country-year observations in total. We construct an index of environmental policy (EPI) by interacting stringency and enforcement, which captures the idea that stringent environmental policy is only relevant if it is enforced.

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[5] There are currently 203 *de facto* states in the world.

[6] These are (rank; industry): Shell (6; petroleum), Unilever (36; food product), Philips (37; electrical & electronic equipment), Ahold (51; retail), Reed Elsevier (90; publishing and printing). (UNCTAD, http://www.unctad.org/Templates/Page.asp?intItemID=2443&lang=1) .

[7] This is not to say that determinants of horizontal FDI (such as GDP and similarity) do not play a role as well; see the survey given by Blonigen (2005). Bloningen et al. (2007) find evidence for vertical-specialization FDI in a world sample based on estimation with spatial lags and fixed effects, but export-platform FDI for a sample of European OECD countries, which suggests that the average organizational structure depends on the sample.

[8] The actual survey questions are: The stringency of overall environmental regulation in your country is: (1=lax compared with most other countries, 7=among the world's most stringent); Environmental regulation in your country is: (1=not enforced or enforced erratically, 7=enforced consistently and fairly).

Tables 1 and 2 give outward FDI by region and by stock for the years 1999 and 2005 and also report average regulation enforcement faced in destination countries. We see a spectacular growth in outward FDI from the Netherlands between 1999 and 2005. Most of outward FDI has gone to other Western European countries and to a lesser extent to North America. Still, outward FDI to the countries of East Asia and the Pacific and the Latin America and the Caribbean is not negligible and also growing fast.

There is a big variation in average regulation enforcement of environmental policy across countries, with Western Europe having the heaviest regulation and South Asia and Sub-Saharan Africa having the least regulation. The United States is relatively less stringent and could therefore be attractive for polluting Western European firms. Since the source country for our dataset of FDI has a more stringent and better enforced environmental policies (with score of 34.0 and 34.7 in 2005) than the potential destination countries in our sample, one might think that firms in the home country are either on the lookout for countries with a more lax environmental policy (pollution havens) or avoid countries that put their stakeholders to shame from a green perspective. Since most of the outward FDI has been going to Western Europe despite the strictly enforced environmental regulation, we must capture in our empirical work all the other factors that affect outward FDI by allowing for time fixed effects, sector fixed effects and country fixed effects as well as the most relevant explanatory variables.

Table 1: Outward FDI by region (stocks, 2000 $ millions)

Region	Total FDI		Average regulation * enforcement faced in destination countries	
	1999	2005	1999	2005
East Asia & Pacific	13,870	28,463	18.5	22.7
Eastern Europe & Central Asia	6,584	18,625	12.9	14.3
Latin America & Caribbean	11,618	21,209	10.8	13.6
Middle East & North Africa	3,124	4,731	15.0	16.8
South Asia	654	1,605	7.8	13.4
Sub-Saharan Africa	2,413	8,125	11.5	13.0
Western Europe	102,294	320,691	29.3	31.2
United States	42,682	53,919	31.6	27.5
Canada	2,984	9,056	29.5	30.2
Total	186,225	466,424		
Score for home country			34.02	34.72

Table 2 indicates that most of Dutch outward FDI has come from natural resources extraction and refining, which has shown a spectacular growth in FDI and some slackening of average regulation enforcement of environmental policies in destination countries. A similar trend can be seen for the retail

sector. Interestingly, a sector such as machines, electronics and automotive has also seen a rapid growth in FDI but a tightening of regulation enforcement. To a lesser extent, this is true for the sector chemicals, rubber and plastics as well. Construction has almost doubled its FDI with hardly a change in regulation enforcement. The average environmental protection that each sector faces is much smaller than regulation and enforcement at home.

Because of the variation of environmental protection and FDI across sectors and countries it is an empirical matter to find out what, if any, the effect is of environmental protection on FDI.

Table 2: Outward FDI by sector (stocks, 2000 $ millions)

Sector	Total FDI		Average regulation * enforcement faced in destination countries	
	1999	2005	1999	2005
Natural resources extraction and refining	37,947	140,758	19.5	18.9
Construction, installation	1,567	2,964	24.5	23.3
Chemicals, rubber, plastics	27,962	44,341	19.9	20.9
Retail	27,685	49,887	18.7	19.7
Agriculture	239	106	22.3	25.5
Machines, electronics, automotive	23,590	35,369	19.4	23.9
Real estate	17,487	17,036	20.3	20.9
Business services, other services	7,482	68,564	22.8	21.7
Other manufacturing (paper, textile, medical, furniture)	12,329	16,444	22.6	25.5
Transportation & communication	9,146	45,461	19.0	19.3
Food processing, beverages, tobacco	22,101	47,012	19.0	18.1
Utilities	765	1,368	26.1	26.6
Score for home country	-	-	34.02	34.72

