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The impact of environmental policy stringency on FDI flows:
Evidence from BRIICS-OECD flow panel data

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Abstract

The Paris Agreement has increased interest in environmental policy research, which has alerted that companies will relocate their investment to countries with less stringent environmental standards. This pollution haven effect, although theoretically analyzed, has wide-ranging empirical results which are highly dependent on the selected case and proxy for environmental policy stringency. Attempting to contribute to this debate, this research utilizes a comprehensive policy-based composite index to estimate the relationship between environmental policy stringency and FDI in an OECD-BRIICS panel dataset. Using a fixed-effects estimation, the results of this study show that a larger difference between origin and destination country in environmental policy stringency is associated with an increase in FDI, providing evidence for a pollution haven effect. Additionally, a time dimension of the analysis has also been found to be relevant when considering different time frames for the origin and destination country. Finally, when decomposing the indicator, it is found that market-based instruments of environmental policy have a stronger impact on FDI flow than non-market instruments.

Keywords: environmental policy stringency; pollution haven; FDI; fixed effects; location hypothesis; BRIICS

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List of Abbreviations

BRIICS: Brazil, Russia, India, Indonesia, China, South Africa
CO_2: Carbon dioxide
EPS: Environmental Policy Stringency
FDI: Foreign Direct Investment
GDP: Gross domestic product
MNC: Multinational companies
NO_x: Nitrogen oxides
OECD: Organization for Economic Co-operation and Development
PHE: Pollution haven effect
R&D: Research and development
SO_2: Sulfur dioxide
SO_x: Sulphur oxides
UNCTAD: United Nations Conference on Trade and Development

1 Introduction and aim

A distinctive characteristic of the globalization of the world economy has been the liberalization of foreign direct investment (FDI) flows. All over the world, countries seem to have placed the attraction of FDI at a very high place in the public agenda, and boosting a country's FDI appeal has been of concern for policymakers for decades, especially in developing countries (Denisia, 2000; Du, Lu & Tao, 2012).

Developing economies usually benefit from FDI as a source of modernization, growth, employment and economic development. Therefore, such inflows are usually welcomed and encouraged by the recipient countries (OECD, 2002). The BRIICS, a term coined by the OECD to add regional representation to BRICS by including Indonesia, have been particularly successful in this matter in the past two decades. As for the latest estimations, the BRIICS account for more than 15% of the total inward FDI flow in the world, a number that has boosted from 10% in 2000 (UNCTAD, 2018a). However, a downward trend since 2012 in the total available flow has made the competition for FDI more intense, mainly since it represents an average of 28% of GDP in BRIICS economies (UNCTAD, 2018a).

Since the Paris Agreement, governments have put increasing emphasis in strengthening their environmental regulations. In turn, this has given space for new variables to be considered in the competition for FDI. Among the multiple hypotheses trying to explain the attractiveness for FDI, the Pollution Haven Effect (PHE) has become more relevant in the past years. This FDI-environment argument builds on the base that FDI is attracted to lower-regulations locations, meaning that capital and trade will flow from countries with stringent regulations to those with less stringent ones (Cole, Elliott & Zhang, 2017). Generally, this means that liberalization and trade openness may act as an investment attractor, but also as an environmental degradation factor (Birdsall & Wheeler, 1993).

Although environmental policy as an FDI determinant has been empirically and theoretically studied, the evidence is not conclusive (i.e., Cole, Elliott & Zhang, 2017). Moreover, the scope of these studies is usually country-specific, using independent variables that could very much be *consequences* of FDI rather than its determinants.

This research, therefore, aims to contribute to the Pollution Haven Effect debate by examining the relationship of a policy-based instrument – OECD's Environmental Policy Stringency Index – on the flows of FDI between OECD countries and the BRIICS. This will be done by the use of 6 fixed-effects linear models. Overall, it will be argued that there is evidence for the Pollution Haven Effect (PHE), but not when focusing on the levels of environmental policy stringency of either origin or destination country, but instead on the difference between both. This is a definition of the PHE elaborated by Copeland & Taylor (1994), which establishes the environment in the analysis of comparative advantages in location determinants. Additionally, it will be argued that the impact of a more stringent environmental policy is not bound to a single-year relationship but may come into effect later. Finally, the two main components of environmental policy will be studied separately, showing that market-based instruments have a stronger relationship with FDI flows than non-market ones.

1.1 Research Problem

The relationship between environmental policy and FDI establishes a paradox for policymakers. Since polluting activities have high regulatory costs in advanced economies, a comparative advantage may arise in deregulating markets (Mani & Wheeler, 1998). Therefore, governments might face pressure to deregulate environmental standards in order to attract FDI (Cole, Elliott & Fredriksson, 2006; Levinson, 1996a; List & Co, 2000; Madsen, 2009). As argued by Jeppesen et al. (2002), an increase in environmental regulations can bring up different responses from companies, which would then impact the incentives set for policymakers. In the best-case scenario, multinational corporations (MNC) could continue their production with modifications to the process itself. Otherwise, they could relocate their whole production process; or they could shift the production from the particular plant affected by new regulations; or finally, they could decide to leave the industry without relocating, since it would not bring enough profits (Jeppesen, List & Folmer, 2002).

Recently, more pressure burdened governments: although BRIICS have been getting a continuously larger share of the world's FDI, the available stock is growing less rapidly than it was 10 years ago (see Figure 1.1). Even if their combined share has reached an 18% of the total world stock, the raw value only represents a 2% increase since 2015. This downward trend on overall FDI has also been stated by the last reports of the United Nations Conference on Trade and Development (UNCTAD, 2018b). In this sense, deregulating environmental policy may have disastrous effects on the environment, but encourage a 'race to the bottom' for already curtailing FDI that may be well received by developing countries.

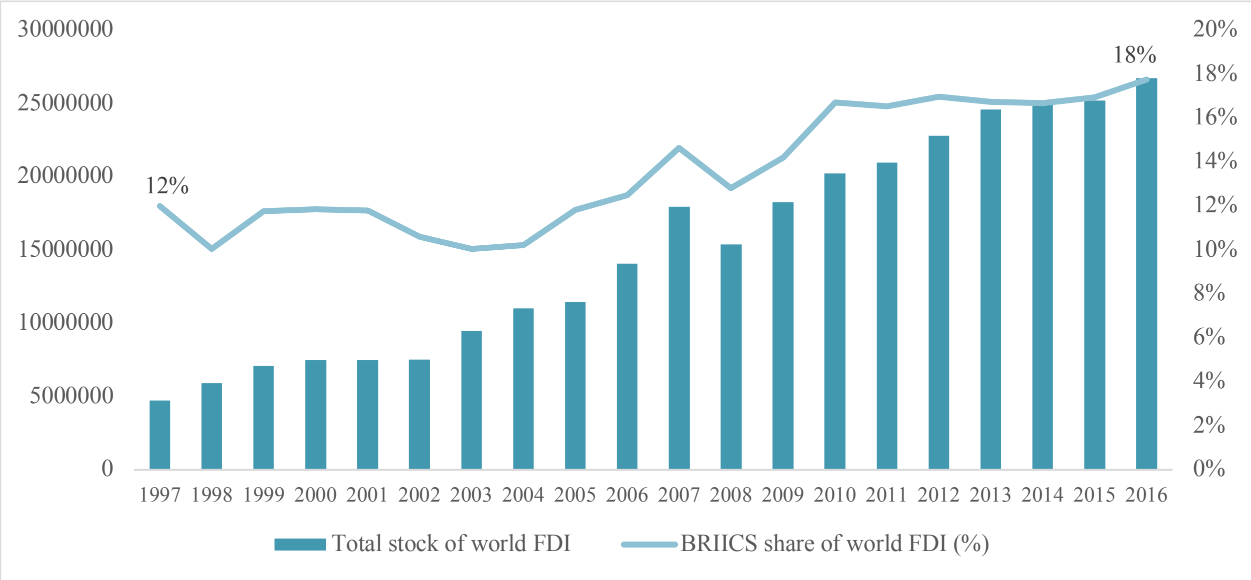

Figure 1.1:Total stock of FDI in the world (right axis) and BRIICS share of world FDI (left axis). 1997-2016.

Source: Based on World Investment Report 2017 (UNCTAD, 2018b).

There is a large number of studies attempting to measure both the existence and the extent of this pollution haven effect. However, although the results are far from conclusive, a commonly offered explanation is that compliance costs are too small relative to other costs to have a significant effect on industry location decisions: either taxes, wages costs, market accessibility or human capital may have a stronger role (Brunel & Levinson, 2013; Cole, Elliott & Zhang, 2017; Kheder, 2006; List & Co, 2000).

Given this context, this research seeks to contribute in answering two research questions:

1. *What is the influence, if any, of a more stringent environmental policy on the inflow of FDI in the BRIICS-OECD relationship?*

2. *To what extent do different aspects of environmental policy stringency have different impacts over FDI flow?*

The first research question aims to explore the relationship between a more stringent environmental policy and the inflow of FDI. According to UNCTAD, FDI is an investment that involves a long-term relationship, which reflects a lasting interest and control by a resident entity in one economy in an enterprise resident in an economy different than the foreign direct investor's, the destination country (UNCTAD, 2018c). It is expected for a more stringent policy to imply a decrease in FDI-inflow; or a laxer policy to increase flows. For this purpose, environmental policy stringency will be defined as "*the "cost" imposed on polluting or other environmentally harmful activity*" that individual policy instruments or comprehensive policies have (Botta & Koźluk, 2014: pp. 6). Moreover, the fact that the relationship is defined as long-term implies that the temporality of the relationship between FDI and environmental policy stringency may not be bound to a year-to-year basis but may have an extended time span to come into effect.

On the other hand, environmental policy has different components. As defined by the Intergovernmental Panel on Climate Change, a division of environmental policy can be made on the way they establish incentives; meaning whether they reach market-based policies, or non-market policies (IPCC, 2001). Market-based policies are meant to attach market forces like additional costs to interact with the incentive structure of polluters, instead of establishing explicit directives such as standards limitations or direct expenditure on new energy development (Stavins, 2006). Since market instruments have a much more direct relationship to the comparative advantage a country can quantify, therefore affect MNC much more directly, the expected impact of these two different components should also be different. This relationship will be analyzed in the second research question.

1.2 Relevance and objectives

Empirically, the pollution haven hypothesis has been extensively tested. This study attempts to tackle two of the limitations that previous research has faced. First, they are mostly country, industry or even firm-specific (see Cole, Elliott & Zhang, 2017). This allows for control in the origin country and details in the FDI type but hinders the identification of non-location specific factors in testing the PHE.

A second limitation has been the use of specific greenhouse gases pollution as proxies for environmental policy stringency. Quantifying the regulation itself has been a critical issue for all research dealing with environmental policy, as stated by Brunel & Levinson (2013), and the selection of the proxy is not without consequences. Most studies select indicators such as CO_2 emissions, which may be descriptive for some economies and for which there is data availability. However, greenhouse gas emissions are highly variable among and within industries, and also, not necessarily associated with higher costs in investments (Althammer & Hille, 2016). Mining, for once, although a highly pollutant industry, is not related with CO_2 emissions but with SO_2, while the recycling of plastics, which could be evidence of higher stringency is a heavy emitter of CO_2. Therefore, high levels of CO_2 could be interpreted either as the effect of lower stringency in environmental policy or as a trigger to take action, and therefore be coincidental with higher stringency (Brunel & Levinson, 2013). Thus, most measures of emission seem to be more one of characteristics of the economy than one of policy stringency, which rises a problem of simultaneity.

