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Environmental standards and the location choices of U.S. Multinational Enterprises

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Abstract

This study explores the effect of differences in environmental stringency on the location choices of U.S. multinational enterprises. It seeks to contribute to the literature in the following ways. First, the "knowledge-capital model" by Carr et al. (2001) is extended by including a measure of differences in environmental stringency. Second, new data which allows for distinguishing between horizontal -and vertical multinational activity is used. The effect of an environmental stringency gap on horizontal multinational activity is as expected statistically not significant. After some adjustments are made, the effect of an environmental stringency gap on vertical multinational activity has the expected sign but is statistically not significant.

Keywords: environmental stringency, multinational activity, knowledge-capital model, pollution haven effect

[1] Special thanks to Dr. Julian Emami Namini for his invaluable contributions to the realization of this master's thesis.

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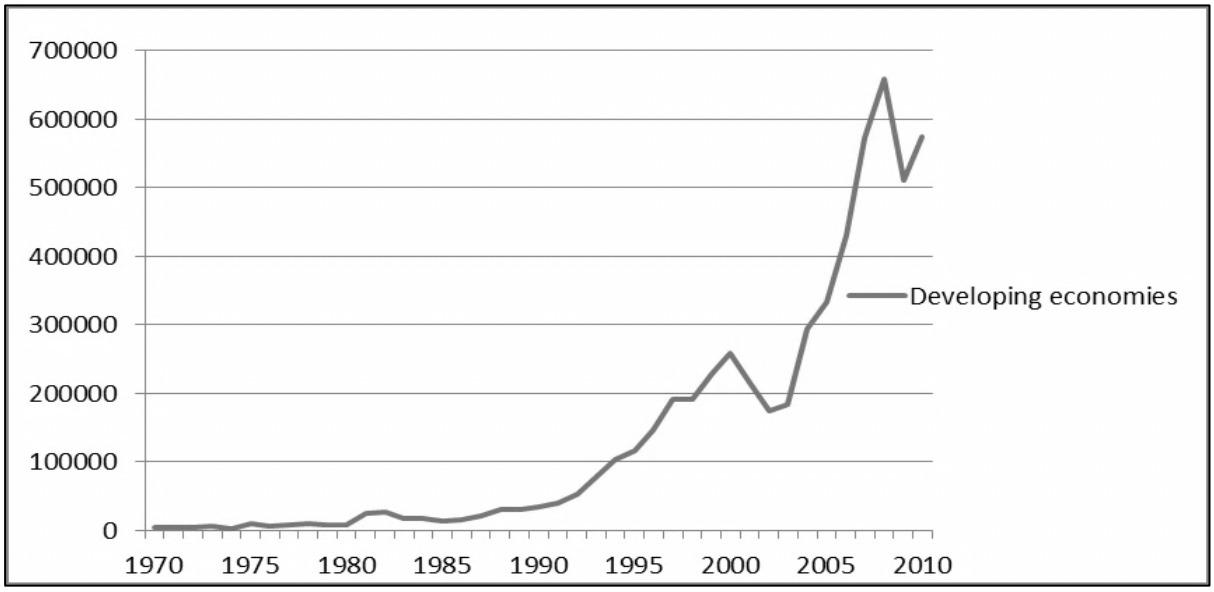
1. INTRODUCTION

Multinational enterprise (MNE) activity in the form of foreign direct investment[2] (FDI) has risen at an unprecedented rate over the last couple of decades. The data on FDI flows to developing countries suggests that MNE's have significantly increased their investments in developing countries since the early part of the 1990s. According to the literature on MNE's, this type of multinational activity can usually be classified as vertical multinational activity. Figure 1 shows a graph of FDI flows to developing countries over the last 40 years with a significant increase since the early part of the 1990s.

Figure 1: **Inward foreign direct investments[3], annual, 1970-2010 for developing countries[4]**



Data source: ***UNCTAD, Division on Investment and Enterprise***

[2] Foreign direct investment (FDI) is defined as an investment involving a long-term relationship and reflecting a lasting interest in and control by a resident entity in one economy (foreign direct investor or parent enterprise) of an enterprise resident in a different economy (FDI enterprise or affiliate enterprise or foreign affiliate). Such investment involves both the initial transaction between the two entities and all subsequent transactions between them and among foreign affiliates (UNCTAD).

[3] Measured in U.S. dollars at current prices and current exchange rates in millions.

[4] There is no established convention for the designation of "developed" and "developing" countries or areas in the United Nations system. In common practice, Japan in Asia, Canada and the United States in northern America, Australia and New Zealand in Oceania, and Europe are considered "developed" regions or areas. In international trade statistics, the Southern African Customs Union is also treated as a developed region and Israel as a developed country; countries emerging from the former Yugoslavia are treated as developing countries; and countries of Eastern Europe and of the Commonwealth of Independent States in Europe are not included under either developed or developing regions (United Nations Statistics Division).

Until the 1st industrial revolution the production of goods was mostly done by hand labor. The 1st industrial revolution, which started around the mid -1700s in Great Britain, ushered in a change from hand production to the production of goods using machinery. It was during this period that fossil fuels became the main input into production processes. The use of machinery during the production of goods and with that the industrial revolution, would spread to the rest of Europe and North America about a century later (www.history-world.org).

It was with these industrial developments that pollution became a mayor issue. During the twentieth century, the progression of technology allowed large corporations to dominate the industrial landscape and have the most drastic negative effect yet on the environment (www.pollutionissues.com).

The need to preserve and improve environmental quality, fearing the still unknown effects of global warming and climate change, has resulted in intensified efforts to reduce pollution worldwide. The Stockholm Conference on Environment and Development in 1972 was the United Nations first major conference on global environmental issues. It was during this conference that the ground work was laid for global environmental regulations. Ever since that first conference in Stockholm, great strides have been made regarding the implementation of worldwide environmental standards. Although steady progress has been made during the decades past, environmental regulations are far from uniform across the globe. According to Dasgupta et al. (1995) it is quite clear that the enforcement of environmental laws has been hampered by inadequate staffing and funding in many developing countries.

The implementation of more stringent environmental standards, while to the benefit of social well-being, implies extra cost for firms operating in these countries. The extra costs associated with the compliance to higher environmental standards may lead firms to relocate their polluting production facilities elsewhere." There are three primary justifications for this view. Strong environmental regulations are viewed to: (a) directly drive up production costs by requiring certain equipment; (b) decrease waste disposal capacity (e.g., by restricting areas that can be used for landfills); and (c) prohibit certain factor inputs or outputs" (Kolstad and Xing, 1998:1).

The relocation of polluting MNE's towards countries with lax environmental standards has become known as the "pollution haven" effect (PHE). In theory the PHE seems rather straight forward. If environmental standards are not uniform across countries, then polluting MNE's will relocate their production facilities to countries where environmental standards are more lax and thus producing a polluting good becomes cheaper. The PHE states that more stringent environmental regulations will have an effect on plant location decisions and trade flows at the margin (Copeland and Taylor, 2004).

The PHE should not be confused with the pollution haven hypothesis (PHH), which states that when trade barriers are reduced pollution-intensive industries are transferred from countries with more stringent environmental regulations to countries with weaker environmental regulations (Copeland and Taylor, 2004). One example that comes to mind is the ratification of free trade agreements where participants have different environmental standards.

Carr et al. (2001) took the theoretical predictions of recent theory on the multinational enterprise and subjected them to econometric tests. They present a model which they refer to as the "knowledge-capital model" of the multinational enterprise. The three principal assumptions of this model are that: 1) Research and development (R&D) activities can be separated across countries and be supplied to multiple production facilities at the same time, thus resulting in lower cost; 2) Relative to production, activities such as R&D are skilled-labor-intensive; 3) Activities such as R&D can be used by multiple production facilities at the same time. The first two points may lead to production processes being split up and locating R&D activities where skilled labor is cheap, while locating production where unskilled labor is in abundance[5].

This paper argues that another motive for vertically splitting up production processes might be differences in environmental regulations across countries. On the other hand if the environmental policy regime in a host country is considered as a sign of other governance characteristics then, after a certain threshold, very loose environmental standards should discourage relocating production facilities towards such host countries (Kalamova and Johnstone, 2011).

[5] Vertical multinational activity is covered in section 2.4.2.

The effect of differences in environmental stringency on different types of multinational activity varies. By using a dataset that allows for distinguishing between horizontal -and vertical multinational activity, the goal is to confirm the existence of a significant effect of differences in environmental stringency on the location choices of U.S. vertical MNE's.

The empirical hypothesis can thus be stated as follows:

- ✓ *Horizontal multinational activity should not a priori be sensitive to environmental stringency differences between parent -and host country;*
- ✓ *A decrease in environmental stringency of the host country relative to that of the parent country should positively affect vertical multinational activity;*
- ✓ *When environmental stringency in the host country becomes too lax, the effect of a positive gap in environmental stringency between the parent -and the host country on multinational activity should be negative though.*

The remainder of the paper is organized as follows. Section 2 takes a look at the theoretical basis and background for this research. Section 3 describes the "knowledge-capital model" by Carr et al. (2001). Section 4 covers the data and the empirical model used, while in section 5 the empirical results are reported. Finally in section 6 concluding remarks are given.