3. A first shot at the effects of regulation and enforcement on FDI

A first shot at estimating the effects of regulation and enforcement on non-financial FDI going into destination countries is offered in table 3. We allow for the standard determinants of FDI, but we also allow for spatial effects in market potential and the dependent variable which requires maximum likelihood estimation (see also Poelhekke and Van der Ploeg (2010) for an application of this method in the context of FDI). We explain the estimation method and the corresponding LM test statistics in more detail in the appendix. The normal determinants of FDI turn up significantly: the size of the market as measured by the population size and GDP per capita has a positive effect on FDI. In column b we change the unit of observation from a country-year to a sector-country-year. The negative effect of distance now becomes significant (which is the gravity effect), surrounding market potential has a negative effect on FDI, and the share of government spending in GDP in the destination country appears to deter FDI. Other variables such as the spatial lag or institutions are statistically insignificant. Finally, in the last column we

include not only year, but also country and sector fixed effects. Following the method of Cameron et al. (2011), we also cluster the standard errors on years, countries and sectors to allow for unobserved correlation of the errors at these non-nested levels. The result is that no variables are significant anymore.

Table 3: No average effects of regulation and enforcement, 1999-2002

Dependent Variable:	(a)	(b)	(c)
ln non-financial FDI (stocks, current USD)	SAR-ML	SAR-ML	OLS
Unit of observation	country, year	country, sector, year	country, sector, year
ln total population	1.024***	0.754***	0.487
	(0.098)	(0.064)	(5.089)
ln GDP per capita (t-1)	1.414***	1.325***	0.506
	(0.227)	(0.229)	(0.594)
ln GDP surrounding market potential	0.503	-1.073***	
	(0.770)	(0.401)	
Real exchange rate with NL based on GDP price level	-1.126	-1.924**	0.305
	(1.092)	(0.851)	(0.820)
General government final consumption expenditure (% of GDP)	-0.116***	-0.095***	-0.009
	(0.039)	(0.031)	(0.127)
ln (Regulation * Enforcement)	**0.018**	**0.320**	**0.098**
	(0.361)	**(0.345)**	**(0.464)**
ln distance from NLD (km)	-0.401	-1.007***	
	(0.339)	(0.247)	
Trade liberalization	0.653*	0.243	
	(0.346)	(0.309)	
Institutions, 5 year initial	0.014	0.024	
	(0.041)	(0.029)	
Spatially lagged dependent variable	-0.067	0.217	
	(0.257)	(0.335)	
Fixed effects	year	year	country, sector, year
Observations	280	2130	2180
R-squared			0.570
Log-likelihood	-477.4	-4883	-4703
robust LM spatial AR(1)=0	0.348	7.294***	
robust LM spatial MA(1)=0	0.246	5.357***	
Variance Ratio	0.720	0.355	

Clustered (by country) standard errors in parentheses, except in column (c) where standard errors are also clustered on sectors and years. *** p<0.01, ** p<0.05, * p<0.1. All regressions include year effects; column (c) also includes country and sector fixed effects.

However, the main insight we obtain from table 3 is that enforcement interacted with regulation of environmental policy does not have any statistically significant effect on FDI. This is in line with previous empirical studies which also have trouble finding a significant and robust effect of

environmental policy on FDI. Since we did not find significant average effects of regulation and enforcement of environmental policy, we will investigate whether we can establish pollution haven effects at the sector level. Before we do this, we discuss our econometric specification and our choice of instruments for regulation and enforcement of environmental policy.

4. Econometric specification of tests for pollution havens and green havens at the sector level

Given that there is no empirical support for pollution haven or green haven effects at the aggregate level, we decided to test for them at the sector level. For this purpose, we use the index *i* to denote the country of destination for the FDI, the index *j* to denote the sector receiving the FDI in the destination country, and the index *t* to denote the year. The variable we are trying to explain is the log of FDI from the Netherlands to sector *j* of destination country *i* in year *t*, and denote this by $\ln(FDI_{ijt})$. Our main interest is in the so-called environmental policy index in the destination country, EPI_{it}. To test for pollution haven and green haven effects, we specify the following econometric model:

$$\ln(FDI_{ijt}) = \alpha_i + \delta_{jt} + \phi_j \ln(EPI_{it}) + \varepsilon_{ijt},$$

