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Department of Economics and Business Economics
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MNE's location decision and environmental stringency, a PMG-ARDL approach.

By Gijs Philipsen (4603117)

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Program: Master's Program in Economics
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Supervisor: Dr. I.M. Sifat (Imtiaz)

Radboud Universiteit

Abstract

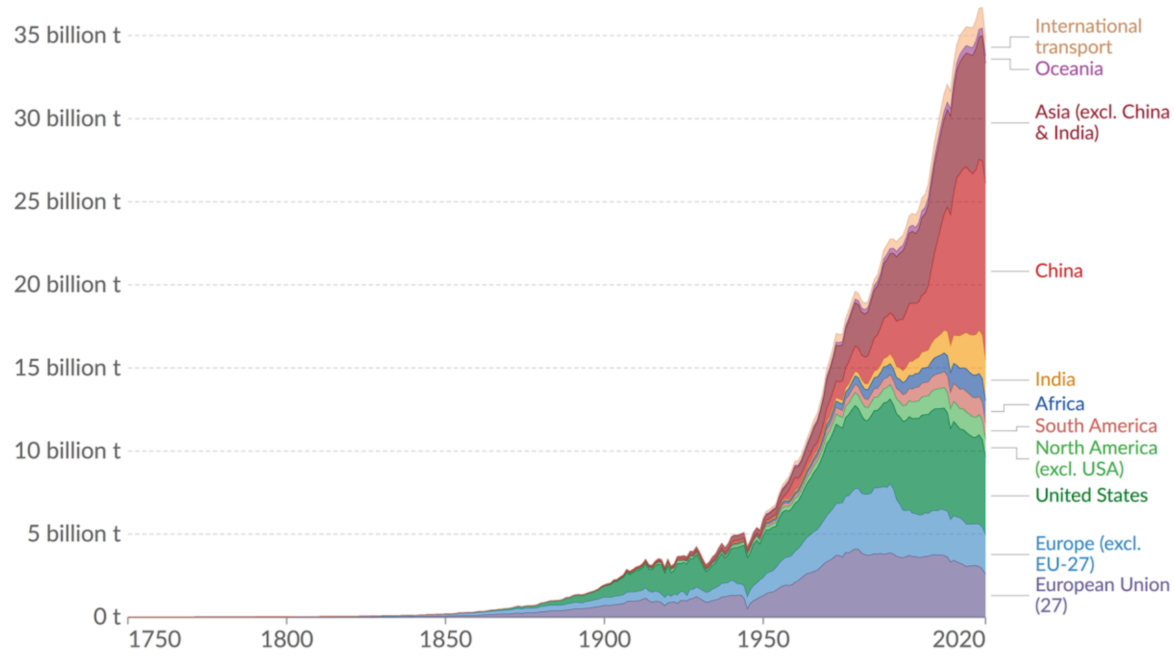
This paper examines the transfer of polluting activities by multinational enterprises (MNEs) towards countries with low environmental stringency—the so-called pollution havens. The empirical validity of the pollution haven hypothesis (PHH) across countries is examined using annual data of 117 countries between 1990 and 2014 using a Pooled Mean Group (PMG) ARDL approach. This entailed estimating a dynamic heterogeneous panel model followed by a Granger causality test. The results show a long-run causal influence of environmental stringency on inward FDI, which differs across GDP per capita panel groups. This indicates that lower host country environmental stringency attracts transfer of polluting activities. These findings further reinforce the validity of the PHH and the existence of pollution havens while also partly explaining the non-linear shape of the environmental Kuznets curve (EKC).

Contents

Introduction

Historically the western developed world has been the largest producer of greenhouse gas emissions (GHG) due to the industrial revolution. Over the last decades, though, the emissions of Asian Pacific countries have significantly increased, with China taking part in approximately 60% of the Asia Pacific's emissions in 2020 (World Bank, 2020), making China the world's largest producer of GHG emissions. This increase in GHG emissions in Asia pacific started with the rise of neoliberal globalisation in the 80s when manufacturing shifted from more developed countries within the western world to developing countries within the global South. This shift in production resulted in the global South being responsible for the most significant part of global industrial production (Hickel et al., 2022; 2016).

Figure 1: Global CO_2 emissions from fossil fuels and land-use change, by world region.



Source: (Friedlingstein et al., 2022)

According to the conventional narrative, this shift in GHG emissions could be explained by the Western world producing more environmentally friendly while the developing countries are producing more, with a general disregard for environmental implications. However, some questions arise because production has shifted from the global north toward the global South. For example, who is responsible for emitted GHG? Is it the producing country or the country that consumes the final product? This question continues to motivate a growing body of research on globalisation, transferring polluting firms from the global north toward the global South. Furthermore, due to the increasing stringency of environmental regulations in the global north, polluting firms are incentivised to move towards countries with more lenient regulations—the so-called pollution havens. This idea was first theorised by Walter and Ugelow and named the pollution haven hypothesis or PHH (Walter & Ugelow, 1979).

When the PHH holds, it could also have implications for what Emmanuel (1972) and Amin (1978) call an 'unequal' exchange (Hickel et al., 2022). An unequal exchange implies the hidden transfer of the negative externalities of production towards developing countries. This could also affect how modern-day value chains are constructed and harbour inherent imperialistic traits that keep global southern countries comparatively weak (Hickel et al., 2022; Suwandi, 2019). In this case, the transfer would not be monetary per se but would be a shift of the pollution and its adverse externality effects on the global South. However, it might be seen as an unequal exchange as richer global north countries could exercise their relative power to shift the polluting production towards developing countries.

Although the harmful effects of GHG emissions affect all countries globally, the potential adverse effects are not distributed evenly. The global South is likely to be affected more, as these countries depend heavily on their natural environment and have few resources to adjust to or cope with the changing climate (EU-Commission, N.Y.). Furthermore, many global south countries already have more extreme weather conditions due to their location, which could worsen because of global warming. This transfer of negative externalities would have some significant ethical implications for global North countries, as it could be seen as the global north helping the global South reinforce climate change, which would affect global south countries most. If this were the case, the transfer of pollution towards the global South would increase the inequality between the global north and south further and, in the process, the global South could be harming their environment the most. This problem raises the following goal for this research paper:

Does the pollution haven hypothesis hold across countries?

Leading to the following research question:

To what extent are pollution-intensive industries transferred towards countries with low environmental stringency globally?

The paper will start with a discussion of the relevant literature, followed by a discussion of the methodology and data used. Then, based on the results of the econometric model, a conclusion will be made that tries to answer whether the pollution haven hypothesis holds within a cross-national study. Based on the results of this study, first conclusions will be made, along with recommendations for further research and a discussion of the study.

Literature review

This section critically reviews the different positions within the field of the transfer of pollution toward other countries. This includes seminal and contemporary works to allow the reader to understand the evolution of the context and the most current state of knowledge regarding it. The latter helps solidify the research question and informs this thesis's methodological decisions. Different and opposing findings within the literature and approaches to the PHH will be discussed.

Pollution haven hypothesis

First, a clear definition of a pollution haven must be established to address this paper's research goal and related research question. Within the literature, there are two different approaches to the PHH. The first branch of studies focuses on the effect environmental stringency has on FDI to or from a country, thus looking at the location decision of MNEs based on local policy (Pearson, 1987; Xing & Kolstad, 2002). This paper uses 'the location decision approach' to describe this branch of literature. This approach assumes that countries with lower environmental stringency have a comparative advantage in polluting activities. As these countries have fewer restrictions on pollution, the costs of polluting production will also be lower. Furthermore, this branch of the literature assumes that MNEs are willing to relocate their facilities to minimise costs (Cole et al., 2017; Rezza, 2015; Wagner & Timmins, 2009). This cost minimisation is a logical assumption, as it is in line with the reasoning of other branches of literature on the determinants of FDI or location decisions, such as the OLI or the eclectic paradigm by Dunning (2006) that will be discussed later in this chapter.