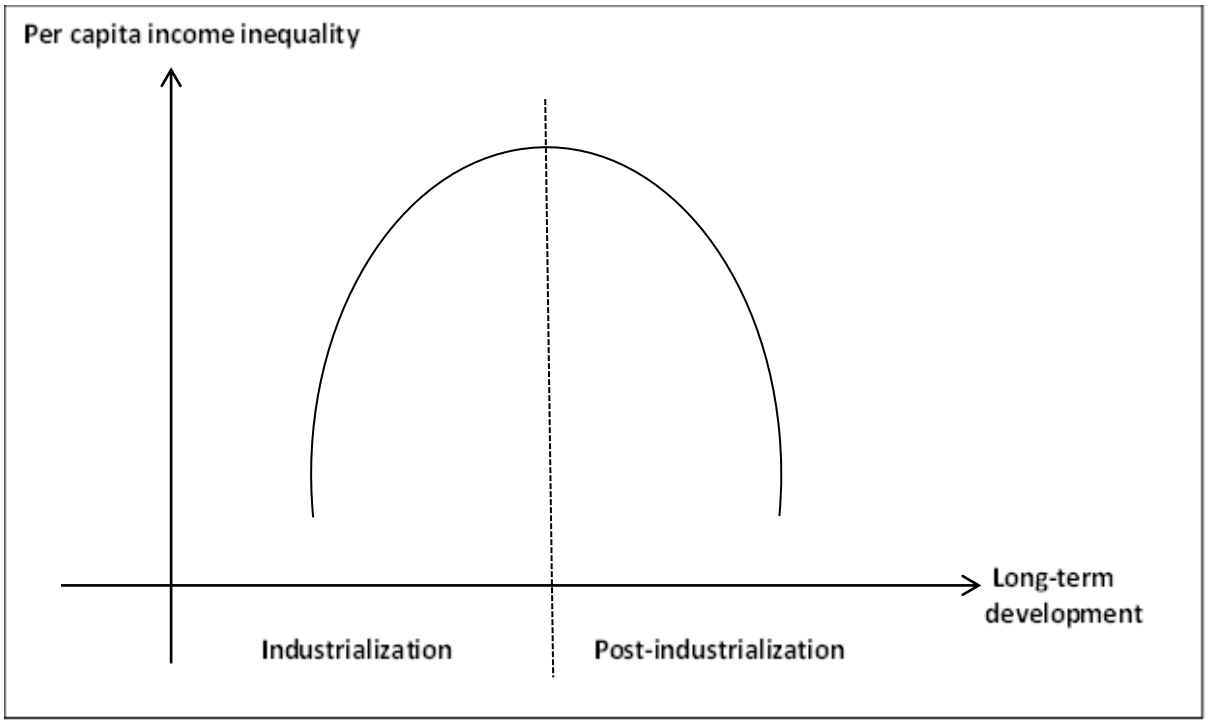
2. THEORETICAL MOTIVATIONS - AND BACKGROUND

In this section the theoretical basis -and framework for this research are discussed. First the environmental Kuznets curves, which illustrates that developing countries should have lower environmental standards and thus are excellent candidates as host countries for vertical multinationals, is discussed. Secondly the theory regarding pollution havens is discussed. This theory entails that polluting firm's will relocate their polluting activities to countries with lower environmental standards, thus turning these countries into pollution havens. In the following chapter the link between environmental standards and comparative advantages is made. Finally multinational activity, where a distinction is made between horizontal -and vertical multinational activity, is discussed.

2.1. THE ENVIRONMENTAL KUZNETS CURVE (EKC)

Kuznets (1955) described the relationship between per capita income and income inequality. He implied that both per capita income and income inequality increase up to a certain point in the early stages of economic development. Thereafter, with economic growth, income inequality starts declining. What this implies is that when an economy is in the early stages of economic growth the distribution of income becomes more unequal, but as this economic growth continues differences in income become smaller. If one plots this relationship graphically the result is an inverted U-shaped curve, which is now known as the Kuznets Curve, shown in figure 2.

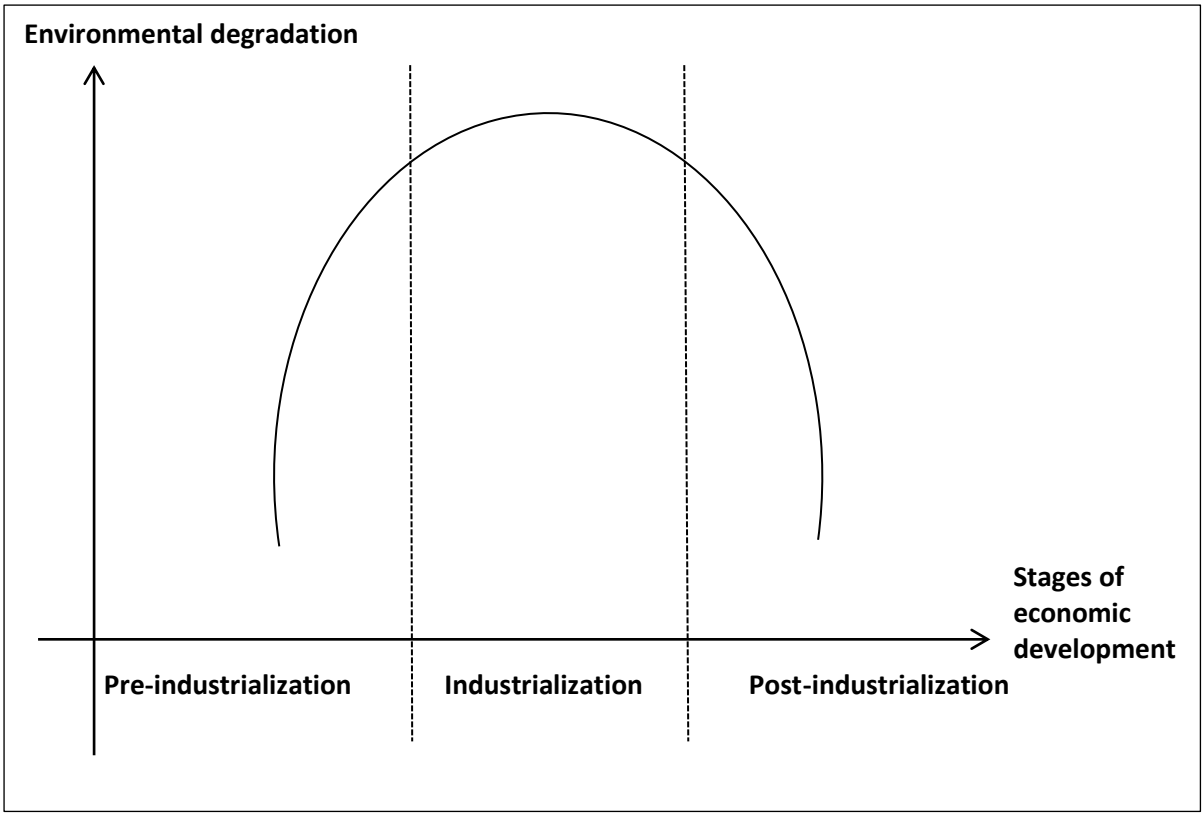
Figure 2: **The Kuznets Curve**



Source: ***Sommeiller, E. (2006)***

Studies conducted in the early 1990s suggest a similar relationship between the quality of the environment and the level of income within a country. Grossman and Krueger (1991) examined the relationship between economic growth and environmental quality and where one of the first to suggest the existence of an inverted U-shaped relationship. The curve describing this relationship has become known as the Environmental Kuznets Curve (EKC), which is shown in figure 3.

Figure 3: **The Environmental Kuznets Curve**



Source: ***Panayotou (2003)***

If one interprets the EKC, one notices that in the early stages of a country's economic development (lower levels of income per capita), there is a negative relationship between economic growth and the quality of the environment, thus pollution increases. As the economy moves to more advanced stages of economic development, economic growth is still detrimental to the quality of the environment but less so than in the early stages of economic development. Then after income per capita reaches a certain level, from that point onwards there exists a positive relationship between economic growth and the quality of the environment. What this means is that pollution starts to decline in post-industrial economies.

A host of studies have been conducted on the EKC since the early work of Grossman and Krueger (1991). The results have been mixed at best. Some studies corroborate the existence of an EKC (Panayotou, 1995) (Canas et al. 2003) (Seldon and Song, 1994); some

suggest that it exists under some circumstances (Shafik, 1994) (Dijkgraaf and Vollebergh, 1998).

In table 1 data is displayed linking the economic development of randomly chosen low, middle and high income countries and their levels of sulfur dioxide emissions (SO2). SO2 is a poisonous gas that in large concentrations can have adverse effects on the environment, but also on social health. SO2 can be classified as part of a group of highly reactive gasses known as "oxides of sulfur." The main culprits of SO2 emissions are fossil fuel burning at power plants, which account for almost 73% of total SO2 emissions. While other industrial facilities account for nearly 20% of these emissions. Other sources of SO2 emissions include industrial processes such as extracting metal from ore, the burning of high sulfur containing fuels by locomotives, large ships and non-road equipment (www.epa.gov). Table 1 shows that in most low and middle income countries SO2 emissions are still on the rise. The high income countries included however all show a steep decline in SO2 emissions during the last decade. The data presented in table 1, although stylistic would support the existence of an EKC.