where α_i and δ_{jt} denote, respectively, the country fixed effect and the sector-year fixed effects, ϕ_j denotes the effect of the (log of the) environmental policy index on the amount of FDI received by sector *j*, and ε_{ijt} denotes the serially uncorrelated normally distributed error term. Instead of running a regression for each sector, we let $\phi_j \ln(EPI_{it})$ be composed of *j* variables: the overall effect of $\ln(EPI_{it})$ and *j-1* interactions of $\ln(EPI_{it})$ with sector dummies. The overall effect conditional on the interactions can then be interpreted as the effect for the baseline *j*th sector, in this case 'business services and other services'. Each ϕ_j exploits time variation to measure the effect of an increase in a country's EPI on sector *j*'s inward FDI conditional on fixed country characteristics, and secular developments that affected sector *j*'s investment in *all* countries in each year (such as a sector's pollution intensity). Most of the traditional explanatory variables such as distance from the destination countries are captured by the fixed effects. Although we have tried to include time-varying, country-specific market potential variables such as GDP and population size and other variables such as institutional quality, openness to international trade, the real exchange rate and government spending as a fraction of GDP they did not turn up significantly in view of the rich set of fixed effects that have been included. Compared with Kellenberg (2009), we have more fixed effects. Instead of having only regional effects and abstracting from sector fixed effects, we allow in equation (1) for country fixed effects and sector-year fixed effects which is statistically more

satisfactory (see section 5). It is especially important to allow for sector fixed effects. For example, different industries may have different capital-labour ratios, different transportation costs, etc. and a proper test of our main hypotheses should correct for these factors. It might have been interesting to allow for an interaction term between the pollution intensity of the sectors of the country that is sending FDI and the EPI index, but that is already picked up by the sector-year dummies.

The null hypothesis $\phi_j = 0$ implies that there are no direct pollution haven effects or green haven effects in sector *j*. If $\phi_j < 0,$ then FDI going to sector *j* is hindered by a more stringent and more strictly enforced environmental policy in the destination country. This is the *pollution haven* effect. If $\phi_j > 0$, then FDI going to sector *j* is deterred by a less stringent and less strictly enforced environmental policy in the destination country. This is the *green haven* effect.

5. Instruments for regulation and enforcement of environmental policy

To instrument the environmental policy index in a regression of US multinational affiliate activity abroad, Kellenberg (2009) uses variables related to agriculture in addition to survey data on public schools, infrastructure and crime, which are each GDP-weighted averages of other countries within the same large region. The idea is that, for example, crime and land per agricultural worker in Germany (which is a large share of European GDP) influences Austrian environmental standards through regional strategic policy competition, but does not affect US multinational affiliate sales in manufacturing in Austria directly. However, if this mechanism holds, then a policy change in Germany that affects a policy change in German and Austrian environmental standards is likely to affect MNE investment in *both* countries also.

Levinson and Taylor (2008) alternatively examine the effect of pollution abatement costs for 130 sectors in US states on net imports from Canada and Mexico. To instrument these costs, they assume that no sector is large enough on its own to affect state regulation. The first sector-year level instrument for the industry's demand of pollution equals the total of each state's total current emission of pollutants by other sectors, summed across states with weights according to the sector's beginning of period value added share. The second instrument for industry pollution supply (regulation) sums the current income per capita of all states weighted by the sector's value added share in each state. Karp (2011) questions this strategy because shocks to a collection of sectors will affect aggregate abatement costs directly such that the instrument is still correlated with the error term. Because some countries are large within Kellenberg's regions, a similar critique applies to those instruments as well.

We take a different strategy. Where Kellenberg (2009) includes year and region fixed effects and Levinson and Taylor (2008) industry and year fixed effects, we are able to include country fixed effects and sector-year fixed effects. The sector-specific influence of destination-country environmental policy on FDI is therefore net of shocks that are specific to each sector in a particular year, but common to all the sector's destination countries, such as unobserved productivity or demand shocks that may affect the sector's demand for pollution. These also absorb global shocks that affect all sectors and countries equally, and country fixed effects absorb country characteristics that do not change between 1999 and 2005, which may include a significant share of a country's demand for environmental protection. We therefore identify the main effect through time variation in sectoral FDI and environmental policy at the country level. The inclusion of this large set of fixed effects implies that it is much less likely that the error term in our regressions for outward FDI is correlated with environmental policy.