The other branch of PHH studies focuses on the effect the FDI has on local policy. So, to what extent can foreign FDI influence policy decisions within a country? This is known as 'the political economy approach' (Cole et al., 2017). This branch of literature argues that MNEs that transfer polluting activities towards developing countries will lobby within the host countries to adjust local policy. This lobbying will often deteriorate local environmental policy or prevent further restrictions, to gain a competitive advantage (Hillman & Ursprung, 1992; Oates & Schwab, 1988). However, this approach is based on the MNEs already present within countries and not on the location decision. Therefore, this approach is unsuitable for this paper's scope and is thus not used. Hence, any reference to PHH in this paper is underpinned by the location decision interpretation.

The OLI or eclectic paradigm argues that MNEs, when investigating an investment abroad, consider three different determinants; ownership, location and internalisation advantages (Dunning et al., 2007; Santos & Forte, 2021). These determinants traditionally are not influenced by policy decisions. In this framework, ownership advantages are advantages that MNEs own internally and generate revenue, such as patents or copyrights. Internalisation advantages are advantages that are only beneficial when they are done within the MNE's internal structure. This is opposed to outsourcing certain parts of the value chain. Finally, location advantages are location specific. They can only exist when an MNE establishes at a specific location. These benefits are traditionally related to access to the host country's market or local resources. If MNEs replace their production or facilities, this could be seen as efficiency-seeking or strategic asset-seeking (Dunning et al., 2007; Santos & Forte, 2021). The results for the PHH could have implications for the location advantage part of the OLI or eclectic paradigm, as it could be an additional determinant in determining location-specific advantages and the related location decision. This approach is closely related to the research question of this paper as it focuses on host country-specific characteristics, in this case, the environmental stringency, that influences the location decision.

The approach to finding the location decision PHH differs significantly. However, most empirical studies follow the same theoretical reasoning for transferring pollution-intensive industries. Which is an increased comparative advantage due to reduced costs associated with more lenient environmental policy and the resulting increase in marginal returns for MNEs (Cole et al., 2017; Wagner & Timmins, 2009). This reasoning is closely related to the eclectic paradigm's location decision, as the comparative advantage in polluting activities could be seen as a location-specific advantage that can only be obtained by being present within the country (though FDI). The PHH could, therefore, ad an additional determinant to the location dimension of the eclectic paradigm's location decision. However, the number of empirical studies on the relation between the eclectic paradigm and PHH is minimal. Therefore, this study will expand on the literature by relating the PHH location decision to the OLI or eclectic paradigm.

One of the main theories in the environmental economics literature is the environmental Kuznets curve hypothesis or EKC. This theory posits a (quadratic) inverted U-shaped relation between GDP per capita and pollution within a country (Cole, 2004; Grossman & Krueger, 1991; Sarkodie & Strezov, 2019b). Thus, as GDP per capita rises, initially, pollution within a country will increase (pre-industrial economy), then pollution will stagnate (industrial economy), and finally, it will reduce as the country grows richer (post-industrial economy). If the PHH holds, the PHH could be a possible explanation or determinant for the existence of this inverted U-shaped (EKC) curve (Sarkodie & Strezov, 2019b). Initially, high GDP per capita countries (A) will relocate their polluting production towards low GDP per capita country B, resulting in an increase in pollution in country B (resulting in the upward sloping pollution) and a decrease in pollution in country A. As income starts to rise in country B, due to the additional production and related exports in country B, country B's income slowly rises, and the country could afford to increase environmental stringency (resulting in stagnating pollution in country B). Companies in country B could then afford to transfer their polluting activities to low-income country C. This transfer would result in the downturn of pollution in country B, which finally leads to the downward sloping curve. However, some recent research suggests that the downturn described in the literature might have been caused mainly by the relocation of pollution from developed towards developing countries and not by decoupling pollution from economic growth in developed nations (Murthy & Gambhir, 2018). Murthy and Gambhir (2018) argue, based on their research, that the EKC relation might be cubic (N-shaped) rather than quadratic, which would mean that pollution is only temporarily reduced (Allard et al., 2018). They argue that this effect is due to increased consumption that comes from people that rise in income dramatically. By empirically investigating the relationship between environmental stringency and the location decision of polluting industries (PHH), this paper could reinforce or critically reevaluate the EKC literature and expand on the PHH literature. Therefore, this paper will use the empirical results to potentially explain the effects on the related EKC literature.

Within the location decision PHH, there are two main issues. The first is the problem of how to measure the unobserved environmental stringency. The second problem is related to how location transfer (through FDI) could also affect environmental stringency (simultaneity) and how to deal with location-specific heterogeneity that is unobserved (Cole et al., 2017; Levinson & Taylor, 2008). This problem will be discussed further below. Most early PHH studies, for example (Javorcik & Wei, 2003; Kheder & Zugravu, 2012; List & Co, 2000), did not consider the second problem as they mostly used cross-sectional data at the country level while not controlling for the country-specific heterogeneity. However, most later studies tried to deal with these issues using more advanced econometric approaches, such as panel data (Chichilnisky, 1994; Cole et al., 2017). Therefore, a panel model will be used within this study to deal with the second issue of location-specific heterogeneity.

Environmental stringency

The problem of tackling the unobserved environmental stringency has been tackled by other research in different ways. Roughly there are three ways of tackling this problem which will be discussed in this chapter step by step. Furthermore, both the benefits and problems with each approach will be discussed to substantiate further the approach taken within this paper.

Abatement costs are the most common way to deal with the unobserved environmental stringency. These are the additional costs MNEs must make to comply with additional environmental stringency. So, costs will be relatively low in a country with low stringency. This measure is used in studies on the PHH in, for example, the US (Eskeland & Harrison, 2003; Javorcik & Wei, 2003) or in Mexico and Canada (Levinson & Taylor, 2008). However, costs are hard to compare across countries due to standardisation issues making it hard to compare across countries (Cole et al., 2017). Therefore, this approach is most applicable to studies on single countries or regions that a relatively comparable. Therefore, this way of dealing with unobserved environmental stringency is unsuitable for this paper's research goal and question.

A different way of tackling the environmental stringency issue is using stringency indices, which combine several different measures into a single quantifiable output score (Cole et al., 2017). Some studies construct an index based on adherence to specific treaties (Javorcik & Wei, 2003), while others combine a measure of abetment costs and the presence of environmental institutions (Kheder & Zugravu, 2012). The problem with these indices for this study is the generalizability of an index across countries caused by the global country-specific heterogeneity. Therefore, this study will not use this particular index to deal with this issue. A different index often used is based on a survey by the World Economic Forum (WEF) (Cole et al., 2017). This study has widely available data across countries and has been used in many studies for cross-country research (Antonietti et al., 2017; Manderson & Kneller, 2012; Tang, 2015). Although it is widely used, it has a significant drawback: it describes per country stringency as perceived by managers within the host country. Using managers' perceptions comes at the risk of perception bias by respondents being overly optimistic or pessimistic. This has implications for the generalizability of the study. Although the survey data is quite extensive, the methods used within the survey have changed through time which makes it hard to compare results before and after the changes (Cole et al., 2017).

A final way of dealing with the issue is by either using environmental pollution (Cole & Fredriksson, 2009; Ge et al., 2020; Xing & Kolstad, 2002) or pollution intensity measures within a specific country (Cole et al., 2017; Eskeland & Harrison, 2003; Javorcik & Wei, 2003; Naughton, 2014). Under the assumption that increased environmental stringency decreases total pollution. The benefit of these measures is that they are widely available, as almost all countries have extensive pollution data across time. However, some critics of these measures argue that they suffer from reverse causality as increased FDI leads to higher pollution levels (Zarsky, 1999). Data availability is a vital issue within this paper, so total environmental pollution will be used to deal with the unobserved environmental stringency. More advanced statistical methods, such as a granger causality test and the inclusion of lags as independent regressors, will be used within this research to deal with the reverse causality issue proposed by Zarsky (1999).

