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- testing the pollution haven hypothesis with a new composite index

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Abstract

Environmental concerns and increasing stringency levels of environmental regulations, especially in developed countries, has given rise to the debate concerning pollution havens. The pollution haven hypothesis argues that differences in environmental policy stringency will give economic incentives to firms and industries to move their production to countries with more lenient environmental regulations. Even though there exists a vast strand of literature investigating this phenomena, their results are inconclusive.

This thesis empirically studies weather difference in environmental policy stringency has a positive effect on foreign direct investment flows between the European OECD and BRIICS countries over the time-period 2003 to 2012. Using a fixed effect model, FDI is determined by the commonly used knowledge capital specification introduced by Markusen and Maskus (2002) in addition to the main independent variable proxied by a new indicator for environmental policy stringency. The results of this study shows a significant but weak support for the pollution haven hypothesis when considering a time-lag of the EPS-variable by one year.

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1 Introduction

In order to address the issue of climate change many European countries have tightened their environmental regulations to improve their environmental performance. Stricter and stricter environmental regulations are likely to not only affect environmental outcomes but also economic performance. More stringent policies imply an extra burden for firms, shifting resources toward pollution abatement innovations and efficiency improvements making firm-level productivity growth slow down in the short run. The cost of complying with environmental regulations is often seen as damaging the firm's economic performance and global competitiveness. At the same time incentives for innovations and efficiency improvements, triggered by environmental regulations, may lead to a higher productivity as suggested by the so called Porter Hypothesis (Porter, 1991 and Porter & Van der Linde, 1995). The hypothesis that firms and industries move their production abroad to avoid the costs of complying with stringent domestic environmental regulations, turning these countries into pollution havens, is the so called pollution haven hypothesis. If pollution havens exist this would be reflected in changes in international trade patterns as well as foreign direct investments (FDI) flows between countries. In the context of FDI, the existence of pollution havens imply that firms would move their business or part of their production out of the country where the cost of complying with domestic environmental regulations is relatively lower.

This thesis will empirically investigate the validity of the Pollution haven hypothesis by looking at the impact of environmental policy stringency on FDI. More specifically, it will examine whether countries with relatively laxer environmental regulations have a competitive advantage in attracting FDI. The main hypothesis of this thesis is that outward FDI-flows will increase with the relative differences in stringency between countries. The research question will therefore be the following: Do relatively differences in environmental policy stringency levels between the European OECD and the BRIICS countries have a significant positive effect on FDI-flows? In contrast to earlier studies done on a global level this thesis will look at the effect on FDI-flows from the European OECD-countries into the BRIICS using a new proxy for environmental policy stringency developed by Botta and Kozluk (2014). This proxy is a new composite index which attempts to incorporate the multidimensionality of countries environmental policies to a comparable proxy across countries. Moreover, the EPS indicator has a broader cross-country and time coverage than other available direct policy measures (Botta & Kozluk, 2014). This study can therefore include more countries over a longer time period compared to earlier cross-country-studies. So far, only one other study investigating the pollution haven hypothesis has used this proxy for environmental policy stringency. However, this study by Kozluk and Timiliiotis (2016) looks at trade patterns instead of FDI-flows. This makes the EPS indicator the most important novelty of this thesis.

Investigating the relationship of environmental regulations and FDI between the European OECD-countries and the BRIICS specifically, has to my knowledge never been done before. FDI outflows have increased considerably over the past decades especially from the OECD countries. According to the OECD Co-operation report (2016), FDI-flows from OECD to non-

OECD countries have more than doubled during the period 2005 to 2014.[1] In addition, Hoffman et al. (2005) states that investments causing pollution havens are most likely to occur in low-income host countries such as the BRIICS because they generally have lower levels of policy stringency.

Further investigating the relationship between environmental policy stringency and industrial activity is important for several reasons. First, as stated above FDI-flows have increased dramatically over the past decades. If stricter environmental policies have a significant effect on FDI-flows this is of great importance for policymakers when designing environmental policy packages. Second, the existence of pollution havens may weaken the incentives for national policymakers to adopt more stringent environmental policies due to the potential loss of competitive advantage in the global market. This could eventually lead to a global decrease in environmental standards increasing overall pollution levels, counteracting the effects of environmental policies according to Copeland (2008). Third, many existing empirical studies have failed to account for issues such as multidimensionality and simultaneity making their results biased. To know the real effect more studies must be conducted that incorporates these econometric problems.

To explain the motivation behind FDI this thesis will use the so called knowledge capital (KC) model introduced by Markusen and Maskus (2002). The knowledge capital model is a well-known FDI model with solid theoretical foundations, which not only includes the standard gravity variables used in trade-theory such as economic size and distance but also includes regulatory quality, difference in skilled labour and whether there exists free trade agreements or custom unions between the country pairs.

The remainder of this thesis is structured as follows. Section 2 presents an overview of previous empirical studies on the pollution haven hypothesis. Section 3 describes the conceptual framework and the EPS-index. Section 4 describes common econometric issues and suggested solutions. Section 5 presents the data used in this thesis. In section 6 the empirical method is presented followed by the results and robustness checks in section 7. Finally, section 8 gives an analyses of the results and section 9 concludes.

[1] See the Appendix for a graphic overview of total FDI-flows in million US dollars from the European OECD to BRIICS countries between 2003 and 2011.

2 Literature review

Pollution havens and the linkage between FDI and environmental regulations have been widely studied around the world in many different contexts. However, so far, the empirical evidence of these studies has been mixed. This section of the thesis summarises the empirical evidence from earlier literature on the effect of environmental regulations on FDI and trade flows and presents possible explanations to the mixed outcomes in the literature.

Kellenberg (2009) tests the pollution haven hypothesis on trade flows using a new dataset on the stringency and enforcement of environmental policy in a cross-country context, accounting for the endogenous determination of income and strategic environment and trade policy. The empirical results show a robust positive confirmation of a pollution haven effect. Unlike many earlier studies, Kellenberg accounts for the endogeneity of environment and other trade policies. In contrast Kozluk and Timilotis (2016) find that environmental policies are not a major driver of international trade patterns. They study how exports are related to national environmental policies by using a gravity model of bilateral trade in manufacturing industries for selected OECD and BRIICS countries between 1990 and 2000. As a proxy for environmental policy stringency the use a composite index constructed by the OECD - the EPS index. To control for endogeneity they introduce lagged values of countries corruption, income, urbanization and education.

More relevant for this study is the literature that focuses on the motion of capital, also known as FDI. Wagner and Timmins (2009) test the pollution haven hypothesis using panel data on outward FDI-flows of various industries in the German manufacturing sector. When accounting for econometric issues such as FDI agglomeration and unobserved heterogeneity they find robust evidence of a pollution haven effect for the chemical industry. Kalamova and Johnstone (2011) empirically study FDI-flows from developed source countries to developing host countries and find statistically significant but weak support for the existence of pollution havens. Kukenova and Monteiro (2008) examine the effect of differences in environmental regulations on bilateral FDI-flows in a multi-country setting between 1981 and 2005. After accounting for endogeneity and spatial dependence they find a negative relationship between FDI and environmental stringency. Cai, X, Lu, Y et al. (2016) investigate whether environmental regulation affects inbound FDI by performing a quasi-natural experiment on industries in China. They find that tougher environmental regulations lead to less FDI and that foreign multinationals from countries with better environmental protections than China are insensitive to the tougher environmental regulation, while those from countries with worse environmental protections than China show strong negative responses.

The mixed outcomes in these studies can partly be explained by difficulties in finding a good proxy for environmental policy stringency across countries and time, and data and methodological problems related to unobserved heterogeneity and endogeneity (Brunel & Levinson, 2013). This conclusion is also supported by both Rezza (2015) and Jeppson et al. (2002) that conduct meta-analyses of earlier literature on the pollution haven hypothesis.

Because of these challenges, approaches to the pollution haven hypothesis differ significantly when it comes to proxies of environmental policy stringency. One of the most common proxies for environmental regulation in empirical research is PACE (pollution abatement control expenditures). A proxy such as PACE suffers from identification problems and the fact that it can be difficult for respondents of such surveys to accurately allocate expenditures to environmental objectives (Brunel and Levinson, 2013). Levinson and Taylor (2008) is one example in the literature that uses pollution abatement costs as a proxy for environmental policy stringency. They examine the effect of environmental regulations on trade flows between U.S., Canada and Mexico for 130 manufacturing industries between 1977 to 1986 using a multi sector partial equilibrium model. Their results show a positive significant relationship between industry pollution abatement cost and net imports into the US from both Mexico and Canada.