Table 1: **GDP per capita and levels of sulfur dioxide emissions.**

	Low and middle income countries					
Country		**1960**	**1970**	**1980**	**1990**	**2000**
Benin	GDP per capita	256,98	291,90	300,30	295,78	345,95
	SO2 emissions	4,87	6,83	7,55	7,00	6,61
CAF	GDP per capita	355,82	354,14	323,39	277,57	259,19
	SO2 emissions	11,02	15,45	19,38	19,16	19,66
Nepal	GDP per capita	139,08	145,25	141,32	176,93	225,17
	SO2 emissions	1,70	1,37	10,27	8,40	15,95
Ghana	GDP per capita	281,80	293,68	241,69	220,83	259,71
	SO2 emissions	0,44	2,69	4,18	3,72	3,11
Malawi	GDP per capita	98,63	121,24	160,22	132,51	155,27
	SO2 emissions	1,93	3,82	7,33	7,77	8,82
Niger	GDP per capita	313,91	307,30	259,49	193,50	164,65
	SO2 emissions	11,16	15,65	16,22	14,22	17,78
Cote d'Ivoire	GDP per capita	550,69	852,92	909,00	662,86	628,22

	SO2 emissions	2,92	13,06	22,18	21,80	24,39
Bolivia	GDP per capita	894,76	927,10	1071,00	871,23	1010,91
	SO2 emissions	15,27	29,81	30,50	35,54	41,40
Egypt	GDP per capita	430,36	565,98	856,60	1153,68	1475,84
	SO2 emissions	78,74	52,02	244,26	301,72	227,64
Peru	GDP per capita	1647,25	2075,56	2261,40	1664,25	2060,58
	SO2 emissions	222,52	228,74	319,65	279,55	473,19

High income countries

Country		**1960**	**1970**	**1980**	**1990**	**2000**
Netherlands	GDP per capita	8562,94	12759,18	15984,15	18858,00	24179,73
	SO2 emissions	305,97	403,50	245,00	102,00	45,50
Luxembourg	GDP per capita	13711,03	17468,24	21005,55	32476,86	46457,89
	SO2 emissions	7,33	28,00	12,00	7,35	1,50
Canada	GDP per capita	9374,88	12986,31	16751,34	19561,88	23559,50
	SO2 emissions	2650,06	3270,00	2321,50	1630,00	1189,50
United States	GDP per capita	13711,44	18213,25	22611,07	28274,12	35081,92
	SO2 emissions	10098,95	14172,97	11769,95	10476,50	7421,54
Germany	GDP per capita	NA	11895,37	15798,70	19600,84	22945,71
	SO2 emissions	3370,94	3946,14	3757,00	2663,00	318,00
UK	GDP per capita	10059,53	12540,32	15004,77	19361,05	25083,00
	SO2 emissions	3076,27	3212,00	2427,17	1861,00	595,00
France	GDP per capita	7503,77	11580,88	15657,46	18761,35	21828,29
	SO2 emissions	876,75	1545,23	1630,60	663,00	313,50
Finland	GDP per capita	7306,04	11007,47	15372,88	19921,02	23529,54
	SO2 emissions	141,41	257,50	292,00	118,50	38,00
Hong Kong	GDP per capita	2967,98	6085,32	11880,14	20188,06	25374,50
	SO2 emissions	3,69	0,37	0,05	76,20	38,21
Singapore	GDP per capita	2252,95	4634,68	9433,26	15747,53	23814,56
	SO2 emissions	0,39	23,73	71,11	95,40	81,58

Source: ***Stern (2005) and the world development indicators (WDI)***

2.2. THE POLLUTION HAVEN EFFECT (PHE) VS. THE POLLUTION HAVEN HYPOTHESIS (PHH)

When trade laws allow for firms to relocate across borders and still serve the same markets, if capital is mobile between countries and environmental stringency differs among these countries, then “pollution havens” may emerge. One of the underlining foundations of the "pollution haven hypothesis" is that environmental protection is a normal good. As a result higher income due to international trade should result in higher environmental stringency, but if environmental protection is a normal good than lesser developed countries will have lower standards of environmental stringency. So because of the unequal distribution of world income free trade may affect national output in such a way that less developed countries turn towards pollution-intensive activities (Copeland and Taylor, 1994). Simplistically stated; the “pollution haven hypothesis” states that free trade will lead to polluting industries being relocated towards countries with less stringent environmental standards. So as pollution in developed countries decreases, total global pollution increases due to the relocation of polluting industries towards those countries with weaker environmental standards.

As Copeland and Taylor (2004) point out empirical work on pollution havens has occasionally blurred the distinction between two completely different empirical findings linking environmental stringency and trade flows. They distinguish between a “pollution haven effect” which entails the effects of environmental standards on the location choices of multinational firms and the “pollution haven hypothesis” which refers to effects of free trade on the decision to relocate to take advantage of differences in environmental stringency. The “pollution haven effect" of environmental policy needs to exist, but is not sufficient in order for the "pollution haven hypothesis" to be validated. This paper focuses on the “pollution haven effect” rather than the “pollution haven hypothesis”

In a nutshell, since the EKC states that lesser developed countries should have lower environmental standards. If there is a “pollution haven effect”, then multinational activity based on differences in environmental standards should be predominant in lesser developed countries.

2.3. ENVIRONMENTAL STANDARDS AND COMPARITIVE ADVANTAGES

Free trade as a trade policy has led to calls for uniformity of environmental regulations in order to create a level playing field, which entails that countries should not be able to gain a comparative advantage in trade through lax environmental standards (Ederington and Minier, 2003). Many argue that higher environmental standards may have had a significant hand in the U.S. economy going from a position of approximate trade balance on a long-term basis to a position of chronic trade deficit. Popular believe is that more stringent environmental standards lead to a decrease in competitiveness, which in turn results in increasing imports, declining exports and movement of manufacturing capacity to other countries (Jaffe et al. 1995). When protection of the environment leads to higher environmental regulations there is a prevailing opinion that this occurs at the expense of the economy. According to Porter and Van der Linde (1995) a transition needs to be made from the static view of environmental regulation, in which everything except environmental regulation is held constant. Business environments are dynamic, which means that higher environmental standards can be compensated trough other measures. Higher environmental standards should encourage innovations that either or both lower the total cost of a product and/or improve its value. These new innovations should allow companies to combine a range of inputs more productively, thus offsetting the costs of adhering to higher environmental standards. Their conclusion is that higher environmental standards should encourage Innovations and increase the competitiveness of companies, not decrease it.

Bhagwati and Srinivasan (1995) recognize several effects that differences in environmental standards might have on trade when engaged in free trade. Two of these effects that regard competitiveness are:

1) Unfair trade: when engaged in trade activities, if one country does not adhere to the same environmental standards this constitutes a unequal playing field and thus unfair trade;
2) “A race to the bottom”: countries engaged in trade with countries that have lower environmental standards, will face pressure to lower their own environmental

standards to ensure survival of their own industry. The fear is that capital will move to countries with lower environmental standards and thus countries engage in a race with each other to adopt environmental standards lower than desired to attract capital.

Over the decades past many empirical studies with different results have been performed linking environmental standards and comparative advantages.

Jaffe et al. (1995) for instance conclude that there is relatively little evidence to suggest that environmental regulations have had a large adverse effect on competitiveness. They list several reasons that might explain their results. First, environmental stringency is very difficult to measure across countries and thus very difficult to incorporate in any empirical analysis. Second, complying with higher environmental standards is just a small percentage of total production costs. Only in highly regulated industries would one find a significant effect of higher environmental standards on total production costs. Third, U.S. environmental laws and regulations maybe some of the most stringent in the world, but when compared to other western industrial democracies they do not differ much, especially for air and water pollution control. Fourth, when U.S. multinationals invest in countries that do have significantly lower environmental standards, they are reluctant to build less than state of the art plants. Fifth, it appears that when investing in developing countries multinational firms typically engage in more pollution control than is required by the host country. To the extent this is true; differences in environmental stringency between countries may not result in significant effects on plant location or other manifestations of competitiveness.

Ederington et al. (2005) empirically test several reasons that might explain why no significant results have been found linking environmental standards and comparative advantages. First they test whether most trade takes place between countries of similar economic development and thus with similar environmental standards, which could mask the effect of differences in environmental standards on comparative advantages. When distinguishing between North-North -and North-South trade they find significant evidence that an increase in U.S. environmental regulations leads to higher imports from developing countries. Secondly they test whether the immobility of pollution-intensive industries explains why the

effect of differences in environmental standards on trade flows has not been observed. They find evidence that due to the costs of transportation, plant fixed costs, or economies of agglomeration pollution-intensive industries are far less sensitive to differences in environmental standards. Finally they investigate a point that was also made by Jaffe et al. (1995), which is that for all but highly regulated industries environmental costs constitute a small fraction of total costs. When testing the effect of differences in environmental standards in highly regulated industries the authors find no significant evidence that pollution-intensive industries or more sensitive to environmental regulations.

Ederington and Minier (2003) estimate the impact of environmental regulation on trade flows when environmental policy is modeled endogenously. They find empirical support for modeling environmental policy endogenously and also that environmental policy has much stronger impact on net imports than had previously been reported. Their results suggest that the U.S. have a tendency of lower environmental standards in import-competing industries and higher environmental regulations in export-competing industries.

As one can see the empirical results testing the theoretical predictions as to whether countries with lower environmental standards have a comparative advantage in international trade have been mixed and inconclusive. Could this mean that other factors are far more important when multinational enterprises choose their production locations?

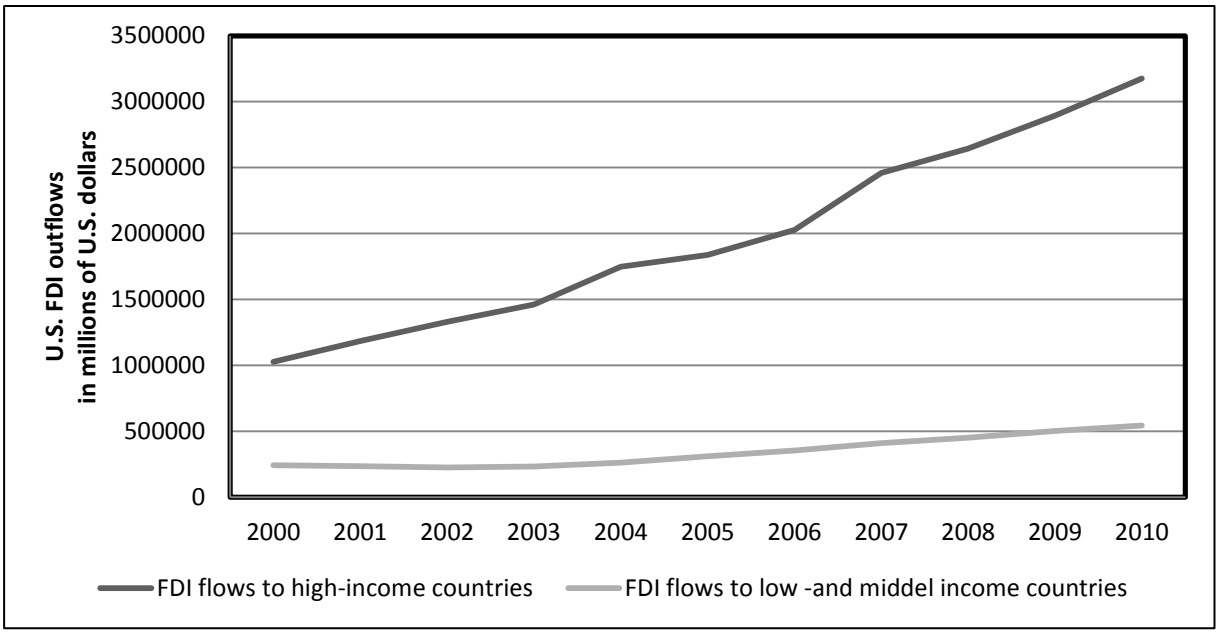
2.4. THE MULTINATIONAL ENTERPRISE (MNE)

“Multinationals are firms that engage in direct foreign investment, defined as investments in which the firm acquires a substantial controlling interest in a foreign firm or sets up a subsidiary in a foreign country” (Markusen, 1995: 170). For an investor to decide to engage in a foreign direct investment, the country that is being invested in must offer a significant advantage for not producing locally and/or exporting the good(s) depending on the type of multinational activity. Over the last decades MNE activity has grown at a far quicker pace than trade flows between countries. It does not come as a big surprise than, that during this period research into FDI has peaked.