Previous findings

Although the theoretical basis for the PHH is robust, empirical support for the PHH is still lacking. Within the literature, there is no consensus on pollution havens (Cai et al., 2018). Some studies find no significant effect of environmental regulations on the transfer of polluting activities, or it does not have a strong significant impact on world trade (Manderson & Kneller, 2012; Rezza, 2013). However, these studies generally use cross-sectional data of the US or another single country, implying that the results are not generalisable outside their specific situation. Other studies find significant effects that favour the PHH and argue that relatively laxer environmental institutions in the host country increase the transfer of polluting industries towards these countries or regions (Cai et al., 2018; Solarin et al., 2017; Xing & Kolstad, 2002). Several factors could explain the difference in results. Earlier studies used aggregated data and less sophisticated econometric modelling less sensitive to the effects.

Some research argues the opposite effect, known as the pollution halo hypothesis. According to the logic of this hypothesis, foreign companies bring advanced and cleaner technologies to the host countries through FDI, which would decrease pollution per output (Grossman & Krueger, 1991; Koźluk & Timiliotis, 2016; Zarsky, 1999). When companies bring these more advanced technologies to lower GDP per capita countries, these countries can become known as 'green havens' or GHH. The GHH posits that MNEs concerned with the environmental pollution in developing nations will export their more environmentally friendly technology to these countries (Gill, 2018). However, the empirical evidence for this hypothesis is scarce and only limited to specific case studies and is not statistically significant for FDI in general (Zarsky, 1999). Nevertheless, the scarcity of proof could also be due to lacking empirical research in this field. This study will also check for the GHH as the pollution-based approach to environmental stringency is also sensitive to the GHH.

Within the empirical literature, several approaches are used to find evidence for the PHH. Roughly, they can be divided into two different categories. One branch of literature applies a cross-country approach using a different subset of countries over time. This is done, for example, by using a subset of less-developed countries (Dick, 2010) or based on the implementation of specific policies within countries, such as the Belt and Road initiative (Cai et al., 2018). This comes at the benefit of being more sensitive to individual country or region heterogeneity, as models can include specific legislation or events. However, it also comes with a lack of generalizability across countries. Cross-country research is generally used as it can endogenously determine the in- and output of carbon emissions embodied within the trade or FDI (Cai et al., 2018). However, it comes at the risk of not finding significant results due to the great heterogeneity between countries that could explain the variance. On the other hand, there has been plenty of research on effects within specific countries, such as China, Norway, Ghana, and the US (Ren et al., 2014; Rezza, 2013; Shapiro & Walker, 2018; Solarin et al., 2017). As most studies are focussed on the country- or region-specific, this study will use a panel model to get generalisable results across countries.

This study will use the pollution-based approach to environmental stringency, as it allows for an extensive dataset that does not suffer from perception bias (Cole et al., 2017). Furthermore, as most studies on the transfer of pollution towards pollution havens (PHH) are focused on transfers of pollution within countries (Shapiro & Walker, 2018; Solarin et al., 2017), they are focused on the transfer from or to a specific country (Cai et al., 2018), this paper will take a global cross-country approach to the PHH. Most global cross-country research is relatively old (Dick, 2010; Walter & Ugelow, 1979). This paper will expand on the literature by studying the pollution haven hypothesis using recent cross-country panel data on the effect of environmental stringency and inward FDI. Furthermore, this study will incorporate a panel causality model using recent econometric modelling to check for a causal relation between the explanatory variables. This will allow for a more sensitive approach to the global existence of a PHH relation.

Methodology

This study will use a dynamic heterogenous panel analysis to examine the relationship between environmental stringency and the transfer of pollution. Using a panel model has the advantage of considering cross-sectional characteristics between countries while capturing the dynamic interaction between both variables of interest (Lee & Wang, 2015; Pesaran et al., 1999). In addition, panel data allows for a global approach to the transfer of pollution. Furthermore, the paper will apply a bivariate Granger causality test to check for a causal relation between environmental stringency and the transfer of pollution (Granger, 1969).

The research question is first operationalised by defining the transfer of polluting industries. In general, a transfer can happen in two ways. Either transfer (a part) of the production abroad through FDI (capital flows) or outsource production to a different country through trade. Trade is less sensitive to environmental stringency as it takes more time to adjust production patterns because investments must first capitalise on producing goods. Because capital flows are likely to be more sensitive to environmental regulations in the short run, when compared to trade, FDI is a more logical choice when investigating the effects of environmental stringency (Xing & Kolstad, 2002). Therefore, within this study, only FDI will be considered for the transfer of polluting industries.

Other determinants of FDI must be included in the FDI model to reduce the unobserved heterogeneity bias to a minimum. In the following part, determinants of FDI will be discussed.

Determinants of FDI within the literature

Foreign direct investment, or FDI, is a concept that is widely used in economic research. The amount of FDI within a country can indicate a country's attractiveness for foreign investment (Agarwal, 1980). However, many different hypotheses are available within the FDI literature, most of which use differences in capital returns as an important explanatory variable. FDI can show how capital and the associated production shift from one country to another.

The most widely used hypothesis for FDI determinants is based on the differences in returns to capital between countries. This means that capital flows from countries with a low return to capital toward countries with a high return to capital. FDI could be seen as a form of capital arbitrage (Agarwal, 1980). This higher return to capital could also be applied to the PHH, as capital is moved from countries with stringent environmental policy (and associated higher costs) to countries with lower environmental stringency (and, therefore, relatively lower costs). In other words, FDI due to higher environmental stringency in one country could be seen as a form of capital arbitrage (Cole et al., 2017; Xing & Kolstad, 2002). Therefore, this shift in capital flows is triggered by the difference in factor rewards between the host- and home country, resulting from the different levels of environmental stringency (McGuire, 1982). McGuire (1982), however, finds this based on a theoretical Heckscher-Ohlin model and does not provide additional empirical research in support of his model. In his paper, he argues that the FDI flows towards the host-country increase as, environmental stringency increases. FDI could therefore be used as a proxy for transferring production to a different country. This does, however, not yet specifically entail the transfer of pollution intensive industries.

Although environmental stringency could explain FDI towards a country to some extent, more variables can explain variance in inward FDI across countries. One of the other main determinants of FDI towards a specific country is the market size of the host country. As countries grow in market size, foreign firms are more likely to increase capital flows toward the country because larger markets give more opportunities to sell within the market (Agarwal, 1980). However, this effect usually only starts after surpassing a threshold level of market size. Market size is mainly proxied by GDP, or per capita GDP, due to its relationship between aggregate demand and capital stock (Naughton, 2014; Xing & Kolstad, 2002). This means that market size, proxied by GDP per capita, positively affects the amount of FDI towards the specific country.

Environmental stringency and FDI

This paper aims to verify the pollution haven hypothesis with an extensive dataset. A key issue in assessing whether pollution is being transferred to countries with lower environmental stringency is quantifying and comparing environmental stringency, especially across countries. This is partly due to the diversity of countries' environmental policy approaches and policy enforcement. Enforcement of policy is also crucial in assessing the actual environmental stringency. This issue is still the most controversial part of most research on the PHH. Many different approaches are taken to deal with the unobservable environmental stringency. This paper uses a variation of the procedure used by Xing and Kolstad (2002). The authors rely on using the amount of pollution emission within a country to deal with the latent variable problem caused by the unobservable environmental stringency (Xing & Kolstad, 2002). This procedure will be discussed in more detail below.

Derivation of the model

First, FDI (FDI), according to the model (equation 1) used in this paper, depends on two factors: the exogenous variables influencing FDI (Z) and the unobserved environmental stringency in the host country (E*).

$$FDI = f(Z, E^*) \tag{1}$$

Because E* is unobserved, an additional equation (2) is needed to deal with the variable. In line with Xing and Kolstad (2002), national pollution emission is used (C). This depends on the exogenous determinants of the national pollution emissions (X) as well as on the unobserved environmental stringency E*:

$$C = e(X, E^*) \tag{2}$$

The assumption must be made that equation 2 can be solved for E* as a function of the other variables to obtain equation 3, which can then be substituted into equation 1 to get to equation 4.

$$E^* = h(X, C) \tag{3}$$

$$I = g(X, Z, C) \tag{4}$$

Equation 4 shows the reasoning used for making the latent variable measurable. This research will use nationwide CO_2 emissions instead of SO_2 emissions, as data is more widely available and as it is one of the main components of global warming, the worldwide air pollution, and has been a critical issue for policy across countries (Hoffmann et al., 2005; Talukdar & Meisner, 2001). It does, however, come with some setbacks. As CO_2 does not provide an exhaustive measure of (air) polluting activities in general, it might not give a clear and extensive indication of the pollution caused within a country (Ge et al., 2020; Hoffmann et al., 2005). Furthermore, because CO_2 poses primarily global problems, some countries might not implement policies to decrease CO_2 emissions as they feel they might not be directly affected (Managi, 2004).