In that sense, it seems that a problem in answering questions about the effects of environmental parameters relies on the fact that policies themselves are not considered, but in its place, its effects which could be accidental or correlated to other factors. That is why it is relevant to introduce the variable of environmental policy stringency into account, an issue that, to current knowledge, has not been addressed so far in a non-country specific research.

The selection of BRIICS as destination countries is also relevant. In a more general term, BRIICS represent around 40% of the world's population and around 25% of total GDP, a number that keeps growing (The World Bank, 2018a). Specifically, FDI represents a large percentage of BRIICS' GDP: 15% of India's, 24% of Indonesia's and China's, 30% of Russia's, 31% of Brazil's and 46% of South Africa's economy (OECD, 2018). This percentage has continuously increased, making these economies more dependent on FDI and large recipients of total global flows. Moreover, it is estimated than BRIICS will become both large recipients and exporters of FDI, and as the more developed of the emerging world' economies, it is expected from them to set trends for the remaining of the transitioning economies (Nistor, 2015).

The fact that the countries are economically dependent on different sources, located on different regions and have diverse sizes, levels of openness, and tax structures allows for controlling for differences within OECD's economies pattern of investment as well, limiting the extent of selection biases (Geddes, 1990). Moreover, the fact that they have similar relative levels of development overcomes what Blonigen & Wang (2004) have identified as a systematic difference between the determinants and conditions of FDI in developed and developing countries, which may bias results when they are pooled together. On a practical note, BRIICS have been compared by the OECD concerning environmental policy stringency in the Environmental Policy Stringency Index indicator, which allows for inter-country assessments on a relatively long period.

Finally, regarding policy prescription, research on environmental policy and its effects seems to be gaining relevance in the latest years. The need for effective climate policy instruments has become more pronounced under the Paris Agreement, as existing pledges are insufficient to meet global temperature goals. Therefore, strengthening the understanding of factors conducive and detrimental to the adoption of stringent environmental policy can increase the likelihood of its implementation. Since the level of agreement over climate-related problems is low even at the level of the questioning it being a problem at all – let alone how to solve it -, the traditional model of policymaking is somewhat questioned (Evans, 2012). For most cases, this means a cost-effective, problem-minimizing strategy that works under great deals of scientific certainty, which is not the case of environmental problems (Davoudi, 2006). Therefore, all evidence that can provide some light in the face of newly tackled environmental challenges would hopefully contribute to this debate.

The remaining of this research will be structured as following. Chapter 2 contains the theoretical development regarding the relationship between environmental policy and FDI, including previous research regarding the Pollution Haven Effect, the use of different indicators of environmental policy stringency, and the determinants of FDI in the location hypothesis. Chapter 3 explains the dataset put together for this research and its limitations, while Chapter 4 goes over the proposed methodology. Chapter 5 contains the results of the empirical analysis of 6 fixed-effects linear models testing the relationship between environmental policy stringency and flows of FDI, the discussion of results and possible biases. Finally, Chapter 6 summarizes the conclusion, policy implications, and further research.

2 Theory and previous research

To provide a better understanding of the theoretical and empirical research of the FDI-environmental policy relationship, this chapter will be separated in two sections. The first one will analyze the literature regarding FDI determinants from a theoretical perspective under the location hypothesis, presenting the mechanisms underlying the location selection for investments. The second part will review the theoretical development of the pollution haven effect, and the issues regarding how to measure environmental policy and the different implications of its proxies as independent variables, as well as previous findings. Finally, the hypotheses deriving from this literature will be outlined.

2.1 The location hypothesis and location selectivity

Given the rise of FDI in the past decades, a growing number of theories has tried to explain causes of why would multinational companies (MNC) incur in FDI; what leads them to choose a country over other; and why they choose a particular way of entry (Moosa, 2002). Mainly, these theories can be divided in two large groups: one of them explaining MNCs' choice of location, while a second group tries to address what gives countries the ability to attract FDI (Moosa, 2002). Although this distinction does not have a substantial empirical relevance since modelling strategies have been similar for both, it does have an important underlying assumption that gives agency to different actors, which, therefore, impacts the expected policy implications of either way of analysis.

The general theory behind analyzing country-level determinants comes from the assumption that choosing one country over other has different associated costs, which may therefore influence the profitability of a company (Root & Ahmed, 1979). These determinants are regarded as location factors. According to the location hypothesis, FDI is determined by the international immobility of some factors of production, such as labor, natural resources or, as relevant for this research, environmental abundance (Levinson, 1996a; List & Co, 2000). Therefore, this leads to location-related differences in the costs of production factors, which give countries locational advantages such as low wages. Locational advantages can take the form of any factor of production that allows for the saving of costs: energy subsidies, capital taxes subsidies, or environmental regulation stringency (Moosa, 2002).

The location hypothesis has been included in a more formal theoretical framework by John Dunning in the 'Eclectic Paradigm'. According to Dunning, MNC will incur in FDI when three forces are coincidental: **o**wnership, **l**ocation and **i**nternalization comparative advantages of relocating abroad, which is why the framework has been refer to as 'O-L-I' (Dunning, 1977). Ownership advantages refer to the benefits of owning productive processes, intellectual patents, technology or management skills, either formal or informally, which may arise from relocating a company abroad (Dunning & Lundan, 2008). Internalization advantages, on the other hand, refer to comparative advantages rising from the internal exploitation of ownership advantages instead of transacting them in an open market (Dunning, 1977).

Although all three of these components are equally relevant in Dunning's paradigm, both internalization and ownership comparative advantages refer to the internal characteristics of firms and the way they are shaped to take advantage of international trade (Dunning, 1998). Location advantages, in the other hand, are related to the characteristics of the country, and are a company's response to the incentive system that countries establish; therefore, a direct function of a comparative advantage (Dunning, 1977). Location benefits are defined at a country level, and theoretically put agency in companies' response to countries' decisions. This is why the focus of this research is on the location comparative advantages.

Moreover, although the components may have the same relevance, they occur in different timelines: both internalization and ownership characteristics are constrained by the choice location, since business will incur gain more or less advantages depending on the costs and benefits of doing at home or in a foreign location (Dunning, 1998). Therefore, location advantages are previous to the other two components.

In the case of the location hypothesis, the traditional approach to model the firm location selection has been assuming that firms (a) will select a location (j) if the expected profits π_{aj}, exceed the profits of locating somewhere else π_{ak} for all alternative locations. Such profits are given by the equation 2.1 based on McFadden (1973):

Equation 2.1: Profits for firm A at location J

$$\pi_{aj} = \beta' X_j + \mu_{aj}$$

In this case, X_j is the vector of state characteristics that affect production costs, β' are the estimated parameters for all the components of the vectors, and μ_{aj} is the random error (List & Co, 2000). Polity characteristics thought to affect location decisions are wage rates, labor union rates, energy costs, tax structures, infrastructures and market size (Brunnermeier & Levinson, 2004). This follows the idea that firms will choose locations where inputs are cheaper and will be attracted to larger market sizes to utilize resources efficiently and exploit economies of scale.

According to Dunning, theoretical determinants of locational advantages are varied, and can be separated according to the type of FDI they are responding to. Generally, advantages are determined by availability and price of natural resources; infrastructure; government restrictions of FDI, and availability of local partners to promote knowledge-intensive resource exploiting (Dunning, 1998). All of these elements are expected to increase a location advantage positively. Additionally, large markets; availability of human capital and business suppliers;

macroeconomic stable institutions; and cheaper production costs will become a relevant determinant; while theoretically, the remoting of obstacle to investments will have an equally large impact (Dunning, 1998). Environmental regulation, therefore, may fall in the latest category and become a locational advantage when supporting investment efforts, but erode it when it works as a cost-increaser.

2.2 The relationship of FDI and environmental policy

2.2.1 Theoretical developments of the Pollution Haven Effect

The original literature regarding the effect of the pollution haven hypothesis came from trade theory, and its roots come from the early 1970's, as well as the previous work in the topic. The theoretical stance for this research was the Heckscher-Ohlin model of trade, which argues that countries will export goods in which they have local abundance of production factors (Brunnermeier & Levinson, 2004). Thus, the pollution haven hypothesis suggested that a reduction in barriers of trade will imply a shift in pollution-intensive industries from countries with stringent environmental barriers, to those with less stringent ones. However, little theoretical and empirical support has been found for this claim, since trade theory has suggested that many additional factors will affect trade flows (Copeland & Taylor, 2003).

A reduced version of this theory, for which more theoretical and empirical support has been found, is addressed to as the Pollution Haven *Effect*. The main argument has been that trade and capital will flow from countries with more stringent regulation to those with less stringent ones, which is the foundation ground for the pollution haven hypothesis (e.g., Baumol & Oates, 1988; Chichilnisky, 1994; Motta & Thisse, 1994). However, it is defined by the fact that is an *effect*, or an additional variable, and not the whole determinant of trade. Hence, it implies that more stringent pollution regulation will marginally have an effect on plant location decision and trade flows (Copeland & Taylor, 2003)

The causal mechanism for the pollution haven effect is the following: the theory of comparative advantages states that countries will specialize in the production of goods they are efficient at, implying that countries will specialize in producing good that use factors of production with which they are strongly endowed (Pearson, 2000). Therefore, if the environment is considered a provider of services that enter the production function, it is a relevant comparative advantage in one of three functions: as consumption good; as an unpriced complementary input; or as a provider of assimilative capacity through waste disposal services (Pearson, 2000). Pethig (1976) states that, in a two-country open economy trade situation, and without any environmental protection policy, trade will take place purely based on comparative labor productivities, but it will lead to a welfare loss in the country specializing in the environmentally-intensive good (Pethig, 1976). Environmental controls, then, erode the comparative advantage.

A key aspect of the pollution haven effect seems to be that the comparative advantage of a country by having low environmental standards is precisely that they have to be lower than those of the host country. According to Copeland & Taylor (1994), it is the differences in environmental policies which give comparative advantage and create the incentives for trade. This has meant that a pollution haven effect is thought to mean that economic activity will shift from jurisdiction with stricter environmental regulations, to those with less strict ones (Brunnermeier & Levinson, 2004). Therefore, it is possible to infer that a pollution haven effect will only occur if the differences in environmental policy and its associated costs are enough to offset other costs associated to offshore production (Copeland & Taylor, 2003).

Finally, tackling the issue of endogeneity, a different string of literature states that the relationship between FDI and environmental regulation is not necessarily unidirectional: it is possible that FDI may also impact the way environmental policy is determined. This is a different causal mechanism, although it has the same implication. Stating that companies themselves have the power to determine a lower environmental standard for countries, especially for those that have a stronger reliance on highly pollutant activities such as natural resources extraction, it is expected of FDI to flow from highly-stringent countries to poorly-stringent ones (Cole, Elliott & Fredriksson, 2006).

2.2.2 Measuring environmental policy stringency

The capacity to research about the effects of environmental policy over different factors is highly dependent on the measurements of stringency of such policy (Brunel & Levinson, 2016). However, this has proven to be one of the difficulties of the literature regarding environmental regulation.