Nevertheless, to the extent that regulation changes because of promised investment by foreign MNEs through policy competition, there may still be some correlation left. As instruments we use the predetermined *demand for environmental protection*, because it is determined by taste and pollution (Copeland and Taylor, 2003, chapter 2). To proxy for taste, we use the *net present value of protected areas per capita* in 1995 and 2000. These are calculated as the opportunity costs of preservation such as its alternative use for agriculture. Whether a country chooses to designate part of its land to nature reserves is therefore a trade-off between a future stream of consumption from agriculture and a stream of consumption from nature. We assume that a county's taste for nature will correlate strongly with the stringency and enforcement of environmental regulation, although it may vary less over time than the environmental policy index. In particular, we use 1995 (constant dollar) values of protected areas for the years 1999 through 2003, and 2000 levels for the years 2004 and 2005. We thus suppose that this lagged instrument is driven by past demand for environmental protection rather than by current political activities, lobbying, or the structure of the economy. The robust Hansen over-identification test suggests that this is indeed a valid instrument.

Stringent environmental policy is most likely a result of past rather than current pollution levels. As countries develop, they become both dirtier and wealthier and people will start to demand a cleaner environment. Since changing regulation takes time, we suspect that lagged levels of pollution have more predictive power for current regulation than current pollution, apart from the obvious endogeneity of current pollution levels. We proxy past pollution with CO2 emissions in kilograms per GDP, since good data exists for a long time period. The data confirms that a lag of 10 years has more predictive power for current regulation and enforcement than shorter lags.

6. Evidence for pollution haven and green haven effects at the sector level

Using these instruments for regulation and enforcement of environmental policy, table 4 reports the evidence for pollution haven and green haven effects at the sector level. The dependent variable in each column is the log of the stock of FDI in a sector *j*, country *i* and year *t*. The regression includes country and sector-year fixed effects which effectively absorb all of the standard determinants of FDI (as shown in table 3). However, we still find a weak positive effect of a time-varying measure of institutions on average sector level FDI. The regression in column (a) allows for a sector-specific effect of the log of the Environmental Policy Index. A higher EPI has a deterring effect on natural resource extraction and refining, agriculture, food processing, construction, and utilities, while FDI in the sectors machines, electronics and automotive, and transportation and communication is attracted to countries with high regulation and enforcement.

Next we address the potential endogeneity of the EPI, which may occur if countries that attract a lot of FDI are under pressure to change the stringency and enforcement of their environmental policy. They could either succumb to pressure to lower their EPI or greener companies from abroad might influence them to have a more ambitious EIP. Regression (b) lists the first-stage regression of country level EPI on a full set of country and time dummies, a measure of institutions and the two instruments. Lagged levels of pollution are strong predictors of current environmental standards. An increase of one standard deviation of lagged emissions (in kg per PPP $ of GDP) of 0.467 predicts an increase in the EPI of 18%. The small negative effect of an improvement in institutions on environmental protection seems counterintuitive, unless better general institutions (such as less corruption and more government stability) can substitute for enforcement of environmental legislation. Unfortunately, the measure of the net present value of protected areas changes too little over time to yield significant results. However, the instruments still yield a combined F-test of 23.43, which implies that they jointly predict EPI very well.[9] In the second stage (regression (c)), we allow the predicted values of log EPI to have sector-specific effects on sector-level FDI. The result is only marginally less precisely estimated, and the robust Hansen over-identification test does not reject that the instruments are uncorrelated with the second stage error term. As before, we cluster the standard errors on countries, years and sectors, implying that the estimates are robust to correlated shocks within countries, within years and within sectors.

The largest effects are in the sectors agriculture, food processing, natural resources, and utilities. For example, an average year-on-year increase in the destination country environmental policy index (of 4.2%) leads to a decrease in outward FDI by the natural resource sector of -4.2*-1.957 = 8.3%. The US

[9] In contrast, the first-stage F-test statistics in the sector level regressions in Kellenberg (2009) are never higher than 1.6, which implies that the estimates are biased towards the non-instrumented OLS estimates.

decreased its environmental policy index between 1999 and 2005 by 4 points, a 14% reduction. Our estimates suggest this explains part of the large increase in FDI towards the US between 1999 and 2005.