Although CO_2 poses some problems, it does come with some substantial benefits. First, as stated before, data is widely available while many other variables are not, and the data is generally considered good quality. Furthermore, although SO_2 is often used instead of CO_2, the correlation between both the variables is strong (approximately 0.95 in 1990 among 111 countries). This shows that CO_2 could also be used as a valid proxy for national pollution emissions (C) within this research (Hoffmann et al., 2005).

Several different determinants of CO_2 pollution must be added to the model to reduce endogeneity issues and use CO_2 pollution as a proxy for environmental stringency. Environmental stringency can have a twofold effect on CO_2 pollution (C), either through reduced emissions per unit of energy used within a country or by increased costs due to higher stringency (Ge et al., 2020; Pindyck, 1979; Rezza, 2015; Xing & Kolstad, 2002). The level for C is expected to rise as overall energy consumption (EC) increases, and the same goes for a higher level of E* (lower E* means higher environmental stringency) (Sharma, 2011). The level of CO_2 pollution within a country also depends on the energy type variables that describe energy consumption. Both energy type variables positively affect the level of CO_2 pollution within a country (EC1 and EC2) (Sharma, 2011).

Furthermore, CO_2 pollution (C) is expected to rise as GDP rises (Pindyck, 1979; Sharma, 2011). Finally, the level for C is expected to drop when urbanisation (U) within a country increases as returns to scale effects can reduce per-person CO_2 emissions (Sharma, 2011). Therefore, these variables must be added to the model to reduce unobserved heterogeneity bias. Remaining with CO_2 (C), GDP (GDP), urbanisation (U), energy consumption (EC), country-specific determinants (W) and environmental stringency (E*) as determinants of CO_2 pollution, based on Xing and Kolstad (2002) and also used in a similar way in more recent empirical research (Antonietti et al., 2017; Ge et al., 2020). This results in equation 5 for environmental stringency under the previously mentioned assumption that the equation can be solved for E*.

$$E^{*} = h(C, GDP, \mathrm{U}, \mathrm{EC1}, \mathrm{EC2}, \mathrm{W}) \tag{5}$$

PMG-ARDL

The above variables are used in a panel ARDL framework to test the relation between environmental stringency and inward FDI. Using a pooled mean group (PMG) estimator, based on the approach of Pesaran et al. (1999). PMG allows short-run deviations of the slopes and lags for all the variable coefficients to vary across countries while keeping the slope the same across countries in the long run. In other words, PMG allows for heterogeneity of the slope in the short run while assuming homogeneity of the slopes in the long run. This allows for a single prediction of the effect of environmental stringency for the entire sample and for finding the speed of adjustment for any sample country (Baek, 2016). The assumption of heterogeneous slopes in the short run is plausible due to the considerable heterogeneity across countries. Using a PMG is helpful since it provides consistent estimators of long-run estimations. The PMG estimator is also less sensitive to outliers, which is very useful in an extensive cross-country estimation (Pesaran et al., 1999) as it can be used to deal with cross-country heterogeneity. To deal with possible endogeneity issues, the PMG estimator will be augmented using lags of the regressors and the dependent variable to minimise the possible bias because of potentially serially correlated residuals (Pesaran & Shin, 1995; Zahonogo, 2016).

The PMG-ARDL approach is based on research on the relation between trade and economic growth in developing countries (Zahonogo, 2016) and the relation between CO_2 resource rent and renewable energy (Bekun et al., 2019). This approach also deals with the cause-and-effect issue proposed by Zarsky (1999) by including the regressors' lags into the model and performing a causality test. However, it is adjusted to the transfer of pollution to low environmental stringency countries by using determinants related to this research. Bekun et al. (2019) also apply a causality test after the PMG-ARDL estimation to further test and reinforce the long-run causality between the main explanatory variables. Therefore, a similar causality test will be used after the primary estimations in this research.

This model will describe a relation both in the long- and short-run. The long-run model is specified by inserting equation 5 into equation 4 and adjusting it to a long-run linear PMG regression (equation 6):

$$FDI_{it} = \beta_0 + \beta_1 logE(C)^*_{it} + \beta_2 logGDPcap_{it} + \beta_3 GDPgrow_{it} + \beta_4 URBAN_{it} + \beta_5 EC_{1,2\,it} + \beta_6 W_{it} + \beta_7 Z_{it} + u_{it} \quad (6)$$

Where logFDI is the logarithm of the net inflow of FDI; 'E*' is proxied by 'C', which is the logarithm of the total CO_2 emissions in kilotons; 'GDPcap' is the logarithm of the GDP per capita; 'GDPgrow' is the growth rate of GDP; 'URBAN' is the percentage of the urban population; 'EC1' is the percentage of fossil fuels used; 'EC2' is the logarithm of the total energy consumption in BTU; 'W' represents the country-specific determinants; 'Z' represents the other determinants of FDI (GDP per capita and GDP growth); and 'u' represents the error term. The subscripts 'i' and 't' represent the country and year, respectively. This paper's primary variable of interest is the E* variable proxied by C.

Equation 6 is then rewritten in the form of an ARDL (p, q,…,q) model as described by Perasan et al. (1999):

$$FDI_{it} = \sum_{j=1}^{p} \lambda_{ij} FDI_{i,t-j} + \sum_{j=0}^{q} \delta_{ij} x_{i,t-j} + \mu_i + \varepsilon_{it} \quad (7)$$

Where 'x_{it}' represents the different explanatory variables used in this paper as described in equation 6. 'μ_i' Represents the country fixed effects. 'ε_{it}' Is assumed to be independently distributed across country (i) and time (t), with a means of zero and a variance of $\sigma_i^2 > 0$ that is distributed independently of the regressors. In equation 8, the error correction will be added to equation 7:

$$\Delta FDI_{it} = \varphi_i (FDI_{i,t-1} - \beta_{0i} - \beta_i' x_{it}) + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta FDI_{i,t-k} + \sum_{j=1}^{q-1} \delta_{ij}^* \Delta x_{i,t-j} + \mu_i + \varepsilon_{it} \quad (8)$$

Where $\varphi_i = -(1 - \sum_{j=1}^{p} \lambda_{ij})$; $\beta_i = -(\sum_{j=0}^{q} \delta_{ij}/\varphi_i)$; $\lambda_{ij}^* = -\sum_{m=j+1}^{p} \lambda_{im}$; $j = 1, 2, \dots$; $p - 1$ and $\delta_{ij}^* = -\sum_{m=j+1}^{p} \delta_{im}$ And $j = 1, 2, \dots, q - 1$. In this model, the effect of the independent variables on the short-run is captured by the 'Σ'-term. Furthermore, 'p' represents the different lags used within the model. The values for 'p' will be decided by minimising the Akaike Information Criterion (AIC). 'β_i' represents the vector of the long-run coefficient, while 'φ_i' shows the speed of adjustment towards the long-run equilibrium (Baek, 2016).