There have been five main approaches to analyze environmental policy as a quantifiable variable. The first one is the use of private-sector abatement costs as proxy for environmental policy. Abatement costs refer to the expenditure that companies have to incur in to reduce direct pressures on natural assets, such as waste-treatment facilities or noise mufflers (OECD, 2013). According to Brunel & Levinson (2016), this are usually reported in company surveys, or calculated indirectly based on accounting values. Different studies have used them in several ways: cost surveys coming directly from plants (e.g. Levinson, 1996b) or indexed costs based on industry adjustments (Keller & Levinson, 2002). Shadow costs mechanisms are also grouped under this category, referring to mechanisms that estimate the hidden costs of pollution by revising the energetic inputs (Althammer & Hille, 2016).

There are some problems with this kind of measures. First, by surveying companies on how much they spent on pollution abatement, biases can arise when the survey is performed by the government (Lavrakas, 2008). Another drawback of this measure, although it calculates exactly the economic costs that companies incur, is that not all of it will come from regulatory stringency: setting up noise mufflers may have varying costs in different locations, although the stringency of the policy may be the same (Brunel & Levinson, 2016). Finally, this data is hardly internationally comparable (Althammer & Hille, 2016).

A second type of measurements is the direct assessments of regulations (Brunel & Levinson, 2016). These studies usually analyze case-specific results of particular legislative pieces and relies on natural experiments as a way to not incur on a simultaneity problem, meaning, making sure that the causality is going from environmental policy to the measured output. Besides natural experiments, another way of measuring policy stringency through direct assessments is by measuring standards of maximum allowances, such as the lead content in gasoline for a proxy for the whole environmental policy (Cole, Elliot & Fredriksson, 2006). Although these studies can give in-detail information about the specific case that they choose as subject, it is nearly impossible to analyze more than one case at the time, and the results are not comparable over time or space (Brunel & Levinson, 2016).

A third type of measure is public sector expenditure as a proxy for stringency, although it has not been prevalent. This is due the fact that the relationship between stringency and expenditure is not straightforward from a theoretical point of view: if the government is spending more and by that is taking over the expenditure of private MNC, it is unclear if the policy is more or less stringent (Pearce & Palmer, 2001).

The fourth measure, and by far the most common, is the use of emissions, pollution or energy use as proxy for stringency of policy, analyzing the raw measurements or the decline in different pollutant agents, such as lead, water pollution, or most commonly, carbon dioxide. A newer approach has included the use of energy consumption, while others have argued that it is not carbon dioxide but sulfur dioxide that captures the laxity of environmental stringency (Cole, Elliot & Zhang, 2017).

A problem with this approach is that it is unclear whether the changes in energy use or pollutant emissions are due to policy stringency: for once, energy prices could be driving the use of energy down, and they are not always nationally determined. On the other hand, the industrial composition of an economy very much determines the emission composition and variation, and therefore, the impact in the pollution haven effect. For example, Xing & Kolstad (2002) find statistical significance in their analysis only for the SO_2 proxy, while not for any of the remaining greenhouse emission gases. Another limitation is that, although the relationship may be varying according to the industry, FDI may also be a cause for emission, therefore creating a problem when analyzing the direction of causality (Brunel & Levinson, 2016)

Thus, all of these measures deal with 4 conceptual challenges, as defined by Brunel & Levinson: multidimensionality, simultaneity, industrial composition and capital vintage. The first one refers to the fact that environmental regulation and standards are multidimensional, so matching the regulation to the addressed issue is also multidimensional, meaning it will be intermediated by different factors, which, in turn, will harden the measurement of specific issues (Brunel & Levinson, 2006). Secondly, the issue of simultaneity is relevant: it could well be that the initial conditions of an economy have a large impact on the stringency of its environmental policy, while the causality may be pointing in the other direction. A third issue are the differences in industrial composition: while the raw industrial production is a much more pollutant than textiles in air contamination, water may be more polluted from textile activity and therefore better captured in some measurements than others (Brunel & Levinson, 2006). Finally, capital vintage refers to the fact that new sources of pollution are regulated in a much stricter way than old sources, such as coal.

Much of these issues are overcome by composite indexes, and specifically, by policy-evaluating ones, which are underexploited in the reviewed studies (Botta & Koźluk, 2014). These come from aggregating individual indicators into a single score, and although they compare the effect of specific policies, the comparison of larger samples allows to control for simultaneity better than the direct assessment of regulations. They also play a better part addressing multidimensionality, since they can capture more aspects of a specific policy. Finally, although capital vintage and industrial composition are possible distortion factors for all environmental measures, composite indexes allow the inclusion of more measurements that can include some level of control, although they face the risk of bias in the creation of the index. That is why the proposed approach for this study is the use of a policy-based composite index that, to some extent, averts the limitations of the previously used measures.

2.2.3 Empirical evidence

Concerning the empirical evidence, the results finding a pollution haven effect are far from being conclusive, but also, have used a variety of indicators for policy stringency.

In the group of studies that find evidence for the existence of a negative relationship between environmental policy and FDI, Ferrara, Missios & Yildiz (2014) find that the likelihood for companies to relocate to low-environmental regulation havens increase when the equilibrium relationship between home and host country is shifted towards the latter. This is analyzed in the case of US-states, using environmental standards as independent variable. Poelhekke & Van der Ploeg (2015) find that stricter environmental policy, measured by asking experts, deters FDI inflows in specific sectors, such as natural resources extraction and refining, construction, and tobacco by 8% of each point of stringency increase in outward Dutch FDI. These results are consistent with those found by Cai et al., (2016) for the Chinese provinces, and by those of Chung (2014) for South Korea, both whom analyze CO_2 emissions as independent variable. There is evidence for the PHE at a subnational level, as supported between U.S. different states, in which it is shown that a USD1000 environmentally-related abatement cost increase would decrease the likelihood of new companies' attraction by 10% (List & Co, 2000). Similar to the approach to be conducted in this research, Tang (2015) concludes that the effect of environmental policy only comes in effect when host countries have stricter policies than home countries; but for U.S. outward FDI, with environmental policy measured as a function of business competitivity.

However, there have been numerous studies that find no or limited relationship between FDI and environmental policy stringency, or that is mediated by other economic or institutional factors. Early work showed very limited effects of environmental policy over FDI, which would only affect very large companies (Levinson, 1996a; Mani & Wheeler, 1998). This result is consistent with that of Masden (2009), who concludes that for the automobile industry, costs are high enough to not be altered by environmental taxes, when these are measured by CO_2 emissions. Hanna (2010) argues that, for U.S. based investments, no evidence allows to prove the PHE when using self-reported abatement costs from companies, and Manderson & Kneller (2012) find similar evidence for UK-based firms with the same indicator. For within-OECD countries, the effect has been estimated to be extremely limited, and to have a threshold under which environmental policy stops acting as a deterrent (Kalamova & Johnstone, 2011). Other studies have found that more stringent policy will even attract FDI when benefits are offered in home countries (Elliott & Zhou, n.d.). Sarmidi (2015) concludes that, although environmental policy stringency by itself has a negative effect over FDI inflow, when interacting with low levels of corruption, the effect is over-ridden.

Overall, there is no straight-forward evidence confirming or rebating the existence of a pollution haven effect. Moreover, the similarity of cases but differences in results when changing the indicator or method raises the relevance of choosing a theoretically consistent indicator.

2.2.4 Environmental policy components

There are several ways to classify environmental policy tools or instruments. A first approach is to divide tools depending on the main objective, or what is the policy trying to modify: it could be directed towards the change of human activity, or to the change of environmental processes (Klok, 1995). An example of the first type would be putting fines on polluting a water source, while the second type of policies would instead find ways to re-establish the natural sanitization process of such lake.

A second classification can be established based on the time of the intervention, establishing two different sets, a mitigation approach, and an adaptational one. The first one refers to the human intervention to reduce the sources of polluting agents such as greenhouse gases, while the second one, means the adjustments in systems, either natural or humans, in response to climatic challenges posed by environmental changes (IPCC, 2001). These two approaches have different policy instruments as well, that produce different incentives in MNC. As a rule of thumb, subsidies, taxes, cap-and-trade systems and demand-side control mechanisms of pollutants are considered mitigation tools, since they act in the proactive line of the climate (Parker-Flynn, 2014).

A third taxonomy, and more relevant to this study, is based on the way policy establishes incentives in the different agents of a society. In this approach, instruments can be market-based or non-market based, and it is the way OECD’s Environmental Policy Stringency Index divides the evaluated policy tools. Market-related tools, which are more recent than non-market ones, are thought to be more efficient and easier to administer than prescriptive regulation, and are thought to encourage firms to undertake control efforts that also decrease their own production costs, but also, to constraint them better if they are not willing to since they adapt better to different firms' standards (Freeman & Kolstad, 2006). Unlike non-market regulations, which also include government actions and its own investment, market regulations impose direct incentives and sanctions on companies that may work into shaping their incentive system.

As a general classification, market-based instruments of environmental policy usually take one of four forms: charges for pollution, tradable permits, market friction reductions and subsidy establishments or reductions (Stavins, 2006). The first refers generally to taxes; and the second one is generally known in carbon schemes as cap-and-trade systems or emissions trading. As for market friction reduction, it usually refers to information-problem reduction, such as labelling rules. Finally, subsidy reductions seek to reduce the economically inefficient or environmentally damaging practices, such as the elimination of fossil fuel subsidy, while subsidies seek to encourage changes in conducts, like feed-in tariffs (Stavins, 2006). Therefore, it is possible for different components of a country's environmental policy to have different impacts on the flow of FDI, and it would be expected to MNC to be more constrained by market regulations than by non-market regulations.

2.3 Hypotheses

Based on the literature analyzed in this section, this research will work towards testing the following hypotheses:

H_1: The FDI flow of a country will be negatively related to the stringency of its environmental policy.

H_2: The FDI flow of a country will be negatively related to the time-lagged stringency of its environmental policy.

Following the pollution haven effect idea, it is expected for countries that show a lower stringency on their environmental policy stringency to have a location advantage in comparison to placing investments in countries with higher environmental policy stringency. However, following Copeland & Taylor (2003), and since it seems to be a marginal difference between both countries, the difference between origin and destination country in the stringency of environmental policy is expected to relate positively to FDI flow. Hence, the expected relationship should work as to the bigger difference between origin and destination country in environmental policy stringency, the larger the FDI flow.

As with most of location advantages, changes in environmental policy at time T are expected to impact both other advantages and the measured outcome at time T_{+1} (Dunning & Lundan, 2008).

H_3: A larger difference in market-based instruments of environmental policy stringency will have a larger impact over the FDI flow than difference based on non-market instruments.

As mentioned, market-based and non-market-based instruments build on different incentives systems, and therefore will impact MNC differently. In that sense, market-based instruments will likely erode the location advantage in a more direct way for MNC than non-market instruments and are expected to have a larger impact on FDI-flows change than non-market tools.

3 Methodology

Most of the studies analyzing the relationship between FDI and environmental policy stringency are quantitative. This is relevant in order to capture a generalizable effect in a macro trend for a region, controlling for different country set-ups (Creswell, 2014). For analyzing the effects of policy stringency, a fixed effects model with FDI-inflow as dependent variable will be conducted. Specifically, for environmental policy stringency's relationship with FDI, this is not an uncommon approach, and has been a usual methodological strategy for medium-to-large N studies (e.g., Birsdall & Wheeler, 1993; Eskeland & Harrison, 1997; Keller & Levinson, 2002; Xing & Kolstad, 2002).

