UNIVERSITY OF ECONOMICS IN PRAGUE
Faculty of International Relations

M.A. Economics of International Trade and European Integration
2009/2010

Firms' location sensitivity to the European Union's environmental policies

Pollution haven hypothesis or Porter hypothesis?

October 2010

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Acknowledgement

Herewith, I express many thanks to my supervisor Prof. Stéphane Vigeant from Université des Sciences et Technologies de Lille for his kind guidance, valuable comments and support in successfully finalising this work. I am also grateful to Ing. Vilém Semerák, PhD for useful consultations regarding econometric issues.

Table of contents

1. Introduction 1

2. European Union's environmental standards 6

3. Literature review 11

4. Model specification and the data 14

5. Empirical results 20

6. Conclusion 25

References 28

Appendix 33

List of tables

Table 1: Greenhouse gas emissions and Kyoto Protocol targets for 2008-12 9

Table 2: Member State greenhouse gas emission limits 33

Table 3: Data definitions, expected effects and sources 19

Table 4: Descriptive statistics 19

Table 5: Empirical results 22

Table 6: Correlation matrix of all variables of the model 33

List of graphs

Graph 1: Total greenhouse gas emissions of EU15 with the Kyoto target 6

Graph 2: Total greenhouse gas emissions of EU27 with the 2020 target 7

1. Introduction

As a result of an increasingly globalised and integrated world, all kind of barriers have been reduced and firms' location choices have become undoubtedly broader than before. Their location decision has, thus, become more difficult to make. Nowadays, every firm while choosing the place to settle down and start business has to take into account not only typical features of the location such as its prices of factors of production, market size and potential, infrastructure, political stability, legislative framework or degree of corruption, but also factors emerging from today's world changes. Certainly, one of such factors is a region's increasing level of environmental protection, which, to some extent, causes higher costs that a firm has to endure.

Consequently, an environmental policy implemented by a country can have a negative effect on its attractiveness. The more stringent the environmental regulation is and the more polluting the firm is, the stronger the effect is. In the case of a firm with high pollution abatement costs, its location decision would be more likely to be directed into regions with lower legislative environmental protection. In other words, countries through lax environmental standards create an additional comparative advantage and use it in order to attract firms' investments. Such a view is known in the literature as "industrial flight", "pollution haven" or "race-to-the-bottom" hypothesis (henceforth, the "PHH").[1]

As the name of the "industrial flight" suggests, this phenomenon is theoretically expected to be found for firms within the industrial sector, since these firms are the largest polluters, thus having the highest probability of relocating due to stringent environmental standards. According to several studies using U.S. data, the most pollution-intensive industries, measured by pollution abatement expenditure intensity in U.S. industries, pollution abatement costs or their percentage of total costs, are chemicals and allied products, primary iron and steel, paper and pulp, primary nonferrous metals, food products, beverages and tobacco, leather products, coke, petroleum and nuclear fuel, rubber and plastics, and wood products.[2] In the Smarzynska and Wie's (2001) study on European transition countries, we can find, among the high pollution industries classified by 3-digit SIC sectors, similar or same industries to those aforementioned. Jeppesen and Folmer (2001) recommend for empirical investigation to disaggregate sectoral data, since the most polluting sectors like pulp, paper and paperboard, chemicals and iron, steel and ferroalloys and

[1] Mihci, Cagatay and Koska (2005, p. 690).

[2] See ranking tables in studies presented, for example, by Cole and Elliott (2005), Kneller and Manderson (2009), Tobey (1990), or Xing and Kolstad (2002).

oil industry tend to show the largest responses to changes in environmental policy. Therefore, only the data on foreign direct investment (henceforth, "FDI") of manufacturing sectors are used for our analysis. In particular, we aggregate data on food products, wood, publishing and printing, refined petroleum and other treatments, chemical products, metal products including primary nonferrous metals and primary iron and steel in an attempt to comprise all relevant polluting industries as mentioned previously.[3]

In the literature, generally less-developed countries have been called "pollution havens", since they are supposed to have lax environmental standards along with their low level of enforcement. The empirical evidence for the pollution haven hypothesis has been anything but ambiguous.[4] On the one hand, there are several authors that find some evidence of the PHH. For instance, MacDermott (2009), while using a gravity model to test the effects of environmental regulations on FDI bilateral flows between 26 OECD countries, finds some evidence of the pollution haven hypothesis. Also, Keller and Levinson (2002), estimating the effect of changing environmental standards on foreign direct investment in the United States, have found robust evidence that abatement costs had moderate deterrent effects on foreign investment. The evidence that more stringent pollution regulations affect pollution-intensive as well as non-pollution-intensive firms is also presented in a study by List and Co (2000).

Levinson and Taylor (2008) test the PHH by trade flows using data on the U.S. imports in three-digit manufacturing sectors from Mexico and Canada over the 1977-1986 period. They find that a one percent increase in pollution abatement costs in the U.S. is associated with a 0.2 increase in net imports from Mexico and a 0.4 percent increase in net imports from Canada. When using the two-stage least squares (2SLS) estimates instead of the fixed-effects ones, they find even larger effects on net imports, i.e. 0.4 percent and 0.6 percent, respectively. Ederington and Minier's (2003) study also provides strong evidence of environmental regulations affecting trade flows, if one allows for endogenous modelling of environmental policy.

On the other hand, Smarzynska and Wei (2001) find only weak evidence of a pollution haven effect for a sample of 24 transition countries. Dean, Lovely and Wang (2009) in a study of China, provide evidence of the PHH but only for ethnically Chinese investors[5], particularly for Hong Kong, Macao and Taiwan, and only in industries that are highly polluting. Eskeland and Harisson (2003) testing whether multinationals are flocking to developing country "pollution

[3] Some of the heavy polluting sectors were left out due to data limitations.
[4] Busse (2004, p. 4).
[5] The non-ethnically Chinese group of investors includes high income countries such as the United States, the EU and Japan for which no significant evidence of pollution haven behaviour was found. For more details, see Dean, Lovely and Wang (2009).

havens" to take advantage of lax environmental standards, find no evidence that foreign investments in less-developed countries, particularly in Mexico, Venezuela, Morocco and Côte d'Ivoire, are related to abatement costs in industrialized countries. While exploring the linkages between environmental regulations and international trade flows for 119 countries, Busse (2004) has found no evidence supporting the pollution hypothesis for five high-polluting industries with the exception of iron and steel products. The final conclusions of Jeppesen and Folmer's (2001) literature review is that there is little evidence that environmental regulations would significantly affect firm location. If environmental capital flight is to be found, then it is most likely to be in highly polluting industries. In addition, they also conclude that foreign investments are more sensitive to environmental policies than domestic investments.

The expression "race-to-the-bottom" stems from country's legislative procedures aimed at wittingly worsening environmental standards in order to gain a comparative advantage over those countries with more stringent environmental regulations. As other countries are losing their competitive position, they start lowering their own environment stringency policies. Hence, this process of intergovernmental competition leads to inefficient lax environmental policies.[6] Jeppesen and Folmer (2001) oppose to this process and argue that in the above described situation so called "location arbitrage" occurs. Migrating firms will increase the level of pollution in host country, where the implementation of more stringent environmental policies is likely to occur as a consequence of worsened environmental conditions. At the same time, countries from which these firms leave will experience a reduction or stabilisation of emissions and, thus, might even lower the level of environmental standards, ceteris paribus.

Additionally, according to Cole and Elliott (2005) the so-called "capital-labour hypothesis" should be taken into account while identifying pollution haven countries. They assert that capital intensive industries are also typically pollution intensive. Therefore, a capital demanding firm is likely to invest in a capital abundant country whereas a labour intensive firm would prefer a labour rich country. As Cole and Elliott (2005) show capital rich countries are usually those with some of the highest environmental regulations and, thus, firms specialised in capital intensive activities are more likely to face also high ecological taxation costs. This implies that pollution haven countries are those which comply with two conditions. They do not have only lax environmental regulations but they are also capital abundant. While regressing outward FDI stocks in different U.S. industrial sectors on pollution abatement costs, Cole and Elliott (2005) find that U.S. FDI to Mexico and Brazil is concentrated in industrial sectors that are both capital

[6] Kim and Wilson (1997, p. 537-538).

intensive and pollution intensive, thus supporting the importance of capital in identifying pollution havens.

Contrary to the PHH, Porter and van der Linde (1995) suggest that well-designed environmental regulations might have positive effects and lead to improve competitiveness instead. The shock of having to meet stricter environmental regulations may induce firms to actively search for and remove possible inefficiencies in their production process.[7] Moreover, firms under more stringent environmental policies are forced to enhance their innovatory activities and invest into more up-to-date and green technologies if they want to reduce their pollution abatement costs and preserve or increase their competitiveness.[8] In such a scenario, no relocation of firm's production will occur, which contradicts the industrial flight hypothesis. Costantini and Crespi (2008) provide empirical evidence of the relevance of the Porter and van der Linde hypothesis (henceforth, the "Porter hypothesis"). Their results show that a more stringent environmental regulation provides a positive impulse for increasing investments in advanced technological equipments and support the European strategies aimed at environmental protection and energy security. Also Leiter, Parolini and Winner's (2010) results prove the Porter hypothesis, although the quadratic terms of their proxies for environmental regulation stringency show to be significantly negative, suggesting that the positive effect of environmental regulation on investments into cleaner production technologies diminishes with tighter regulations.