Data

This paper uses panel data from different sources regarding countries worldwide based on data availability. Although selection based on data availability could increase selection bias, it is still the most extensive dataset that can be used for panel research, and therefore, it will be used. Furthermore, because panel data is used, the total number of observations is increased, and the variance in explanatory is reduced. This results in less noise for the estimation while reducing issues with multicollinearity and inefficient modelling (Wooldridge, 2015). For CO_2 (C), GDP (GDP), FDI (FDI), GDP per capita (GDP), GDP growth (GDPgrow) and urbanisation (U), data from the 'world bank development indicators' are used (World Bank, 2021), while the variables describing total energy consumption (EC2) and the kind of energy used (EC1) within a country are taken from US Energy Information Administration (EIA) (U.S. Energy Information Administration, 2021). Finally, the corporate tax rate per country was taken from the Tax Foundation database (2021). This database provides annual corporate tax rates between 1981 and 2021 per country and combines several other databases. An overview of the hypothesised effect on inward FDI, nit of measurement, code and origin of the data can be found in Table 1.

The final data is comprised of 117 countries across the world between 1990 and 2014. The countries were chosen based on the data availability of all the explanatory- and control variables. Countries were dropped when they had fewer than 15 years of complete data to ensure sufficient degrees of freedom and the addition of leads or lags. This sampling choice comes at the cost of an unbalanced panel dataset, but the trade-off is acceptable since our requirements are met. The final sample consists of a broad spectrum of countries, both relatively high and low GDP per capita (table 3) and from across the world. As a result, the sample has a wide variance across the main explanatory variables.

First, a test was done for correlation amongst the variables (table 2). This shows a problem with the EC2 variable, as it strongly correlates positively with CO_2. This could lead to multicollinearity problems; therefore, the EC2 variable is dropped from further regressions. In line with the hypothesis, there is a relatively strong positive correlation between CO_2 and FDInet. However, this does not give any form of confirmation for the PHH as it only shows a correlation. Therefore, further econometric methods will be performed to validate or refute the hypothesis.

Table 1: Data description

Variable name	Code	Unit	Source	Expected sign on FDI
Foreign direct investment, net inflows	FDInet	BoP current $ in millions of $	World Bank	n/a
CO_2 emissions	C	Total Mton (megaton)	World Bank	+
Environmental stringency	E*	n/a	Xing and Kolstad (2002	+
GDP per capita growth	GDPgrow	Annual %	World Bank	+
GDP per capita	GDPcap	Constant 2017 $	World Bank	+
Electricity production from hydroelectric sources	HYDRO	% Of total energy production	World Bank	-
Fossil fuel energy consumption	EC1	% Of total energy	EIA	+
Corporate tax rate	Tax	% Of tax on corporate income	Tax Foundation	-
Urbanisation rate	URBAN	% Of total population	World bank	+

Table 2: Correlation matrix of variables.

Variables	CO2	FDInet	GDPgrow	GDP/cap	HYDRO	EC1	EC2	Tax	Urban
CO_2	1.000								
FDInet	0.598	1.000							
GDPgrow	0.060	0.010	1.000						
GDPcap	0.112	0.307	-0.126	1.000					
HYDRO	-0.152	-0.155	0.003	-0.283	1.000				
EC1	0.162	0.155	0.013	0.360	-0.635	1.000			
EC2	0.979	0.632	0.029	0.170	-0.154	0.167	1.000		
Tax	0.124	0.033	-0.068	-0.106	0.074	-0.130	0.140	1.000	
URBAN	0.052	0.198	-0.118	0.672	-0.266	0.483	0.106	-0.113	1.000

Table 3: Summary statistics for sample countries under review.

Variable	Obs.	Mean	Std. Dev.	Min	Max
FDInet	2687	1.0e+10	3.6e+10	-3.0e+10	7.3e+11
C	2689	2.22e+5	7.81e+5	190	9.93e+6
GDPgrow	2689	2.4	5.0	-62	121
GDPcap	2689	19,900	18,100	469	111,500
HYDRO	2689	32	33	0	100
EC1	2653	67	27	1.6	100
Tax	2606	30	10	0	75
URBAN	2689	61	20	13	100

Note: data is rounded for additional clarity.

Empirical results

Because the model used is a PMG-estimator, the variables must be tested for the presence of unit-roots. The variables used have to be either I(1) or I(0) in order to be used within this PMG framework, as variables of I (2) can produce inconsistent estimators (Kim et al., 2010; Pesaran & Shin, 1995; Pesaran et al., 1999). To check for the presence of I (2) variables, a unit root test was done by using IPS and Fisher PP test. These tests are traditionally used to verify whether the used variables are stationary over time by setting a null hypothesis that states that variables are non-stationary. The null hypotheses of the IPS-test and the Fisher PP test were rejected and show that all variables are either I (0) or I (1) while using a minimum of two lags. This shows that non-stationarity does not pose any issues for the model. However, FDInet, C1, GDPcap and EC11 are I (1) variables, but this does not pose any issues for the model, as the first differences of these variables are used within the regression models.

Because the model uses variables of different orders of integration, co-integration can pose an issue for the model. Therefore, a co-integration test by Westerlund (2007) was performed between the main variables FDInet and C. The Westerlund (2007) test uses four test statistics to test for co-integration. The test shows co-integration amongst the variables. The null hypothesis of no co-integration amongst variables is rejected for all four tests at the 5% confidence level. Due to the unbalanced nature of the dataset, some widely used tests, like the Pedroni (1999), are not performed as they require a balanced dataset. Therefore, only the Westerlund (2007) test was performed.

The PMG-estimator is only consistent and efficient when the long-run coefficients within the model are homogeneous across countries (Pesaran et al., 1999); this assumption of homogeneity was tested within the panel. To test this assumption, a Hausmann test (1978) was performed to check if the PMG-ARDL model is the best fit for the data. The Hausmann test (1978) runs the model using the PMG and MG, estimator and then tests which is the most efficient. The Hausmann (1978) tests for homogeneity of the long-run slopes, with the null hypothesis that PMG is preferred. The test does not reject the null hypothesis at the 5% level, which shows that the PMG-estimator is the most efficient and consistent estimator for this model.

Discussion

The results of the PMG-ARDL model, shown in (Table 4), show a significant long-run relationship between the main variables C and FDInet. This is to say that as the value for C increases, the FDInet increases in the long run. This is in line with the hypothesis that low environmental stringency can increase inward FDI (as a higher level for C indicates lower environmental stringency). However, the coefficient of the C variable is relatively small in the long run. As both variables have been log-transformed, this must be considered when discussing the coefficient. Table 4 shows that for every 1% increase in C emissions within a country, the value for FDInet to that country will, on average, increase by 0.012% ceteris paribus. This is in the same order of magnitude and has an overlapping 95% confidence interval compared to results other studies have found for specific countries or regions (Baek & Koo, 2009; Solarin et al., 2017; Xing & Kolstad, 2002). These findings reinforce the pollution haven hypothesis as it shows that the effect holds in an extensive sample of countries worldwide and not only for specific countries or regions. It shows that the location decisions of MNEs are correlated to the extent of environmental stringency within a country, albeit relatively small.

The value for C does not directly translate to the unobserved environmental stringency E*; environmental stringency's precise effect on FDInet is ambiguous. However, it can be stated that there is at least some significant positive effect on the net inflow of FDI and does, therefore, confirm the PHH in line with other empirical works (Cai et al., 2018; Solarin et al., 2017; Xing & Kolstad, 2002). The coefficient for C, in the light of E*, can be interpreted as follows: when a country increases environmental stringency in a way that the CO_2 emissions decrease by 1% for that country, then FDI will decrease by 0.012%. Because a higher value of C translates to a lower level of environmental stringency, the results show that higher environmental stringency decreases inward FDI towards the country. It must be noted, however, that the inflow of FDI is not necessarily polluting FDI. A different dataset would have to be used to assess purely polluting FDI. However, this was not possible within this study due to data constraints.