2.4.1. HORIZONTAL MULTINATIONAL ACTIVITY

A horizontal multinational enterprise is a MNE that has affiliates in multiple countries producing roughly the same goods. In general horizontal multinationals create more jobs in the host country, when compared to vertical multinationals. History shows that horizontal multinationals are far more prevalent than vertical multinationals (Yokota, 2005). Figure 4 shows the data for U.S. outward direct investments. Direct investments in high income countries are taken to represent horizontal multinational activity, while U.S. direct investments in low -and middle income countries are taken to represent vertical multinationals. In the case of the U.S., indeed horizontal multinational activity is far more prevalent than vertical multinational activity.

Figure 4: **Outward direct investments, annual, 2000-2010 towards high income countries and low- and middle income countries.**



Data source: ***BEA.gov***

The underling goal of horizontal multinational activity is to serve the host market in the most profitable way, thus one may consider market access as its primary objective. Horizontal multinational activity usually occurs between a parent -and host country that are often quite

similar in economic size, thus it is more prevalent between countries that are in similar stages of development. Horizontal MNE's arise to penetrate new foreign markets. Say that there is a company which operates in local market A. This company decides it wants to broaden its horizons by also serving markets B and C. In this case there are two options: 1) The MNE can export to countries B and C; 2) If trade costs between country A and countries B and C are high the MNE can decide to set up production facilities in countries B and C.

One of the first theoretical models regarding horizontal multinational activity is from Markusen (1984). It is a general equilibrium model where MNE's exist to access new markets instead of exporting.

An important factor in deciding to horizontally fragment production is whether the fixed costs in the host country are lower than the cost of exporting to that host country. When the removal of trade costs is not enough to offset the fixed costs that are associated with setting up a production facility in host country, exports are chosen over setting up a production facility to serve the market abroad. However, when the opposite is true, FDI is chosen over exports. Thus a larger host market, smaller plant-level fixed costs, and larger trade costs are factors that seem to stimulate horizontal multinational activity.

As far as environmental stringency goes, it is assumed that horizontal multinational activity is not extremely sensitive to environmental regulations. That being said some environmental standards have to be met in order to be allowed to serve the host market (Kukenova and Monteiro, 2008).

2.4.2. VERTICAL MULTINATIONAL ACTIVITY

Vertical multinationals fragment production between countries. The main objective is to take advantage of differences in factor costs between countries. In case of vertical fragmentation the parent country is usually of larger economic size than the host country, so it usually occurs between countries that are in very different stages of their development.

An early model of vertical multinational activity is that of Helpman (1984). He builds a two-factor framework in which he shows that if there is monopolistic competition and trade costs are absent, vertical multinationals will arise based on comparative advantages.

With vertical multinational activity headquarters are located in the home/parent country; production can be either located in the parent country or separated and located abroad. Production costs are taken to be higher in the parent country than in the host country. Hence the decision to fragment production across different countries is made between the trade-off of lower costs of producing abroad and the cost associated with exporting the goods back to the parent country.

When parent country A decides to vertically fragment production to country B, this decision is made at the expense of vertically fragmenting production to for instance host country C. Thus with vertical multinational activity, all other things being equal, a difference in environmental standards between host countries B and C might be the deciding factor for the parent company in deciding whether to fragment production to host country B or C (Kukenova and Monteiro, 2008). The expectation is thus that differences in environmental stringency should indeed have a positive significant effect on vertical multinational activity.

3. METHODOLOGY

In this section the knowledge capital model is highlighted. This model will be extended and thus forms the basis for the empirical analysis.

3.1. THE KNOWLEDGE CAPITAL MODEL OF THE MULTINATIONAL ENTERPRISE

The knowledge-capital model of the multinational enterprise (Carr et al. 2001) relies on insights from new trade theory about increasing returns to scale, joint inputs, and international costs of investing and exporting. It is a framework that combines the theories of the multinational firm e.g. the horizontal- and vertical model and allows for both multi-plant scale economies and exploitation of factor-price differences. The three principal assumptions of this model are that: 1) Research and development (R&D) activities can be separated across countries and thus be supplied to multiple production facilities at low cost at the same time; 2) Relative to production, activities such as R&D are skilled-labor-intensive; 3) Activities such as R&D can be used by multiple production facilities at the same time. The first two points may lead to production processes being split up and locating R&D activities where skilled labor is cheap, while locating production where unskilled labor is in abundance (vertical multinational activity). The last assumption leads to horizontal multinational activity.

The characteristics of the MNE's described above are captured in the theoretical framework by a series of assumptions about factor intensities of six firm types in a home and foreign country. The six firm types can be categorized as two strictly national firms, which maintain a single plant and headquarters in one country, two horizontal MNE's, which maintain plants in both countries and headquarters in a parent country, and two vertical MNE's, which maintain headquarters in the parent and a single plant in a host nation. Vertical MNE's sell in affiliate markets and also export back to the parent country as mentioned before.

There are several factors which will lead to national firms being the dominant type active in a market. These factors are: 1) the country is both large and skilled-labor abundant; 2) the

home -and foreign country are similar in size and relative endowments, while transport costs are small or foreign investment barriers are high.

Horizontal MNE's tend to be favored if home -and foreign country are similar in size and relative endowments but transport costs are higher, in that case firms prefer to penetrate markets through FDI rather than trade. Finally, vertical MNE's tend to be dominant if the parent country is small and skilled-labor is abundant, while transport costs are relatively low. In that case the firm takes advantage of lower factor costs abroad and exports back to the parent country.

4. DATA & EMPIRICAL MODEL

This chapter focusses on the data and model used to estimate the empirical relationship between differences in environmental stringency and the location choices of U.S. multinational enterprises. A (unbalanced) panel of cross-country observations over the period 2001-2009 forms the input for this estimation, while the model used and extended is drawn from Carr et al. (2001).

4.1. DEPENDENT VARIABLES

One of the objectives of this paper was to differentiate between horizontal –and vertical multinational activity, therefore to test the main hypothesis a distinction is made between markets U.S. affiliates serve. This distinction has led to the selection of the following dependent variables: 1) U.S. affiliate sales to host market; 2) U.S. affiliate sales back to the United States; 3) affiliate sales back to U.S. parents. The first dependent variable captures horizontal multinational activity, while variables 2 and 3 capture vertical multinational activity.

The U.S. Bureau of Economic Analysis (BEA) (www.bea.gov) provides annual data on direct investment and multinational companies, this allows for distinguishing between markets where U.S. affiliates sell their products to. In every observation he U.S. thus serves as the parent country, while the selection of host countries is based on the ranking of the largest recipients of U.S. direct investments according to the BEA. After removing those countries for which there was no data available, 43 Countries are left for which at least 1 year of complete data is present. U.S. affiliate sales are measured in millions of U.S. dollars. The list of countries used for the empirical analysis is included in appendix A.

4.2. EXPLANATORY VARIABLES

The main explanatory variable of interest is the difference in environmental stringency between the United States as the parent country and host countries, while environmental stringency difference squared is just its squared term.

The data are drawn from the World Economic Forum's Global Competitiveness – and Travel & Tourism competitiveness Reports (www.**wef**orum.org). A yearly "Executive Opinion Survey", is conducted by the World Economic Forum in which business executives are asked to give their opinions on several topics regarding the environment their company's operate in. One of many topics covered by this survey is the standard of environmental regulations in the country in which the executive operates in. through the survey respondents are asked to indicate the "stringency" of a country's overall environmental regulation. Specifically, they were asked to assess the degree of stringency on a Likert scale, with 1 = lax compared with that of most other countries, 7 = among the world's most stringent[6].

The rest of the explanatory variables used are taken from the Knowledge-Capital Model (Carr et al. 2001) and include:

- ✓ Joint market size, which is measured by the sum of gross domestic product (GDP) levels in the United States and host countries;
- ✓ The squared difference of GDP between the United States and host countries;
- ✓ The difference in skilled-labor abundance between the United States and host countries;
- ✓ The product of differences in economic size and skill endowments;
- ✓ The cost of investing in host country;
- ✓ Trade cost in exporting to host country;
- ✓ Trade cost in exporting to United States[7];
- ✓ The distance between the United States and host country[8].

The World Bank provides annual data on GDP. Data are in constant 2000 U.S. dollars, which means that dollar figures for GDP are converted from domestic currencies using 2000 official exchange rates.

The cost of investing is constructed by taking the average of six indices considered to impact investment. The investment impediments considered include hiring and firing practices, intellectual property protection, judicial independence, ease of access to loans, access to credit and the effectiveness of antitrust policy. The results range from 1 to 7, with a higher

[6] For Egypt 2002 the missing value is taken to be equal to the average of the year before and after.
[7] Is excluded from the fixed-effects model because of collinearity.
[8] Is excluded from the fixed-effects model because of collinearity.

number indicating higher investment costs. The data are collected from the yearly "Executive Opinion Survey", reported in the World Competitiveness Report of the World Economic Forum.