From the theoretical point of view, one can, thus, encounter two main contrasting theories. The first one which says that more stringent environmental regulations cause moving of firms elsewhere and no ecological improvement takes place, and the second one which states that such regulations are enhancing environmental protection by an increase in firm's investments into ecologically friendlier technologies. The aim of this paper is to try to find some evidence of the pollution haven hypothesis or indirectly of the Porter hypothesis for industrial firms located within the European Union (henceforth, the "EU"), where environmental policies play a significant role. In other words, we seek to uncover how sensitive industrial firms within the EU are to its increasing efforts in enhancing the level of environmental protection and particularly its fight against climate change.

For the empirical investigation, unbalanced panel data are used on inward foreign direct investment positions[9] of heavily polluting industries in the EU manufacturing sector. Based on

[7] Soest, List and Jeppesen (2006, p. 1152).
[8] Wagner (2003, p. 6).
[9] FDI positions data indicate the levels of investment at a given point in time. Since they are also referred to as FDI stocks, FDI positions and FDI stocks are used as synonyms in this paper. For more details on the definition, see OECD's Glossary of Foreign Direct Investment Terms and Definition, available online at http://www.oecd.org/dataoecd/56/1/2487495.pdf. [04/10/2010]

the literature, we consider FDI to be an appropriate way of testing the PHH.[10] As argued in the paper presented by Kneller and Manderson (2009), only the best firms in the industry are sufficiently productive to cover the sunk costs associated with their relocation. Therefore, we expect that domestic firms with insufficient monetary and funds resources to relocate their production are more likely to invest into greener technologies or go bankrupt, whereas multinational enterprises (henceforth, “MNEs”) will more probably relocate their production to avoid high compliance costs induced by more stringent environmental measures. While running the regression of inward FDI stocks on environmental regulation stringency, we are, thus, testing only the latter case.

As a proxy for environmental stringency, we use greenhouse gas (henceforth, “GHG”) emissions not only for its data availability, but also because we want to evaluate EU’s environmental regulations aimed at reducing greenhouse gas emissions. Our sample consists due to data unavailability only of 11 European Member States for 18 years from 1990 to 2007. Other explanatory variables of industrial foreign direct investment are similar to determinants commonly used in many empirical FDI papers. Our model, in particular, controls for country’s level of development, market size, labour market characteristics, production factor prices, human capital, trade openness and agglomeration effect. Our empirical model was tested by the fixed-effects estimator and we have found rather surprising results on the variable of interest suggesting a positive effect of environmental regulations on firm’s investment decisions. However, these findings should be considered with caution, given the several drawbacks of the model and of the method chosen for empirical testing.

The rest of the paper is organised as follows. Since the primary motive of this study is to evaluate the impact of the EU’s increasing environmental stringency on firms’ location behaviour, the next section gives insight into the current and new EU’s environmental regulations and plans implemented for air protection or climate change fight, and discuss each country enforcement efforts. Section 3 gives a more detailed literature review in order to give some explanations to unclear evidence of the pollution haven hypothesis and outline possible complications found in the literature while testing for this hypothesis. The model is set up in Section 4, which also presents all variables used in the empirical specification and summarises the data sources. In Section 5, the empirical findings are presented together with possible drawbacks of the model. Finally, Section 6 concludes.

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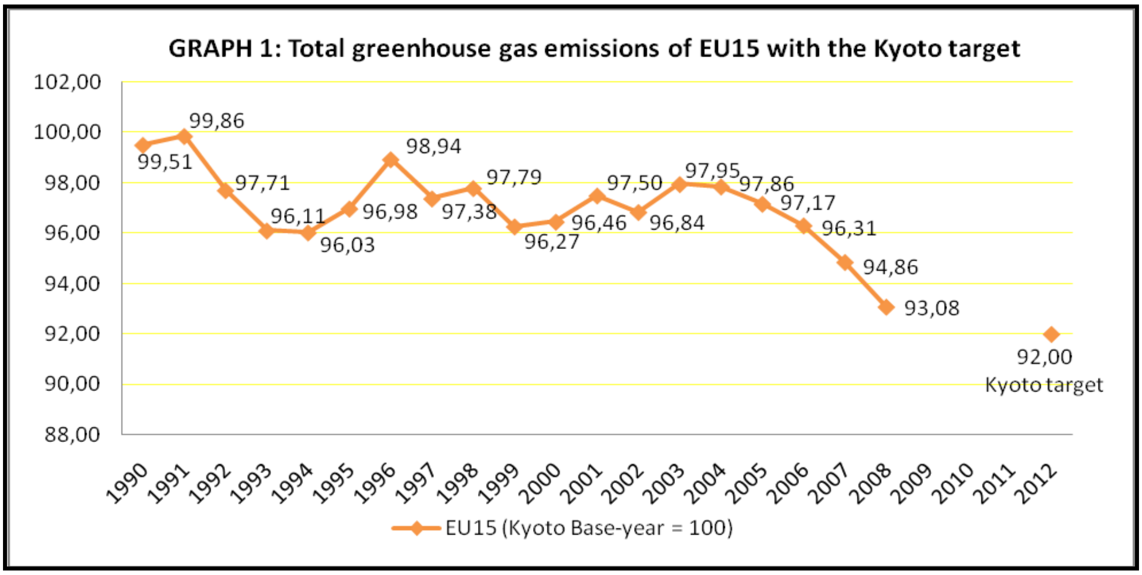
[10] For studies using FDI to test for PHH, see, for example, Cole and Elliott (2005), Keller and Levinson (2002), Kneller and Manderson (2009), List and Co (2000), MacDermott (2009), Smarzynska and Wei (2001), Mihci, Cagatay and Koska (2005), Timmins and Wagner (2008), Waldkirch and Gopinath (2008), or Xing and Kolstad (2002).

2. European Union's environmental standards

The European Union has been recently increasing its efforts in fighting against climate change and according to Geden (2010), the EU is the most ambitious player and self-proclaimed leader in international climate policy. This is one of the reasons why we use greenhouse gas emissions as a proxy for the environmental stringency. The increase of its efforts can be seen from the adaptation of the new EU's decision of April 2009[11] by which all Member States are bound to diminish their greenhouse gas emissions. By this resolution, the Community made a unilateral commitment to achieve at least 20% reduction of greenhouse gas emissions by 2020 compared to 1990 and transform Europe into a highly energy-efficient, low carbon economy.[12] This legislative act was mainly introduced to prolong the EU15 commitments to reduce emissions by 8% between 2008 and 2012 compared to emissions in the base year 1990, taken under the Kyoto Protocol.[13] Graphically the current Kyoto target and the new 2020 target together with up-to-now achieved reductions are presented in Graph 1 and Graph 2, respectively.

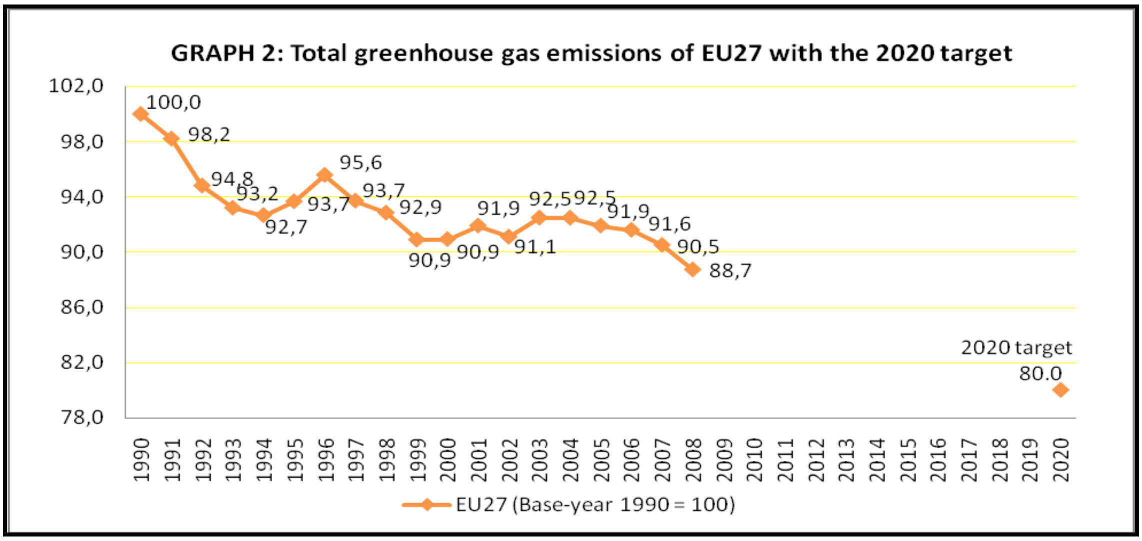


Source: European Environment Agency's Technical report (2010). Data available online at http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=475. [07/10/2010]

[11] DECISION No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020, available online at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0136:0148:EN:PDF. [11/10/2010]

[12] DECISION No 406/2009/EC, p. L 140/137, available online at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0136:0148:EN:PDF. [11/10/2010]

[13] European Environment Agency's Technical report (2010, p. 16), available online at http://www.eea.europa.eu/publications/european-union-greenhouse-gas-inventory-2010/. [30/09/2010]



GRAPH 2: Total greenhouse gas emissions of EU27 with the 2020 target

Source: European Environment Agency's Technical report (2010). Data available online at http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=475. [07/10/2010]