Composite indexes are another commonly used proxy. These indexes are meant to summarize multidimensional regulations into one comparable proxy to generally apply to entire economies in an attempt to solve the multidimensionality issues. They are however at the same time criticised of being arbitrary and their magnitudes can be difficult to interpret. Studies that have used this type of proxy among others are Kalamova and Johnstone (2011) who uses the WEF-index created by World Economic Forum, and Kozluk et al. (2016) who uses the new EPS-index constructed by Botta and Kozluk (2014). The WEF-index is widely used in the literature while the EPS index is a recently developed composite index. Other proxies frequently used in studies on the pollution haven hypothesis are measures based on pollution and energy use and direct assessments of the regulations themselves (Brunel and Levinson, 2013).

An important econometric issue often ignored in the literature of pollution havens is simultaneity bias. Simultaneity bias occurs when the dependent and independent variable in a regression simultaneously influences each other and causes biased estimates. Researchers deal with this problem mainly in two ways: natural experiments and instrumental variables. Today the most common approach is using instrumental variables because of the scarcity of natural experiments (Brunel & Levinson, 2013). Millmet and Roy (2015) divide the literature into those who use instruments based on lagged variables (Cole & Elliott, 2005; Jug & Mirza, 2005), those who include instruments based on geographic dispersion of industries (Taylor, 2008; List et al. 2003) and researchers who use location specific attributes that ranges from per capita income to infant mortality and corruption (Xing & Kolstad, 2002; Kellenberg, 2009). A third and more intuitive way to address this issue is to include lagged independent variables. Kozluk and Timiliotis (2016) use this approach when controlling for both timing of the effect of environmental regulations and endogeneity problems such as simultaneity. Given this background I will now turn to the conceptual framework of this thesis.

3 Conceptual framework

3.1 Environmental regulations and competitiveness

This section attempts to give a conceptual understanding of the relationship between environmental policy stringency and competitiveness. It discusses the theory behind the pollution haven hypothesis and its opposite the Porter hypothesis and explains the KC model and the theory behind FDI.

The main goal of environmental polices is to improve environmental outcomes driven by mitigating the possible negative impacts of climate change. However, the traditional neo-classical view is that productivity is disadvantaged because environmental regulations such as technological standards, environmental taxes or tradable emissions force firms to reallocate labour and capital towards research and innovation to meet new demands (Ambec et al., 2013). Except from direct costs caused by reallocation, firms might also experience indirect costs through increases in input prices in the industries affected by regulations (Barbara and McConnell, 1990).

On the other hand, Porter (1991) suggests that "the right kind" of environmental policies triggers innovation making production processes and products more efficient and in that way improve firm's business performance. Firms and industries face market imperfections, such as asymmetric information, organizational sluggishness or control problems (Ambec et al., 2013). Stringent and well-designed environmental regulations will according to Porter push firms to overcome some of these market failures and to pursue otherwise neglected investment opportunities. The key mechanism is that regulations promote innovation intended to lowering the cost of compliance. This will in turn increase resource efficiency and product value, offset compliance costs and improve firm's productivity. In this perspective environmental regulations are seen as a "win-win" strategy leading to better environmental quality and higher firm productivity (Porter, 1991 and Porter& Van der Linde, 1995).

This thesis focuses on the opposite effect of the porter hypothesis which has given rise to the pollution haven hypothesis that stricter environmental regulations affect firm and industry competiveness negatively in line with traditional neo-classical view described earlier. If ambitious environmental policies will negatively affect firm's competiveness this will be shown in lower exports and a gradual movement of production abroad where there are laxer environmental regulations. Nevertheless, researchers have not yet come to a conclusion about the existence of pollution havens. According to Söderholm (2012), to know the real effect of strict environmental regulations on competitiveness it is important to understand how different environmental regulations affect different firms and industries and in what way they are able to pass on the cost of complying to the consumers. Söderholm also concludes that most negative effects of environmental regulations on industrial competitiveness arise in the short or medium-term before the firm has had time to adapt to the new technology acquired. It is therefore important that environmental policies give clear incentives and time to adapt to environmental standards.

3.2 The knowledge-capital model

The FDI model used in this study is the knowledge-capital (KC) model presented by Markusen & Maskus (2002). This model is based on the standard gravity model often used in trade theory and combines both vertical and horizontal motives for direct investments, allowing firms the options of building multiple plants in many different locations (horizontal firms) or geographically separating headquarters from a single plant (vertical firms). Further the model assumes that: 1) it is possible to geographically separate services referred to as knowledge based and knowledge generating activities such as R&D from production and supply these services to production facilities at a low cost. 2) These knowledge-based services are skilled-labor- intensive relative to production. 3) Type of services defined in the first assumption have joint input characteristic in that they can be used simultaneously by multiple production facilities (Markusen, 2002). Together the two first assumptions allow for vertical MNE(multinational enterprise) activities, implying that R&D is located where skilled labor is available at low cost but production location will be close to cheap unskilled labor. Production is also performed where firms can exploit economies of scale in production plants. The third assumption allows for scale economies at firm level and gives incentive for horizontal multinational activity.

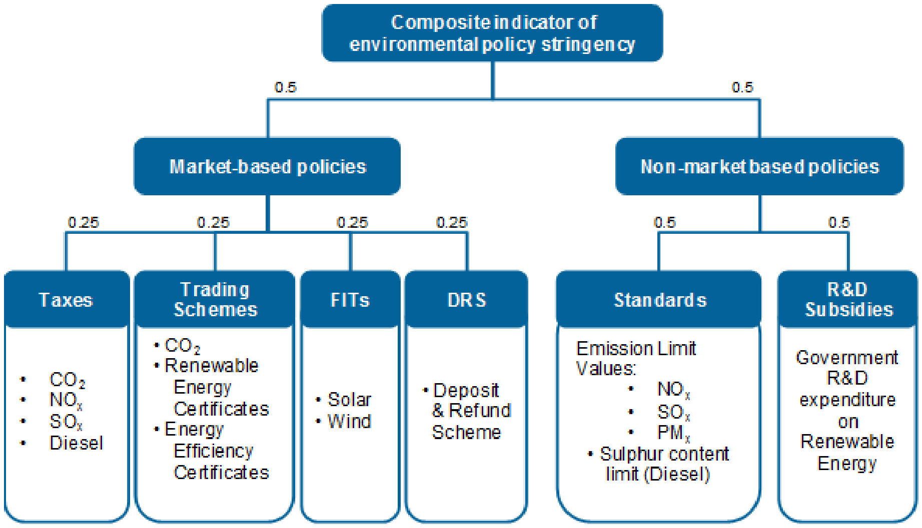
The empirical model of the KC-framework tries to explain the motivations behind FDI decisions and the choice of investments type by including different measures of economic conditions such as difference in size between the source and host country and regulatory quality in the host country. Earlier studies have found weak or mixed evidence on the validity of the KC model. The results are mostly coming from the weak support for the vertical part of the model (they find weak support that FDI may take place in order to benefit from factor endowment differences across countries.) However, Braconier et al. (2005) investigates the source of heterogeneity of the evidence and finds strong support for the KC model. They conclude that the model seems to fit the data on FDI well. Their results provide a strong support for the KC model as characterizing the overall pattern of world FDI activity.

3.3 The EPS index

As mentioned before there is a vast number of different proxies for environmental regulations used in earlier empirical research. The analysis in this study is based on a new composite index of environmental policy stringency (EPS) developed by the OECD (Botta and Kozluk, 2014). The EPS index covers 28 OECD and 6 BRIICS countries for the period 1990-2012 and is a new internationally comparable proxy for environmental regulations. The main advantage of this new indicator is that it is based on actual policies, meaning that it tries to capture the the multidimensionality of environmental policies and making it more comparable between countries. Stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behavior. The indicator ranges from 0 to 6 with higher numbers associated with more stringent environmental policies.