As a proxy for skill, following Kalamova and Johnstone (2011) GDP per capita is used. The data on GDP per capita are obtained from the World Bank development indicators and measured in constant 2000 U.S. dollars.

To measure impediments on the imports of goods a trade-cost index is constructed, by taking the average of four indices considered to negatively impact trade. The trade impediments considered include the quality of port infrastructure, the quality of air transport infrastructure, the prevalence of trade barriers and the burden of regulation. The results also range from 1 to 7, with a higher number indicating higher trade costs. The data are also collected from the yearly "Executive Opinion Survey", reported in the World Competitiveness Report of the World Economic Forum.

4.3. STYLIZED FACTS

When industrial processes reduce the quality of the natural environment, one says that the environment is deteriorating. Deterioration of the environment can take place locally or globally. At present some of the biggest concerns are air pollution, the loss of rain forests and ozone depletion. Developing countries are especially affected by pollution increases, because they are more dependent on ecosystem functions[9].

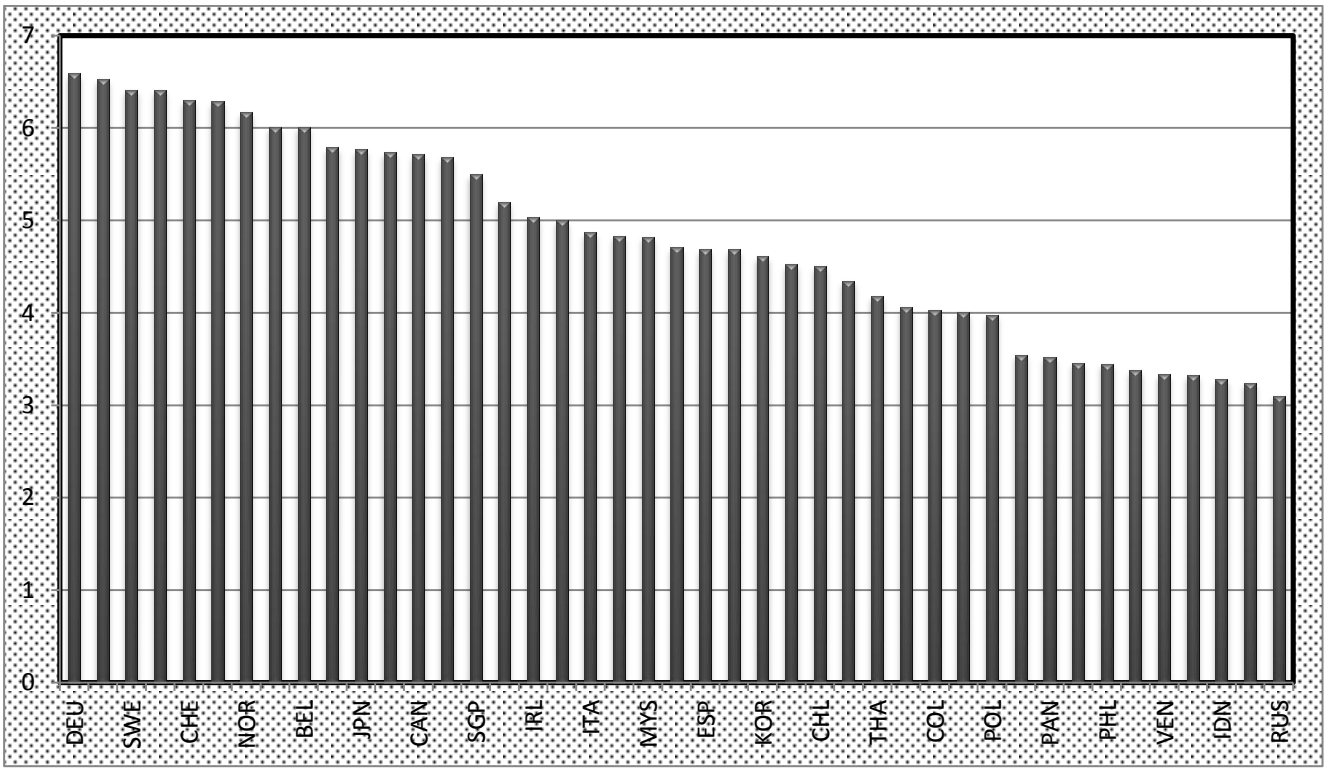
During the Industrial Revolution, companies were basically only concerned with their bottom line. There was little attention being paid to the pollution that the production of goods brought with it. Once income inequality started to decline with the wealth generated by the mass production of goods, the awareness towards pollution generated by factories increased. Over the next hundred years environmental changes did occur gradually, but it was during 1960s that the greatest increase in environmental concerns raised by the public was observed (www.pollutionissues.com).

[9] Ecosystem function is the capacity of natural processes and components to provide goods and services that satisfy human needs, either directly or indirectly (de Groot et al 2002).

Climate change and global warming have become a few of the more discussed topics over the last decades. Scientists are convinced that the release of greenhouse gases is the main culprit in the earth's surface temperatures rising during the last century (www.epa.gov).

With these developments academic research into environmental standards has also gained much more attention. Most measures of environmental stringency used in the literature as of now however suffer from endogeneity problems. As Kalamova and Johnstone (2011:15) state "Given the heterogeneity of environmental policy regimes both across countries, and within countries across sectors and impacts as well as through time, it is difficult to construct a general index of the stringency of environmental policy regimes". In order to circumvent endogeneity problems associated with most measures of environmental strategy, following Spatareanu (2007) and Kalamova and Johnstone (2011) a measure of Stringency of the Environmental Regulations from the Global Competitiveness Report published by the World Economic Forum is used. In figure 5 the mean values of environmental stringency are shown for host countries over the years 2001-2009, with Germany having the highest average at 6,59 and Russia the lowest at 3,1.

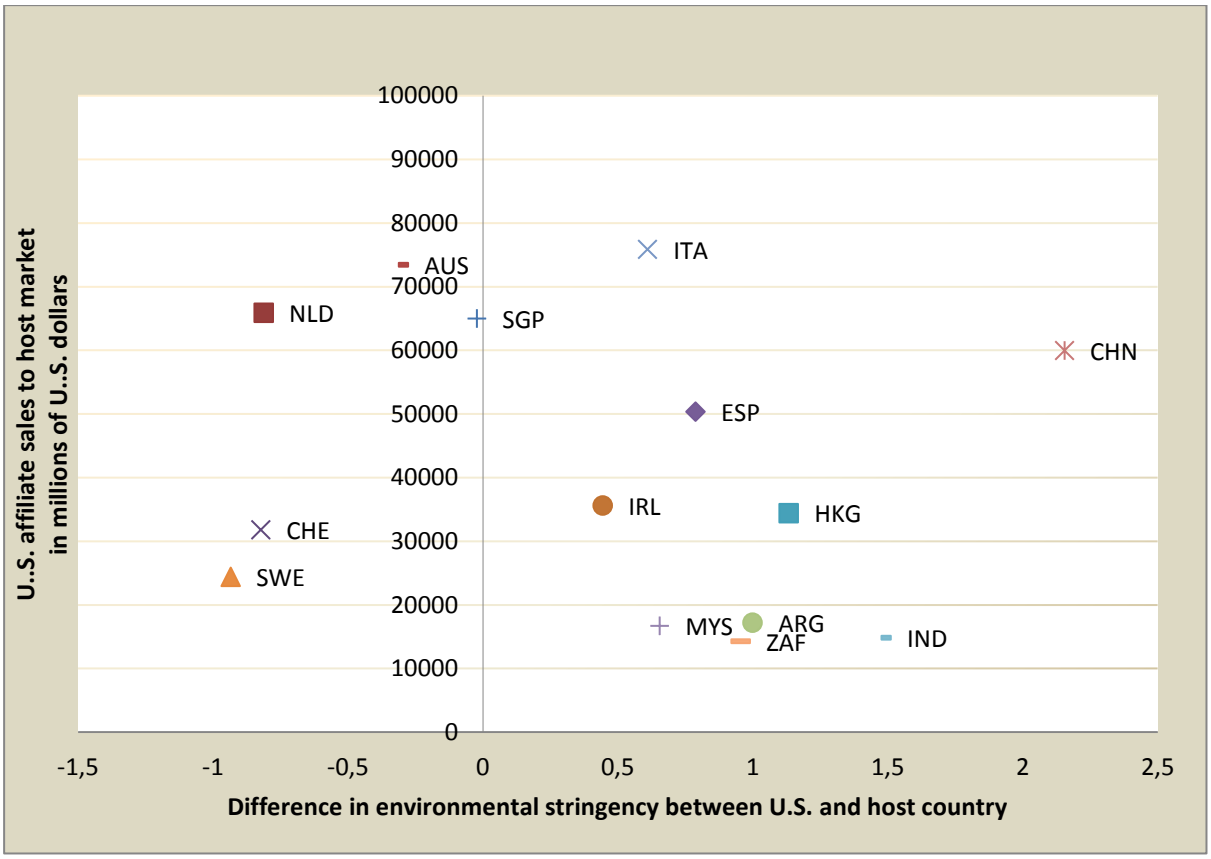
Figure 5: **Environmental stringency (Average values 2001-2009)**



Data source: ***WEF Global Competitiveness Report and Kalamova and Johnstone (2011)***

In figure 6 the difference in environmental stringency between the U.S. and host countries are plotted against sales of U.S. affiliates to host markets. The countries[10] included are the 17 for which complete data is available for al years, of which the average values for 2001-2009 are used. The plot suggests a (weak) negative relationship between U.S. affiliate sales to host markets and the environmental stringency gap between the U.S. and host countries. This result could be intuitively plausible since horizontal multinational activity is predominant between countries of similar economic size and the main objective of horizontal multinational activity is market access and not to take advantage of differences in factor costs. One would suspect this relationship not to be statistically significant though.