3.1 Fixed effects models

The rationale behind a fixed effects model is to account for omitted variables, in the sense that observations may not be independent one from another, and it is possible to expect more similarity within certain groups than outside of them (Gorard, 2003). In that sense, a fixed effects model uses each group, individual, firm or country as its own control (Allison, 2009). Formally, this means that if y and x (see Equation 4.1) are the observed explained and explanatory variable, and c is an unobservable random variable, c is attempted to be held constant as a group-invariant omitted variable (Angrist & Pischke, 2009).

Equation 3.1: Population regression function

$$\mathrm{E}(y|x_1, x_2, \dots, x_k, c)$$

This, however, does not exclude the possibility of a non-observed error, or an idiosyncratic disturbance. Hence, these disturbances are the ones varying across time and country and set up the final part of the fixed effects equation as the *u* term (see Equation 4.2).

Equation 3.2: Fixed effects equation

$$y_{it} = x_{it}\beta + c_i + u_{it}$$

According to Wooldridge (2002), a fixed effects model should be chosen over a random-effects one in the case that the parameter *c* is a 'fixed' parameter to be estimated for each cross-section observation in macroeconomic data. This, however, does not mean that *c* is a non-random variable, but rather, it allows for an arbitrary correlation between *c* and the observed explanatory variables. Moreover, since strict exogeneity cannot be assured, a fixed effects analysis may be more robust than a random effects analysis. Finally, a Hausman test was performed in all models, which gave formal evidence to prefer a fixed effects approach (see Annex B).

The conditions for a fixed effects analysis are the following: neither a proxy nor an instrumental variable for c is available; the data contains a time dimension; and c is thought to be constant. If such conditions are met, it may be assumed that c is an unobserved effect in a panel data analysis (Wooldridge, 2002). In the case of this analysis, the fixed effect is set to be on the specific country effect for each destination country. Therefore, 6 groups are created – one for each BRIICS country -. It is assumed therefore that the unobserved effect is a constant country-specific effect, which was not captured in any of the specific controls.

For a fixed effects model to be a valid inferential tool, it is necessary that the strict exogeneity assumption is fulfilled. This means that, when c is accounted for, no other group-specific variable should be correlated with the outcome (see Equation 4.3). A second assumption for a fixed effects model to be valid is that no time-constant variable should be part of the analysis. If this is the case, a time-dummy should be introduced. The final assumption for a valid estimator implies that the idiosyncratic error (u_{it}) has a constant variance across t, and is serially uncorrelated.

Equation 3.3: Strict exogeneity assumption

$$\mathrm{E}(y_{it}|x_{i1}, x_{i2}, \ldots, x_{it}, c_i) = \mathrm{E}(y_{it}|x_{it}, c_i) = x_{it}\beta + c_i$$

Under these three assumptions, a fixed effects estimator is consistent, asymptotically normal and has a proper estimation value (Wooldridge, 2002). To control for heteroscedasticity and serial correlation biasing the estimators, a clustered standard error approach was introduced for all models (details in Appendix B) (Abadie et al., 2017).

3.2 The models

As was stated in Section 2.1, the idea in the equation of determining the flows of FDI is given by a vector of state characteristics that affect production costs (List & Co, 2000). Following List & Co's argument, this vector - X_j - can be then divided into two different components: X_{j1} and X_{j2}. X_{j1} represents the vector of all environmental regulatory attributes of a country, while X_{j2} represents all other characteristics of a polity affecting the location decision. For a fixed effects approach to modelling FDI flows, the following models are proposed. To allow for comparison, all controls are kept constant and will be explained in the following section.

Equation 4.4 shows the econometric approach for a first model. The main independent variable for this model is the environmental policy stringency score of the destination country – the

BRIICS economy -. The underlying assumption is, following Brunnermeier & Levinson (2004), that countries with lower environmental policy stringency will attract more FDI inflows that countries with higher policy stringency, keeping all other factors equal. Equation 4.5 shows the specification for Model 2. Unlike the previous one, it is the difference between EPS scores between origin and destination country that is tested, to acknowledge what Copeland & Taylor (1993) describe as the marginal effect of more stringent pollution regulation on plant location decision. These two models are expected to analyze Hypothesis 1, and it is expected for EPS of destination country to have a negative effect on FDI flow, while EPS difference to have a positive one.

Equation 3.4: Model 1 – Destination country EPS, fixed effects linear model

$$
\begin{aligned}
FDI\ Flow_{log} = {} & EPS_{destination} + distance + same\ language + natural\ resources_{rev.} + population \\
& + bilateral\ investment\ treaties + capital\ tax\ rate + tax\ revenue \\
& + tertiary\ educated\ population + FDI\ restrictiveness + growth\ rate_{origin} \\
& + growth\ rate_{destination} + inflation_{destination} + \varepsilon
\end{aligned}
$$

Equation 3.5: Model 2 – Difference between destination and origin country EPS, fixed effects linear model

$$
\begin{aligned}
FDI\ Flow_{log} = {} & EPS_{difference} + distance + same\ language + natural\ resources_{rev.} + population \\
& + bilateral\ investment\ treaties + capital\ tax\ rate + tax\ revenue \\
& + tertiary\ educated\ population + FDI\ restrictiveness + growth\ rate_{origin} \\
& + growth\ rate_{destination} + inflation_{destination} + \varepsilon
\end{aligned}
$$

Models 3, 4 and 5 introduce a time lag for Hypothesis 1. Assuming that policy will not come interact with the incentives of those making location choices for companies – and therefore, will not erode the comparative advantage of a country – as they are approved, the possible impact of environmental policy stringency will be lagged by a year (Chung, 2014). For this, three possible specifications are tested. Model 3 lags the EPS score of the destination country; Model 4 lags the whole difference between origin and destination country; and finally, Model 6 lags the score of the destination country, keeping the score of the current year for the origin country. This is made following Chung (2014), with the idea that information from the origin country, and therefore production costs are more easily available than those of the destination.

Equation 3.6: Model 3 – 1-year lag in destination country EPS, fixed effects linear model

$$
\begin{aligned}
FDI\ Flow_{log} = {} & EPS_{t-1\ destination} + distance + same\ language + natural\ resources_{rev.} \\
& + population + bilateral\ investment\ treaties + capital\ tax\ rate + tax\ revenue \\
& + tertiary\ educated\ population + FDI\ restrictiveness + growth\ rate_{origin} \\
& + growth\ rate_{destination} + inflation_{destination} + \varepsilon
\end{aligned}
$$

Equation 3.7: Model 4 – 1-year lag in EPS difference, fixed effects linear model

$$FDI\ Flow_{log} = EPS_{t-1\ difference} + distance + same\ language + natural\ resources_{rev.} + population + bilateral\ investment\ treaties + capital\ tax\ rate + tax\ revenue + tertiary\ educated\ population + FDI\ restrictiveness + growth\ rate_{origin} + growth\ rate_{destination} + inflation_{destination} + \varepsilon$$

Equation 3.8: Model 5 - 1-year lag in destination, difference in EPS, fixed effects linear model

$$FDI\ Flow_{log} = EPS_{t-1\ destination\ difference} + distance + same\ language + natural\ resources_{rev.} + population + bilateral\ investment\ treaties + capital\ tax\ rate + tax\ revenue + tertiary\ educated\ population + FDI\ restrictiveness + growth\ rate_{origin} + growth\ rate_{destination} + inflation_{destination} + \varepsilon$$

Finally, Model 6 will test for Hypothesis 2, which seeks to analyze the different components of environmental policy stringency. As mentioned above, different components of environmental policy are expected to have different levels of relevance in the flows of capital, mainly when it comes to the location selectivity of MNC. Expectedly, market instruments will have larger impacts over FDI than non-market instruments. The difference in scores of host and destination countries is included, as of Model 2.

Equation 3.9: Model 6 - Components of EPS difference, fixed effects linear model

$$FDI\ Flow_{log} = EPS_{market\ instruments\ difference} + EPS_{non-market\ instruments\ difference} + distance + same\ language + natural\ resources_{rev.} + population + bilateral\ investment\ treaties + capital\ tax\ rate + tax\ revenue + tertiary\ educated\ population + FDI\ restrictiveness + growth\ rate_{origin} + growth\ rate_{destination} + inflation_{destination} + \varepsilon$$

3.2.1 Control variables

Based on the literature review presented in the previous section, 12 additional variables are included in all models. First, a control variable for distance, measured in kilometers. According to Blonigen & Piger (2011), distance is one of the typical controls in FDI determinants modelling, and acts both as a proxy for friction between countries when it comes to investment selection, from the most obvious aspects such as time to get to the location to issues as time zones. It is expected for greater distance to have a negative impact on FDI flows. Secondly, and in a similar matter, a dummy for the same official language is included, attempting to capture the effects of 'cultural distance', meaning the existence of some common ground that facilitates the interaction of origin and destination representatives, based on institutional similitude (Madsen, 2009). This is either measured by including a 'colonial heritage' variable or a common language one, which is the case for this analysis (Blonigen, 2005). This is expected to have a positive influence over FDI flow.

The revenues coming from natural resources are often considered to be a strong determinant of FDI and are relevant for the location advantages in the OLI paradigm. Based on the location hypothesis, natural resources revenue is a function of factor endowments which empirically have been proven to have large impact in the flows of FDI and seem to be become more relevant when institutional capacities are not very strong. This overrides the positive effects of good governments over FDI (Biglaiser & DeRouen, 2006). Specifically, for this sample, all countries have substantial revenues coming from natural resources, primarily from extractive activities (World Bank, 2018). Therefore, they are expected to have a positive effect on FDI.

Population and GDP growth in destination are included in the model as a proxy for market size and accessibility, expecting to have a positive impact over FDI flow (Dunning, 1998) . Also, as general control for economic situation, inflation in destination country is included, expected to have a negative impact on FDI flows as a proxy for economic instability. Finally, GDP growth rate of origin country is included, although Assunção, Forte & Teixeira (2011) argue that the location fitting of this variable has different effects: while a higher GDP growth may imply more availability to invest abroad, it also means that comparatively the marginal returns of investing abroad become less relevant in a situation of financial boom. Therefore, it could be possible for growth of host countries to imply a lower flow of FDI.

To control for business costs in the host country, a dummy variable for the existence of a bilateral investment treaty is included, which is expected to give a location advantage over the non-existence of it (Blonigen & Piger, 2011). As defined by UNCTAD, these treaties usually impede double taxation and protect intellectual property, so they should encourage more relationships between origin and destination countries having signed them (UNCTAD, 2018d), therefore having a positive impact over FDI flow. Capital tax rates, on the other hand, should diminish the location advantages from a theoretical perspective purely based on costs, but they could also be indicative of state capacity and quality of institutions, and therefore also positively impact FDI (Blonigen & Piger, 2011; List & Co, 2000). Since the result of this control is not straightforward, total tax revenue as percentage of GDP is added. To control for general business environment and trade openness towards FDI, a control for FDI restrictiveness is included as well, which is expected to have a negative relationship with FDI: the more restrictive, the lesser the flow.