The EPS index covers 14 different environmental policy instruments mainly focused on the environmental policy areas, air and climate. This means it overlooks other important areas such as water, biodiversity, natural resources or waste. Also soft policies such as tax incentives for environmental friendly investment, land use regulation, labelling obligations and voluntary approaches has been ignored because of the difficulty in assessing and comparing stringency with these types of instruments. However, testing the EPS index Botta and Kozluk (2014) conclude that while the EPS indicator is not perfect it can provide a basis for cross-country analysis. The overall structure of the EPS index is presented in Figure 1.

Figure 1.Overall structure of the EPS-index. Source: Botta & Kozluk (2014)



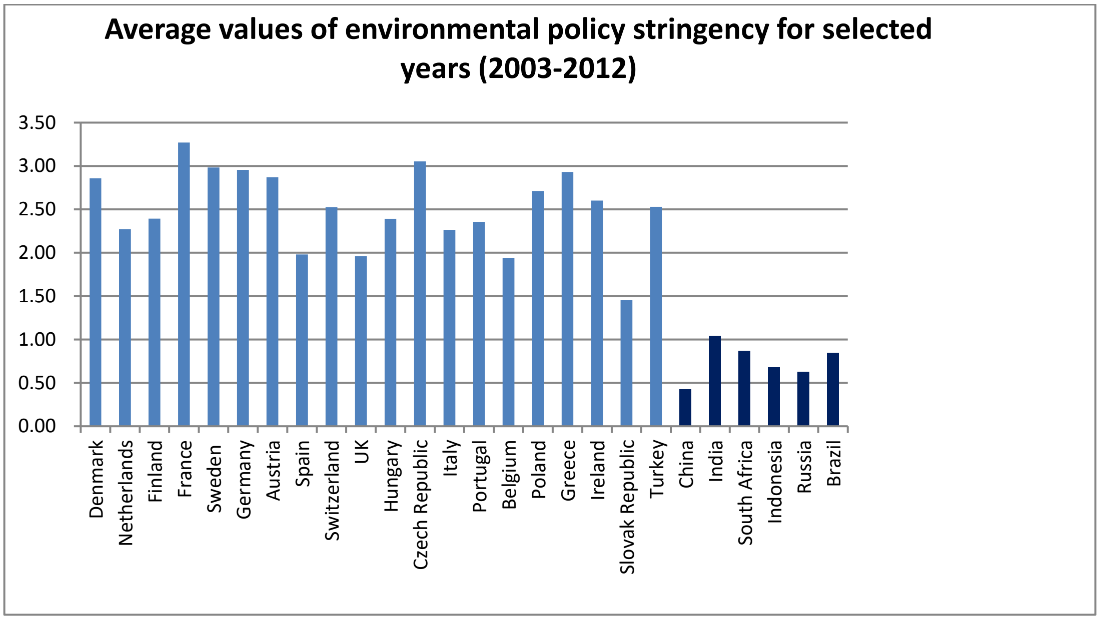
Among other robustness tests, Botta and Kozluk (2014) looks at the correlation between the EPS-indicator and other common proxies used. Their results show highly significant correlations with many other measures of stringency supporting the confidence in the EPS-indicator. Part of their results is presented in table 1. Figure 2 shows the average values of the environmental policy stringency in selected countries used in this thesis. As predicted stringency is higher in the European OECD countries compared to the BRIICS.

Table 1. Correlation between the EPS-indicator and common used measures of environmental policy stringency. Spearman rank over maximum available sample. Source: Brochure from OECD.org; How stringent are environmental policies?.

EPS measure	Correlation with EPS	Sample characteristics
Original EPS	0.92***	OECD-countries only, 1990-2012
World economic forum's executive opinion survey	0.50***	OECD countries and BRICCS, 1990-2012
Energy price(Sato et al.2015)	0.50***	OECD countries and BRIICS, 1990-2012

*Note: ***, **, * denote significance at 99%, 95% and 90% respectively*

Figure 2. Environmental policy stringency in OECD and BRIICS countries. Source: OECD database



4 Econometric issues

The existing literature has been unable to convincingly prove the empirical validity of the pollution haven hypothesis mainly because of the challenges of finding a good proxy for environmental policy and dealing with important econometric issues such as unobserved heterogeneity and the fact that environmental regulations and FDI may be endogenous to each other (Brunel & Levinson, 2013). This section presents the most important econometric problems faced by researchers when empirically testing the pollution haven hypothesis.

4.1 Simultaneity

The possibility that FDI can have environmental consequences and environmental policy can have consequences for FDI is known as simultaneity bias and is not an easy violation to deal with. This means that environmental regulations can affect FDI due to for example increasing abatement costs. At the same time, as direct investments of polluting industries increase in a country, overall pollution levels will also increase which can affect the level of stringency of the countries environmental regulations. A possible solution is to use an Instrumental Variable (IV)approach. However, for the IV approach to work we need to find a genuinely exogenous instrument that strongly correlates with the potentially endogenous regressor and only influences the dependent variable through the independent variable which is very difficult. An instrumental variable approach is only good if there exists a credible instrument and is therefore a very challenging method to use.

Another way to approach this problem is to include lagged values of the suspect endogenous variable. The intuition behind lagged variables is that although current values of EPS might be endogenous to FDI, past values of EPS might not be subject to the same problem. Even though this is a commonly used method, including lagged independent variables might still cause inconsistent estimates due to serial correlation (Millimet & Roy, 2015).

4.2 Unobserved heterogeneity

Unobserved heterogeneity refers to unobserved industry or country characteristics, which are likely to be correlated with strict regulations and FDI. If these unobserved variables are omitted in a simple cross-sectional model, this will produce inconsistent and biased results, which cannot be meaningfully interpreted. One solution to this problem would be to use panel data, with time variation, and incorporate country or industry-specific fixed effects (Brunnermeier & Levinson, 2004).

4.3 Multidimensionality

Finding a proxy that can represent environmental policy stringency is difficult (Levinson & Taylor, 2008). Environmental regulations are complex and multidimensional due to the fact that countries have different policy portfolios which need to be incorporated in the indicator to avoid biased estimates. In addition to multidimensionality, sampling and identification problems may arise. When policies themselves may be driven by the sample of industries that are subjected to policies, this is called sampling. Identification is the difficulty in properly measuring to which extent the expected consequences of stricter regulations can be truly attributed to environmental policy stringency (Botta and Kozluk, 2014).

5 Data

This study analyzes outward FDI-flows from the European OECD countries (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Slovak republic, Spain, Sweden, Switzerland, Turkey and the UK) into the BRIICS (Brazil, Russian Federation, India, Indonesia, China and South Africa) countries. The FDI dataset is an unbalanced panel of yearly data obtained from the OECD-database is in millions of US dollars and ranges from 2003-2012. FDI-flows are widely used as a proxy for multinational enterprise (MNE) activity. A recent study by Wacker (2016), investigating measures of MNE activity concludes that FDI is a good proxy for measuring most real economic activities of multinational firms. There are some FDI observations missing in the dataset. Because these observations are such a small fraction (only about 5%) of the total observations in the dataset, these missing values will be dropped from the sample using pair-wise deletion with motivation that the sample size still have enough statistical power.

The data for environmental policy stringency used for the analyses is secondary data provided by the OECD- database. The EPS index developed by Botta and Kozluk (2014) ranges from 0 to 6 with higher numbers associated with more stringent environmental policies. Data for GDP and GDP per capita was taken from the world development indicators database. Total GDP and GDP per capita is measured in real international dollars with base year 2003. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. Data for distance between capitals, common language and common border are taken from the CEPII database. Distance is measured in km between capitals of the source and host country. Rating of regulatory quality in host country comes from Kaufmann et al. (2008) and ranges from -2,5 to 2,5. Higher values correspond to better governance. Information about data for free trade agreements and custom unions is own gathering through the WTOs homepage. CO_2 emissions per capita used as an alternative proxy for environmental policy stringency is measured in metrics tons per capita and taken from the world development indicator database.

The following European OECD countries are not included in this study due to missing EPS values: Iceland, Estonia, Israel, Slovenia, Luxemburg. In addition Norway was excluded from the sample due to missing FDI-observations. The period 2003-2012 is decided on the basis of FDI-data availability. *Table 2* below summarizes the data used in this thesis.

Table 2. Summary statistics.