Table 4: Pooled mean group with dynamic autoregressive distributed lag (1) [PMG-ARDL (2,0,0,0,0,0,0,0)]

Variable	Coef.	Std. Err.	Prob.	[95%Conf.	Interval]
logFDInet					
		Long-run			
logC	0.025***	0.004	0.000	0.011	0.026
L.2logFDInet	0.026	0.026	0.319	-0.025	0.076
GDPgrow1	-0.001	0.002	0.406	-0.005	0.002
logGDPcap1	-0.321***	0.028	0.000	-0.376	-0.265
$GDPcap^2$	0.023***	0.002	0.000	0.020	0.025
HYDRO1	-0.0002***	0.0002	0.085	-0.0003	0.000
EC1	0.001***	0.0001	0.758	-0.001	-0.001
URBAN1	0.001***	0.0002	0.000	0.0008	0.0018
		Short-run			
ECT	-0.580***	0.041	0.000	-0.660	-0.500
logC1	-0.213	0.199	0.285	-0.604	0.178
GDPgrow1	-0.003	0.003	0.289	-0.008	0.002
logGDPcap1	1.792***	0.529	0.001	0.755	2.830
HYDRO1	-0.005	0.052	0.925	-0.106	0.096
EC1	-0.007	0.010	0.490	-0.026	0.013
URBAN1	0.106	0.115	0.355	-0.119	0.331
Constant	5.311	0.334	0.000	4.656	5.966

Note: Number of countries =117
*Note: *, ** and *** indicate significance at 10%, 5% and 1% levels respectively.*

When looking at the other variables used within the model, almost all variables have the hypothesised coefficient direction and are highly significant. However, GDP growth and the second lag of FDI are insignificant when looking at the long-run relation. Furthermore, GDPcap has a significant negative coefficient, while a highly significant positive coefficient for the squared GDP per capita variable implies the existence of an inverted U-shaped relation between FDInet and GDPcap. In the short run, however, only GDP per capita is significantly positive. This indicates that shifts in GDP per capita will cause an increase in FDI towards specific countries, which is in line with what was expected. However, because of the nature of the PMG model, it is expected that the short-run values are not significant across countries because the PMG model allows the short-run slopes to be heterogeneous across countries.

Table 4 shows a strongly significant value for the error correction term (ECT). When combining all short-run regressors, the ECT has an average convergence speed of -59%. The negative value for the ECT confirms the existence of a unique cointegrating vector amongst the specified variables in the long run. Furthermore, it indicates a relatively slow return towards the long-run equilibrium after a shock in the short run when looking at the entire sample. This shows that a deviation from the long-run equilibrium is on average corrected for 59% within a year. This shows that a new policy to combat pollution will take approximately two years to settle to its long-run equilibrium. The long-run co-integration implies a causal relation between C and FDInet and, by extension, environmental stringency. This causal relation will later be formally tested.

Table 5: Pooled mean group with dynamic autoregressive distributed lag grouped on GDP/cap countries [PMG-ARDL2,0,0,0,0,0,0]

GDP per capita group	(2) Low/ middle-low GDP/cap countries	(3) Upper-middle GDP/cap countries	(4) High GDP/cap countries
Variable FDInet	Coef.	Coef.	Coef.
		Long run	
logC1	0.016***	0.002	0.036***
L2. logFDInet	-0.080	-0.026	-0.041*
GDPgrow1	-0.0001	0.002***	0.010***
logGDPcap1	-0.053***	0.051*	-0.099***
$GDPcap^2$	0.048***	-0.012	0.068***
URBAN	0.004***	0.002***	0.003***
EC11	-0.0001***	-0.0002	-0.001***
		Short run	
ECT	-0.550***	-0.564***	-0.630***

Note: Number of countries =117
*Note: *, ** and *** indicate significance at 10%, 5% and 1% levels respectively.*

Within the literature, there has been extensive debate about how GDP per capita could affect the relationship between the environmental stringency and FDI, resulting in either the pollution haven (Cai et al., 2018; Solarin et al., 2017; Xing & Kolstad, 2002) or pollution halo hypothesis (Ahmad & Du, 2017; Grossman & Krueger, 1991; Zarsky, 1999). Other authors argue for the existence of an environmental Kuznets curve, where when GDP per capita rises; initially, pollution will rise, then the increase will stagnate, and finally, pollution will decrease (following the shape of the Kuznets curve) (Baek, 2016; Cole, 2004; Lau et al., 2014). Therefore, three additional PMG-ARDL models were run, of which the results can be seen in Table 5. The panels were selected based on the World bank (2021) country classifications for GDP per capita. For the panel selection, the average GDP per capita per country is taken and based on this, the country is placed within a specific group, as some countries would otherwise shift between different panels during the sample period. The division of countries is made the following way: low/ middle-low GDP/cap < \$4.095, upper-middle \$12.695 > GDP/cap > \$4.095 and high GDP/cap > \$12.695. In the first (1) regression, the low and middle-low GDP per capita countries were grouped, as the sample size would have been too small to run a PMG model when separated. This is not in line with the World bank division but allows for better comparison across groups, making it possible to use the same estimator for all three groups. This combination of two GDP per capita groups was necessary due to the limited data availability for low GDP per capita countries. Furthermore, a squared GDP per capita term ($GDPcap^2$) was added to test for a U-shaped relation between FDI and GDP per capita.

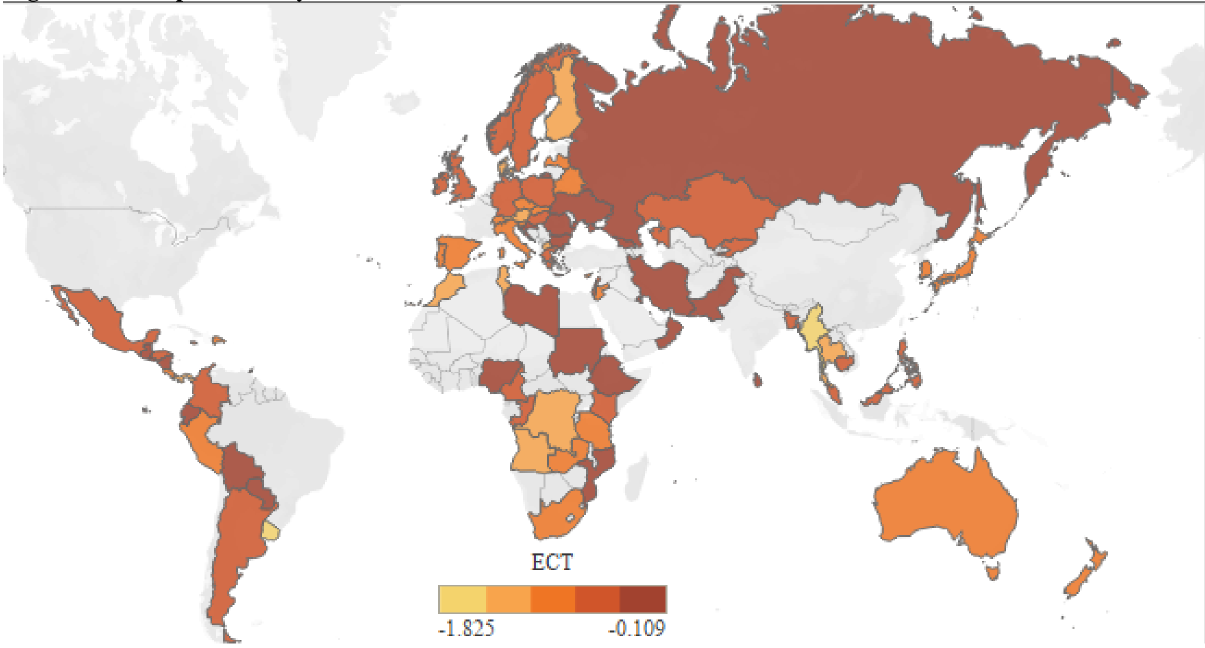
First, the coefficients for C are positive for all three panels. However, only regressions 1 and 3 are significant. This is in line with the first regression in table 4, as the coefficients are all positive, further reinforcing the pollution haven hypothesis. It shows how FDI transfers to countries with lower environmental stringency and increases pollution. There is a big difference in coefficient between regression 2 (low/ middle-low GDP/cap countries) and regression 4 (High GDP/cap countries), where the coefficient for regression 4 is almost double the size. This is in line with previous research showing similar coefficient differences between countries with different levels of GDPcap (Baek, 2016; Yilanci et al., 2020). It shows how high GDP/cap countries are relatively more attractive to invest in when they decrease environmental stringency as the coefficient of C is higher in these countries. This could be explained by the higher absolute amount of FDI towards high GDP/cap countries or by the fact that high GDP/cap countries generally receive higher FDI as they are more attractive to investors (Agarwal, 1980). A different explanation could be that higher GDP/cap countries tend to receive a relatively large part of FDI in the service industry, which is usually not very polluting (Baek, 2016). This could skew the coefficients of the C-value. In further research, this could be corrected by using only specific (polluting) FDI or by correcting for this using per country industry information.