From the historical point of view, however, the EU environmental protection had not started until the first United Nations Conference on the Environment in Stockholm in 1972, when the Commission became active and a Community environmental policy was established. The first European Environmental Action Plan (henceforth, "EAP") was launched in November 1973.[14] The current EU's 6th EAP, "Environment 2010: Our future, Our choice"[15], basically formulates a framework of general principles and objectives which are aimed, among others, at stabilising greenhouse gas concentrations in the atmosphere so that the maximum global temperature would not exceed an increase of 2° Celsius over pre-industrial levels. As identified by the Intergovernmental Panel on Climate Change (IPCC), this might require a global reduction in emissions of greenhouse gases by 70 % as compared to levels in 1990.[16]

Not only new decisions and plans have been presented by the EU in order to increase the environment protection, but also new institutions were established. In 1993, when the EU environmental policy was substantially expanded by the Treaties of Maastricht, the European Environment Agency[17] (henceforth, the "EEA") came into force. As stated in the Council Decision No 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions, the EEA assists the Commission with analysing the Community progress towards the fulfilment of the commitments under the United Nations Framework Convention on Climate

[14] Hey (2001, p. 18), available online at http://www.eeb.org/publication/chapter-3.pdf. [30/09/2010]
[15] Air, available online at http://ec.europa.eu/environment/air/index_en.htm. [11/10/2010]
[16] DECISION No 1600/2002/EC, p. L242/3, available online at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:242:0001:0015:EN:PDF. [11/10/2010]
[17] As presented at its website page, the EEA's main task is to provide sound, independent information on the environment for those involved in developing, adopting, implementing and evaluating environmental policy as well as for the general public. More information on the EEA can be found at http://www.eea.europa.eu/about-us/who. [30/09/2010]

Change (henceforth, the "UNFCCC") and the Kyoto Protocol.[18] In particular, this agency is involved in compiling the annual EU greenhouse gas inventory together with the Member States, the European Commission Directorate-General Climate Action (GD CLIMA) and other institutions such as Eurostat or the Joint Research Centre (JRC).[19]

The EEA's technical report from 2010 on the EU greenhouse gas inventory gives an interesting insight into air pollutants emission trends in the EU. From Table 1 presented below, the comparison based on the total amount of greenhouse gas emissions can be made between the Kyoto Protocol base year and the year of 2008. Similarly, one can observe the percentage changes in greenhouse gas emissions for each member state from 1990 to 2008. Also, this Table 1 shows the national differentiated CO_2 targets, also called "burden-sharing agreement"[20], which were negotiated within the EU and set according to state's differences in population size, fuel mix, economic development and structure, and the competitiveness of internationally oriented industries.[21] In other words, the member states of EU15 have jointly[22] agreed to accomplish the commitment of reducing emissions by 8% under the Kyoto Protocol, but for political acceptability their greenhouse gas emission limits for 2008-2012 differ, in some cases, quite substantially. Under the newly adopted regulation concerning greenhouse gas emission reduction commitments up to 2020, unequal limits were established for each member state for the second time (see, Table 2 in the Appendix).

More importantly, however, the level of a real environmental stringency of each member state (i.e. enforcement efforts) could be inferred when the two last columns of Table 1 are compared. While looking, for example, at figures of two largest emitters, Germany and the United Kingdom, accounting for about one third of total EU27 greenhouse gas emissions[23], we can conclude that both countries seem to be more than successful in their environmental law enforcing. On the other hand, Spain and Italy, which are third and fifth largest polluters in the EU, respectively, are both far from complying with their Kyoto Protocol targets along with other countries such as Austria, Denmark, Ireland or the Netherlands. Thus, quite large differences in enforcement efforts of environmental regulations are found within the EU. Soest, List and

[18] DECISION No 280/2004/EC, p. L 49/2, available online at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:049:0001:0001:EN:PDF. [11/10/2010]
[19] European Environment Agency's Technical report (2010, p. 16), available online at http://www.eea.europa.eu/publications/european-union-greenhouse-gas-inventory-2010/. [30/09/2010]
[20] Hey (2001, p. 25), available online at http://www.eeb.org/publication/chapter-3.pdf. [30/09/2010]
[21] Sijm et al. (2007, p. 23), available online at http://www.rivm.nl/bibliotheek/rapporten/500102009.pdf. [04/10/2010]
[22] United Nations (2002, p. 6), available online at http://www.ccsr.u-tokyo.ac.jp/unfccc3/pdfs/unfccc.int/resource/docs/cop8/02.pdf. [30/09/2010]
[23] European Environment Agency's Technical report (2010, p. 24), available online at http://www.eea.europa.eu/publications/european-union-greenhouse-gas-inventory-2010/. [30/09/2010]

Jeppesen (2006) perform a study on environmental stringency and international competitiveness for nine European OECD countries which confirms our observations. They found a fairly high variability of environmental stringency within these countries, thus highlighting the importance of distinguishing the environmental policy design from its actual stringency within countries over time and across space.[24]

TABLE 1: Greenhouse gas emissions and Kyoto Protocol targets for 2008–12

Member state	1990 (million tonnes)	Kyoto Protocol base year (1990) (million tonnes)	2008 (million tonnes)	Change 2007–2008 (million tonnes)	Change 2007–2008 (%)	Change 1990-2008 (%)	Change base year–2008 (%)	Targets 2008–12 under Kyoto Protocol and "EU burden sharing" (%)
Austria	78.2	79.0	86.6	-0.3	-0.4%	10.8%	9.6%	-13.0%
Belgium	143.4	145.7	133.3	3.0	2.3%	-7.1%	-8.6%	-7.5%
Denmark	68.9	69.3	63.8	-3.0	-4.5%	-7.4%	-7.9%	-21.0%
Finland	70.4	71.0	70.1	-7.9	-10.2%	-0.3%	-1.2%	0.0%
France	563.2	563.9	527.0	-3.2	-0.6%	-6.4%	-6.5%	0.0%
Germany	1231.8	1232.4	958.1	0.7	0.1%	-22.2%	-22.3%	-21.0%
Greece	103.3	107.0	126.9	-5.0	-3.8%	22.8%	18.6%	25.0%
Ireland	54.8	55.6	67.4	-0.2	-0.3%	23.0%	21.3%	13.0%
Italy	517.0	516.9	541.5	-11.1	-2.0%	4.7%	4.8%	-6.5%
Luxembourg	13.1	13.2	12.5	-0.30	-2.3%	-4.8%	-5.1%	-28.0%
Netherlands	212.0	213.0	206.9	0.0	0.0%	-2.4%	-2.9%	-6.0%
Portugal	59.3	60.1	78.4	-1.5	-1.9%	32.2%	30.3%	27.0%
Spain	285.1	289.8	405.7	-32.9	-7.5%	42.3%	40.0%	15.0%
Sweden	72.4	72.2	64.0	-2.2	-3.3%	-11.7%	-11.3%	4.0%
United Kingdom	771.7	776.3	628.2	-11.8	-1.8%	-18.6%	-19.1%	-12.5%
EU-15	4244.7	4265.5	3970.5	-75.7	-1.9%	-6.5%	-6.9%	-8.0%
Bulgaria	117.4	132.6	73.5	-2.4	-3.2%	-37.4%	-44.6%	-8.0%
Cyprus	5.3	_	10.2	0.4	3.7%	93.9%	_	_
Czech Republic	195.2	194.2	141.4	-6.1	-4.1%	-27.5%	-27.2%	-8.0%
Estonia	40.8	42.6	20.3	-1.8	-8.2%	-50.4%	-52.5%	-8.0%
Hungary	97.4	115.4	73.1	-2.6	-3.4%	-24.9%	-36.6%	-6.0%
Latvia	26.8	25.9	11.9	-0.4	-3.1%	-55.6%	-54.1%	-8.0%
Lithuania	49.7	49.4	24.3	-1.1	-4.5%	-51.1%	-50.8%	-8.0%
Malta	2.0	_	3.0	-0.05	-1.8%	44.2%	_	_
Poland	453.3	563.4	395.6	-4.3	-1.1%	-12.7%	-29.8%	-6.0%
Romania	242.1	278.2	145.9	-6.7	-4.4%	-39.7%	-47.6%	-8.0%
Slovakia	73.9	72.1	48.8	1.1	2.3%	-33.9%	-32.2%	-8.0%
Slovenia	18.5	20.4	21.3	0.7	3.5%	15.2%	4.6%	-8.0%
EU-27	5567.0	_	4939.7	-99.0	-2.0%	-11.3%	_	_

Notes: Greenhouse gas emissions are in CO_2 equivalents (excluding Land Use, Land-Use Change and Forestry – LULUCF). As Cyprus, Malta and EU-27 do not have targets under the Kyoto Protocol, they do not have applicable Kyoto Protocol base years, denoted by "_".
Source: European Environment Agency's Technical report (2010).

As far as new Member States are concerned, most of them have the same target, except for Hungary and Poland with -6% targets. Since Cyprus and Malta are no Annex-I Parties to the

[24] Soest, List and Jeppesen (2006, p. 1164).

UNFCCC, they have no target.[25] After the fall of communism, Central and East European countries experienced the collapse of the heavy industries, which significantly helped them to cut down their GHG emissions. The aggregate emissions based on existing domestic policies and measures of the EU12 are still about 29.8% below their base year levels in the commitment period. However, according to the report on progress towards achieving the Kyoto objectives of the Commission, they were projected to rise after 2007.[26] Given the new EU's 2020 target, not only the EU15 will have to increase their enforcement efforts but also the new Member States ought to implement a new legislation in order to meet a much steeper emission reduction objective after 2012 as compared to the period 1990-2012.