VARIABLES	*(1) nr of observations*	*(2) mean*	*(3) standard deviation*	*(4) min*	*(5) max*
GDP squared difference	*1,108*	*8.692e+12*	*1.787e+13*	*177.0*	*9.177e+13*
Sum of GDP	*1,108*	*3.056e+06*	*2.452e+06*	*324,230*	*1.213e+07*
EPS difference	*1,108*	*1.755*	*0.671*	*-0.208*	*3.717*
Distance	*1,108*	*7,414*	*3,003*	*892.7*	*12,679*
Regulatory quality	*1,108*	*-0.103*	*0.350*	*-0.780*	*0.780*
Common language	*1,108*	*0.0379*	*0.191*	*0*	*1*
Common border	*1,108*	*0.0181*	*0.133*	*0*	*1*
Customs union	*1,108*	*0*	*0*	*0*	*0*
Free-trade agreement	*1,108*	*0.143*	*0.350*	*0*	*1*
CO2 difference	*1,108*	*2.849*	*4.794*	*-9.510*	*12.27*
Interaction term I	*1,108*	*-3.340e+10*	*5.240e+10*	*-2.857e+11*	*4.870e+10*
Interaction term II	*1,108*	*6.149e+10*	*5.899e+10*	*0*	*3.026e+11*
Interaction term III	*1,108*	*-1.445e+06*	*2.837e+07*	*-7.018e+08*	*0*
Log of FDI	*1,108*	*8.061*	*0.366*	*0*	*10.10*

6 Empirical method

In this section the empirical model and a detailed description of the variables included are presented. The empirical analysis of FDI-flows between 20 sources countries and 6 host countries will be based on the knowledge capital specification explained earlier. The main estimated model is:

$$lnFDI_{ijt} = \beta_1 \sum GDP_{(ij)t} + \beta_2 (\Delta GDP_{(ij)t})^2 + \beta_3 INT1_t + \beta_4 INT2_t + \beta_5 INT3_t + \beta_6 Dist_{ij} + \beta_7 TradeCosts_{ijt} + \beta_8 INVC_{jt} + \beta_9 \Delta Stringency_{(ij)t} + \alpha_t + \gamma_{ij} + c + \varepsilon_{ijt}$$

Where, *i* and *j* indicates the source and host country respectively and *t* stands for years. According to Blongien (2003) most FDI-data are highly skewed and a simple way to statistically control for this is to log the data. Therefor the dependent variable *lnFDI* is the logarithmic outward FDI-flow from source to host country over time. Because there exist some negative values of FDI due to disinvestments made by the source country we first add a constant to the data variables before the natural log transformation (the natural logarithm of zero and negative numbers is undefined). The constant added is equal to the lowest FDI-value + 1 (Mehmetoglu & Jacobsen, 2016).

$\Delta Stringency_{(ij)t}$ is the main explanatory variable and represent the differences in environmental policy stringency between the source and host country. As environmental policy stringency in the source country increases relative to the host country, FDI-flows from the source country are expected to increase as a host country with relatively low environmental policy stringency is expected to attract flows of FDI. In addition, the variables from the KC-model describing FDI will serve as controls.

The two independent variables $\sum GDP_{(ij)t}$ and $(\Delta GDP_{(ij)t})^2$ is representing economic size and size differences. The sum of GDP represents aggregated economic size of the source and host country and the squared difference is reflecting the absolute differences in size between source and host countries. The GDP-measures are included because investments are expected to increase with size of both source and host country and decrease with an increase in squared size differences.

The variable $\Delta Skill$ is included to capture differences in relative factor endowments between source and host country. The theory behind is that when the source country becomes more skilled compared to the host country, FDI will increase. The three interaction terms INT1, INT2 and INT3 relates to the different types of production fragmentation. INT1 which is expected to be negative, captures vertical productions fragmentation and is equal to $\Delta Skill * \Delta GDP$ if $\Delta Skill > 0$, and 0 otherwise. INT2 captures firm motives for horizontal fragmentation and is equal to $\Delta Skill * \sum GDP$ if $\Delta Skill > 0$, 0 otherwise. This term is predicted to have a negative sign. The interaction term INT3 also captures horizontal motives and is equal to $-\Delta Skill * \sum GDP$ if $\Delta Skill < 0$, 0 otherwise. The third interaction term should have a negative sign because outward investment activity falls as the source country becomes more unskilled-labor abundant.

$INVC_{jt}$ is representing investment conditions in the host country measured by regulatory quality. Good regulatory quality in the host country is expected to increase investments and have positive effect. $TradeCosts_{ijt}$ is the costs of trading between source and host countries and measured by international barriers resulting from sharing or not sharing the same language, border, belonging to the same customs union or free trade agreement. An increase in investment costs are expected to decrease the amount of FDI into the host country. To capture the closeness to customers the variable distance is included. As distance increase, FDI is expected to decrease. A variable description with data source and predicted signs is found in table 11.1 in the Appendix. The description of variables is taken directly from Markusen and Maskus (2002) and Carr et al. (2001).

In the first step a simple pooled OLS-regression is performed that regresses the logarithmic FDI on the differences in environmental stringency and the rest of the independent variables from the KC model described above. To account for the possibility that environmental regulations will affect FDI with a delay, lagged variables of environmental policy stringency are included in the next step. The exact timing of the effect of environmental policy is difficult to determine and therefor three different lag-structures are tested. The timing can for example depend on the choice and design of policy instrument, how they are implemented and differences in industry characteristics such as degree of competition and state of technology. The lagged variables of environmental policy stringency also help to deal with the simultaneity problem that increasing polluting industries in the host country might increase pollution levels and thereby urge policy makers to tighten their level of environmental policies. By using time lags of the main independent variable it is less likely that the effect of simultaneity in our estimation will be an issue (Kozluk & Timiliotis, 2016).

A problem with the OLS-model is that it does not take into account that countries are heterogeneous. Therefor a fixed effects model is used as the main estimated model. Time fixed effects α_t are included to control for omitted variables that differs across time but are constant across entities. Further country-pair fixed effects γ_{ij} are included to capture unobserved characteristics related to each country-pair that differ across country-pair but are constant over time (Stock & Watson, 2011). All variables in the the KC-model that does not vary across time will therefor automatically be dropped when regressing the fixed effects model. In all estimations clustered standard errors, robust to heteroscedasticity and serial correlation are used to control for these potential issues. Finally, ε_{ijt} is the error term and c the intercept.

7 Empirical results

7.1 OLS estimations

This chapter presents the results of the OLS and the fixed effects estimates of the empirical model. In the first step an OLS-model was estimated where the natural logarithm of FDI was regressed on the environmental policy stringency gap between source and host country controlling for all KC variables. The results are presented in table 3. The first column presents the results without the lagged values of the main independent variable. In the three remaining columns the same OLS regression was performed with lagged values of environmental policy stringency in an attempt to control for timing and endogeneity issue presented earlier. In all estimations heteroscedastic robust standard errors were reported to account for potential independencies between the FDI-flows into a host country from a certain source country. The results suggest that differences in environmental policy stringency have a highly significant and positive impact on FDI-outflows from the OECD to the BRIICS countries. The magnitude of the coefficient of the main independent variable varies from 0, 0509 to 0, 0752 depending on time-lag and they are all significant at a 1% level. In addition, size of host and source countries, distance, regulatory quality in the host country and sharing the same language seems to be important determinants of FDI. The results for these variables are all significant at a 1% level and consistent over all four estimations with a slightly difference in magnitudes. The R^2 ranges from 0,112 -0,122 which indicates that the model used is note explaining more than about 12% of FDI decisions.