Table 4: Sectoral pollution haven and green haven effects, 1999-2005

Dependent Variable:	ln FDI	ln R * E	ln FDI
	(a)	(b)	(c)
Unit of observation	country, sector, year	country, year	country, sector, year
	baseline	first stage	2nd stage
Sector specific effects of:	**ln Regulation * Enforcement**		
Natural resources extraction and refining	-1.738***		-1.957***
	(0.327)		(0.466)
Construction, installation	-0.978**		-1.272**
	(0.407)		(0.559)
Chemicals, rubber, plastics	-0.036		-0.202
	(0.226)		(0.145)
Retail	-0.308		-0.491
	(0.266)		(0.320)
Agriculture	-2.467***		-3.317***
	(0.374)		(0.361)
Machines, electronics, automotive	1.674***		1.730***
	(0.431)		(0.480)
Real estate	0.225		0.170
	(0.268)		(0.262)
Business services, other services	0.243		0.912
	(0.536)		(0.957)
Other manufacturing (paper, textile, medical, furniture)	0.852		0.032
	(0.717)		(0.355)
Transportation & communication	0.996***		0.841***
	(0.244)		(0.261)
Food processing, beverages, tobacco	-1.406***		-1.708***
	(0.326)		(0.405)
Utilities	-1.819***		-1.464***
	(0.508)		(0.448)
Institutions	0.062*	-0.013**	0.047
	(0.033)	(0.006)	(0.029)
Excluded instruments:			
CO2 Emissions in kg per GDP (t-10)		0.382***	
		(0.079)	
ln protected areas per capita (t-4)		0.006	
		(0.034)	
F-test excluded instruments		23.43	
Hansen robust over-identification test, p-value			0.317
Observations	4155	498	3463
R-squared	0.624	0.951	0.658

Clustered (by country, sector and year) standard errors in parentheses, except in column (b) where standard errors are clustered on countries and years. *** p<0.01, ** p<0.05, * p<0.1. All regressions include country and sector-year effects, except column (b) which includes country and year effects.

Kellenberg (2009) also finds a negative and significant effect for the food sector, but insignificant effects for mining, utilities, and primary metals, which could be do to the fact that his dataset is smaller and more selective, and/or weakness of the instruments.

However, we also find that machines and electronics and transportation & communication are *attracted* to higher environmental standards. These sectors thus display green haven effects. Kellenberg (2009) also finds a positive, although insignificant, effect for computers and electronics.

This may make sense if computer and electronics rely more on clean environments (or even sterile in the case of chip making) as an input in production (such as clean water). In the case of transportation it could be that most of their investment has to be as clean as in the home country. Trucks for example may need to be allowed on the road in both the destination and the origin country.

As far as robustness is concerned, we have re-estimated the equations separating rubber from chemicals but this did not make a difference. Separating base metals from natural resources also made no difference. Taking logs of trade or FDI usually leads to the problem that zero observations are dropped from the sample, possibly causing sample selection bias. However, our data has enough detail and coverage that FDI is never zero or missing for observations where we observe stringency and enforcement, so a Heckman two-step estimator is not required. Sample selection bias could still be introduced if the sample of countries that was surveyed in the GCR is not random, which is similar to 'censoring'. The solution to this problem (apart from extending the survey) is to instrument the environmental policy index (Wooldridge, 2002), which is what we have done in table 4.

7. Conclusion

The idea that dirty industries migrate to parts of the world with less stringent and strictly enforced environmental policies is known as the pollution haven hypothesis. We pit against this the green haven hypothesis, which may be relevant for firms in home countries that already have a tough environmental policy. For them starting operations in parts of the world which do not take the environment very serious may make bad sense from a CSR business perspective. Unfortunately, there has been a paucity of robust empirical evidence for pollution haven effects in the literature and there have been no tests of the green haven hypothesis. Using a comprehensive and exhaustive dataset for outward FDI from the Netherlands and data on the regulation stringency and enforcement of environmental policy collected in various Global Competitiveness Reports for the World Economic Reform, we do not find in our cross-country estimates any significant pollution haven or indeed green haven effects at the aggregate level.

However, we do find different pollution haven and green haven effects for outward FDI at the sector level. Our empirical evidence suggests that in the sectors natural resources extraction and refining, construction, retail, food processing, beverages and tobacco, and utilities a more stringent environmental policy in the host country significantly deters FDI. What is important for these *pollution haven* effects is not only regulation but also enforcement of environmental policy. In contrast to earlier results (Kellenberg, 2009), it is not only footloose industries that display pollution haven effects, but also the traditional pollution-intensive industries such as refineries. In fact, for the sectors machines, electronics and automotive and transportation and communication a more stringent environmental policy attracts more FDI. This suggests that Dutch multinational firms in these latter sectors are deterred from investing in countries with bad environmental policy as this may hurt their reputation for sustainable management, and attracted to places with strict and strictly enforced environmental standards. This thus establishes g*reen haven* effects for these relatively footloose, CSR-minded sectors.

Of course, our evidence for green havens is only tentative. To establish that the demarcation between green havens and pollution havens really occurs along industry lines rather that footloose technologies and other less footloose technologies with high fixed costs are used in different plants in the same industry, more work is needed. This would require detailed FDI data at the plant level, which we unfortunately do not have at our disposal. Alternatively, our analysis could be backed up with in-depth case studies in future work to establish whether the demarcation occurs across industry or plant lines.