Figure 6: **Environmental stringency gap and U.S. affiliate sales to local market (average values 2001-2009)**

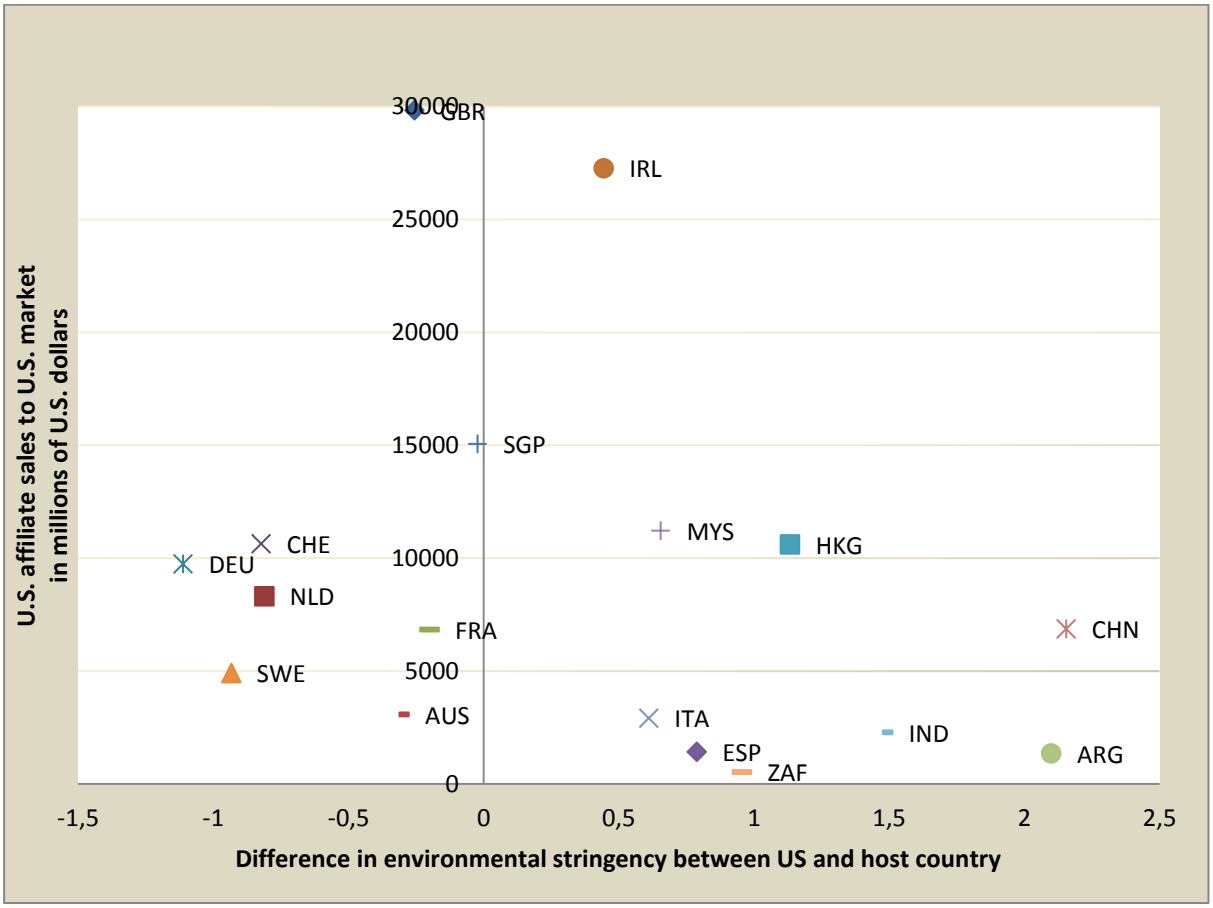


Data source: ***bea.gov and WEF Global Competitiveness Report***

[10] The countries included are in italic in appendix A.

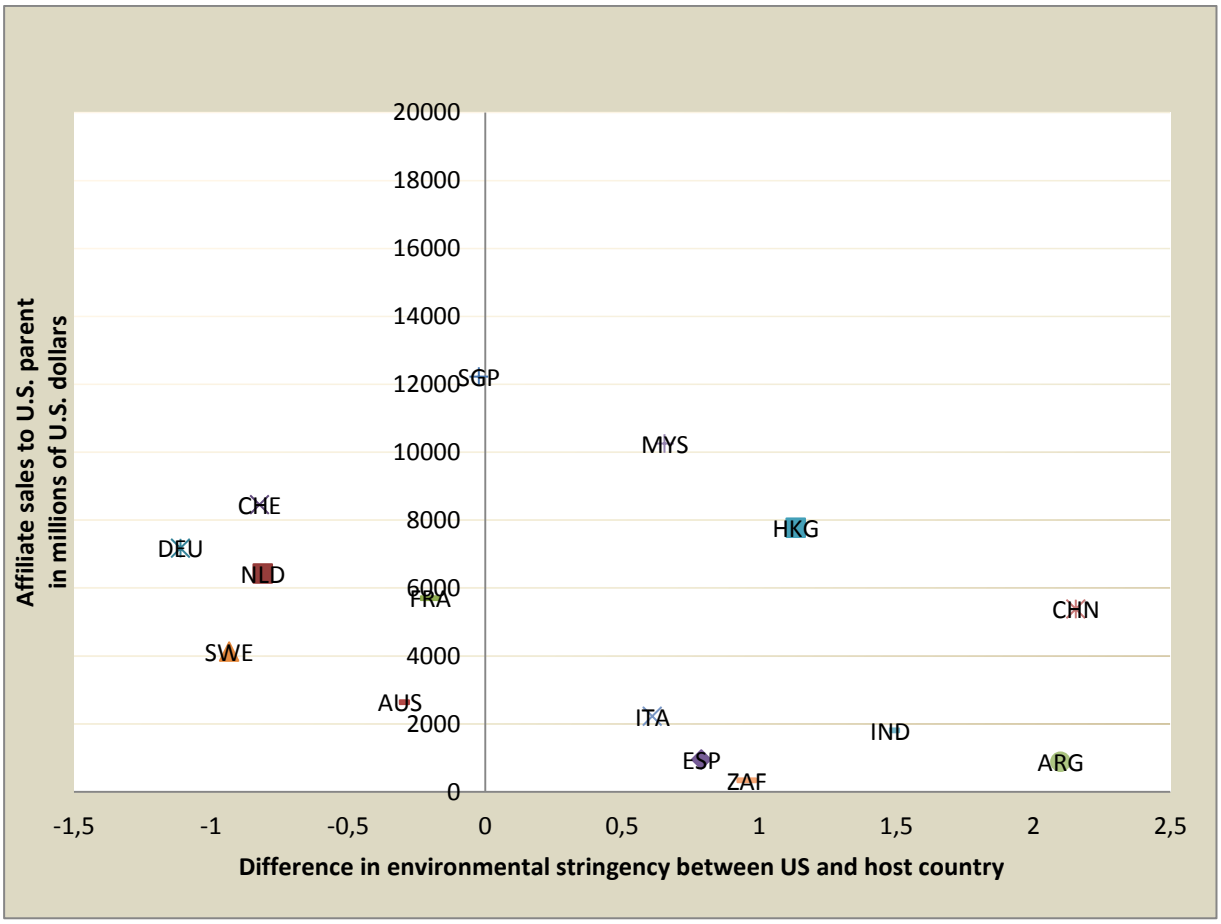
Figure 7 and 8 plot environmental stringency differences between the U.S. and host countries against vertical multinational activity. Both plots suggest a (weak) negative relationship. This goes against theoretical expectation, but one should keep in mind that the plot only contains the 17 (mostly high income) countries for which complete data is available for all years.

Figure 7: **Environmental stringency gap and U.S. affiliate sales back to the U.S. (average values 2001-2009)**



Data source: ***bea.gov and WEF Global Competitiveness Report***

Figure 8: **Environmental stringency gap and affiliate sales back to U.S. parents (average values 2001-2009)**



Data source: ***bea.gov and WEF Global Competitiveness Report***

4.4. EMPIRICAL MODEL AND ESTIMATION PROCEDURE

As mentioned before the effect of differences in environmental stringency on different types of multinational activity is the main focus of the empirical analysis. The other independent variables are taken from the "knowledge-capital model". The three central estimation equations are:

1) $LOCALSALES_{jt} = B0 + B1\ (SUMGDP_{ijt}) + B2\ (GDPDIFFSQ_{ijt}) + B3\ (SKDIFF_{ijt}) + B4\ (GDPDIFF_{ijt}*SKDIFF_{ijt}) + B5\ (INVC_{jt}) + B6\ (TC_{jt}) + B7\ (TC_{jt}*SKDIFFSQ_{ijt}) + B8\ (STRINGDIFF_{ijt}) + B9\ (STRINGDIFFSQ_{ijt}) + u_{ijt}$
2) $USSALES_{jt} = B0 + B1\ (SUMGDP_{ijt}) + B2\ (GDPDIFFSQ_{ijt}) + B3\ (SKDIFF_{ijt}) + B4\ (GDPDIFF_{ijt}*SKDIFF_{ijt}) + B5\ (INVC_{jt}) + B6\ (TC_{jt}) + B7\ (TC_{jt}*SKDIFFSQ_{ijt}) + B8\ (STRINGDIFF_{ijt}) + B9\ (STRINGDIFFSQ_{ijt}) + u_{ijt}$
3) $SALESTOUSPARENTS_{jt} = B0 + B1\ (SUMGDP_{ijt}) + B2\ (GDPDIFFSQ_{ijt}) + B3\ (SKDIFF_{ijt}) + B4\ (GDPDIFF_{ijt}*SKDIFF_{ijt}) + B5\ (INVC_{jt}) + B6\ (TC_{jt}) + B7\ (TC_{jt}*SKDIFFSQ_{ijt}) + B8\ (STRINGDIFF_{ijt}) + B9\ (STRINGDIFFSQ_{ijt}) + u_{ijt}$

Here, i and j indicate the parent and host country, respectively, and t stands for year.