Table 3.OLS estimates

	(1)	*(2)*	*(3)*	*(4)*
VARIABLES	*OLS*	*OLS lag1*	*OLS lag2*	*OLS lag3*
EPS difference	0.0509***			
	(0.0166)			
Sum of GDP	7.15e-08***	8.13e-08***	8.33e-08***	8.55e-08***
	(1.79e-08)	(1.32e-08)	(1.36e-08)	(1.43e-08)
GDP difference squared	-7.99e-15***	-9.05e-15***	-9.38e-15***	-9.64e-15***
	(1.91e-15)	(1.50e-15)	(1.53e-15)	(1.58e-15)
Distance	-1.53e-05***	-1.62e-05***	-1.67e-05***	-1.72e-05***
	(4.44e-06)	(5.26e-06)	(5.30e-06)	(5.13e-06)
Regulatory quality	0.169***	0.174***	0.182***	0.185***
	(0.0451)	(0.0300)	(0.0302)	(0.0306)
Common language	0.191***	0.200***	0.207***	0.211***
	(0.0560)	(0.0605)	(0.0611)	(0.0621)
Common border	-0.00359	-0.0112	-0.00679	-0.00473
	(0.0822)	(0.0455)	(0.0444)	(0.0440)
Customs union = o,	-	-	-	-
Free trade agreement	-0.0167	-0.00973	-0.0180	-0.0242
	(0.0442)	(0.0270)	(0.0274)	(0.0281)
Interaction term I	1.45e-13	-9.25e-14	-1.32e-13	-1.84e-13
	(5.55e-13)	(6.15e-13)	(6.20e-13)	(6.57e-13)
Interaction term II	9.40e-13	6.07e-13	5.77e-13	5.19e-13
	(6.08e-13)	(5.53e-13)	(5.66e-13)	(6.30e-13)
Interaction term III	-4.05e-11	-9.10e-11	-8.21e-11	-5.89e-11
	(3.70e-10)	(5.60e-11)	(6.03e-11)	(5.28e-11)
EPSlag1		0.0752***		
		(0.0117)		
EPSlag2			0.0731***	
			(0.0128)	
EPSlag3				0.0749***
				(0.0123)
Constant	7.893***	7.854***	7.867***	7.873***
	(0.0485)	(0.0402)	(0.0410)	(0.0514)
Observations	1,138	1,138	1,138	1,138
R-squared	0.112	0.121	0.121	0.122

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Summarizing the OLS-estimations provides significant results for the main hypothesis that increasing environmental policy stringency gap increases FDI-flows from the source to the host country. An increase in the environmental policy stringency gap by one unit increases the FDI-flows from source to host countries with a magnitude of 0,052-0,0752 million US dollars. The results are robust to different time-lags of environmental policy stringency.

7.2 Fixed effects estimations

Because a simple pooled OLS-model does not account for unobserved heterogeneity, a fixed effects model is performed in the next step which is the main empirical specification in this thesis. Both time and country-pair-fixed effects are included. The regression is performed on the same dataset with the difference that the binary variables for trade costs has been taken out of the equation and are instead contributing to the intercept c. As before clustered standard errors and lags of environmental policy stringency are included to test the robustness of the results.

The results from the fixed effects estimations differ considerably from the OLS. Environmental policy stringency is now negative and insignificant in the main estimation which implies that differences between environmental regulations would decrease outward FDI-flows from the source country. The magnitude of the EPS difference coefficient is -0, 0140 suggesting that an increase in environmental stringency of the source country by one unit, increasing the stringency gap by the same amount, would cause a decrease in FDI-flows by 0, 0140 million US dollars. In the second estimation, with a one-year time-lag on the EPS variable, the stringency gap has positive and weak significant effect on outward FDI-flows. The results suggest that an increase in EPS-gap would increase the FDI-flows by 0, 0439 million US dollars. The result is significant at the 10% level. For the remaining to estimations including the two and three-year lag effect on the EPS-indicator, the results show positive but insignificant effect on FDI.

Overall very few determinants expected to have an impact on FDI show significant results in the fixed effects model. Only two variables, Interaction term I and Interaction term II, in the KC-model showed a significant result at the 5% level which was consistent over all four estimations. The signs of these variables were both negative which also match the prediction. This implies that difference in skilled labor in addition to difference in size is an important determinant when deciding to invest abroad. The magnitudes of the results are however very small and imply that even though they are significant, the impact on FDI will be trivial. Looking at the year effects, especially two years, 2008 and 2011, seems to be important, consistently over all estimations. Adjusted R^2 is approximately 0,220 for all estimations indicating a better degree of explanation than the OLS. Concluding, the results for the fixed effect model are mixed and shows only a weak support for a pollution haven effect.

Table 4. Fixed effect estimations.

VARIABLES	*(1)* *FE*	*(2)* *FE lag1*	*(3)* *FE lag2*	*(4)* *FE lag3*
EPS difference	-0.0140			
	(0.0569)			
Sum of GDP	2.21e-08	4.49e-08	3.24e-08	3.64e-08
	(6.33e-08)	(6.43e-08)	(6.18e-08)	(6.25e-08)
GDP difference squared	-5.46e-15	-6.73e-15	-5.95e-15	-6.16e-15
	(4.25e-15)	(4.32e-15)	(4.15e-15)	(4.20e-15)
Regulatory quality	0.0394	0.0168	0.0300	0.0239
	(0.0759)	(0.0618)	(0.0619)	(0.0615)
Interaction term I	-2.92e-11**	-2.80e-11**	-2.87e-11**	-2.84e-11**
	(1.19e-11)	(1.20e-11)	(1.20e-11)	(1.18e-11)
Interaction term II	-2.62e-11**	-2.52e-11**	-2.58e-11**	-2.54e-11**
	(1.19e-11)	(1.21e-11)	(1.21e-11)	(1.19e-11)
Interaction term III	-7.01e-11	-1.02e-10*	-8.25e-11	-6.59e-11
	(7.21e-11)	(5.57e-11)	(5.10e-11)	(0)
year = 2004	0.0357	0.0281	0.0312	0.0291
	(0.0314)	(0.0285)	(0.0290)	(0.0292)
year = 2005	0.0597	0.0395	0.0479*	0.0436
	(0.0427)	(0.0268)	(0.0263)	(0.0270)
year = 2006	0.0692	0.0257	0.0516*	0.0458
	(0.0532)	(0.0309)	(0.0294)	(0.0283)
year = 2007	0.0685	0.0196	0.0472	0.0414
	(0.0543)	(0.0493)	(0.0444)	(0.0449)
year = 2008	0.113*	0.0727*	0.0863**	0.0672*
	(0.0584)	(0.0395)	(0.0422)	(0.0387)
year = 2009	0.0742	0.0227	0.0499	0.0200
	(0.0604)	(0.0324)	(0.0311)	(0.0351)
year = 2010	0.0952**	0.0398	0.0684	0.0511
	(0.0399)	(0.0739)	(0.0693)	(0.0770)
year = 2011	0.173***	0.123***	0.146***	0.122***
	(0.0590)	(0.0347)	(0.0392)	(0.0375)
year = 2012	0.109*	0.0613*	0.0838**	0.0554
	(0.0564)	(0.0328)	(0.0340)	(0.0372)
EPSlag1		0.0439*		
		(0.0250)		
EPSlag2			0.0153	
			(0.0244)	
EPSlag3				0.0370
				(0.0254)
Constant	8.606***	8.459***	8.540***	8.499***
	(0.460)	(0.430)	(0.425)	(0.407)
Observations	1,138	1,138	1,138	1,138
Adjusted R-squared	0.220	0.221	0.220	0.220

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

7.3 Robustness of results

7.3.1 Alternative proxy

Even though the EPS-index is highly significantly correlated with other possible proxies for environmental policy stringency it is still relevant to test to what extent the results are sensitive to the use of a different proxy. The EPS-index has a wider range of countries and years than many earlier used proxies which makes it hard to find a credible alternative. Ideally it would have been interesting to use another type of composite index such as the WEF-index but due to data unavailability CO_2 per capita emissions will be used instead. Because environmental regulations are designed to reduce emissions such as CO_2 it might seem backwards to us it as proxy. However, depending on the situation, changes in emissions can be seen in different ways. One approach used by Constantini and Crespi (2008) is to look at high levels of emission as a measure of stringency because high levels of stringency will force governments to introduce stricter environmental policies. The opposite approach is to look at higher pollution levels as a measure of relatively lax environmental regulations. The emission levels should be lower in a country that is applying stringent and efficient environmental regulations. This thesis will follow the approach of Constantini and Crespi (2008), implying that higher CO_2 emission per capita levels indicates a higher level of environmental policy stringency.