The share of tertiary educated population is included as a proxy for human capital, following Levinson & Taylor (2008) and Dunning (1998). Since education may increase the differences of destination and origin country, a higher level of education will likely improve productivity and technological innovation, as well as act as a cultural differences buffer (Assunção, Forte & Teixeira, 2011). Therefore, a higher share of highly educated population is expected to have a positive impact on FDI flows.

4 Data

The dataset created for this research comprises 1642 observations in 19 variables, in an unbalanced panel dataset. It includes information for 6 FDI-destination countries, the BRIICS, and 31 FDI-origin countries; all OECD members. The panel is structured in country pairs – origin and destination – for each year between 2003 and 2012.

Table 4.1: Origin countries

Australia	France	Japan	Slovakia
Austria	Germany	Korea (Rep.)	Slovenia
Belgium	Great Britain	Luxembourg	Spain
Chile	Greece	Netherlands	Sweden
Czech Republic	Hungary	New Zealand	Switzerland
Denmark	Iceland	Norway	Turkey
Estonia	Ireland	Poland	United States
Finland	Italy	Portugal	

Source: Based on International Direct Investment Statistics (OECD, 2014)

Table 4.2: Destination Countries

Brazil
China
India
Indonesia
Russian Federation
South Africa

Source: Based on International Direct Investment Statistics (OECD, 2014)

4.1 The dependent variable: FDI flows

The dependent variable, FDI flows, is an extraction of the OECD recording of International Direct Investment Statistics (OECD, 2014a). It includes all FDI flows in millions of US dollars from OECD countries to BRIICS from 2003 to 2012, including years with absolute 0 values. For the case of China, only mainland China values were included, excluding Hong Kong and Macau from the FDI flow data for two reasons. First, because it is unclear whether the Environmental Policy Stringency Index – the main explanatory variable- is inclusive of those territories; and second, because the remaining control variables correspond to nationally compiled data. 1642 observations were collected for this variable.

Table 4.3: Descriptive statistics – FDI flows

Variable	Range	Mean	SD
FDI flows	-4186,093 21415,894	556,187	1600,000
FDI flows (log)	8,110, 10,273	8,983	0,151

Source: Based on International Direct Investment Statistics (OECD, 2014)

As seen in Table 4.3, the dispersion of FDI flows is large and usually transformed to the natural logarithm to address its skewness (Blonigen & Piger, 2011). However, because of the existence of negative observations, a constant was added to all values and the variable was rescaled, following Kheder (2006). Since the results of a log-linear model will address changes in percentages, there is no need to back-transform the variable. Figure 4.1 shows the differences in FDI inflows between countries for all years included in the analysis.

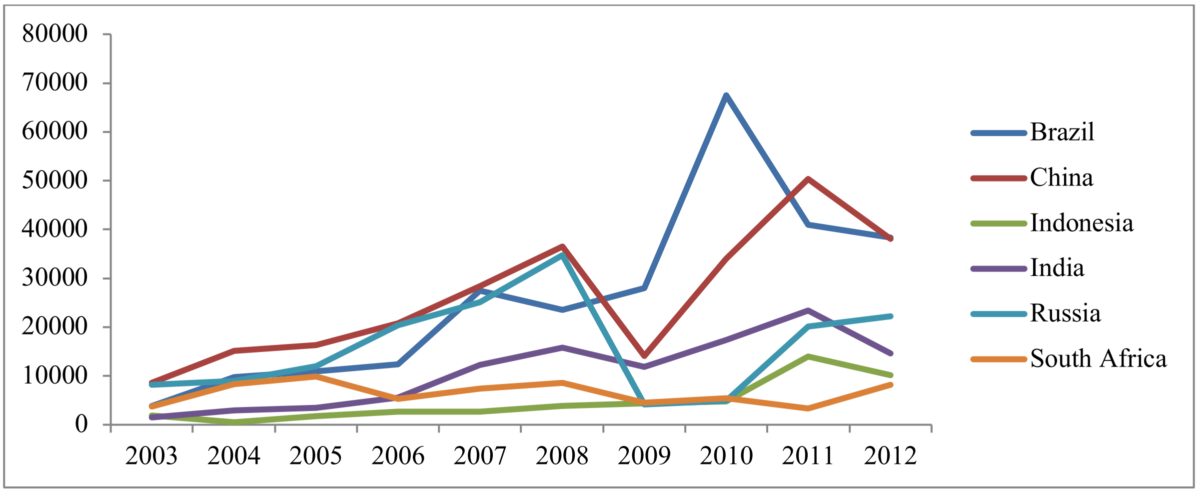

Figure 4.1: FDI inflows to destination countries in millions of dollars (yearly sum)

Source: Based on International Direct Investment Statistics (OECD, 2014)

4.2 Independent variables

4.2.1 The Environmental Policy Stringency Index

The Environmental Policy Stringency Index constitutes a proxy for the main independent variable. This composite index is defined as an 'economy-wide' indicator, meaning that it does not only include market based instrument, but also non-market based such as government expenditure in R&D for renewable technologies, or emissions limit standards for greenhouse effect gases (Botta & Koźluk, 2014). It includes 14 weighted indicators (See Figure 4.2).

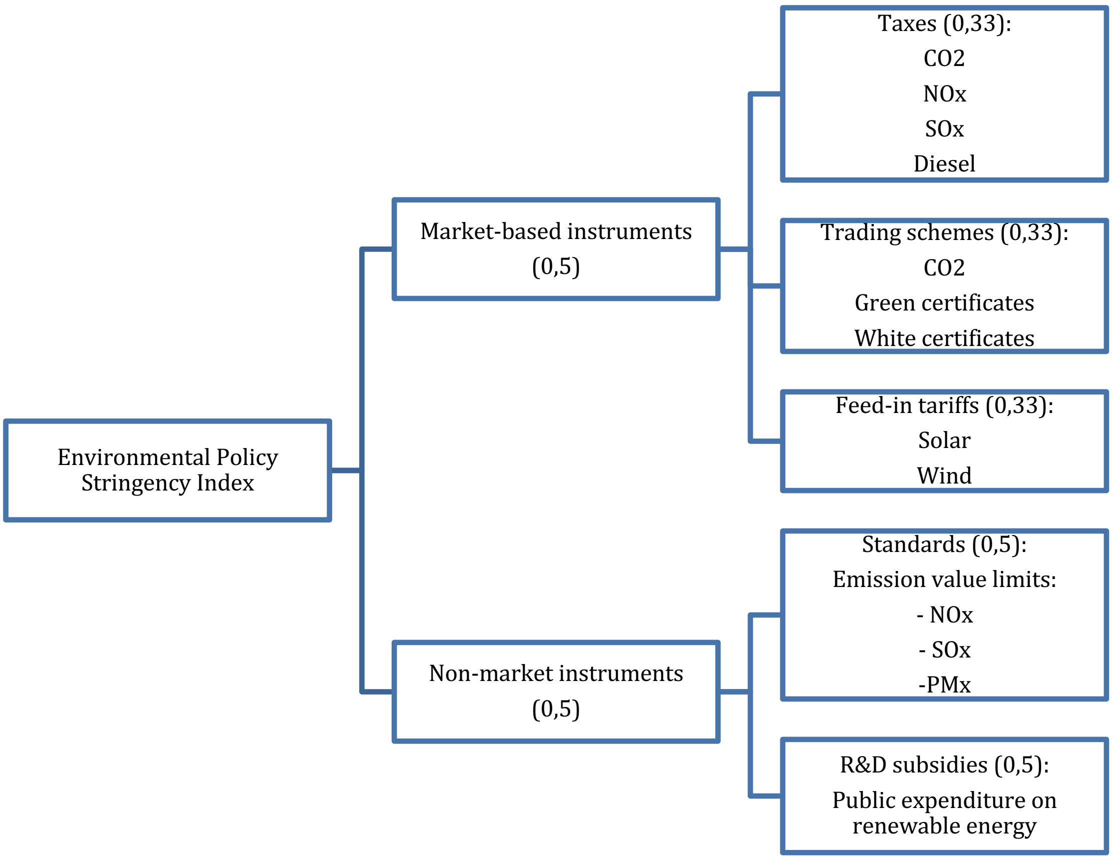

Figure 4.2: Environmental Policy Stringency Index – Components and weights

Source: Based on Botta & Koźluk, 2014.

The market component includes market-based instruments such as taxes, trading schemes and feed-in tariffs. A new version of the EPS index also includes waste deposit schemes, but is only available for OECD countries, so in order to compare OECD and BRIICS scores, the 2014 version is used for this study (OECD, 2014b)

The first component of the indicator are taxes, which include emissions of CO_2, NO_2 (nitrogen dioxide), SO_2 (sulfur dioxide) and diesel taxes. Each of these are weighted equally (0,25), and in all cases, a higher tax indicates higher stringency.

The second component – trading schemes -, include certificates and a carbon trading scheme. Green certificates refer to the obligation to source a given percent of electricity from green sources, while white certificates indicate the amount of annual energy saving (expressed in kWh) (Botta & Koźluk, 2014). In the first case a higher percentage indicates higher stringency, while in the second, a higher energy saving does. The carbon trading scheme is ranked dependent on the average annual price of allowances of carbon to establish stringency.

The third component is feed-in tariffs. These correspond to long-term contracts that consider a fixed price for produced renewable energy, in the case of this indicator, coming from solar and wind sources (OECD, 2017a). Generally, feed-in tariffs are a mechanisms that has the aim to accelerate the investment in renewable energy and offer a premium over electricity market price, operating as a subsidy.

As for the non-market instruments, the EPS Index includes two components: standards and research and development subsidies. Emission value limits refer to the maximum amount that is legally allowed to discharge by a polluting agent. In this case, NOx, SOx, and particulate matter (PMx) are included (OECD, 2017). The final component is the GDP percentage of expenditure on R&D in renewable energy.

In terms of the scoring, it is straightforward for taxes: a higher price implies higher stringency; while lower emission limits act in the same way. For subsidies, like R&D related or feed-in tariffs, a higher subsidy is interpreted as a more stringent policy: as argued by Botta & Koźluk (2014), subsidies increase the opportunity cost of polluting which are paid by consumers and provide advantages to cleaner activities.

In comparison to other measures of environmental policy stringency, it has the advantages of analyzing a substantial number of countries over a longer period of time, in a non-expert surveyed manner, reducing the evaluator-bias (Lavrakas, 2008). Secondly, it includes a large set of policies that can capture the effect of multidimensionality in a better way. Thirdly, it includes mostly all different kind of measurements into one score: abatement costs, public expenditure, policy assessment and emissions. Finally, unlike measures of environmental performance, in the EPS Index the policies themselves are evaluated alongside its results, therefore reducing the risks of capturing simultaneity, while still addressing the impact of its consequences. Hence, it seems like an analytical tool that can give a fuller picture than the use of other indicators, while having a good equilibrium of specificity and generalization.

Theoretically, the results of the EPS vary between 0 (lowest EPS) and 6 (highest EPS), and there is relevant variation between origin and destination countries. As shown in Table 4.4, the mean for origin countries is more than 3 times higher than for destination countries, with higher lowest scores as well for the whole period (2003-2012).