The latest EU's efforts in reducing GHG emissions came in May 2010, when the Commission presented a communication analysing the costs, benefits and options for moving beyond the EU's GHG reduction target for 2020 from 20% below 1990 levels to 30%.[27] Due to the global economic crisis, the absolute costs of meeting the 20% target have dropped from the initial estimate of €70 billion to €48bn per year until 2020.[28] Although the newest unilateral EU 2020 climate goal of a 30% GHG emission reduction seems to be affordable and technically feasible due to this estimated cost cut, most Central and East European countries appear to be opposed to the proposal to move beyond the 20% greenhouse gas emission target.[29] Also, the Alliance of Energy Intensive Industries is against the Commission incentive to develop a 30% GHG emission reduction unilateral policy, since EU industries are already operating under the most stringent environmental policies worldwide and are simultaneously exposed to international competition.[30]

To sum up, the EU has committed itself to achieve the 8% GHG emission reduction under the Kyoto Protocol. This commitment is extended by a new goal of 20% and might even reach a 30% reduction for the upcoming period. Therefore, one can expect for the future even a higher stringency of environmental regulations within the EU's area. The empirical evidence of this

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[25] Greenhouse gas monitoring and reporting, available online at http://ec.europa.eu/environment/climat/gge.htm. [30/09/2010]

[26] Commission of the European Communities (2009, p.10), available online at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0630:FIN:EN:PDF. [30/09/2010]

[27] Analysis of options to move beyond 20% greenhouse gas emission reductions and assessing the risk of carbon leakage-briefing, available online at http://www.eubusiness.com/topics/environ/climate-options.10. [30/09/2010]

[28] European Commission (2010, p. 3), available online at http://ec.europa.eu/environment/climat/pdf/2010-05-26communication.pdf. [30/09/2010]

[29] Eastern Europe struggling to meet EU climate targets, available online at http://www.euractiv.com/en/priorities/eastern-europe-struggling-meet-eu-climate-targets-news-496400. [30/09/2010]

[30] European Confederation of Iron and Steel Industries (2010, p. 2), available online at http://www.eurofer.org/index.php/eng/News-Publications/Press-Releases/EU-industry-opposes-proposal-to-increase-EU-climate-change-target-unilaterally-to-30. [30/09/2010]

paper shows a rather positive effect of the current environmental regulations. The question left for future investigation is whether the positive trend is going to remain even with the new more severe objectives.

3. Literature review

The introduction presents several papers from which the evidence of the pollution haven hypothesis appears to be indefinite. This part focuses mainly on two dissimilarities observed from the literature which should shed a little bit more light on why the results from up-to-date empirical studies on the pollution haven hypothesis appear to be unstable and inconsistent. Firstly, estimation results are sensitive to the measurement of environmental regulation. Since the major problem lies in trying to measure the exact compliance costs that environmental regulations impose on manufactures, several different approaches on how to proxy for environmental policy stringency have been adopted.[31]

Most researchers have used data on pollution abatement costs.[32] However, the only country that has collected pollution abatement cost data for a significant time period is the United States.[33] Therefore, we are limited in terms of data availability on pollution abatement costs for the European countries, which this paper is focused on. Moreover, Cole and Elliott (2005) present in their study some criticism of pollution abatement costs as a measure of environmental stringency. They are said to underestimate the true regulation costs, since they do not incorporate investments in green technologies, which are, however, very likely to be undertaken by U.S. polluting firms under more stringent regulations.

Other researchers use some composite measures in form of various indexes in order to test for the PHH.[34] For instance, Mihci, Cagatay and Koska (2005) use an index of environmental sensitivity performance constructed for the OECD countries for their empirical analysis testing the impact of the environmental stringency on foreign direct investment. Since this index is available only for the year 1999, they use a cross-section analysis. Their results give some evidence suggesting that environmental stringency has an important impact on FDI outflows of the OECD countries and, thus, support the industrial flight hypothesis. Contrary to these

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[31] Busse (2004, p. 6).

[32] See, for example, Cole and Elliott (2005), Ederington, Levinson and Minier (2005), Eskeland and Harrison (2003), Keller and Levison (2002), Levison and Taylor (2008), or List and Co (2000).

[33] Ederington, Levinson and Minier (2005, p. 4) and Soest, List, Jeppesen (2006, p. 1152).

[34] See, for example, Busse (2004), Cave and Blomquist (2008), Dam and Scholtens (2008), Eliste and Fredriksson (2002), Eskeland and Harrison (2003), List and Co (2000), Mihci, Cagatay and Koska (2005), Tobey (1990), or Soest, List and Jeppesen (2006).

findings, Busse (2004), using a unique, new and comprehensive database[35] compiling different environmental indicators for his cross-sectional analysis due to only one year data availability, has found no evidence to support the pollution haven hypothesis. Also, Eliste and Fredriksson (2002) and Tobey (1990) use cross-country data analysis, since their index measuring the stringency of environmental regulations is available only for the year 1990 and 1976, respectively. Since this paper works with panel data, all these indexes from previous studies available only for a year cannot be used for our own analysis. Other approaches seem also unnecessarily complicated to carry out given data limitations such as that of Soest, List and Jeppesen (2006), who based their index calculation on the difference between shadow and market price of polluting inputs.

Another approach of indirect measuring for environmental policy stringency is to use emission pollutants such as carbon dioxide, sulphur dioxide, nitrogen oxide, particulate matter and lead content per gallon of gasoline.[36] As in other studies, also MacDermott (2009) faces the problem of quantifying the strictness of environmental regulations. Similarly to Xing and Kolstad's (2002) approach, he uses SO_x, NO_x and CO_2 emissions as a measure of level of environmental protection and expects their negative correlation. His results do not change appreciably when using these measures per capita or per gross domestic product. Although CO_2 is considered a weak measure of environmental regulations in comparison to SO_x or NO_x, which are more closely tied to air quality regulations, its data series are, on the other hand, much more complete. Moreover, he finds that all three measures are highly correlated in spite of the weak data availability of the SO_x and NO_x series. Despite the lack of adequate and comprehensive data on the stringency of regulations across countries other than emission pollutants, Busse (2004) still claims that emissions produced by companies are not a very good proxy for compliance costs and may result in a bias in the estimated coefficients. This is explained in the example of the Los Angeles area which has the worst air quality and at the same time the most stringent regulation.

In spite of the Busse's (2004) and MacDermott (2009) criticisms of CO_2, we decided for greenhouse gas emissions[37] as a proxy for European environmental policy stringency, since they seem to comply with all four conditions presented by Waldkirch and Gopinath (2008). They

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[35] The database provided by the Centre for International Earth Science Information Network (CIESIN) can be found at http://www.ciesin.org/. [30/09/2010]

[36] For studies using emission pollutants as a proxy for environmental stringency, see, for example, Cole, Elliott and Fredriksson (2006), Costantini and Crespi (2008), He (2006), MacDermott (2009), Smarzynska and Wei (2001), Waldkirch and Gopinath (2008), or Xing and Kolstad (2002).

[37] According to DECISION No 406/2009/EC, p. L 140/140, the main components of greenhouse gas emissions are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrof-luorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

consider a pollutant to be a useful proxy if it is a by-product of a goods production, if it varies in emissions intensity across industries, if it is subject to regulations because of its harmful effects and lastly if it has abatement technologies available for implementation. Moreover, given the main motive of this study to evaluate the impact of the EU's increasing environmental efforts described in Section 2, greenhouse gas emissions are chosen as a proxy for environmental policy stringency, since they directly represent one of the main threat against which the European Union tries to fight. In addition, the choice of greenhouse gas emissions is driven also by practical purposes. The European Environment Agency provides us with the data on greenhouse gas emissions stemming from the exact manufacturing sectors taken under investigation by this study.

Secondly, estimation results are not only sensitive to the measurement of environmental regulation but also to the empirical specification. With regard to cross-sectional analyses, Keller and Levinson (2002) draw attention to some drawbacks from which empirical papers on the PHH might suffer, one of which are the analyses based on cross-section estimations. Particularly, they argue that cross-section analyses are not suitable due to their impossibility to control for unobservable heterogeneity among countries. The natural resources desirable to a pollution industry or protections of polluting industries such as tax breaks and subsidies are good examples of unobservable factors that, if not controlled for, would cause an estimation bias to the predicted effect of environmental standard stringency on investments. Levinson and Taylor (2008) also admit that studies using cross-sections of data make it difficult to control for unobserved characteristics of countries or industries. Jeppesen and Folmer (2001) recommend using panel data as a method to control for missing observations on important, systematic time-invariant variables, since a misspecification due to omitted explanatory variables is likely to have an impact on the results of studies on the PHH.