Our estimated green haven and pollution effects are economically important for the sector distribution of FDI. To illustrate this, *everything else equal* and depending on other standard determinants of FDI, if China (with a 2005 stock of total FDI of 2.2 billion USD) were to double its environmental regulation and enforcement to the level of Korea (i.e. from 10 to 20), it may stand to lose all of its inward FDI in dirty utilities and natural resources, but at the same time more than double FDI in machines, electronics, automotive and the transportation sector. Depending on the relative scope for technology spillovers in these sectors, that may be a beneficial strategy to pursue.

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Appendix: Data, variable definitions and sources

Variable	Description	Source
ln FDI	ln value of outward foreign direct investment from The Netherlands in current mln USD, by country, year and sector, see also text.	DNB (2010)
ln population	ln of total population	World Bank (2009)
Trade liberalization	= 1 if liberalized, dummy	Wacziarg & Welch (2008)
ln distance	Vincenty distance in km between country centroids	CID data and Vincenty (1975)
ln GDP per capita	ln GDP per capita in current USD	World Bank (2009)
ln GDP surrounding market potential	distance weighted ln GDP in current USD	authors' calculation
Institutions	Sum of the following institution indices: Government Stability, Investment Profile, Corruption, Law and Order, Bureaucracy Quality. See also text. 'Initial' implies that values are set to the value of the beginning of each non-overlapping five year period.	International Country Risk Guide (2006)
Real exchange rate	Real exchange rate with Netherlands based on GDP price level	PWT6.2, from Heston et al. (2006)
Government share of GDP	Government share of GDP	World Bank (2009)
Environmental Policy Index (Regulation * Enforcement)	Stringency of Environmental Regulation score times the Consistency of Environmental Regulation score. Year, Question (Table) in Global Competitiveness Report: 2000: 12.06 & 12.12; 2001: 11.06 & 11.12: 2002: 11.05 & 11.11; 2003: 11.05 & 11.10; 2004: 10.01 & 10.02; 2005: 9.01 & 9.02; 2006: 10.01 & 10.02. The GCR year corresponds to survey data from the preceding year.	World Economic Forum, various years
CO2 emissions in kg per GDP, lagged 10 years	CO2 emissions in kg per PPP USD of GDP	World Bank (2009)
ln protected areas per capita, lagged 4 years	The value of protected areas is estimated as the opportunity cost of preservation i.e. the minimum of wealth derived from alternative uses of land such as growing crops and livestock. For the years 1999-2003 we use the value for 1995, and for years 2004-2005 we use the value for 2000.	World Bank (2011)

Environmental Policy Index (constructed from the Global Competitiveness Reports 2000-2006)