- ✓ $LOCALSALES_{jt}$: sales of U.S. affiliates to host markets
- ✓ $USSALES_{jt}$: sales of U.S. affiliates back to the United States
- ✓ $SALESTOUSPARENTS_{jt}$: sales of affiliates back to their US parents
- ✓ $SUMGDP_{ijt}$: the sum of parent and host economic size
- ✓ $GDPDIFFSQ_{ijt}$: the squared difference in parent- and host country's economic size
- ✓ $SKDIFF_{ijt}$: the difference in skilled-labor abundance in the parent country relative to that in the host country
- ✓ $GDPDIFF_{ijt}*SKDIFF_{ijt}$: the product of differences in economic size and skill endowments
- ✓ $INVC_{jt}$: the cost of investing in the host country
- ✓ TC_{jt}: cost of exporting to host country
- ✓ $TC_{jt}*SKDIFFSQ_{ijt}$: interaction term between host-country trade costs and the squared endowment differences

- ✓ $STRINGDIFF_{ijt}$: the difference in environmental stringency between parent- and host country, where the environmental stringency of the host country is subtracted from that of the United States as parent country
- ✓ $STRINGDIFFSQ_{ijt}$: the squared difference in environmental stringency between parent- and host country, where the environmental stringency of the host country is subtracted from that of the United States as parent country

In table 2 the theoretically predicted signs of the independent variables regarding horizontal -and vertical multinational activity are given. According to Markusen and Venables (1998) the term SUMGDP should have a positive effect on horizontal multinational activity. Regarding the effect of the term SUMGDP on vertical multinational activity, Helpman (1984) predicts that the coefficient will be zero since differences in the development stages between two countries plays no significant role in the amount of affiliate exports. The expectation is that the GDPDIFFSQ term will have a negative sign regarding horizontal multinational activity, because horizontal affiliate sales have an inverted U-shaped relationship to differences in countries economic size, with a maximum at zero difference (Carr et al., 2001). The coefficient should be zero for vertical multinational activity, because size differences have no effect on vertical multinational activity independent of factor-endowment differences (Markusen and Maskus, 1999). The difference in skilled labor abundance between the U.S. and host country should have a negative sign regarding horizontal multinational activity, because the more similar the factor endowments between parent –and host country the more horizontal multinational activity occurs. The expected sign with regards to vertical multinational activity should however be positive, because vertical multinational activity tends to take advantage of cheap labor (Yokota, 2005). The fourth variable, the product of differences in economic size and skill endowments captures vertical multinational activity and is expected to be negative. The coefficient should be zero regarding horizontal multinational activity (Kalamova and Johnstone, 2011). The next variable, which represents the costs of investing in a host country, is expected to have a negative effect on both horizontal –and vertical multinational activity. The cost of exporting to the host country should have a positive effect on horizontal multinational activity, since higher trading costs encourage inward investments (Markusen and Maskus, 1999).

However regarding vertical multinational activity one could make a case that higher cost of exporting to the host country increase the cost of inputs required for production and thus discourage vertical multinational activity. The next variable is an interaction term between host-country trade costs and squared endowment differences. The idea behind the variable is that trade costs may encourage horizontal investment, but not vertical investment, and that horizontal investment is most important when relative endowments are similar. The coefficient should therefore be negative for horizontal multinational activity and zero for vertical multinational activity (Carr et al., 2001). As stated in the main hypothesis one would not expect environmental stringency gaps to have an effect on horizontal multinational activity and thus the coefficient is expected to be zero. Environmental stringency gaps should however have a positive effect on vertical multinational activity. The environmental policy regime in a host country could be considered as a sign of other governance characteristics in a host country, if so then after a certain threshold very loose environmental stringency standards should discourage relocating production facilities towards such host countries (Kalamova and Johnstone, 2011). The STRINGDIFFSQ variable should therefore have a negative sign for both horizontal –and vertical multinational activity.

Table 2: **Expected signs of regression coefficients**

	Local sales	**U.S. sales**	**Sales to U.S. parents**
Variable	**Predicted sign**	**Predicted sign**	**Predicted sign**
SUMGDP	+	+/-	+/-
GDPDIFFSQ	-	+/-	+/-
SKDIFF	-	+	+
GDPDIFF*SKDIFF	+/-	-	-
INVCJ	-	-	-
TCJ	+	-	-
TCJ*SKDIFFSQ	-	+/-	+/-
STRINGDIFF	+/-	+	+
STRINGDIFFSQ	-	-	-

Note: +/- in this case means that the coefficient is expected to equal zero.

A panel data procedure is used, because the objective of this study is to observe the behavior of countries across time and it allows controlling for unobserved characteristics of countries that may be correlated with both environmental regulations and economic activity (Levinson and Taylor, 2008). The model includes both time -and country fixed effects, which allow for the removal of omitted variable bias. Table 3 provides the descriptive statistics of all dependent and independent variables used in the empirical analysis. The unit of measure and/or currency can be found in sections 4.1 and 4.2.

Table 3: **Descriptive Statistics**

Variable	Mean	Standard deviation	Minimum	Maximum
Local sales	55592.59	79079.68	1927	431778
US sales	8432.535	17877.15	0	131226
Sales to US parent	6886.386	14488.94	0	103053
GDP Sum	1.15E+13	1.06E+12	1.00E+13	1.69E+13
GDP Difference Squared	1.10E+26	1.91E+25	2.84E+25	1.36E+26
Skill Difference	22224.67	12148.99	-3494.319	38056.22
GDP Difference * Skill Difference	2.35E+17	1.32E+17	-3.87E+16	4.33E+17
Investment Cost Host	2.739444	0.764943	1.116667	4.883333
Trade Cost Host	2.489729	0.835139	0.55	4.3
Trade Cost Host *Squared Skill Difference	1.90E+09	1.67E+09	30210.72	5.17E+09
Environmental stringency difference	0.673643	1.163267	-1.4	3.6
Environmental stringency difference squared	1.803488	2.175117	0	12.96

5. RESULTS

In this chapter the main results of the empirical analysis are reported. First, U.S. affiliate sales to host markets are regressed on the difference in environmental stringency between the U.S. and host countries (horizontal multinational activity). Secondly, the sales of U.S. affiliates to the U.S. are regressed on the difference in environmental stringency between the U.S. and host countries (vertical multinational activity). Finally the sales of affiliates to their U.S. parents are regressed on the difference in environmental stringency between the U.S. and host countries (vertical multinational activity). All these regressions are performed controlling for explanatory variables, except the cost of exporting to the U.S. and distance, of the "knowledge-capital model". The former is removed since it does not vary from one country to another and the latter because it does not differ within countries from year to year. This is logical, since the U.S. is the parent country in each observation pair.

5.1. RESULTS OF ESTIMATIONS

In summary, the results regarding the relationship between positive differences in environmental stringency between the U.S. and host countries and vertical multinational activity are statistically not significant. There is evidence of a positive relationship that turns negative when environmental stringency in the host country becomes too lax, when using a sample of non-OECD host countries. The results were however statistically not significant.

Table 4: **fixed-effect estimation of basic model: Panel Least Squares; dependent variable: U.S. affiliate sales to host market**

Variable	OLS	Sign as predicted	t-Statistic	Prob.
GDP Sum	-4.23E-08	N	-1.688824	0.0924
GDP Difference Squared	-3.46E-21	Y	-3.265811	0.0012
Skill Difference	6.563184	N	2.197220	0.0289
GDP Difference * Skill Difference	-4.54E-13	Y	-2.311938	0.0215
Investment Cost Host	3775.988	N	0.853662	0.3941
Trade Cost Host	22494.50	Y	3.636617	0.0003
Trade Cost Host *Squared Skill Difference	-1.60E-05	Y	-2.386385	0.0177
Environmental stringency difference	3357.835	Y	0.810087	0.4186
Environmental stringency difference squared	-47.66535	Y	-0.031744	0.9747
Intercept	847960.9		2.100335	0.0366
Observations	327			
Adjusted R^2	0.97			

Notes: Y indicates "Yes" and N indicates "No."; Predicted signs are based on total affiliate sales.

Table 4 captures the effect of an environmental stringency gap on the sales of U.S. affiliates to host markets. It shows that the environmental stringency gap between the U.S. and a host country has a positive effect on horizontal multinational activity. This result is statistically not significant though. The squared term of environmental stringency, which suggest an inverted U-shaped relationship between U.S. affiliate sales and environmental stringency has the expected sign but is also not statistically significant. The first result is as expected, since the theoretical expectation was that an environmental stringency gap between the U.S. and host countries should not a priori have a significant effect on horizontal multinational activity. The fact that the second result is statistically not significant goes against the

theoretical expectations. The results obtained are in line with the findings of Kalamova and Johnstone (2011) for an OECD[11] only sample.

Most other explanatory variables also, although not all statistically significant, have the predicted signs. The trade cost host variable is statistically highly significant, which is in accordance with the expectations for horizontal multinational activity. Carr et al. (2001) also find this positive relationship using total affiliate sales, although the relationship only becomes statistically significant after they use a Tobit procedure. Kalamova and Johnstone (2011) use different variables as proxies for trade costs between parent –and host countries. In their OECD only sample all these variables have a positive sign.

The skill difference variable has the wrong sign and is statistically significant, although one would expect it not to be regarding horizontal multinational activity (Yokota, 2005). This however might be due to the influence of developing countries within the sample, since the theory suggests that horizontal multinational activity usually occurs between countries that are in similar stages of economic development. In light of this in appendix B regression results are displayed using only OECD[12] members as host countries. All explanatory variables that are predictive of horizontal multinational activity, although not all statistically significant, now have the theoretically predicted signs. The skill difference variable is also no longer statistically significant.

[11] Horizontal multinational activity is assumed to be prevalent amongst countries of similar economic development, thus the OECD only sample is here assumed to proxy horizontal multinational activity.
[12] OECD countries included are in bold in appendix A.