As a result, the fixed-effect specification appears more reasonable than the cross-section or pooled estimation approaches. In the panel context, both fixed effects and random effects specifications are commonly used in the literature on the pollution haven hypothesis. These specifications were used in some of the aforementioned papers, for instance, in Cole and Elliott (2005), Cole, Elliott and Fredriksson (2006), Ederington, Levinson and Minier (2005), Keller and Levinson (2002), or Levinson and Taylor (2008). Studies, such as Costantini and Crespi (2008) and MacDermott (2009), specifying their equations in a gravity model, also find appropriate to apply fixed effects and random effects estimates, since they account for heterogeneity across observations. Keller and Levinson (2002) and Cole and Elliott (2005) go a step further in their empirical investigation and derive from their static model of investment also a dynamic one using FDI lagged as an additional explanatory variable, since one might object that foreign direct investments are by nature part of a dynamic process. Such a dynamic model is tested by a generalized method of moments (GMM) estimation that uses FDI lagged values as instruments for the additional FDI lagged explanatory variable and first differences all variables to eliminate the fixed country effects, as suggested by Arellano and Bond (1991).

Also, other more sophisticated specifications have been adopted to test for the PHH. In particular, Leiter, Parolini and Winner (2010), Levinson and Taylor (2008) and Xing and Kolstad (2002) all use instrumental variable estimation. For such estimation, one needs to seek an instrument which is uncorrelated with the error term but at the same time correlated with the unobserved variable. Besides the abovementioned empirical specifications, in the literature on the PPH, one can also encounter conditional logit parameter estimates, probit estimation or estimations of functional form of the profit function.[38] Nevertheless, we use the most common way of panel data analysis and estimate our model by the fixed-effects specification.

4. Model specification and the data

The empirical model presented below was inspired by several papers found in the literature. In particular, it is based on three main papers. The first examines how FDI inflows to U.S. states are influenced by environmental stringency using pollution abatement costs (Keller and Levinson, 2002), the second presents determinants of FDI for the OECD countries (Agiomirgianakis, Asteriou and Papathoma, 2006) and the third sets up FDI determinants for manufacturing (Ramasamy and Yeung, 2010). Since we want to examine the effect of environmental stringency proxied by greenhouse gas emissions on the inward FDI positions of manufacturing sectors in the EU countries, these three papers were found as a very good basis for our own model. The model per se is specified as follows,

$$\mathbf{FDIstockgdp_{i,t} = \theta_t + \beta 1GHGgdpi_{,(t-1)} + \beta_2 GDPcapcon_{i,(t-1)} + \beta_3 PopDen_{i,(t-1)} + \beta_4 Empl_{i,(t-1)} + \beta_5 Taxgdp_{i,(t-1)} + \beta_6 Topencon_{i,(t-1)} + \beta_7 Enrol2_{i,(t-1)} + \beta_8 LTIR_{i,(t-1)} + \beta_9 FDIstockgdp_{i,(t-1)} + \alpha_i + \varepsilon_{i,t}}$$

where i = 1, 2, ..., N (countries), t = 1, 2, ..., T (time periods), α_i indicates the unobserved country fixed effect, θ_t denotes different year intercepts and $\varepsilon_{i,t}$ is an error term. Following the approach of Agiomirgianakis, Asteriou and Papathoma (2006), the set of independent variables is measured prior to the investment decision in order to overcome the possible problem of

[38] See, for example, Dean, Lovely and Wang (2009), Kneller and Manderson (2009), List and Co (2000), or Smarzynska and Wei (2001).

endogeneity rising from the fact that the dependent variable and the explanatory variables such as environmental regulations or employment can be determined simultaneously. At the same time, such an approach allows for dynamic nature of FDI. We estimate the effect of environmental regulations in Europe on inward foreign direct investment stocks of the most polluting industrial sectors denoted by *FDIstockgdp*. If the accumulated levels of foreign direct investment decrease or increase as a result of environmental measures, one can infer that MNEs operating in heavily polluting industries in Europe are indeed negatively or positively sensitive to such regulations. The FDI variable is scaled by the gross domestic product of each country concerned in order to adjust for inflation and other price changes through years.

The proxy for environmental regulation stringency, *GHGgdp*, are greenhouse gas emissions divided by gross domestic product in order to adjust for business cycle swings, since emissions are higher during expansions and lower during recessions. As explained by MacDermott (2009), we expect positive relationship between GHG emissions and FDI. The more emissions of GHG are spewed into the atmosphere, the lower the level of environmental protection is inferred and, thus, the fewer deterrents imposed for multinational companies and their FDI decisions by a country. So, if the pollution haven hypothesis holds, the GHG emissions and FDI are positively correlated.[39] To the contrary, if a negative relationship is found, there is no pollution-intensive industry relocation response, no pollution haven effect, and, thus, no need to worry about a race to the bottom in environmental policies.[40] In fact, this suggests that industries are attracted to countries with stringent environmental regulations, since they do not consider them to be a deterrent but a location advantage instead. In such a scenario, we expect a positive impact of environmental regulations on investment activities undertaken by firms and, thus, indirectly test for the Porter hypothesis.[41]

Generally, most of the papers using FDI as a dependent variable include different proxies as determinants to control for market size and its potential, level of country's economic development, labour market characteristics, factors of production prices, cultural and language differences, political stability, human capital, agglomeration effect, infrastructure, legislative framework or degree of corruption. However, in the aforementioned model, we control only for some of these factors determining FDI owing to time or country unavailability of the data or data costs.

The level of development of a country is proxied by gross domestic product per capita in constant prices denoted by *GDPcapcon*. Consistent with the literature, we expect the inward FDI

[39] MacDermott (2009, p. 3).
[40] Keller and Levinson (2002, p. 697).
[41] Leiter, Parolini and Winner (2010, p. 4).

to increase with per capita income. *PopDen* stands for population density and is included as a measure of market size. The larger the market size, the bigger the purchasing power and the better possibilities for economies of scale for MNEs.[42] Therefore, a positive relationship is expected between PopDen and our dependent variable. *Empl* indicates employment measured by persons engaged in manufacturing industry and is included in the model as a determinant controlling for labour market characteristics of a country. Contrary to other measures of a labour market, such as wages or labour costs, employment is expected to be positively correlated to FDI.

Taxes on capital and business income of corporations (i.e. corporation tax), expressed as percentages of GDP and denoted by *Taxgdp*, along with long-term interest rate, abbreviated as *LTIR*, are both included as measures of costs of capital. As Ramasamy and Yeung (2010) argue, a higher discount rate reflects a higher cost of borrowing, thus negatively influencing the extent of FDI in a country. Similarly, we can derive a negative relationship between corporation tax and FDI, since higher fiscal burdens induce lower net profits of a firm, thus lowering internal capital for firm's financing.

Human capital is found in the literature as one of the main determinants of FDI.[43] Therefore, we include the rate of secondary enrolment, which is the ratio of gross secondary enrolment, regardless of age, to the total population in the officially defined age group for secondary schooling. This variable is expressed in percentages and denoted by *Enrol2*.

Not only human capital is commonly incorporated in the models explaining FDI, but also the degree of international openness is said to be a significant determinant.[44] Our proxy for trade regime expressed as the ratio of the sum of exports and imports of goods to gross domestic product in constant prices is denoted by *Topencon* and can take a positive as well as negative sign. Following the logic of MacDermott (2009), firms are expected to penetrate foreign markets by way of trade rather than horizontal FDI, if the level of trade openness is high. In this case, a priori expectation of the beta coefficient of Topencon would be negative. Nevertheless, if we consider vertical FDI, firms might take advantage of a country's large engagement in trade by producing goods abroad and shipping them back home. In this case, a higher amount of FDI is generated and, thus, one can expect positive correlation between trade openness and FDI. As the

[42] Ramasamy and Yeung (2010, p. 578).

[43] For studies recommending and controlling for human capital, see, for example, Agiomirgianakis, Asteriou and Papathoma (2006), Jeppesen and Folmer (2001), Kneller and Manderson (2009), Mihci, Cagatay and Koska (2005), or Ramasamy and Yeung (2010) recommending and controlling for human capital.

[44] For studies recommending and controlling trade openness, see, for example, Agiomirgianakis, Asteriou and Papathoma (2006), MacDermott (2009), Ramasamy and Yeung (2010), or Waldkirch and Gopinath (2008).

data does not distinguish between horizontal and vertical FDI, there are no a priori expectations for the Topencon beta coefficient.[45]

Given that FDI attracts FDI[46], the last variable included in the model is the lagged dependent variable of inflow FDI positions divided by current GDP, $FDIstockgdp_{(t-1)}$. Following the existing literature on determinants of FDI, this variable is added into our model not only to allow for dynamic nature of FDI but also to capture the agglomeration effect.[47] This effect is associated with all potential positive externalities, such as availability of market information, technology transfers, access to a skilled labour pool or established suppliers' network, from which a firm can profit if it locates in close proximity to other firms.[48] In other words, firms' location behaviour is said to be influenced by the location of other firms which invested previously.[49]

The main reason for including in our model a proxy controlling for agglomeration effect is Timmins and Wagner's (2008) argumentation. They emphasise that if such an effect is omitted from the estimation equation, it will cause bias in the estimated coefficient on environmental regulatory stringency, since environmental regulatory agencies across countries are likely to respond to agglomeration of dirty industries by tightening environmental standards.[50] Hence, there can be a positive correlation between stringency and agglomeration effect, which can bias the results if omitted. Moreover, the lagged dependent variable of FDI is included in all three papers by which the present model was inspired. Common to the empirical FDI papers which account for agglomeration effect, we expect a positive beta coefficient of the lagged FDI variable.[51]