Country	1999	2000	2001	2002	2003	2004	2005
Albania						4.20	4.84
Algeria				8.70	7.83	8.37	11.55
Angola				3.04	5.04		6.48
Argentina	8.37	8.68	7.20	9.57	9.60	12.24	9.28
Armenia						9.28	8.10
Australia	32.45	34.72	30.16	32.45	32.45	30.74	31.32
Austria	36.96	37.62	36.48	35.84	35.84	36.40	38.28
Azerbaijan						9.90	8.40
Bahrain					15.21	9.92	12.24
Bangladesh		6.96	6.75	8.99	7.28	8.70	7.83
Barbados							14.43
Belgium	29.68	31.11	30.68	31.62	29.89	25.20	30.50
Benin						8.40	12.21
Bolivia	5.52	6.96	5.72	5.52	8.70	7.84	9.60
Bosnia and Herzegovina					5.98	6.44	7.80
Botswana			12.96	12.24	12.24	12.21	12.92
Brazil	14.43	16.38	19.78	18.90	21.07	19.50	19.89
Bulgaria	11.20	11.90	9.92	8.68	10.88	9.60	8.99
Burkina Faso							12.96
Burundi							7.29
Cambodia						6.72	9.90
Cameroon				11.52		9.30	7.29
Canada	29.50	32.45	30.74	32.45	30.74	30.74	30.16
Chad				4.80	5.28	4.60	5.04
Chile	14.82	16.38	18.40	19.74	19.27	19.27	21.93
China	10.15	11.90	14.00	13.65	12.58	10.85	9.90
Colombia	12.16	12.95	14.76	14.06	14.82	16.34	15.91
Costa Rica	13.65	14.40	15.75	16.65	19.74	17.94	21.00
Croatia			14.62	12.80	11.55	14.40	15.96
Cyprus					13.68	16.00	13.69
Czech Republic	18.86	18.36	18.55	21.56	18.40	23.92	24.20
Denmark	38.28	37.52	38.28	38.35	40.95	40.92	42.24
Dominican Republic		7.02	9.28	9.28	10.56	5.76	12.24
Ecuador	8.64	5.28	5.76	5.94	7.84	6.76	8.68
Egypt	12.95	15.20		13.32	12.95	9.92	9.61
El Salvador	5.98	5.52	9.24	9.86	10.89	10.23	13.60
Estonia		19.27	19.32	20.70	23.03	23.03	21.62
Ethiopia				5.46	6.21	6.44	6.76
Finland	38.40	41.60	36.54	39.65	38.40	34.10	38.40
France	28.50	34.10	24.84	28.56	28.00	30.74	30.74
Gambia, The				17.02	16.38	13.26	15.17
Georgia					7.56	8.12	12.96
Germany	36.40	38.19	35.64	40.87	37.40	38.86	40.20
Ghana				13.94	14.82	17.22	
Greece	14.43	11.84	11.55	16.40	15.54	15.54	15.17
Guatemala		4.62	4.18	6.00	7.00	6.50	10.54
Guyana						7.29	9.00
Haiti			1.68	2.08			
Honduras		5.75	6.75	7.56	10.24	10.15	9.57
Hong Kong SAR	12.87	18.04	17.20	19.78	19.35	18.06	23.04
Hungary	15.12	19.78	18.45	16.65	20.00	21.84	22.95
Iceland	24.91	35.34	29.15	32.40	30.24	30.09	32.49
India	7.84	11.22	10.50	13.30	13.65	14.40	18.00
Indonesia	7.56	12.95	6.96	12.92	15.96	11.56	9.86
Ireland	21.56	24.96	17.16	18.04	25.48	25.97	25.97
Israel	17.16	18.92	17.60	18.04	23.03	21.60	21.62
Italy	19.89	23.94	18.72	21.07	16.72	19.11	21.00
Jamaica		14.43	9.28	10.24	10.56	10.56	11.20
Japan	30.74	30.78	26.46	27.44	33.04	33.04	34.20
Jordan	14.40	16.40	12.60	18.06	15.60	15.60	13.69
Kazakhstan						11.52	12.21
Kenya				8.40	11.90	11.56	13.32
Korea, Rep.	18.06	17.64	21.15	21.15	18.06	22.09	21.16
Kuwait						9.92	11.56
Kyrgyz Republic						6.38	8.37
Latvia		18.92	16.80	18.92	15.60	16.00	18.92