Table 5: **fixed-effect estimation of basic model: Panel Least Squares; dependent variable: U.S. affiliate sales to U.S. market**

Variable	OLS	Sign as predicted	t-Statistic	Prob.
GDP Sum	5.57E-09	Y	0.813456	0.4167
GDP Difference Squared	4.04E-22	Y	1.386212	0.1668
Skill Difference	3.245624	Y	3.916776	0.0001
GDP Difference * Skill Difference	-2.40E-13	Y	-4.364146	0.0000
Investment Cost Host	514.6415	N	0.425072	0.6711
Trade Cost Host	1029.425	N	0.607298	0.5442
Trade Cost Host *Squared Skill Difference	-1.36E-06	Y	-0.722109	0.4709
Environmental stringency difference	112.5200	Y	0.100036	0.9204
Environmental stringency difference squared	-230.4489	Y	-0.598220	0.5502
Intercept	-116697.5		-1.052502	0.2935
Observations	331			
Adjusted R^2	0.96			

Notes: Y indicates "Yes" and N indicates "No."; Predicted signs are based on total affiliate sales.

Table 6: **fixed-effect estimation of basic model: Panel Least Squares; dependent variable: U.S. affiliate sales to U.S. parent**

Variable	OLS	Sign as predicted	t-Statistic	Prob.
GDP Sum	8.08E-09	Y	1.539344	0.1249
GDP Difference Squared	4.65E-22	Y	2.079375	0.0386
Skill Difference	2.540659	Y	4.005774	0.0001
GDP Difference * Skill Difference	-1.84E-13	Y	-4.353260	0.0000
Investment Cost Host	27.47784	N	0.028442	0.9773
Trade Cost Host	713.6261	N	0.542872	0.5877
Trade Cost Host *Squared Skill Difference	-1.01E-06	Y	-0.693740	0.4885
Environmental stringency difference	-337.6063	N	-0.362299	0.7174
Environmental stringency difference squared	-60.75964	Y	-0.200716	0.8411
Intercept	-150240.2		-1.766529	0.0785
Observations	321			
Adjusted R^2	0.96			

Notes: Y indicates "Yes" and N indicates "No."; Predicted signs are based on total affiliate sales.

Table 5 and 6 show the effect of differences in environmental stringency between the U.S. and host countries on vertical multinational activity. Both the difference in environmental stringency and the difference squared have the expected sign in table 5, although both are statistically not significant. In table 6 only the environmental stringency difference squared has the theoretically predicted sign, but is also not statistically significant. The empirical sign of the environmental stringency difference squared is in line with the results from Kalamova and Johnstone (2011) for a sample of FDI flows from OECD to non-OECD countries[13].

[13] Vertical multinational activity generally occurs between countries in different stages of economic development, thus the sample of OECD to non-OECD is here taken as a proxy for vertical multinational activity.

In accordance with the theory of vertical multinational activity skill difference and the interaction term of GDP difference and skill difference, which are important predictors for vertical multinational activity, have the correct signs and are both statistically highly significant. Carr et al. (2001) find similar results using total affiliate sales, although their OLS estimates are not statistically significant.

The theory regarding vertical multinational activity states that such activity usually occurs between countries that are in different stages of economic development. Therefore in Appendix C and D the regression results are displayed of the effect of environmental stringency differences on affiliate sales to U.S. parents, using only non-OECD host countries. Also because the effects of environmental stringency gaps might only become visible over a longer period of time a 1 year lag regarding environmental stringency is included. The results now point towards an unambiguous positive effect of environmental stringency gaps on vertical multinational activity; although the results are statically not significant. These results are in accordance with the results from Kalamova and Johnstone (2011) for a sample of FDI flows from OECD to non-OECD countries in which they estimate the effect of environmental stringency gaps on total affiliate sales. The important predictors for vertical multinational activity e.g. skill difference and the interaction term of GDP difference and skill difference, still have the theoretically predicted signs and are also statistically highly significant.

6. CONCLUSION

This paper focusses on the effect of environmental stringency gaps between the United States as the parent country and different host countries, on (vertical) multinational activity. The "knowledge-capital model" by Carr et al. (2001) is extended by including a variable of differences in environmental stringency and a variable that measures its squared term as the main explanatory variables of interest. Furthermore data is used which allows for distinguishing between horizontal -and vertical multinational activity. Using ordinary least squares the effect of an environmental stringency gap and the stringency gap squared on multinational activity is estimated. The hypothesis is tested in a panel data analysis using both time -and country fixed effects over the period 2001 to 2009. The results regarding horizontal multinational activity are mostly as predicted; a statistically non-significant positive effect of an environmental stringency gap between the U.S. and host countries which turns negative if environmental stringency differences become too large. Regarding the effects of environmental stringency gaps on vertical multinational activity, the results are mixed at best while also not statistically significant. When a 1 year lag regarding environmental stringency gaps is included in a sample of non-OECD host countries the results point towards a positive effect on U.S. vertical multinational activity. These results where statistically not significant though. The empirical results should not necessarily lead one to conclude that there is no significant effect, of an environmental stringency gap between countries, on vertical multinational activity. The theory on vertical multinational activity states that vertical MNE's tend to be dominant if the parent country is small and skilled-labor-abundant. This analysis however uses the United States as the parent country in every observation and since the United States is not a small country the theory would suggest that most U.S. multinational activity is horizontal rather than vertical. The country sample is thus inherently chosen based on the ranking of total U.S. foreign direct investments, dominated by horizontal multinational activity. For further research it might thus be of interest to use a small and skilled-labor-abundant country, like the Netherlands for instance, as the parent country. Also since the effect of environmental stringency differences might only become visible over a longer period of time, one could also benefit from using a longer time frame. The results obtained by this analysis could however be

prove that factors other than differences in environmental standards play a much more important role in the location choices of U.S. vertical MNE's.

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APPENDICES

Appendix A: Host countries included in empirical analysis

Argentina	**Hungary**	Philippines
Australia	*India*	**Poland**
Austria	Indonesia	**Portugal**
Belgium	***Ireland***	Russia
Brazil	**Israel**	*Singapore*
Canada	***Italy***	*South Africa*
Chile	**Japan**	***Spain***
China	**Korea, Republic of**	***Sweden***
Colombia	*Malaysia*	***Switzerland***
Czech Republic	**Mexico**	Thailand
Denmark	***Netherlands***	**Turkey**
Egypt	**New Zealand**	***United Kingdom***
France	**Norway**	Venezuela
Germany	Panama	
Hong Kong	Peru	

Notes: countries in bold are OECD members; countries in italic are the ones included in the scatter plots in section 4.3.

APPENDIX B: Fixed-effect estimation; Panel Least Squares; OECD host countries; dependent variable: U.S. affiliate sales to host market

Variable	OLS	Sign as predicted	t-Statistic	Prob.
GDP Sum	5.24E-08	Y	0.519863	0.6039
GDP Difference Squared	-1.98E-21	Y	-0.812358	0.4178
Skill Difference	11.05053	N	1.929532	0.0554
GDP Difference * Skill Difference	-4.66E-13	Y	-1.492168	0.1376
Investment Cost Host	-16.34585	Y	-0.002162	0.9983
Trade Cost Host	35350.11	Y	3.880792	0.0002
Trade Cost Host *Squared Skill Difference	-3.66E-05	Y	-2.898796	0.0043
Environmental stringency difference	11637.64	Y	1.927148	0.0557
Environmental stringency difference squared	-3317.608	Y	-1.206117	0.2296
Intercept	-467222.1		-0.319337	0.7499
Observations	202			
Adjusted R^2	0.97			

Notes: Y indicates "Yes" and N indicates "No."; Predicted signs are based on total affiliate sales.

Appendix C: Fixed-effect estimation; Panel Least Squares; NONOECD host countries; dependent variable: U.S. affiliate sales to the U.S.; 1 year lag regarding environmental stringency

Variable	OLS	Sign as predicted	t-Statistic	Prob.
GDP Sum	-6.65E-09	Y	-0.879646	0.3817
GDP Difference Squared	1.21E-22	Y	0.333517	0.7396
Skill Difference	5.529093	Y	4.440003	0.0000
GDP Difference * Skill Difference	-4.04E-13	Y	-4.946281	0.0000
Investment Cost Host	-462.1069	Y	-0.604573	0.5472
Trade Cost Host	-3255.570	Y	-2.303410	0.0239
Trade Cost Host *Squared Skill Difference	2.36E-06	Y	1.719672	0.0894
Environmental stringency difference (-1)	257.5037	Y	0.620341	0.5368
Environmental stringency difference squared	-219.9555	Y	-1.462256	0.1476
Intercept	33118.03		0.259610	0.7958
Observations	113			
Adjusted R^2	0.96			

Notes: Y indicates "Yes" and N indicates "No."; Predicted signs are based on total affiliate sales.

Appendix D: Fixed-effect estimation; Panel Least Squares; NONOECD host countries; dependent variable: Affiliate sales to U.S. parents; 1 year lag regarding environmental stringency

Variable	OLS	Sign as predicted	t-Statistic	Prob.
GDP Sum	-2.77E-09	Y	-0.392381	0.6959
GDP Difference Squared	1.19E-22	Y	0.353138	0.7250
Skill Difference	3.900649	Y	3.362638	0.0012
GDP Difference * Skill Difference	-2.78E-13	Y	-3.657567	0.0005
Investment Cost Host	-716.5461	Y	-0.943008	0.3487
Trade Cost Host	-2592.493	Y	-1.966936	0.0529
Trade Cost Host *Squared Skill Difference	2.03E-06	Y	1.560573	0.1228
Environmental stringency difference (-1)	224.3827	Y	0.543726	0.5882
Environmental stringency difference squared	-152.9349	Y	-1.076146	0.2853
Intercept	-3272.948		-0.027505	0.9781
Observations	108			
Adjusted R^2	0.96			

Notes: Y indicates "Yes" and N indicates "No."; Predicted signs are based on total affiliate sales.