Our database has been built using a number of different data sources. Data on each Member State's greenhouse gas emissions of the particular industries taken under estimation, annually reported to the UNFCCC and to the EU Greenhouse Gas Monitoring Mechanism, are compiled by the European Environment Agency.[52] In particular, we gather the data on GHG emissions stemming from petroleum refining, iron and steel, non-ferrous metals, chemicals, pulp, paper and

[45] MacDermott (2009, p. 4).
[46] Ramasamy and Yeung (2010, p. 583).
[47] For studies adding lagged dependent variable due to the agglomeration effect or FDI dynamic nature, see, for example, Agiomirgianakis, Asteriou and Papathoma (2006), Cole and Elliott (2005), Keller and Levinson (2002), or Ramasamy and Yeung (2010). List and Co (2000), Timmins and Wagner (2008), and Waldkirch and Gopinath (2008) use total number of existing plants in the industry, total stock of inward FDI and accumulated FDI, respectively.
[48] List and Co (2000, p. 7)
[49] Agiomirgianakis, Asteriou and Papathoma (2006, p. 11).
[50] Timmins and Wagner (2008, p. 8).
[51] Agiomirgianakis, Asteriou and Papathoma (2006, p. 10).
[52] The data from the EEA can be found at http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-4. [30/09/2010]

print, and food processing, beverages and tobacco.[53] The OECD database provides us with data on inward FDI positions into each Member State in our sample. Also, data on trade openness and long-term interest rate are covered by the OECD database[54]. The World Bank's World Development Indicators[55] is the source of population density, gross secondary school enrolment and gross domestic product per capita. Data on people employed in manufacturing industry are taken from the Annual Macro Economic database (AMECO)[56] and we use Eurostat database[57] as the data source for taxes on capital and business income of corporations. Overall, the database includes 11 countries over a time period from 1990 to 2007 and it covers information from five pollution-intensive industries classified by OECD's ISIC/NACE codes[58]: food products (1605), wood, publishing and printing (2205), refined petroleum and other treatments (2300), chemical products (2400) and metal products (2805).

Table 3 summarises the description of all variables chosen for estimation together with their units, expected signs and the source of data. The arithmetic mean, maximum, minimum, median, standard deviation and number of observation for each variable of the model are presented in Table 4.

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[53] A detailed description of each combustion activity is provided by EMEP/EEA emission inventory guidebook (2009), available online at http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-2-combustion-in-manufacturing-industries-and-construction-tfeip-endorsed-draft.pdf. [30/09/2010]

[54] OECD database can be found at http://stats.oecd.org/index.aspx?r=639547. [30/09/2010]

[55] World Databank can be found at http://databank.worldbank.org/ddp/home.do. [30/09/2010]

[56] AMECO database can be found at http://ec.europa.eu/economy_finance/ameco/user/serie/SelectSerie.cfm. [11/10/2010]

[57] Eurostat database can be found at http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database. [30/09/2010]

[58] A detailed classification is available in OECD Handbook on Economic Globalisation Indicators (2005, p. 71).

TABLE 3: Data definitions, expected effects and sources			
VARIABLE	SHORT DESCRIPTION	EFFECT	DATA SOURCE
FDIstockgdp	Inward FDI position divided by GDP in current prices (both in millions)	dependent variable	OECD database / World Development Indicators
GHGgdp	GHG emissions in Gg divided by GDP in millions U.S. dollars (constant prices, base year 2000)	**+/-**	EEA / World Development Indicators
GDPcapcon	GDP per capita in millions U.S. dollars (constant prices, base year 2000)	**+**	World Development Indicators
PopDen	Population density (1000 people per sq. km)	**+**	World Development Indicators
Empl	Employment of persons in manufacturing industry (in millions)	**+**	AMECO database
Taxgdp	Corporation tax (taxes on capital and business of corporations in % of GDP)	**-**	Eurostat database
Topencon	Trade openness (ratio of trade of goods to GDP in constant prices, OECD base year 2000)	**+/-**	OECD database
Enrol2	Gross secondary school enrolment (in %)	**+**	World Development Indicators
LTIR	Long-term interest rate (in %, per annum)	**-**	OECD database

Countries in sample: Austria, Czech Republic, Denmark, Finland, France, Germany, Italy, Netherlands, Poland, Slovak Republic and United Kingdom

TABLE 4: Descriptive Statistics						
VARIABLE	MEAN	MAXIMUM	MINIMUM	MEDIAN	S.D.	OBSERVATIONS
FDIstockgdp	0.04064	0.25566	-0.02597	0.02513	0.04473	169
GHGgdp	0.11533	0.82470	0.01421	0.06704	0.14927	198
GDPcapcon	0.01786	0.03277	0.00287	0.02011	0.00845	198
PopDen	0.17021	0.48524	0.01637	0.12683	0.11444	192
Empl	2.685	9.801	0.387	1.402	2.470	183
Taxgdp	3.207	5.900	1.700	3.200	0.805	121
Topencon	63.803	182.027	24.952	52.009	33.121	190
Enrol2	104.362	139.444	79.405	100.488	12.622	132
LTIR	6.058	13.266	3.351	5.187	2.207	163

Notes: Descriptive statistics are given for variables in levels for the whole time period, although in the estimated regressions all variables are lagged by a year. Numbers are rounded to 3 or 6 decimal places.

5. Empirical results

Table 5 summarises our empirical findings.[59] However, only fixed-effect estimates are presented, since the Hausman test statistic shows a very small p-value (0.000005). Such a result leads to a rejection of the hypothesis that the individual effects (α_i) are uncorrelated with the other regressors in the model.[60] Hence, the key random-effects assumption does not hold and, thus, we use fixed-effect estimates.[61] The choice of fixed-effects instead of random-effects was also made because of the nature of the data set. As our panel data comprises observations on a fixed and relatively small set of units, there is a presumption in favour of fixed-effects.[62]

As we suspect that our panel data may suffer from both heteroscedasticity and autocorrelation, the robust covariance matrix estimator suggested by Arellano (2003) is used in order to obtain robust standard errors. They can provide for asymptotically valid statistical inference as long as the model is correctly specified and the sample is relatively large.[63] Due to data limitation, however, our sample is rather small. Also, Arellano‘s (2003) approach is Heteroscedasticity Autocorrelation-Consistent (HAC) only if many units are observed in relatively few periods, which does not seem to hold in our case either. Taken these first two drawbacks of empirical testing into account, the overall model is considered to be well specified, inferred from the F-test and the test for differing group intercepts.

When estimating a model using fixed-effects, we look first at the test for differing group intercepts for the null hypothesis that the cross-sectional units all have a common intercept. In our case, the p-value (approx. 0.0003) of the test is small enough to reject the null hypothesis even at the 1% level, suggesting that individual effects are not negligible at all and, thus, the pooled OLS turns out not to be the optimal estimator approach. This result supports the right choice of fixed-effects estimator for our analysis. With regard to the F-test, a very small p-value (1.41e-37) confirms that all explanatory variables in the model are jointly significant. As for the Wald statistic, it is testing the joint null hypothesis that none of the time dummies has any effect on the outcome. Since the p-value of approximately 0.0053 rejects the null hypothesis at the 1% level, we keep them in our model.

The model fit seems to be very good, as indicated by the size of both the R^2 and the adjusted R^2, 0.984 and 0.975, respectively. Also, no correlation exceeding 0.65 between estimated

[59] For complete regression results provided by Gretl, see Printouts A1 and A2 in the Appendix.
[60] Greene (2002, p. 303)
[61] Wooldridge (2008, p. 494).
[62] Cottrell and Lucchetti (2010, p. 128).
[63] Cottrell and Lucchetti (2010, p. 119).

explanatory variables was found (see, Table 6 in the Appendix). All the estimated beta coefficients have a priori expected signs and for most of the variables' p-values indicate statistical significance of at least the 10% level. With regard to our variable of interest, GHGgdp is significant at the 10% level and has a negative sign. We interpret the result as follows: if the ratio of greenhouse gas emissions to GDP in constant prices increases by 0.1, the estimated ratio of inward FDI stocks to GDP decreases by about 0.0037, other things being equal. Such a result suggests that there has not been found any deterrent effect of EU's stringent environment regulations so far. This indicates that we have indirectly found evidence of the Porter Hypothesis in the European Union's case, despite the fact that the impact of environmental regulations on firm's investment decisions is relatively small in comparison with the effects of the rest of the determinants of the model.

Yet, the result of the variable of interest is rather surprising, as we would primarily expect the evidence of the PHH or no effect at all. Ederington, Levinson and Minier (2005) in their study on the effect of environmental regulations on trade, might give three good explanations to our results showing no evidence on the pollution haven hypothesis. They empirically test and find that the first possible reason might be due to the fact that most trade and FDI flows take place among developed countries, which share similarly high levels of environmental stringency. Therefore, one should not aggregate data across multiple countries, as we did, but divide the sample of countries into relatively low-standard and relatively high-standard instead in order to unmask the real effect of an increase of regulatory stringency.

The second reason is that some industries are less geographically mobile due to transportation costs, plant fixed costs, or agglomeration economies. This means that such industries would be insensitive to any changes in regulatory stringency between countries because of their inability of easy relocation. From this point of view, the interpretation of our results is that less mobile industries in the EU do, in fact, invest into ecologically friendlier technologies to keep the pace with the competition.

Finally, they show that the environmental regulation represents only a small portion of total production costs for the most heavily regulated industries in the United States, which suggests that they are not a dominant factor of an industrial location. This is confirmed by Busse's (2004) study, in which he argues that total abatement costs do not exceed 4 per cent of total costs and, thus, there might not be clear influence of environmental regulations.