Table 4.4: Descriptive statistics – EPS in origin and destination countries

Variable	Range	Mean	SD
EPS origin	0,688, 4,133	2,478	0,670
EPS destination	0,375, 2,042	0,748	0,380

Source: Based on Environmental Policy Stringency Index Dataset (OECD, 2014)

Figure 4.3 shows the trend for all BRIICS. Brazil consistently presents a lower score than the rest of the sample, and the only one with a pattern of decline. South Africa, although improving since 2008, suffered a fall in year 2012, while China has shown a great improvement since year 2008. This is consistent with policy findings for China, which approved a ETS experimental system for some regions, as well as announced a nation-wide carbon tax in 2008.

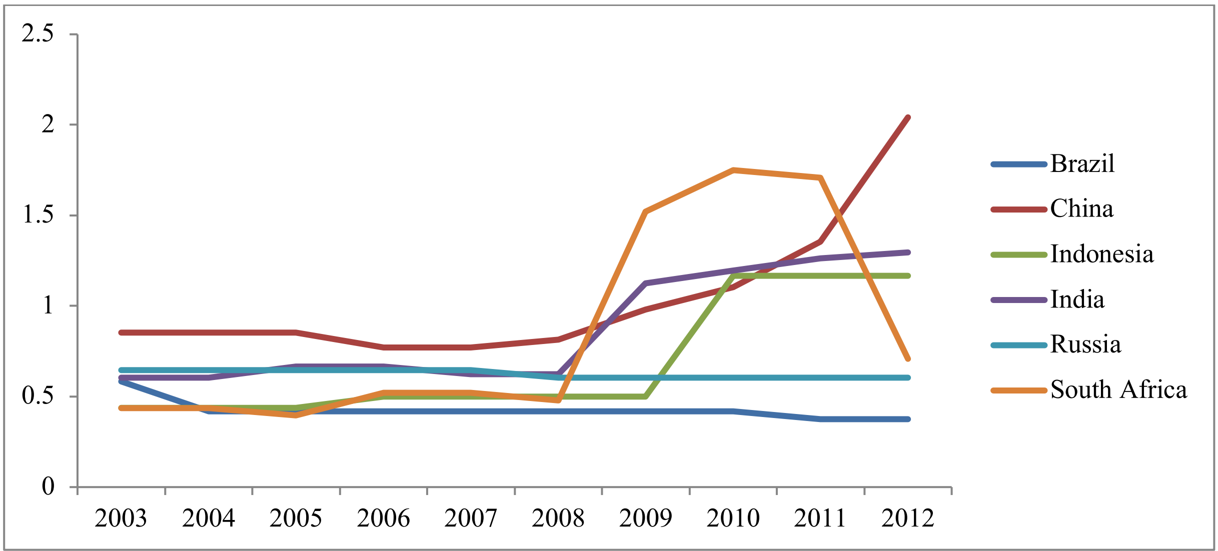

Figure 4.3: EPS Scores in destination countries – Trend

Source: Based on Environmental Policy Stringency Index Dataset (OECD, 2014)

Figure 4.4 shows the first, medium and final score of EPS for the analyzed sample. Since the 1990's, the first measurements of EPS, the trend for all the measured countries has been to tighten their policy. However, dispersion has also been increasing both in the aggregate level, but mainly at the market-based instruments. Particularly for EU countries, the introduction of the European Trading Scheme for carbon emissions in 2005 has accounted for most of the variation in the instrument, and also for the relative decline in scores in year 2008, when carbon prices plummeted (See Appendix A for full indicator).

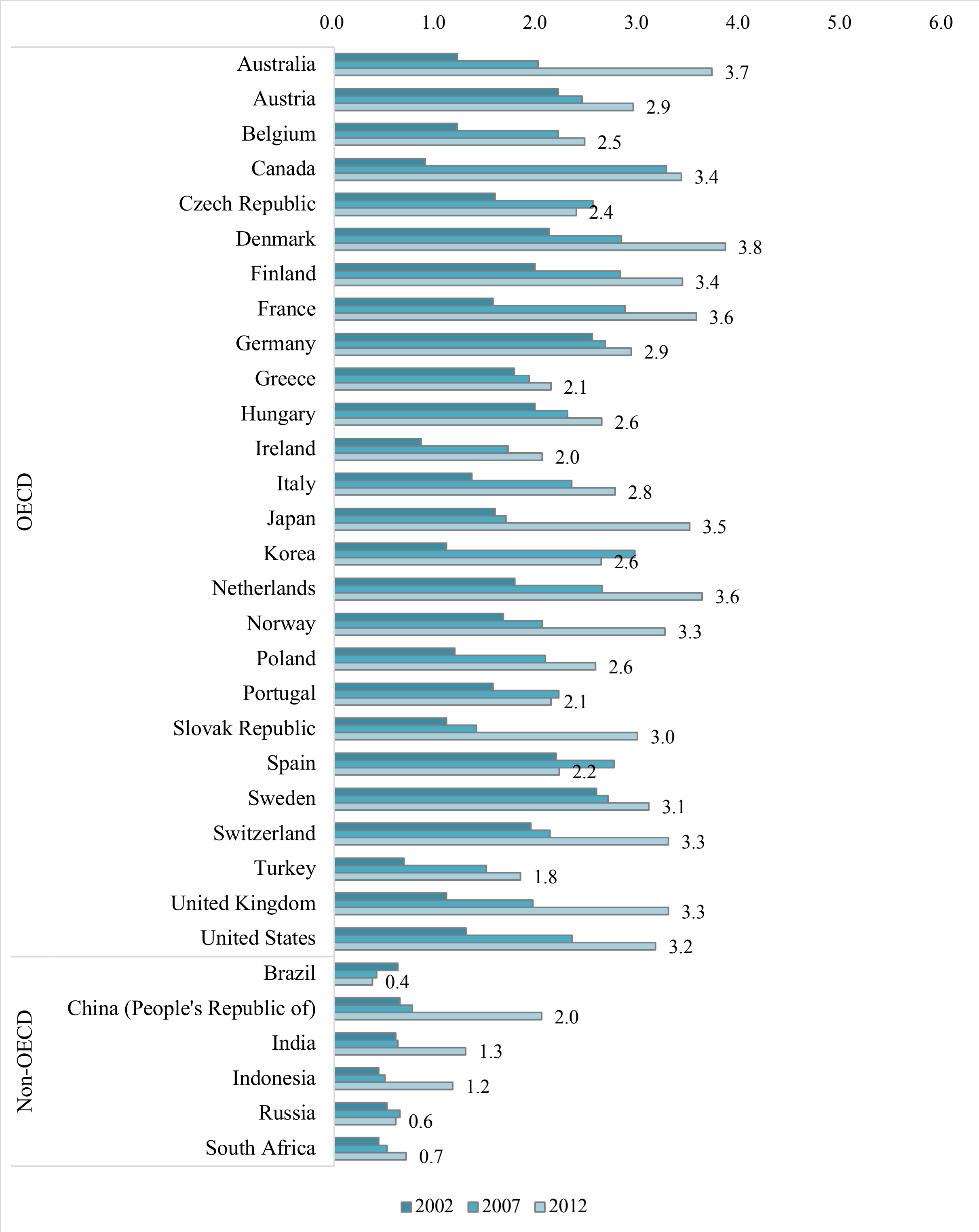

Figure 4.4: EPS Scores for OECD and BRIICS – latest year available

Source: Based on Environmental Policy Stringency Index Dataset (OECD, 2014)

As was mentioned in the models section, different specifications of the EPS Index are used to test different hypotheses. For a time-dimension aspect, a 1-year lag is introduced for the EPS of the destination country. Secondly, following the difference between origin and destination argument by Copeland & Taylor (1994), the difference between origin and destination country in EPS scores was added, including an one-year lag version, and a version in which only the destination country's EPS score was lagged, while the origin country's score was remained the analyzed year. The details are shown in Table 4.5.

Table 4.5: Specifications of environmental policy stringency variable

Variable	**Year**	**Specification**
EPS destination	T	Score of destination country
EPS difference	T	Difference of origin and destination country
Lagged EPS difference	T_{-1}	Difference of origin and destination country
Lagged EPS destination	T_{-1}	Score of destination country
Lagged EPS difference (destination)	$T_{-1\ destination}$	Difference of origin and destination country
EPS division: Market	T	Difference of origin and destination country in market components of EPS
EPS division: Non-market	T	Difference of origin and destination country in non-market components of EPS, excluding R&D expenditure

Finally, a disaggregation according to the component of the index – market and non-market -. The distribution of the aforementioned variables is shown in Figure 4.5. As it seems, a larger proportion of the difference may be tracked down to the non-market EPS component, which is expectable given that it entails a relevant proportion of public expenditure which developing countries lack. However, since public expenditure in renewable energy may have limited impact on a company's decision to locate their company in one country over the other, and to avoid the risk of uncovered multidimensionality, this component was not included in the calculation.

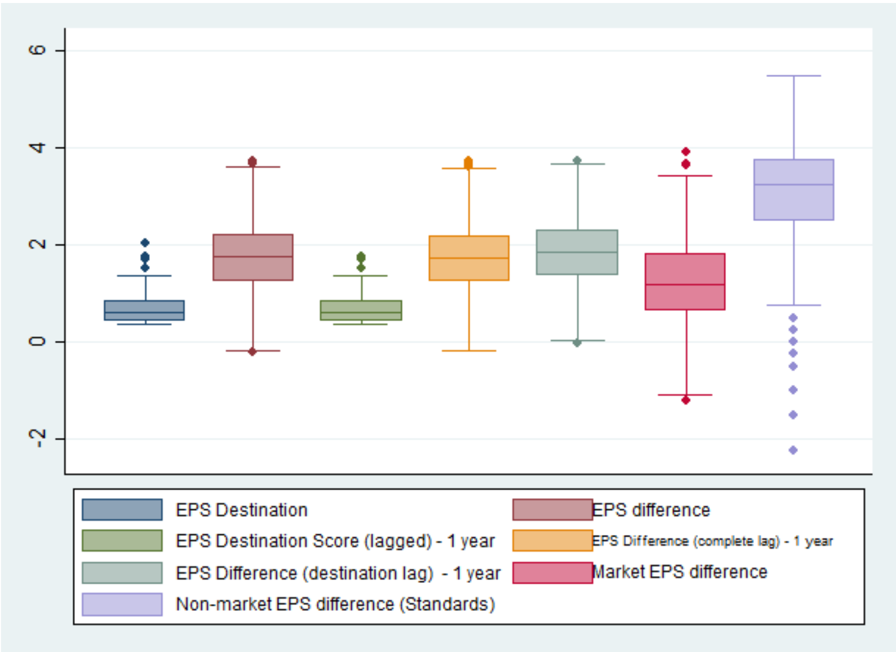

Figure 4.5: Distribution of EPS: Complete index, market instruments and non-market instruments

4.2.2 Other independent variables

Twelve additional variables were included in the models, attempting to isolate the relationship of environmental policy stringency. Ten of them are continuous variables summarized in Table 4.6, while two remaining are categorical dummies: shared language and bilateral investment treaties.

Distance is measured from Google Maps as the distance between countries capitals. Shared language was compiled to check for matches in any official language. Population, share of tertiary educated and tax revenue as percentage of GDP were obtained from the World Development Indicators (World Bank, 2018). Natural resources income was included in million USD, taking the share of GDP from the World Bank and then multiplying it by the total GDP to get the actual revenue. GDP growth rates were obtained from the World Bank, as well as inflation by consumer prices index, while capital tax rate was obtained from the 'International Investment Comparator' by KPMG (KPMG, 2018).