Intuitively we can see how CO_2 emissions can be used as a proxy, however the correlation between the EPS-index and CO_2 emission per capita is very low, indicating that they seem to measure different things. Also, CO_2 emission per capita is a proxy based on environmental outcomes and is very different to the policy based EPS- index. A performance based proxy often suffers from identifications issues because these kinds of measures does not only reflect environmental policy stringency but also other policies, costs of factor production and other factors such as technological advancement, market structure etc. The output from the estimation should therefore be looked at carefully.[2]

The result from the fixed effect estimation with an alternative proxy of environmental policy stringency does not change considerably from the fixed effect estimates with the EPS-index. The results only differ when it comes to the timing-effect of environmental regulations. In difference to the main estimation these results imply that the pollution haven effect is most significant when lagging the EPS-variable two years. There is also a small difference in magnitudes. The remainder of control variables from the KC-framework does not change considerably. Table 5 shows the fixed effects estimations when using CO_2 emissions per capita as a proxy for environmental policy stringency.

[2] See Appendix for detailed results from the fixed effect estimation with CO_2 as main independent variable.

Table 5. Fixed effect estimation with an alternative proxy: CO_2 emissions per capita.

VARIABLES	(1) FE	(2) FE lag1	(3) FE lag2	(4) FE lag3
CO_2 difference	-0.0122			
	(0.00913)			
Sum of GDP	1.82e-08	1.93e-08	2.03e-09	5.68e-09
	(6.08e-08)	(6.38e-08)	(6.20e-08)	(6.19e-08)
GDP difference squared	-5.15e-15	-5.65e-15	-2.94e-15	-2.91e-15
	(3.98-e-15)	(4.83e-15)	(4.09e-15)	(4.09e-15)
Regulatory quality	0.0321	0.0441	0.00115	0.00423
	(0.0612)	(0.0721)	(0.0598)	(0.0584)
Interaction term I	-2.75e-11**	-2.73e-11**	-2.94e-11**	-2.88e-11**
	(1.21e-11)	(1.15e-11)	(1.24e-11)	(1.24e-11)
Interaction term II	-2.43e-11*	-2.41e-11**	-2.61e-11**	-2.56e-11**
	(1.24e-11)	(1.17e-11)	(1.26e-11)	(1.26e-11)
Interactionterm III	-6.95e-11	-5.47e-11	-1.31e-10**	-1.04e-10**
	(5.19e-11)	(7.77e-11)	(5.34e-11)	(0)
year = 2004	0.0290	0.0306	0.0308	0.0270
	(0.0302)	(0.0296)	(0.0295)	(0.0294)
year = 2005	0.0467	0.0422	0.0562**	0.0465*
	(0.0284)	(0.0315)	(0.0276)	(0.0274)
year = 2006	0.0531*	0.0484	0.0722**	0.0558*
	(0.0296)	(0.0342)	(0.0303)	(0.0290)
year = 2007	0.0499	0.0464	0.0729*	0.0617
	(0.0422)	(0.0438)	(0.0428)	(0.0419)
year = 2008	0.0927**	0.0891**	0.122***	0.110***
	(0.0385)	(0.0430)	(0.0377)	(0.0372)
year = 2009	0.0452	0.0351	0.0789**	0.0626**
	(0.0313)	(0.0398)	(0.0320)	(0.0297)
year = 2010	0.0633	0.0543	0.106*	0.0842
	(0.0713)	(0.0971)	(0.0634)	(0.0673)
year = 2011	0.155***	0.151***	0.203***	0.189***
	(0.0383)	(0.0411)	(0.0437)	(0.0406)
year = 2012	0.0753**	0.0666	0.122***	0.110***
	(0.0348)	(0.0430)	(0.0363)	(0.0358)
CO2lag1		-0.0210		
		(0.0314)		
CO2lag2			0.0353**	
			(0.0156)	
CO2lag3				0.0253*
				(0.0142)
Constant	8.603***	8.634***	8.497***	8.520***
	(0.434)	(0.461)	(0.426)	(0.418)
Observations	1,108	1,108	1,108	1,108
Adjusted R-squared	0.220	0.220	0.221	0.220

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

7.3.2 Lagged values

The choice of policy instrument and design can affect the timing of which environmental policy has an effect on FDI. To account for potential lagged effects and the fact that FDI and environmental policy stringency might be endogenous to each other, time-lags for one, two and three years were tested in both the OLS and fixed effects model. In the OLS regression the results were robust and consistent over all time-lags. In the fixed effects model however the effect of the EPS-variables changed from having an insignificant and negative effect to a significant and positive effect in the one-year lag regression in line with the theory. The change in signs of the main independent variable indicates that the results might still be suffering from endogeneity issues. The outcome of the regression using a time-lag of one year is in line with the fact that firms are likely to take time to adjust to the changing relative costs induced by environmental policies and that investment between countries is not instantaneous.

7.3.3 Non-linear relationship

Even though this thesis assumes a strict linear relationship between foreign direct investments and environmental policy stringency, the possibility of a non-linear relationship is also tested by introducing a squared term of environmental policy stringency. The theory behind is that if the stringency of the host country becomes too lax, there is a possibility that the attractiveness of investing in that country will decrease. Too lax environmental regulations might work as signal to investors that the government is unstable. Once the investment is done in the host country, the government can choose how much to demand from the investment returns. Incentives for such governmental behavior might be either political or financial and would scare potential investors away. If this theory is accurate, outward FDI-flows will increase with the relative difference in stringency up until a certain point, after which it starts to decrease, suggesting an inverse U-shaped relationship. The expected sign for the squared term of environmental policy stringency should therefore be negative.

The environmental policy stringency gap could also be increasing because of an increase in stringency levels in the source country. As the stringency levels gets higher and higher it is intuitive to think that FDI-flows would increase at a faster rate after a while, causing an exponential relationship. If this is true, the expected sign of the squared term should be positive.

Even in this case the results changes from the ones in the main specification. The estimations now show highly significant results for the three year lagged variable of environmental policy stringency and its squared term. However, the outcome is not in line with the theories described abow since the squared term enters with different signs, both positive and negative over the different estimations. Also for the ordinary stringency variable the results are mixed and inconclusive. From these results there is no evidence of a nonlinear relationship. Detailed results are reported in the Appendix.

In addition to the robustness checks abow, tests to control for heteroscedasticity and multicollinearity are performed. Multicollinearity is a common problem in panel-regression and refers to when two or more regressors are highly correlated to each other which can cause biased estimates. Heteroscedasticity on the other hand refers non-constant residuals with an increasing variance of the residuals over time (Stock and Watson, 2011). The multicollinearity test shows that we should not be worried about multicollinearity in our panel affecting our estimates. However, the scatterplot over residuals for the variables indicates that heteroscedasticity might be present. Clustered standard errors robust to heteroskedasticity are therefore used in all regressions.[3]

In the next part an analysis of the results and robustness test will be done discussing the potential flaws and drawbacks in addition to comparing the results with earlier literature.

8 Analysis/discussion

The main focus in this study has been to investigate if there exists a pollution haven effect between the European OECD and BRIICS countries. The results from the OLS estimation supports the pollution haven hypotheses. It suggests that difference in environmental policy stringency has a positive effect on foreign direct investment flows from the European OECD to the BRIICS countries. However, the OLS-model is vulnerable to omitted variable bias since environmental policy stringency is likely to be correlated with many other factors affecting FDI-flows. For example, stringency levels might be correlated with unobserved country pair specific differences or factors that differ between time periods such as a financial crisis.

The big difference between the results of the fixed effects estimations which is the main specification and the OLS suggests that the OLS estimates indeed are biased. In contrast to the OLS estimations the results from the fixed effect model indicates a weak support for the pollution haven hypothesis. The second column regressing environmental stringency with a one-year lag shows a significant support for the main hypothesis but only at a 10% level. This suggests that increasing differences in tightness of environmental regulations has a lagged effect on FDI-flows with one year. Assuming that the results of this study are correct, the weak support for the pollution haven hypothesis might be due to the fact that firms are able to successfully pass on their costs to customers and is not significantly affected by the tightening of regulations. It might also be an indication that firms actually benefit from stricter environmental regulations causing an increase in innovation as suggested by the Porter hypothesis. The results also suggest that there are more important factors that affect firm decisions to invest abroad. According to the evidence from the fixed effects model both vertical and horizontal motives is highly significant (even though very small). This means that difference in skilled and unskilled labour together with size differences seems to be more important determinants of investments flows from the European OECD countries to the BRIICS. However, even though a fixed effects model takes care of time and country-pair heterogeneity it is not able to control for omitted variables that vary both over time and across countries. For this control variables from the KC-model are used. Because the explanatory power of the control variables using this data is relatively low (about 22% of total FDI-flows) there is a good chance that the fixed effect model still suffers from omitted variable bias which can affect the estimates.