The value for C in upper-middle GDP per capita countries is not significant. This implies that there is no significant evidence for the confirmation of the PHH in these countries. As stated before, other research has also found differences in effects between countries with differences in GDP per capita (Baek, 2016). However, most other research finds the differences between the high GDP per capita countries (Baek, 2016) and the low GDP per capita countries (Sarkodie & Strezov, 2019a). The country-specific heterogeneity could explain the p-value for upper-middle GDP per capita countries. The heterogeneity could be relatively high within this group, as many of these countries have recently advanced out of the lower-income region. This could imply that some countries in the subsample are more like high GDP per capita countries, while others within the same subsample are more like the low-income GDP per capita countries. Further research could separate this group more precisely to test for this specific issue.

Then we turn to the ECT of the new models in table 5. The results show that the ECT is weaker (the lower the number, the faster the return to the equilibrium) for countries with a lower GDP per capita. This is noteworthy as it shows that countries with lower GDP per capita take longer to return to the long-run equilibrium (approximately 13%). This has important policy implications. For low GDP per capita countries, this means that they must act earlier when implementing a new policy to combat pollution within their country, especially as many low GDP per capita countries are affected relatively strongly by climate change and pollution in general (IPCC, 2021). Therefore, especially in these low GDP per capita countries, they must consider their environmental stringency's effects on future inward FDI and pollution within their country. Considering that the ECT values are an average of all the countries within the sample, it shows that some countries have even slower responses to new environmental policies. Therefore, these countries need to adjust their policy even earlier for the full effects to solidify. Some countries with slower ECTs would have to adjust their policy sometime in advance. However, as most of these countries are relatively poor, it might not be easy to adjust their policy in a timely fashion as these countries often have other, more pressing issues in the short term.

To further visualise the ECT values per country, we turn to Figure 2. It shows all values for countries with a significant value for the ECT; darker red colours show a lower value for the ECT, implying a 'slower' return to the long-run equilibrium after a shock. This shows relatively large differences between countries' ability to adjust quickly to a changing environment. Furthermore, it shows relatively strong effects on some countries that are especially vulnerable to climate change due to their geographical location (EU-Commission, N.Y.). Countries like Pakistan, Oman, Iran, Sri Lanka, Guatemala, and Mozambique, should be extra cautious as these countries need longer than average to adjust to new equilibria (up to 9 years) based on these results. This shows that these countries must be extra responsive and act now to prevent additional polluting activities from being transferred as it takes them far longer than most to reset to the long-run equilibrium. This also has implications for MNEs or portfolio managers that want to invest in these low ECT countries. These parties must consider how their actions can (negatively) influence the host country's pollution levels. The host country governments might not be capable of adjusting policy fast enough to counteract rising pollution levels within their respective countries. For the countries with 'faster' ECT, this does not mean that they could not be affected by the transfer of polluting activities; it only shows that shocks in the short run would take their full effect on inward FDI faster. Countries with these 'faster' ECTs can be more responsive to their problems.

Figure 2: ECT per country



Note: Only countries with P< 0.1 for the ECT have been included in this map.
Darker colours show a slower return to long-run equilibrium, indicating that countries have a more delayed response to policy changes.
This indicates that these countries are more likely to be unable to respond to changes in environmental pollution promptly.

As many forms of pollution are a global issue, it also poses policy implications for global organisations, MNEs and high GDP per capita countries. These groups could consider the relatively slow response times and adjust decision-making based on this. Global organisations and high GDP per capita countries could, for instance, pose restrictions on the transfer of polluting activities to combat the shift of pollution or try to lobby lower GDP per capita countries for additional environmental stringency. While MNEs could decide not to transfer pollution towards countries with lower environmental stringency by self-imposing similar environmental standards for foreign subsidiaries at the cost of profits.

A cointegrating relationship among the variables within the model, which can be seen from the significantly negative ECT values in all models, suggests a causal relation in at least one direction. Therefore a Granger Causality test is done based on Dumitrescu & Hurlin (2012), and the results are shown in table 6 as a robustness check for the aforementioned causality. The test shows a one-way long-run Granger causality between CO_2 and net inward FDI, as the H0 hypothesis is rejected at a 1% significance level. This implies that lower environmental stringency granger causes additional inflows of FDI, which are likely to be polluting. These findings solidify the existence of the PHH using an extensive sample of countries.

Table 6: Dumitrescu & Hurlin (2012) Granger non-causality test results:

Lag order: 2	F-statistics (p-values)
W-bar	5.1975
Z-bar	8.6048 (0.0000)
Z-bar tilde	2.2445 (0.0191)

H0: dC1 does not Granger-cause FDInet1.
H1: dC1 does Granger-cause FDInet1 for at least one panel (Country).

Overall, the results show a confirmation of the pollution haven hypothesis. Countries with lower environmental stringency tend to receive higher amounts of inward FDI, confirming earlier empirical findings (Eskeland & Harrison, 2003; Hoffmann et al., 2005; Tang, 2015; Xing & Kolstad, 2002). This effect varies across different GDP/cap counties. However, this research applies an approach that uses a proxy to deal with the unobserved environmental stringency. Therefore, the precise effect of environmental stringency is hard to determine. This must be considered when interpreting the results of this study. Furthermore, net inward FDI was used to determine the transfer of pollution-intensive industries. This variable, however, does not only entail polluting FDI. Therefore, a different measure for FDI could be used for future research to get more precise results. For instance, different kinds of FDI or industry-specific FDI. Furthermore, a more precise deviation between countries could be made to understand better and investigate the difference in effect across countries with differences in GDP per capita.

This paper does not find any indication for the green haven hypothesis, as it does not find results that indicate that inward FDI increases as environmental stringency increases. However, this does necessarily mean that no such green havens exist. It could be that the method used was not sensitive to the existence of these green havens or that the pollution havens' effect outweighs the green havens. The results do, however, show that if there are green haven effects, they do not significantly show in world inward FDI; otherwise, the coefficient of C would have been negative.

Then we turn to the implications these findings have for the OLI/eclectic paradigm. Although the paradigm traditionally does not include policy determinants, the confirmation of the PHH in this paper shows that the OLI/eclectic paradigm must be reconsidered with the PHH in mind. The results show how the location decision of MNEs is affected by the extent of environmental stringency, which is a policy decision. This shows that, albeit a minor (global) effect, environmental policy does govern the (re)location decision. This effect could be classified under the efficiency-seeking or strategic asset-seeking dimensions of the paradigm. However, the results show that the OLI paradigm is in no way exhaustive. The PHH literature, and by extension, this paper, shows that this widely used framework should be revaluated and include an additional policy dimension to become more comprehensive. Although the environmental stringency is only a relatively small part of the location decision, the results show it is significant. When combined with other policy factors that affect different abetment costs, it could amount to a more significant factor that affects location decisions more substantially.

The results also have implications for the environmental Kuznets curve literature. As the results show a strong significant effect of environmental stringency on inward FDI, this also has implications for the EKC. Therefore, the transfer of polluting industries could be a part of the explanation for the EKC. Following the logic described within the theoretical framework, MNEs will initially transfer their pollution toward low GDP per capita countries, allowing these countries to become more prosperous and improve their technology. This could have two different implications depending on whether economic development (a rise in GDP per capita) can be decoupled from a rise in pollution in developing nations. When countries could decouple the pollution effects of a rise in GDP, this would mean that the hypothesised inverted U-shape holds in line with empirical findings confirming this relation (Cole, 2004; Grossman & Krueger, 1991; Pao & Tsai, 2011). However, as this research shows, pollution is also being transferred to other (developing) nations, which could also explain the reduced pollution in developed nations. Following this reasoning for the reduced pollution in developed nations, the PHH could also explain the cubic (N-shaped) form of the EKC caused by increased consumption due to increased income (Allard et al., 2018; Murthy & Gambhir, 2018). This research alone cannot determine which of these explanations for the EKC, considering the PHH, is more likely as both explanations are valid based on the results presented within this paper. However, these results show that the link between the PHH and EKC is important to investigate further.