The FDI restrictiveness variable is proxied by the FDI restrictiveness index by the OECD, which is a composite index for all OECD, BRIICS and G20 economies. It is calculated across 22 sectors and was given a 1 for a totally open economy, and 0 for a totally closed economy (OECD, 2017b). The existence of Bilateral investment treaties were obtained from the UNCTAD 'International Agreement Navigator' (UNCTAD, 2018d). Details on variable operationalization are in Annex A.

Table 4.6: Descriptive statistics for continuous variables

Variable	Unit	Mean	Std. Dev.	Range
Distance	Kilometers (thousands)	8,099	3,540	0,953 – 17,675
Natural resources income	US Dollars (millions)	110,838	123,592	6,424 – 595300,000
Population	Millions	520,848	522,895	47,649 – 1351,000
Tertiary education	Percentage of population	29,317	21,495	10,638 – 76,497
Capital tax rate	Percentage of tax rate	30,680	5,149	20,000 – 37,780
Tax revenue	Percentage of GDP	14,433	5,444	8,244 – 27,596
FDI Restrictiveness Index	Composite index	0,263	0,143	0,055 – 0,562
Inflation (destination)	Consumer prices, annual percentage	6,623	3,432	-0,700 – 14,715
GDP growth rate (origin)	Annual percentage	2,065	3,475	-14,724 – 11,113
GDP growth rate (destination)	Annual percentage	6,027	3,498	-7,821 – 14,232

4.3 Missing data and limitations

For the dependent variable, 3 OECD countries were missing from the FDI flow dataset: Canada, Israel and Mexico. In all three cases, information was market as confidential, and therefore these countries were not included in the sample. There are year-specific missing values for some of the remaining included countries, which are summarized in Table 4.7 according to the destination country.

Table 4.7: Missing observations for FDI flow according to destination country

Country	Missing observations
Brazil	32
China	24
India	33
Indonesia	53
Russia	32
South Africa	43

As for the independent variables, there is no missing data for BRIICS countries, but some OECD countries are not registered by the index. These are Chile, Estonia, Iceland, Luxembourg, New Zealand, and Slovenia. All observations associated to these countries were excluded from the analysis. For the remaining data, no relevant missing data was found except for the tertiary educated population in South Africa, which had 5 observations missing (The World Bank, 2018b). However, an average increase rate was calculated and then the total share was estimated, under the assumption that changes in university graduates will not dramatically increase in 10 years.

This research has limitations coming both from the availability of data and the selection of method. The first one comes from the EPS Index itself. Although it was argued that, as a measure, it captures environmental policy stringency much better than other proxies such as CO_2 emissions, the index is very much based on the energy sector, focusing on policies applied to the generation of electricity, transport, gas and steam – either its production or distribution (Botta & Koźluk, 2014). This choice overlooks other areas of regulation that may be equally relevant for environmental policy, especially in the areas of waste management such as water or air quality policy. The inclusion of a broader share of the economy in the indicator outside of the energy sector may affect the results.

On a second term, there is a limitation coming from the FDI data availability. As argued by Tang (2015), the type of FDI has a relevant role in the testing of the pollution haven hypothesis. Either separating by sector or industry, or by the nature of the investment – vertical or horizontal FDI – have proven to clarify the FDI-environment picture to a great extent. However, this information does not exist at a multinational level, and is why most studies analyzing this have dealt with US FDI.

From a methodological perspective, a fixed-effects model in particular, but a quantitative approach in general have limitations in the way causality is understood. It is clear that analytic leverage can come from direct and close knowledge of cases and its relative context, providing a more appropriate causal and descriptive inference (Brady, Collier & Seawright, 2010). In a medium-N analysis, this is difficult, but limits the extent of the possible implications of the results. Finally, there is the possibility that idiosyncratic factors are varying within time and country groups, which would bias the fixed effects approach (Wooldridge, 2002).

On a practical term, omitted variable bias may arise from not having included certain indicators that would have been theoretically relevant. For example, wage costs are expected to influence a location decision (List & Co, 2000), but they were not available for the whole sample to a reliable extent. Moreover, according to Bloningen & Piger (2011), in a meta-analytical review of FDI determinants, argue that although dozens of country-level determinants have been included in estimating FDI determinants, the related inference is very much related to what other covariates are included and excluded. This research is no exception and different covariates may provide different results.

5 Empirical Analysis

The following section includes results for all models presented in section 4.2. Models 1 and 2 test the statistical significance of EPS score in destination country, as well as the difference between scores in origin and destination countries over FDI flows (log). Models 3, 4 and 5 introduce the time dimensionality, adding 1-year lagged variables for different specifications. Finally, Model 6 analyzes the relevance of the two main components of the EPS Index over FDI flow. For all 6 models, the results are presented with clustered robust standard errors.

5.1 Results

Table 5.1 shows the results for Models 1 and 2. Model 1 has as main independent variable the EPS score of the destination country, while Model 2 has the difference in EPS score between origin and destination country.

The results of Model 1 show that the EPS score of the destination country, by itself, is not statistically significant in explaining the changes in FDI flows. As for the other independent variables, at a 5%-significance level, the revenue coming from natural resources is statistically significant in this specification, although its economic significance is somewhat limited: an increase in 1 billion USD from natural resources implies an interval increase between 0,0011% and 0,0036% in the FDI inflow. Tertiary educated population in the destination country, on the other hand, seems to have a much larger impact: a 1-percentage point increase implies an increase between 0,35% and 0,51% in the FDI flow. Similarly, the increase in the growth rate of the destination country is also significant, causing an expected increase between 0,02% and 0,9% in FDI flow.

At a 10% level, 3 more variables reach statistical significance. Having the same language as the origin country, which acts as a proxy for cultural proximity, increases the expected FDI flow by an estimated 10% in comparison to countries which do not. Capital tax rate, which should diminish the location advantages from a theoretical perspective, has a positive impact over FDI, which means it could be being intermediated by other variables like state capacity. Finally, the growth rate of origin country has a negative relationship to FDI flow, which, although counterintuitive, is not unpredicted by theory since comparatively the marginal returns of investing abroad become less relevant in a situation of financial boom.

Model 2, however, shows a different scene. Although the sign and statistical significance of all control variables remain constant, the EPS difference variable acquires statistical significance at a 5% level. Practically, this means that an additional point of difference will increase FDI flows in a 1,78% average, with margins between 1,92% and 1,67% annually. With the average difference for origin and destination countries at 1,8 points, the result is not to be ignored, although is not the largest impact of all variables.

Other statistical and economically significant variables are, similar to Model 1, tertiary educated population, and growth rate of the destination country. Respectively, the expected impact of the first between a 0,31%-0,45% increase for each percentage point of university-educated; and 0,57%-0,94% for each percentage point of growth. The model has an R^2 of 9,3%, for 1407 observations. These are fewer than Model 1, since more countries have origin countries have some missing values in the EPS variable.

Table 5.1: Fixed effects analysis results: EPS destination and EPS difference as independent variable

Variables regressed over log FDI	**(1)** **EPS in destination country**	**(2)** **EPS Difference**
EPS destination country	-0,010	
	(0,008)	
EPS difference		0,018**
		(0,001)
Distance (thousands of km)	-0,007	-0,007
	(0,005)	(0,007)
Same language = 1	0,097*	0,108*
	(0,038)	(0,046)
Natural resources income (millions USD)	$2,37^{e-07}$***	$2,69^{e-07}$***
	($4,89^{e-08}$)	($5,22^{e-08}$)
Bilateral Investment Treaty = 1	0,038	0,039
	(0,023)	(0,027)
Population (millions)	0,000	0,000
	(0,000)	(0,000)
Tertiary Educated (% population)	0,004***	0,003***
	(0,000)	(0,001)
Capital tax rate	0,005*	0,003*
	(0,002)	(0,002)
Tax revenue (% of GDP)	-0,001	-0,001
	(0,005)	(0,006)
FDI restrictiveness index	0,113	0,221
	(0,097)	(0,126)
Inflation rate - Destination country	0,001	0,001
	(0,001)	(0,001)
Growth rate - Origin country	-0,003*	-0,002*
	(0,001)	(0,001)
Growth rate - Destination country	0,005**	0,006**
	(0,002)	(0,002)
Constant	8,553***	8,451***
	(0,137)	(0,173)
Observations	1642	1407
R-squared	0,083	0,093
Number of countries	6	6

Robust clustered standard errors in parentheses
*** p<0,01, ** p<0,05, * p<0,1

5.1.1 Time dimension

Models 3, 4 and 5 include the impact of environmental policy stringency over FDI in a longer period, shown in Table 5.2. Because of this, the EPS has been lagged in three different ways: first, the destination country score was lagged 1 year (Model 3), then the difference was lagged one year (Model 4), and finally, the destination score was lagged one year while the origin score was kept for the correspondent year (Model 5).

As with Model 1, the EPS score of the destination country was not found statistically significant when lagged for 1 or 2 years (only 1-year is shown), but at a 5% level, neither is the lagged complete difference. More control variables have statistical significance in this specification, and the changes may be attributed to the different sample sizes. However, signs do not change direction and they remain consistent with theory. This acts as an pseudo robustness test, following Levinson & Taylor (2008).

For Model 3, having the same language and bilateral investment treaties (BIT), natural resources income, the share of tertiary educated population and the growth rate of the destination country have a positive relationship with FDI. The first one shows an increase of between 10% and 14% in comparison to those with different languages; while BIT increase FDI flows between 4,5% and 6%. An additional percent point of tertiary educated is expected to increase FDI flows between 0,45%-0,75%, and growth rate points will bring an expected increase between 0,53%-0,93%. Distance, as predicted by theory, shows a negative relationship with FDI flows, and is expected to decrease the flow between 0,69%-0,98% by each 1000 kilometers, while the impact of natural resources, although statistically significant, is economically irrelevant.

Model 4 shows similar results concerning the controls, although with larger expected impacts for all variables except tertiary educated population, which shifts the point estimator from 0,45% to 0,35%. The lagged difference between origin and destination countries is only significant at a 10% level; implying an estimated increase of 1,2%.

Model 5, however, shows a relevant result. The difference between origin EPS score and a lagged destination score has statistical significance, with an interval impact going between 1,98%-2,2%, keeping all constant. This implies that is not only a larger difference that increases FDI flows in average, but instead than the impacts may have be time persistent. This is the largest economic impact of EPS in FDI flow found in this research.

As for the control variables, similar to Models 3 and 4, distance shows a negative impact between -0,76% and -1,2%. The remaining significant control variables have a positive relationship similar to the ones on Models 3 and 4: having the same language implies a 11-15% increase, which is probably capturing all colonial history and cultural proximity factors; having a BIT a 4,5%-6,6% increase, and each growth point, a 0,6%-1,0% increase. Natural resources have an impact of 0,002% by each billion dollars increase, therefore being almost irrelevant.