TABLE 5: Empirical Results				
VARIABLE	COEFFICIENT	T-RATIO	P-VALUE	LEVEL OF SIGNIFICANCE
constant	-0.560551 (0.236513)	-2.3701	0.02153	**
GHGgdp	-0.037009 (0.019461)	-1.9018	0.06275	*
GDPcapcon	7.52276 (3.25562)	2.3107	0.02485	**
PopDen	2.02607 (0.889956)	2.2766	0.02696	**
Empl	0.016128 (0.008808)	1.8311	0.07282	*
Taxgdp	-0.001522 (0.001831)	-0.8311	0.40973	
Topencon	0.000249 (0.000182)	1.3651	0.17811	
Enrol2	0.000611 (0.000332)	1.8382	0.07175	*
LTIR	-0.006063 (0.002754)	-2.2012	0.03218	**
FDIstockgdp lagged	0.232233 (0.123077)	1.8869	0.06476	*
Dependent variable:	FDIstockgdp	***P-value of the Hausman test***		0.000005
Number of observations:	80	***P-value of the F-test:***		1.41e-37
R-squared:	0.983637	***P-value of the test for differing group intercepts:***		0.000333
Adjusted R-squared:	0.975141	***P-value of the Wald test:***		0.005283

Notes: Robust (HAC) standard errors are in parenthesis. * and ** indicate 10% and 5% levels of significance. Numbers are rounded to 6 decimal places.

From the above Table 5, we can draw the following conclusions on the rest of variables in the model. First, the parameter estimates for GDPcapcon, PopDen and LTIR are all statistically significant at the 5% level and can be interpreted as follows. If the gross domestic product per capita increases by 1000 U.S. dollars, the predicted ratio of inward FDI stocks to GDP increases by about 0.0075, holding other variables fixed. If the population density increases by 10 people per square kilometre, the predicted share of inward FDI positions of GDP increases by around 0.0203, other things being constant. If long-term interest rate increases by 1%, the predicted ratio of inward FDI positions to GDP decreases by about 0.0061, other things being equal. In other words, out of the above three most statistically significant variables it is the market size which seems to be the most important determinant of inward FDI stocks within the EU's area. Both variables, GDP per capita and long-term interest rate, were also find statistically significant in Agiomirgianakis, Asteriou and Papathoma's (2006) study and in Ramasamy and Yeung's (2010) paper, respectively, whereas the coefficient of population measuring the size of the domestic market remained insignificant in Keller and Levinson's (2002) work, which obviously contradicts our findings.

Second, the beta coefficients of Empl, Enrol2 and lagged FDIstockgdp are statistically significant at the 10% level. For the measurement of human capital, we followed two papers, which our model was based on, Agiomirgianakis, Asteriou and Papathoma (2006), and Ramasamy and Yeung (2010). Since the authors of both of these papers found their coefficients on secondary education enrolment statistically significant, our result confirming their findings are rather unsurprising. Consistent with literature findings, our study also confirms the important role that the agglomeration effect plays when examining MNEs' investment decisions. The interpretation per se of these three variables can be presented as follows. If the number of persons employed in manufacturing industry increases by 100 thousand, the estimated ratio of inward FDI positions to GDP increases by about 0.0016, keeping other things constant. If the gross secondary enrolment ratio increases by 10, the estimated share of inward FDI stocks of GDP increases by around 0.0061, keeping other things constant. As for the agglomeration effect, if the share of inward FDI positions of GDP of last year increases by 0.01, the predicted share of inward FDI stocks of GDP of current year increases by 0.0023, other things being equal.

Last, although the beta coefficient on corporation tax, Taxgdp, appears to be statistically insignificant, the sign is as one would expect. Such a result corresponds to Keller and Levinson's (2002) findings, even though their tax effort variable appears to be significant in the case of manufacturing.[64] A similar conclusion can be drawn about the ratio of trade of goods to GDP, Topencon. Contrary to findings in Agiomirgianakis, Asteriou and Papathoma's (2006) paper, and in Ramasamy and Yeung's (2010) one, the coefficient on trade openness fails to be statistically significant in our case. However, the expected sign falls in line with their empirical findings.[65]

Even though our results seem to be more than interesting, we have to take into account all drawbacks of the model in order to be able to make final conclusions of our empirical investigation. First of all, the problem with data limitation is one of the major ones. Besides already mentioned problems due to data unavailability, we are not, for instance, able to follow Ederington, Levinson and Minier's (2005) suggestion of disaggregating the sample into high environmental standard countries and low environmental standard ones. If the data were

[64] Keller and Levinson (2002, p. 696).

[65] If the coefficients had been significant, the result could have been interpreted as follows. If the corporation tax expressed in percentage of GDP increased by 1%, the estimated share of inward FDI stocks of GDP would decrease by about 0.0015, other things being equal. If the trade-to-GDP ratio increased by 10, the predicted ratio of inward FDI positions to GDP would increase by about 0.0025, holding other variables constant.

available for all Member States, such an approach would be highly recommended for the future empirical investigation, since quite large differences in enforcement efforts of environmental regulation are found even within the EU.

Also, due to data limitation, our model does not control for country's infrastructure, political stability or level of corruption. All of these factors seem to be important foreign direct investment drivers in the FDI papers. Therefore, on the one hand, one should be aware of the fact that our results might have changed substantially, if they had been included in the model. For instance, Kneller and Manderson's (2009) study on the PHH for United Kingdom firms' outward FDI found that relaxing environmental regulations in an incorrupt country has significantly positive effect on MNEs' location decisions. Nevertheless, their findings suggest that there is no effect of these regulations, if the country is highly corrupted.[66] Also, Smarzynska and Wei (2001) in the study on European transition economies point out the importance of controlling for corruption effect in examining the location choices of multinational companies. However, in our defence, the sample consists mostly of the West European countries with a long tradition of democratic regimes and well developed infrastructure. Therefore, on the other hand, infrastructure, political stability or level of corruption are less likely to be important drivers in this case and might not have had any significant effect on our empirical findings.

With respect to endogeneity, Cole, Elliott and Fredriksson (2006) bring a new finding to the literature concerning the relationship between the stringency of environmental policies and FDI. As most of the empirical studies have treated environmental policy as exogenous in relation to FDI, they were interested in their inverse relationship and, in fact, found it to be endogenous. They concluded that FDI has a positive effect on environmental policy and a negative one, when the degree of government corruptibility is high. As we treat the inward FDI positions and our proxy for environmental stringency exogenously, our empirical results may suffer from such a new finding presented by Cole, Elliott and Fredriksson (2006). In addition, an endogenous relationship between FDI and employment might be also expected in our model, since not only the level of employment affects FDI but also FDI may affect the level of employment simultaneously.[67] Although we are trying to overcome the problems rising from endogeneity by adding the lagged dependent variable and lagging the other explanatory variables by a year, this might not to be a sufficient approach. Therefore, one should consider other econometric ways of empirical testing such as instrumental variable (IV) methods like two-stage least squares (2SLS

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[66] Kneller and Manderson (2009, p. 3-4).
[67] Keller and Levinson (2002, p. 696-697).

or TSLS) or generalized method of moments (GMM), which can solve better the problem of endogeneity of one or more explanatory variables.[68]

Lastly, as we have a relatively small sample with only eleven countries, the variation of environmental protection may be limited. In order to get better results, one could consider a model based on bilateral FDI flows between the EU Member states and other countries with different levels of environmental protection. However, such an investigation would again have to face the common challenge in the literature of quantifying international differences in environmental regulations.[69] Besides the already suggested approaches, List and Co (2000) and Leiter, Parolini and Winner (2010), among others, use also government's or industry's expenditures on environment protection as a proxy for the level of environmental stringency. These proxies could be also a possible way of measuring the environmental regulations in our empirical analysis, if the data availability were better across years.[70]

6. Conclusion

From the theoretical point of view, there are two main contradicting theories. On the one hand, the "pollution haven hypothesis" implies that more stringent environmental regulations will increase firms' costs and, thus, lower their competitiveness. Firms with financial resources high enough to relocate their production will be tempted by the countries implementing lower environmental protection. In case that the environment policy is not well set up or is too strict, this theory says that such firms will actually relocate their production to countries with lax or low enforcing environment standards. However, in such a scenario, environment regulations have a zero or rather a negative effect, improving environment in one country and worsening it in another one.

On the other hand, the "Porter hypothesis" suggests that well-designed environmental standards will reinforce firms' efforts to become less harmful to the environment. In particular, firms under stringent environmental regulations are expected to enhance their innovatory activities and invest into more advanced and environmentally friendlier technologies in order to preserve or even increase their competitiveness. Hence, according to this theory, firms will not relocate as a response to such regulations but they will gradually adapt to them instead. In this case, environmental measures work as they are supposed to, improving the environment in one

[68] Wooldridge (2008, p. 506).
[69] Keller and Levinson (2002, p. 691).
[70] See, the data on environmental protection expenditure in industry provided by Eurostat database available only for time period from 1995 to 2001 online at http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do. [30/09/2010]

country and due to a spillover effect positively influencing also the environment of neighbouring countries.