Another explanation for the lack of significant results in the main fixed effects model might be due to endogeneity problems explained earlier. Even though using lagged independent

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[3] The results of the multicollinearity test and scatterplot are presented in the Appendix.

variables in an attempt to control for simultaneity, it is not an optimal approach and the results might still be affected by endogeneity issues. The changes in the estimates from testing different time-lags indicate that the main results might still suffer from these kind of problems. If there existed a credible instrument for environmental policy stringency more sophisticated methods such as an IV regression would have been more optimal to use in attempt to avoid these problems.

As mentioned before multidimensionality is one of the most important issues stated in the literature. Even though the EPS-index is intended to capture the real effect of environmental policy stringency it is still a proxy. The fact that the EPS-index overlooks some important areas such as water, biodiversity, natural resources and waste might have a significant impact on the results, hiding the true relationship between investment flows and stringency differences. Extending the index to cover more different types of environmental regulations would help to make it even more reliable and optimal for these kinds of studies.

This thesis builds upon the assumption of a linear relationship between difference in environmental regulations and FDI. However, in the robustness section a nonlinear relationship is tested based upon the possibility that FDI-flows would decrease when stringency of regulations in a host country becomes too weak. The results of the robustness test are however not in line with what was expected. In contrast to the findings of Kalamova and Johnstone (2011), there seems to be no consistent evidence of non-linearity. Even though it seems like a reasonable assumption the results are inconclusive which makes it hard to establish if there exists a non-linear relationship or not.

In comparison to this study, Kalamova and Johnstone (2011), who also use a multi-country framework to study the effect of relative stringency on FDI, finds highly significant support for the pollution haven hypothesis. However, even though their results where statistically significant over all estimations they conclude that the effect is relatively small in comparison to other factors indicating a weak support in line with this study. Difference in outcomes compered to Kalamova and Johnstone (2011) might be due to difference in estimated models and econometric techniques. The study also differs in the use of proxy, countries used and timeframe compared. According to the literature, different empirical approaches between studies on the pollution haven hypothesis seem to be one of the main challenges in addition to finding a credible proxy.

The results from this study are also in line with the results of Kozluk and Timiliotis (2016) investigating the pollution haven hypothesis through an international trade perspective. Similar to to this study they use the EPS-index as a proxy for environmental policy stringency. Even though they look at international trade patterns instead of FDI, the strong relationship between FDI and trade gives some support for the weak results in this thesis. Many other studies have found significant results for pollution havens, however the magnitude of the effect are mostly very small. This indicates that increasing stringency levels would overall have a very small impact and the fear of countries loosing their competitiveness on the global market might be overstressed.

9 Future research

This study relies on a two-country framework, ignoring the possibility of a third-country effect in FDI decisions. Including third-country effects suggested by Millimet and Roy (2015) would have been a good independent variable to use as an extension. The third-country effect captures the effect of other neighbourhood host countries to the particular host country. As Millimet and Roy (2015) states, ignoring third-country effects can mask the pollution haven effect and cause biased results. Because of time-issues this thesis only focused on control- variables included in the KC-framework. For further research, however, this would be an interesting factor to include.

In the future it would also be interesting to look at a wider range of countries and an even longer time-frame. Extending the EPS-index to a wider range of countries outside the OECD and BRIICS could help us to draw more general conclusion of an overall pollution haven effect. In addition, improving the EPS index by including more policy instruments and environmental areas would be ideal for further research. It would also be interesting to broaden the research using the EPS index and including another type of dependent variable such as firm location when investigating the pollution haven effect. Further, more research needs to be done to find a more suitable specification that is able to address all the econometric issues that are ignored in most of the literature.

Finally, it is important to remember that this study only looks at the existence of a pollution haven effect between the European OECD countries and the BRIICS. To make a more general conclusion a setup with countries from different part of the world as host countries would have been ideal. Also the results should be interpreted carefully because the potential of omitted variable bias, specification and endogeneity problems.

10 Conclusion

The validity of the pollution haven hypothesis has been highly debated over the past decades for a good reason. Nevertheless, the literature has not yet come to a conclusion about the true relationship between environmental policy stringency and competitiveness. The focus of this study has been to empirically investigate the existence of an overall pollution haven effect between the European OECD countries and the BRIICS by using a fixed effects model, adding to the strand of literature with a multi-country framework. The main contribution to this research topic has been the use of a proxy that holds a relatively high degree of multidimensionality compared to proxies used in previous literature – the EPS-index. Results from the main estimated model show no significant support for a pollution haven effect. However, when lagging the environmental policy stringency variable by one year, the results change and indicate a weak support for the pollution haven hypothesis in line with the recent study done by Kozluk and Timiliotis (2016). The results are robust to an alternative proxy of environmental stringency, however it is important to be aware of the limitations of this study and the results should be interpreted carefully. Even though this thesis has attempted to avoid many of the common econometric problems highlighted in previous literature the results from the robustness tests still indicates that the estimates might be biased especially due to endogeneity or omitted variable bias. Future research should therefore be devoted to find better solutions to these problems.

Concluding, it is evident that past empirical studies are inconclusive in finding strong support for the pollution haven hypothesis. This can be partly attributed to the complicated nature of investigating the question that is often plagued with many econometric issues. This does not however disregard the hypothesis, but draws attention to the need for more sophisticated study designs or different approaches. Alternatively, it is possible that the pollution haven hypothesis does not hold which is also an important finding. Nevertheless, environmental issues are becoming more and more important and stringency levels in the future are likely to increase, therefore it is important to continue to investigate this relationship to obtain a clear picture of the different mechanisms involved.

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12 Appendix

12.1 Variable description

Table 6. Detailed variable description with expected signs.

Variable	Definition and source	Expected sign
FDI	Flow of foreign direct investment from the source to the host country; Source: OECD database.	+
ΔGDP, $\sum GDP$	Difference / Sum of gross domestic products between source and host country in millions US dollars, current year; Source: World Bank, World Development Indicators database (WDI).	-/+
$\Delta Skill$	Difference of GDP per capita between source and host countries in number of years; in the sensitivity analysis we also use the difference of education duration; Source: WDI.	+
Interaction term I	Interaction term equal to $\Delta Skill^*\ \Delta GDP$ if $\Delta Skill > 0$, and 0 otherwise.	-
Interaction term II	Interaction term equal to equal to $\Delta Skill^* \sum GDP$ if $\Delta Skill > 0$, 0 otherwise.	-
Interaction term III	Interaction term equal to - $\Delta Skill^* \sum GDP$ if $\Delta Skill < 0$, 0 otherwise.	-
Distance	Distance in km between the capitals of the source and host country; Source: Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).	-
Common border	A binary variable equal to 1 if the source and host country share the same border and 0 otherwise; Source: CEPII.	+
Customs union	A binary variable equal to 1 if the source and host countries belong to the same customs union and 0 otherwise; Source: World Trade Organization (WTO), own compilation.	+
Common language	A binary variable equal to 1 if the source and host country share the same language and 0 otherwise; Source: CEPII.	+
Free-trade agreement	A binary variable equal to 1 if the source and host countries belong to the same free trade agreement and 0 otherwise; Source: WTO, own compilation.	+
Regulatory quality	Rating of regulatory quality in host country with a range from -2.5 to 2.5; Source: Kaufmann et al. (2008).	+
Δ*Environmental policy stringency*	Differences of the stringency levels of environmental policy stringency between source and host countries. Source: OECD database	+
(Δ*Environmental policy stringency*)^2	Squared differences of the stringency levels of environmental policy stringency between source and host countries. Source: OECD database	-

12.2 List of countries

Table 7. List of countries used.

OECD countries		BRIICS countries
Austria	Slovak republic	Brazil
Belgium	Spain	Russia
Czech Republic	Sweden	India
Denmark	Switzerland	Indonesia
Finland	Turkey	China
France	United Kingdom	South Africa
Germany		
Greece		
Hungary		
Ireland		
Italy		
Netherlands		
Poland		
Portugal		

12.3 Multicollinearity

To make sure there is no multicollinearity present a VIF test is performed. Most literature suggests a VIF value higher than 4 might cause problems in the regression. Most of the independent variables show no indication of multicollinearity as the values are less than four. Also their correlation is relatively low as we can see from the correlation table. Measures including GDP or GDP per capita however shows high correlation and VIF value greater than 4 as expected. The tests indicate that we should not be worried about multicollinearity affecting our output.