Lesotho							8.06
Lithuania		16.80	15.99	19.35	19.74	18.00	19.27
Luxembourg	33.60			33.60	30.00	29.76	34.10
Macedonia, FYR				6.60	5.98	6.75	8.99
Madagascar				9.61	10.85	10.54	12.58
Malawi				11.16	10.88	7.28	10.56
Malaysia	14.06	17.63	18.00	19.27	19.80	23.52	25.97
Mali				7.29	6.76	8.12	10.23
Malta				7.54	6.75	9.28	15.20
Mauritania							8.99
Mauritius	9.86	10.23	13.30	16.34	15.60	11.22	16.80
Mexico	12.25	12.60	13.30	14.04	12.24	12.58	15.96
Moldova						10.24	10.54
Mongolia						6.48	6.21
Morocco			8.96	10.88	12.60	8.12	10.23
Mozambique				5.52	7.83	10.23	8.99
Namibia			16.81	14.04	16.40	14.80	16.80
Nepal							8.70
Netherlands	34.02	39.53	33.80	34.65	35.84	32.86	34.72
New Zealand	28.60	31.86	33.00	32.33	32.33	32.33	32.86
Nicaragua		5.52	5.94	5.52	7.56	8.41	8.12
Nigeria		6.75	4.60	7.25	9.92	13.69	9.60
Norway	31.80	33.48	32.24	33.55	36.58	36.54	37.80
Pakistan				7.83	4.83	8.70	11.90
Panama		10.56	10.85	11.16	11.55	11.55	11.52
Paraguay		5.50	5.75	4.18	5.75	5.52	6.96
Peru	8.64	7.25	7.84	7.54	11.22	10.56	13.30
Philippines	6.50	7.84	7.68	8.32	8.91	10.36	11.16
Poland	12.58	17.64	13.32	16.80	12.21	15.96	16.40
Portugal	16.77	17.55	21.50	22.05	20.58	20.16	23.85
Qatar						22.05	20.24
Romania		10.20	9.90	9.86	12.96	10.56	11.55
Russian Federation	13.68	12.48	10.73	10.85	9.92	10.24	8.41
Senegal				12.60			
Serbia and Montenegro				8.12	6.25	6.72	6.24
Singapore	35.40	37.20	31.92	34.80	32.48	33.63	33.06
Slovak Republic	17.55	19.20	19.68	22.44	20.24	21.60	22.95
Slovenia		20.16	22.08	23.00	20.70	24.96	26.50
South Africa	14.44	14.76	16.77	18.00	20.21	21.12	21.60
Spain	19.32	20.58	20.58	20.24	19.74	21.56	19.32
Sri Lanka		10.23	10.50	10.23	12.21	9.30	11.22
Suriname							5.50
Sweden	33.92	36.40	33.28	39.00	40.32	34.10	38.35
Switzerland	37.76	39.00	35.91	37.17	39.65	37.17	39.65
Taiwan, China	21.15	23.40	24.44	27.56	27.03	26.50	27.54
Tajikistan						8.64	9.57
Tanzania				14.40	10.23	12.24	15.12
Thailand	9.00	14.06	15.96	16.80	15.60	17.64	18.48
Timor-Leste (East Timor)						6.50	6.50
Trinidad and Tobago		8.06	9.24	7.83	10.56	9.30	10.24
Tunisia			28.08	24.99	21.50	20.70	27.04
Turkey	13.30	13.53	7.56	10.89	9.60	11.55	14.04
Uganda				12.80	14.43	12.25	11.22
Ukraine	8.96	8.40	9.57	11.52	12.95	10.89	8.99
United Arab Emirates					18.92	19.80	22.08
United Kingdom	29.64	32.48	31.86	32.48	29.64	30.74	33.63
United States	31.62	34.16	29.07	29.68	28.05	27.50	27.54
Uruguay		15.20	11.22	12.60	11.56	13.32	17.22
Venezuela	7.83	8.64	9.88	5.67	9.57	9.24	10.50
Vietnam	6.96	8.28	7.56	11.16	6.75	8.41	8.70
Zambia				13.60	14.04		5.50
Zimbabwe	7.84	9.61	8.64	8.40	8.70	12.25	11.90

Estimating spatial lags

With *N* potential host countries and *T* years of observation, our baseline specification is[10]:

$\ln(FDI_{ijt}) = \gamma_t + \phi \ln(EPI_{it}) + \rho \ln(FDI_{\not{i}jt}) + \theta X_{it} + \varepsilon_{ijt}$, We estimate with maximum likelihood, where:

$$\rho \ln(FDI_{\not{i}jt}) = \rho \mathbf{W} \ln(\text{FDI})_{\not{i}jt}$$

$$\text{with } \mathbf{W} \equiv \begin{pmatrix} \mathbf{W}_1 & 0 & 0 \\ 0 & .. & 0 \\ 0 & 0 & \mathbf{W}_T \end{pmatrix}, \ \mathbf{W}_t \equiv \begin{pmatrix} 0 & 115.4/d_{1,2} & .. & 115.4/d_{N,1} \\ 115.4/d_{2,1} & 0 & .. & 115.4/d_{N,2} \\ .. & .. & .. & .. \\ 115.4/d_{N,1} & 115.4/d_{N,2} & .. & 0 \end{pmatrix},$$

The block-diagonal matrix **W** corresponds to the spatial lag weighting matrix with each block along the diagonal corresponding to a single year, ρ stands for the spatial autocorrelation coefficient. The blocks along the matrix **W** depend on distances, so are identical for each year. The off-diagonal elements in each block contain the spatial inverse-distance weights between any two potential host countries, where the distances are the Vincenty differences in kilometers between country centroids and are normalized by the shortest distance between two host countries (the distance between Netherlands and Belgium, i.e., 115.4 km). As an alternative to a spatial AR(1) process suggested by theory there may be statistical reasons to include a spatial MA(1) error term instead. We follow Florax et al. (2003) and perform robust Likelihood Multiplier (LM) tests. Only in regression (b) of Table 3 do the LM tests reject the null hypothesis of no spatial AR(1) correlation and no spatial MA(1) correlation at the 99% confidence level. Because the sizes of the test statistics are very similar we allow for spatial AR(1) as predicted by theory.

[10] In section 3 we allow for a spatial lag and an average effect of EPI (coefficient ϕ), while in section 4 we drop the spatial lag (since it is not significant) and let EPI have sector-specific effects on FDI, denoted by a *j* index of ϕ: $\ln(FDI_{ijt}) = \alpha_i + \delta_{jt} + \phi_j \ln(EPI_{it}) + \varepsilon_{ijt}$.