Conclusion

This paper examines the pollution haven hypothesis by examining the relation between MNE location decision (through net inward FDI) and environmental stringency (proxied by CO_2 levels). It does this using an extensive panel data set, combined with a PMG-ARDL dynamic panel approach and Granger causality test. The study finds significant evidence for a negative relation between environmental stringency and inward FDI, meaning that additional stringency causes reduced amounts of FDI towards a country. For the global sample, inward FDI increases by 2.5% for every decrease in environmental stringency, which leads to an increase of 1% in CO_2 emissions. This effect differs across countries with different levels of GDP per capita, where high GDP per capita countries experience a more substantial effect (3.6%) of changes in environmental stringency compared to countries with lower GDP per capita (1.6%). The effect of environmental stringency on FDI does not seem to hold in the middle-high GDP per capita group. However, the effect of environmental stringency on inward FDI is stronger in high GDP per capita countries. The reverse effect holds for the ECT of the different panel groups, as lower GDP per capita countries tend to need a longer time to adjust their inward FDI after increases in environmental stringency. This shows that GDP per capita affects the responsiveness to policy changes. These findings further reinforce the existing literature on the PHH and, more specifically, they further reinforce that MNE's location decision is affected by the host country's environmental stringency. The findings align with other empirical research (Baek, 2016; Hoffmann et al., 2005; Solarin et al., 2017; Xing & Kolstad, 2002).

The results also show relevant findings for the OLI or eclectic paradigm. Environmental stringency is a significant determinant of the location decision for MNEs. Although the original paradigm does offer the location decision's efficiency-seeking- or asset-seeking explanation, this does not fully explain the relation to PHH as the paradigm traditionally does not incorporate local policy decisions. Therefore, the OLI or eclectic paradigm should be revisited to include the PHH as a determinant for the location decision advantage. In further research, it would be interesting to incorporate different kinds of host country abatement costs. For instance, costs arising from increased labour laws and how these additional abetment costs, and therefore local policy, affect the location decisions of MNEs.

Regarding the EKC, this paper does not find conclusive evidence that suggests a single explanation for the different EKC curves' shapes. However, the research shows how FDI transfers pollution to countries with lower environmental stringency. Therefore, it can explain both the reduction of pollution in developed countries (through the shift of polluting activities away from these countries) and the rise of pollution in other, mostly less developed countries (through the shift of polluting activities towards these countries). These results cannot differentiate between a cubic or quadratic relation for the EKC. However, the results of the regressions that were grouped based on GDP per capita do indicate a non-linear shape, as hypothesised in most EKC literature. For further research, incorporating EKC and PHH into a single framework could provide more evidence for the underlying mechanism. This combined framework could lead to more conclusive evidence for the shape of the EKC and its relation to the PHH. This would lead to insights that affect how we address global climate change and country-specific pollution problems. Under the current understanding of the EKC, countries will eventually become cleaner as they grow in economic development. However, if the EKC follows an N-shaped curve, this would not be the case in the long run. The N-shaped curve would show that economic growth is not a long-term solution to pollution and might only increase pollution levels globally due to increased consumption patterns.

These findings could be used by policymakers and other organisations around the world. It shows how local policy can affect the extent of FDI towards the country and how this happens through a delay that must be considered. This delay is especially pressing for some countries such as Pakistan or Oman due to their geographical location. These countries are especially vulnerable due to their proximity to the equator, leading to increased problems caused by climate change (IPCC, 2021). Furthermore, these countries suffer from a delayed effect of policy, making policy changes less responsive. Therefore, countries could implement preventive measures to stop polluting organisations from moving towards their country if they want to keep polluting organisations from transferring their polluting activities. This holds for both low and high GDP per capita countries. However, lower GDP per capita countries need longer to adjust to the new equilibrium after a change, so they would have to act relatively fast. For high GDP per capita countries, however, the effect of a change in environmental stringency is relatively stronger, which shows that these countries should be extra cautious in loosening environmental regulations.

The findings are also relevant to policymakers within high GDP per capita countries and for MNEs from these countries that often have relatively low pollution levels. As many pollution-related problems are not restricted to country borders, it would be wise for these more developed countries to try to implement multilateral policy to affect the ability of companies to transfer pollution or implement policies that force locally operating MNEs to adhere to particular environmental regulations when they have subsidiaries abroad. This could be done, for example, by the EU, by forcing imports to meet the exact pollution requirements that exist within the EU. This will lead to a reduced incentive to transfer the pollution, as the same standards will have to be met. For MNEs that want to contribute to the global environment or to positively affect their corporate social responsibility, it could be interesting to implement relatively clean policies in developing countries. By doing this, the host countries could become green havens. This could ultimately benefit both the MNEs and the host countries through an improvement in their perceived environmental responsibility and improvement in the local environmental development, respectively. As it is unlikely that MNEs will do this voluntarily due to reduces profits, governments of developed nations could implement subsidies to stimulate this behaviour. Furthermore, environmentally conscious consumers and stakeholders should pressure portfolio managers and MNE management to pursue more environmentally conscious decision-making.

When interpreting the results of this paper, some limitations must be considered, first of all, the data selection. The study's results might be biased as data was only taken from countries with extensive data. For example, it could mean that only countries with relatively low (or high) values for C or FDI were excluded from the research resulting in biased estimators. Furthermore, the paper uses a model that assumes homogeneity of the slopes in the long run. This assumption might be strong and could have inflated the estimated coefficients and p-values. Furthermore, the panel selection based on GDP per capita could have been done differently; this might have been possible by using different variables or a different time window.

Further research might help explain the differences in significance per panel. This is especially important for the middle-low and middle-high GDP per capita groups. Finally, this paper uses the main explanatory variable CO_2, to measure the unobserved environmental stringency. As this measure only incorporates CO_2, it might not be sensitive to different pollution forms, which could result in ambiguous estimations. Therefore, in further research, the CO_2 measure could be combined with different variables to test the robustness of the results. For example, to further reinforce the results of this paper, different variables for environmental stringency could be used in a similar model. Such as the WEF survey or pollution intensity, as these additional proxies would add robustness to the results (provided that they show similar effects).

For the dependent variable, it is unclear to what extent the variable can encapsulate polluting activities, as inward FDI is not inherently polluting. This makes that the coefficient for C does not translate directly to the inflow of polluting FDI but rather to FDI in general. In further research, the measure for FDI could be disaggregated. For example, FDI could be split into more narrowly defined subcategories to make it more explicitly polluting FDI. This could be specific industries or different kinds of FDI, such as horizontal, vertical or export platform. Further research could also focus on adding different sub-panels, such as regions. This could give more extensive insight into how the transfer of pollution takes place and if, for instance, continents play a role in this. Because the transfer of pollution can happen through trade and FDI, further studies using the PMG-ARDL approach in a trade setting would benefit the PHH literature. Apart from trade, further research could also implement the PMG-ARDL approach to different variables for environmental stringency and FDI to reinforce this paper's findings further.

The recent Russia-Ukraine war and the resulting deglobalisation and supply-chain disruption that has occurred worldwide, especially in Europe (Harvey, 2022), could impact the PHH relation. As Europe is trying to get less reliant on the polluting oil and gas from Russia due to its significant funding of the ongoing war, the war might be the catalyst that many developed nations need to push towards greener economies (Florizone, 2022). It would be interesting to see how these events affect the relation between environmental stringency and FDI worldwide, as both MNEs and other policymakers might be inclined to move towards more sustainable goals. In the future, as more data is available, more research could be done with the most recent data to show how the Russia Ukraine crisis has influenced the PHH.

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