Table 8. VIF-test

Variable	VIF	1/VIF
Sum of GDP	19.04	0.052517
Interaction term II	12.49	0.080090
GDP^2 difference	12.00	0.083321
Interaction term I	8.21	0.121778
Regulatory quality	2.34	0.426811
Freetrade agreement	2.26	0.443127
Distance	1.69	0.592632
EPS difference	1.18	0.847553
Common border	1.12	0.895180
Common language	1.06	0.939525
Interaction term III	1.03	0.975294
Mean VIF	5.67	

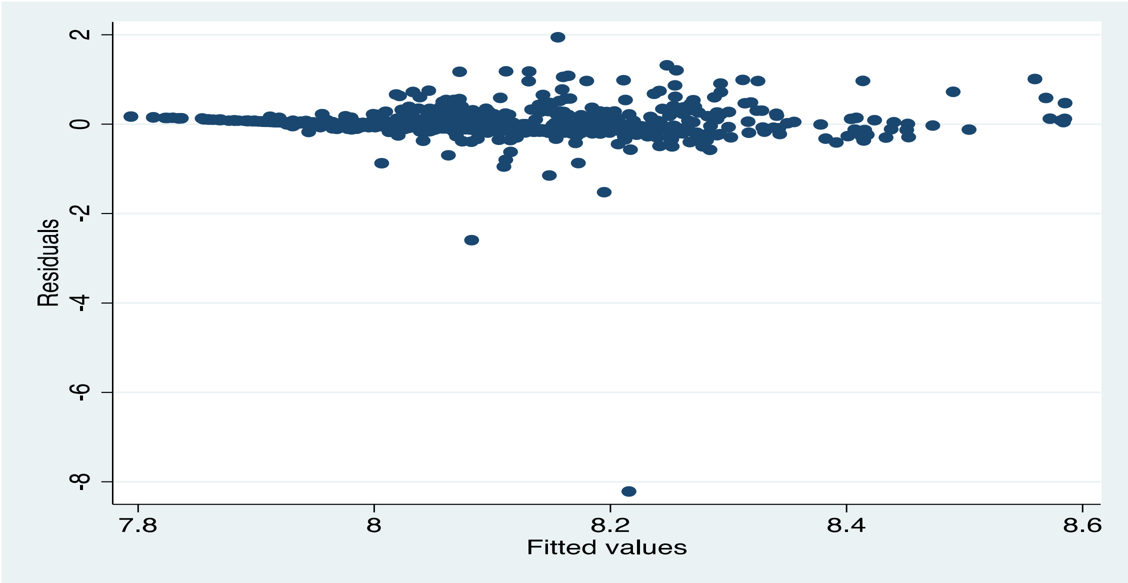
Table 9. Correlation table for all independent variables

	EPS difference	CO2	Sum of GDP	GDP^2 difference	Distance	Regulatory quality	Common language	Common border	Freetrade agreement	Interaction term I	Interaction term II	Interaction term III
EPS difference	1.0000											
CO2	0.0662	1.0000										
Sum of GDP	-0.1611	0.1517	1.0000									
GDP^2 difference	-0.2146	0.0007	0.8608	1.0000								
Distance	-0.0270	0.5562	0.2385	0.1333	1.0000							
Regulatory quality	0.0456	-0.2767	-0.2768	-0.1476	0.2901	1.0000						
Common language	-0.0383	0.0505	-0.0938	-0.0823	0.0283	0.0868	1.0000					
Common border	0.0492	-0.1394	-0.0843	-0.0596	-0.2886	-0.0758	-0.0269	1.0000				
Freetrade agrement	-0.0044	-0.3461	-0.2542	-0.1079	0.1590	0.6846	0.1353	-0.0553	1.0000			
Interaction term I	0.0785	-0.2107	-0.7407	-0.7662	-0.2682	0.2691	0.1361	0.0548	0.2021	1.0000		
Interaction term II	0.0124	0.2528	0.8516	0.6485	0.2769	-0.2752	-0.0675	-0.1014	-0.1781	-0.8194	1.0000	
Interaction term III	0.1046	0.0142	0.0137	0.0209	-0.0503	-0.0373	0.0101	0.0069	0.0208	-0.0325	0.0531	1.0000

12.4 Heteroscedasticity

If heteroscedasticity is present, this would cause an upward bias in standard errors. Bias in our standard errors will affect our t-values and therefore also our t-test. (checking for normality of residuals distributions) Examining figure 2 we se that the the spread of residuals indicates that heteroscedasticity might be present. Clustered standard errors robust to both heteroskedasticity and serial correlation are therefor used in all the regressions.

Figure 3. Scatterplot of residuals.



12.5 Fixed effect estimation including a squared term of EPS difference

Table 10. Detailed results from fixed effects estimation including a squared term of environmental policy stringency.

VARIABLES	(1) FE	(2) FE lag1	(3) FE lag2	(4) FE lag3
EPS difference	-0.000372			
	(0.0665)			
EPS difference squared	-0.00383			
	(0.0328)			
Sum of GDP	1.93e-08	7.46e-08	4.75e-08	4.74e-08
	(6.97e-08)	(6.85e-08)	(6.35e-08)	(6.19e-08)
GDP difference squared	-5.28e-15	-7.72e-15*	-6.35e-15	-6.21e-15
	(4.38e-15)	(4.43e-15)	(4.19e-15)	(4.17e-15)
Regulatory quality	0.0389	0.0167	0.0280	0.0159
	(0.0730)	(0.0620)	(0.0613)	(0.0605)
Interaction term I	-2.92e-11**	-2.84e-11**	-2.93e-11**	-2.97e-11**
	(1.21e-11)	(1.20e-11)	(1.21e-11)	(1.18e-11)
Interaction term II	-2.62e-11**	-2.64e-11**	-2.69e-11**	-2.74e-11**
	(1.20e-11)	(1.24e-11)	(1.23e-11)	(1.20e-11)
Interaction term III	-8.20e-11	5.22e-11	1.48e-11	1.12e-12
	(6.62e-11)	(1.19e-10)	(9.56e-11)	(6.82e-11)
year = 2004	0.0353	0.0312	0.0361	0.0343
	(0.0302)	(0.0284)	(0.0290)	(0.0287)
year = 2005	0.0588	0.0478*	0.0550**	0.0537**
	(0.0369)	(0.0266)	(0.0261)	(0.0266)
year = 2006	0.0683	0.0410	0.0621**	0.0584**
	(0.0475)	(0.0302)	(0.0294)	(0.0277)
year = 2007	0.0673	0.0350	0.0622	0.0573
	(0.0485)	(0.0479)	(0.0437)	(0.0438)
year = 2008	0.112**	0.0924**	0.101**	0.0824**
	(0.0526)	(0.0401)	(0.0424)	(0.0379)
year = 2009	0.0744	0.0405	0.0693**	0.0325
	(0.0616)	(0.0333)	(0.0337)	(0.0345)
year = 2010	0.0949**	0.0434	0.0845	0.0732
	(0.0408)	(0.0720)	(0.0630)	(0.0744)
year = 2011	0.172***	0.129***	0.150***	0.137***
	(0.0569)	(0.0350)	(0.0394)	(0.0366)
year = 2012	0.109*	0.0696**	0.0918***	0.0545
	(0.0568)	(0.0335)	(0.0352)	(0.0369)
EPSlag1		-0.122		
		(0.0946)		
EPS^2lag1		0.0464*		
		(0.0276)		
EPSlag2			-0.101	
			(0.0764)	
EPS^2lag2			0.0335	
			(0.0221)	
EPSlag3				-0.103**
				(0.0486)
EPS^2lag3				0.0446***
				(0.0163)
Constant	8.602***	8.555***	8.618***	8.617***
	(0.444)	(0.449)	(0.440)	(0.413)
Observations	1,138	1,138	1,138	1,138
Adjusted R-squared	0.219	0.224	0.221	0.223

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

12.6 FDI-flows between the European OECD and BRIICS

Figure 4. Development for total FDI-Flows between European OECD and BRIICS countries for chosen years. Source: OECD database.