In order to get the answer to the question of which of these two hypotheses prevails in the case of the European Union, we have examined the impact of the European Union climate change and air protecting environmental standards proxied by greenhouse gas emissions on inward foreign direct investment stocks of heavily polluting industries. Surprisingly, the empirical findings suggest that established environmental regulations have a positive effect on firms' investment decisions so far. In other words, we have indirectly found evidence of the Porter hypothesis. Therefore, one might conclude from our empirical investigation that the current environmental measures, implemented in order to fulfil the Kyoto greenhouse gas emission reduction target of 8% by 2012, are well-designed and leading to improvements in environment protection. This conclusion is in line with Jeppesen and Folmer (2001) who emphasise that the environmental policy does not only have detrimental impacts on firm's profit but also may have positive effects such as higher productivity employees due to lower mortality and morbidity rates and higher quality inputs for industrial processes, e.g. clean air and water.

Due to data limitation our sample consists only of 11 European Member States for 18 years from 1990 to 2007. We have used unbalanced data set which includes aggregated data on inward foreign direct investment stock of five European Union's pollution-intensive industries, namely food products, wood, publishing and printing, refined petroleum and other treatments, chemical products and metal products, for which particular greenhouse gas emissions were available. Besides the variable of interest, i.e. environmental regulations proxied by greenhouse gas emissions, we have included determinants of foreign direct investment commonly used in the literature. Our model, in particular, comprises explanatory variables controlling for country's level of development, market size, labour market characteristics, production factor prices, human capital, trade openness and agglomeration effect. The model per se has been tested by the fixed-effects estimator and despite several limitations and possible drawbacks, concluding from main statistical tests, it seems to be well specified. Contrary to expectations, industrial foreign direct investments have not appeared to be influenced by corporation taxes and trade openness. All the other explanatory variables have shown to be statistically significant determinants of industrial foreign direct investments.

Although we have not found evidence that industrial firms' location behaviour would be negatively sensitive to the European Union's environmental policies, our findings allow us to evaluate only those which have been enacted in order to achieve the Kyoto Protocol commitment. Nevertheless, European Union's environmental efforts aimed at reducing greenhouse gas emissions have been recently enhanced. The new objective of 20% reduction of greenhouse gas emissions by 2020 has been jointly agreed upon by all Member States and adopted in April 2009. In May 2010, the Commission came with a new idea of increasing the 20% reduction commitment to 30%, since the global economical crisis makes such an increase financially affordable and technically reachable. As a result, one can expect even a higher stringency of environmental regulations within the EU's area for the future.

However, more stringent environmental standards imply that the positive trend that we have found may not persist. Following the argumentation of Levinson and Taylor (2008), it seems very unlikely that such regulations would have no effect on firms' costs and international competitiveness whatsoever. One can fear that the European Union's most pollution-intensive firms under increased environment protection will actually go bankrupt or relocate. This would not lead only to an economic slowdown for the European Union as a whole but also to a decrease in environment protection. In other words, the European Union's environment legislative should be set up with caution. The Porter hypothesis is what we want but once the pollution haven hypothesis prevails, the stringent environment regulations lose their justification. Therefore, it would be interesting to carry out further research once the data becomes available in a couple of years, bearing in mind that a good proxy for environment regulation stringency and an appropriate method of testing are the key issues in an empirical work on pollution havens. Nevertheless, we believe that this paper provides a good basis for such future investigation.

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Appendix

TABLE 2: Member State greenhouse gas emission limits					
MEMBER STATE	Member State greenhouse gas emission limits in 2020 compared to 2005 greenhouse gas emissions levels				
Belgium	– 15 %	France	– 14 %	Austria	– 16 %
Bulgaria	20 %	Italy	– 13 %	Poland	14 %
Czech Republic	9 %	Cyprus	– 5 %	Portugal	1 %
Denmark	– 20 %	Latvia	17 %	Romania	19 %
Germany	– 14 %	Lithuania	15 %	Slovenia	4 %
Estonia	11 %	Luxembourg	– 20 %	Slovakia	13 %
Ireland	– 20 %	Hungary	10 %	Finland	– 16 %
Greece	– 4 %	Malta	5 %	Sweden	– 17 %
Spain	– 10 %	Netherlands	– 16 %	United Kingdom	– 16 %

Source: DECISION No 406/2009/EC, p. L 140/147, available online at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0136:0148:EN:PDF. [11/10/2010]

TABLE 6: Correlation matrix of all variables of the model									
FDIstockgdp	GHGgdp	GDPcapcon	PopDen	Empl	Taxgdp	Topencon	Enrol2	LTIR	
1.00	0.18	-0.02	0.66	-0.36	0.32	0.62	0.28	-0.23	**FDIstockgdp**
0.18	**1.00**	-0.61	-0.17	-0.33	0.18	0.37	-0.33	0.04	**GHGgdp**
-0.02	-0.61	**1.00**	0.21	0.06	-0.06	-0.29	0.61	-0.20	**GDPcapcon**
0.66	-0.17	0.21	**1.00**	0.26	0.13	0.15	0.19	-0.08	**PopDen**
-0.36	-0.33	0.06	0.26	**1.00**	-0.36	-0.45	-0.31	0.05	**Empl**
0.32	0.18	-0.06	0.13	-0.36	**1.00**	0.41	0.14	-0.01	**Taxgdp**
0.62	0.37	-0.29	0.15	-0.45	0.41	**1.00**	-0.11	-0.43	**Topencon**
0.28	-0.33	0.61	0.19	-0.31	0.14	-0.11	**1.00**	-0.08	**Enrol2**
-0.23	0.04	-0.20	-0.08	0.05	-0.01	-0.43	-0.08	**1.00**	**LTIR**

Note: Numbers are rounded to 2 decimal places.

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Model 1: Fixed-effects, using 80 observations
Included 11 cross-sectional units
Time-series length: minimum 4, maximum 9
Dependent variable: FDIstockgdp
Robust (HAC) standard errors

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-0.560551	0.236513	-2.3701	0.02153	**
GHGgdp_1	-0.0370092	0.0194605	-1.9018	0.06275	*
GDPcapcon_1	7.52276	3.25562	2.3107	0.02485	**
PopDen_1	2.02607	0.889956	2.2766	0.02696	**
Empl_1	0.0161279	0.0088077	1.8311	0.07282	*
Taxgdp_1	-0.00152164	0.00183093	-0.8311	0.40973	
Topencon_1	0.000248527	0.000182061	1.3651	0.17811	
Enrol2_1	0.000611163	0.000332476	1.8382	0.07175	*
LTIR_1	-0.00606262	0.00275419	-2.2012	0.03218	**
FDIstockgdp_1	0.232233	0.123077	1.8869	0.06476	*
dt_10	0.0408778	0.0171769	2.3798	0.02102	**
dt_11	0.0216934	0.011561	1.8764	0.06621	*
dt_12	0.016101	0.00895729	1.7975	0.07806	*
dt_13	0.0168511	0.0085768	1.9647	0.05480	*
dt_14	0.0169213	0.00968121	1.7479	0.08639	*
dt_15	0.0104599	0.00481913	2.1705	0.03456	**
dt_16	0.00879846	0.00559683	1.5720	0.12201	
dt_17	-0.000377596	0.00435636	-0.0867	0.93126	

Mean dependent var	0.049495	S.D. dependent var	0.048218
Sum squared resid	0.003005	S.E. of regression	0.007602
R-squared	0.983637	Adjusted R-squared	0.975141
F(27, 52)	115.7770	P-value(F)	1.41e-37
Log-likelihood	294.0597	Akaike criterion	-532.1194
Schwarz criterion	-465.4226	Hannan-Quinn	-505.3787
rho	-0.189203	Durbin-Watson	2.163772

Test for differing group intercepts -
Null hypothesis: The groups have a common intercept
Test statistic: F(10, 52) = 4.11291
with p-value = P(F(10, 52) > 4.11291) = 0.000333063

Wald test for joint significance of time dummies
Asymptotic test statistic: Chi-square(8) = 21.8084
with p-value = 0.00528342

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Model 4: Random-effects (GLS), using 80 observations
Included 11 cross-sectional units
Time-series length: minimum 4, maximum 9
Dependent variable: FDIstockgdp

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-0.00958051	0.0300287	-0.3190	0.75064	
GHGgdp_1	-0.0139557	0.0318766	-0.4378	0.66288	
GDPcapcon_1	-1.23295	0.416959	-2.9570	0.00423	***
PopDen_1	0.150487	0.0314585	4.7837	<0.00001	***
Empl_1	-0.00420873	0.00146499	-2.8729	0.00538	***
Taxgdp_1	-0.000736148	0.00194032	-0.3794	0.70554	
Topencon_1	0.000103041	0.000101915	1.0110	0.31548	
Enrol2_1	0.000500357	0.000237492	2.1068	0.03872	**
LTIR_1	-0.00270245	0.00141725	-1.9068	0.06065	*
FDIstockgdp_1	0.556691	0.076145	7.3109	<0.00001	***

Mean dependent var	0.049495	S.D. dependent var	0.048218
Sum squared resid	0.008320	S.E. of regression	0.010825
Log-likelihood	253.3319	Akaike criterion	-486.6639
Schwarz criterion	-462.8436	Hannan-Quinn	-477.1137

'Within' variance = 6.14649e-005
'Between' variance = 3.642e-005

Breusch-Pagan test -
Null hypothesis: Variance of the unit-specific error = 0
Asymptotic test statistic: Chi-square(1) = 0.654313
with p-value = 0.418575

Hausman test -
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(9) = 41.2041
with p-value = 4.59172e-006