Table 5.2: Fixed effects analysis results: Lagged components as independent variables

Variables regressed over log FDI	(3) Lagged EPS in destination country	(4) EPS difference - Complete lag	(5) EPS Difference - Destination lag
EPS Destination Score (lagged)	-0,003		
	(0,015)		
EPS Difference (complete lag)		0,012*	
		(0,007)	
EPS Difference (destination lag)			0,019***
			(0,001)
Distance	-0,007***	-0,008***	-0,008***
	(0,002)	(0,002)	(0,002)
Same language = 1	0,0978***	0,109***	0,110***
	(0,018)	(0,019)	(0,0194)
Natural resources income	2,25e-07***	2,33e-07***	2,37e-07***
	(7,67e-08)	(8,42e-08)	(8,40e-08)
Bilateral Investment Treaty = 1	0,0413***	0,045***	0,044***
	(0,009)	(0,010)	(0,010)
Population (millions)	2,44e-05	0,000	0,000
	(0,000)	(0,000)	(0,000)
Tertiary Educated	0,005***	0,004**	0,004**
	(0,002)	(0,002)	(0,002)
Capital tax rate	0,005	0,004	0,004
	(0,003)	(0,003)	(0,003)
Tax revenue (% of GDP)	-0,001	0,000	0,001
	(0,005)	(0,005)	(0,005)
FDI restrictiveness index	0,099	0,198	0,194
	(0,138)	(0,156)	(0,154)
Inflation rate – Dest. country	0,002	0,003	0,002
	(0,002)	(0,002)	(0,002)
Growth rate - Origin country	-0,002	-0,003	-0,002
	(0,001)	(0,002)	(0,002)
Growth rate – Dest. country	0,005***	0,006***	0,006***
	(0,002)	(0,002)	(0,002)
Constant	8,641***	8,565***	8,527***
	(0,214)	(0,237)	(0,238)
Observations	1493	1275	1275
R-squared	0,076	0,083	0,085
Number of countries	6	6	6

Robust clustered standard errors in parentheses
*** p<0,01, ** p<0,05, * p<0,1

5.1.2 EPS division

Model 6 tests for the impact of individual components of the Environmental Policy Stringency Index over the flow of FDI. As mentioned in Section 4, the two main components of the index, market and non-market instruments were separated for this specification and were included individually. In the case of non-market instruments, the component of public expenditure was not included, as to avoid the theoretical challenges that it poses regarding stringency.

As expected theoretically, it is market instrument-based difference that carries the statistical significance of the indicator, while non-market difference loses it. However, the practical significance is expectedly reduced as well. As shown in Table 5.3, an additional difference point in market instruments stringency is expected to increase FDI flows by 0,89%-0,97%. Non-market instruments are not statistically significant. This is probably due to standards of pollution having more standardized patterns than market tools, especially in the energy industry.

As for the control variables, there are little differences with previous specifications. At a 5% significance level, natural resources revenues have an expected impact of 0,002% by each billion-dollar increase. Tertiary education implies a significant increase of 0,35%-0,45% by each percent point, and so does the growth rate of destination country, showing an expected increase of 0,56%-0,96%. Finally, at a 10%-significance level, both capital tax rate and growth rate of the parent country have statistical significance with the opposite expected sign, which could mean they are capturing other correlated variables and be signed of omitted variable biases.

Table 5.3: EPS division as independent variable

Variables regressed over log FDI	**(6)** **EPS division**
Market EPS difference	0,009**
	(0,000)
Non-market EPS difference (Standards)	0,004
	(0,004)
Distance	-0,007
	(0,007)
Same language = 1	0,105*
	(0,047)
Natural resources income (millions USD)	$2,65^{e-07}$***
	($5,43^{e-08}$)
Bilateral Investment Treaty = 1	0,040
	(0,026)
Population (millions)	0,000
	(0,000)
Tertiary Educated (% population)	0,004***
	(0,001)
Capital tax rate	0,004*
	(0,002)
Tax revenue (% of GDP)	-0,001
	(0,006)
FDI restrictiveness index	0,208
	(0,127)
Inflation rate - Destination country	0,001
	(0,001)
Growth rate - Origin country	-0,002*
	(0,001)
Growth rate - Destination country	0,006**
	(0,002)
Constant	8,474***
	(0,185)
Observations	1407
R-squared	0,091
Number of countries	6

Robust clustered standard errors in parentheses
*** p<0,01, ** p<0,05, * p<0,1

5.2 Discussion

Three hypotheses sought to be analyzed through a fixed-effects specification in this research:

H_1: The FDI flow of a country will be negatively related to the stringency of its environmental policy stringency.
H_2: The FDI flow of a country will be negatively related to the time-lagged stringency of its environmental policy.
H_3: A larger difference in market-based instruments of environmental policy stringency will have a larger impact over the FDI flow than difference based on non-market instruments.

Theoretically, a pollution haven effect implies that a more stringent pollution regulation will marginally have an effect on plant location decision and trade flows (Copeland & Taylor, 2003). In that sense, it seems like there could be evidence for a pollution haven effect for this sample. Regarding the first hypothesis, Model 2 showed that a larger difference between the origin and destination country in the stringency of environmental policy will have a positive impact of FDI flow. This implies that, keeping all constant, a one-point additional difference between two countries will increase FDI flows by 1,67%-1,92%, yearly.

The mechanism operating behind this relationship, probably, refers to the fact that a marginal difference between origin and destination country in any cost determines a change in the location advantages, and therefore, in the comparative advantage structure. A more stringent environmental policy represents higher costs, which, in turn, erode the comparative advantage. Therefore, in absolute terms, a country with low environmental policy stringency does not represent an advantage, unless it is lower than the parent country's stringency.

The second hypothesis responds to the theoretical claim of Dunning (1977) stating that location advantages may take longer to materialize, and that environmental policy has shown evidence of responsiveness to lagged variables, meaning that markets will respond after the approval of policies with some delay, or once costs have been established (Cole, Elliott & Fredriksson, 2006; Eskeland & Harrison, 2003; Tang, 2015). In this regard, Model 5 finds that a one-year lag in the score of the destination country while keeping the origin country with the current year gives environmental policy stringency significance at a 5% level. In practical terms, this means an increase of FDI flow between 1,98% and 2,2%, the largest for all performed analyses for environmental policy stringency.

Finally, the third hypothesis refers to the different impact of environmental policy components. Theoretically, market components of environmental policy impose direct incentives and sanctions on companies that may work into shaping their incentive system. Therefore, they have thought to be more effective in dealing with environmental dumping. As expected, they effectively have a larger impact when it comes to the flows of FDI: in the case of this sample, an additional difference point in market instruments will imply a 0,89%-0,97% increase in FDI. This indicator directly affects the costs in the choosing of location, so its practical significance is smaller than the one in previous specifications.

In the case of the remaining determinants predicted by the location hypothesis that were included in this research, most of them performed as expected. Having the same language, which as stated, is a proxy for cultural distance, institutional similitude and overall common ground in business culture, is found statistically with a large impact, increasing FDI flow by close to 10% in all specifications. The population variable was not found significant in any specification, probably since its effect was captured in the fixed-effects control.

The revenue of natural resources also proved to be statistically significant, although with very limited practical impact. Although all analyzed countries have relevant shares of natural resources FDI, the lack of specific-industry data impeded a more in-depth analysis for better understanding these results.

The existence of bilateral investment treaties seemed to act as a proxy for openness to trade, and probably captured the effect of the FDI-restrictiveness variable, which was not significant in any of the specifications. Overall, although a country may have barriers for general FDI, the existence of a BIT may be more of a driver when analyzing country-to-country investments, and this could explain a large, significant impact.

Capital tax rate showed significance, but with the opposite expected sign. Although theoretically a higher capital tax rate should diminish the location advantage, as it was stated before they could also be capturing the effect of other factors that are correlated with higher tax rates such as quality of institutions (List & Co, 2000), or overall state capacity (Blonigen & Piger, 2011). That could explain the positive impact that it shows over FDI in this sample.

When it comes to growth rates, the results should be taken carefully. First, the growth rate of the origin country is not significant at a 5% level, but at a 10% level it is with the opposite sign than expected. Although theoretically higher growth could mean more resources to invest abroad, it could also mean that location advantages like wages or environmental stringency are not enough to offset the inconveniences of travelling. On the other hand, when it comes to growth rate of destination country, there is risk for endogeneity with FDI inflows. Although these results are consistent in all specifications tried in this research, different functional forms or a robustness test in a different sample should be tested to address their impact.

Is worth mentioning that limitations as the lack of information regarding the type of FDI or firm characteristics, reliable information about wages or additional variables could diminish the effect of environmental policy stringency even further. Even the inclusion of more sectors of environmental policy may have effect on the results.

Thus, the implications of these results are twofold: on one hand, the expected impact of environmental policy stringency over FDI flow is not extremely large and supports the idea that the pollution haven effect is not the sole driver of economic activity, but another aspect to consider alongside human capital, distance, institutional barriers and natural resources' existence. On the other hand, for the analyzed period, they imply there is evidence for a pollution haven effect between OECD countries and BRIICS; that it is not bound to a year-to-year relationship, and that it is driven more strongly by market policy instruments than by non-market ones.

6 Conclusion

The Paris Agreement has put environmental concerns at the top of the public agenda for the next year, and it seems clearer now that the nationally determined contributions set in 2015 will not be enough to reach the climate goals. Therefore, the need to establish effective environmental policy is especially relevant. However, the hardening of environmental policy may be costlier than its sole establishment, since it may diminish a country's comparative advantage, making it less attractive for international flows of capital, and particularly, for FDI.

This research aims to analyze the relationship between FDI flows and environmental policy stringency. By using a policy-based indicator, it attempts to provide an analysis that captures the actual stringency of policy itself, and not its consequences, which could be product of other relationships. The results of this study show that, for the analyzed sample, a larger difference between origin and destination country in environmental policy stringency is associated with an increase in FDI, which suggest the existence of a pollution haven effect. Additionally, a time dimension of the analysis has also been found to be relevant when considering different time frames for the origin and the destination country. Finally, when decomposing the components of environmental policy, it is found that market-based instruments of environmental policy have a stronger impact on FDI flow than non-market instruments.

There are certain limitations of these results that should be kept present, and that could be relevant in future research. First, the fact that the policy-based index is very much reliant on the energy sector, so it may not extrapolate identically to the rest of the economy. Secondly, that the found relationship could be affected if the type of FDI were taken into account, or if firm characteristics were included. A bias could arise also from the selection of covariates, especially from the exclusion of wages information. The case selection for destination country may play a role in the extent of the results: although there is great variability within the BRIICS economies that could control for some aspects, smaller economies may be impacted differently by toughening or relaxing environmental standards.

In that sense, the results of this research may seem discouraging when it comes to policy implications. A larger difference between origin and destination countries in environmental policy stringency will likely increase the FDI flow, which could provide arguments for governments to lower environmental standards to attract FDI in order to increase such difference. However, there are two counter-arguments to this result that may be explored further as policy prescriptions. First, since it is the market component what seems to be comprising most of the weight, the point could be made that there is still room for introducing policies without affecting FDI, although in a less intense way, since it would not comprise the whole economy. Secondly, even if destination countries set their environmental policies, the implications of the significance being on the difference between countries' EPS also gives agency to investors.

Commitments adopted by origin countries may have a role on guaranteeing that investments abroad do not act as environmental dumping. In that sense, the main result of this study can be read as a call for a more responsible engagement of environmental investment from its departure to its ending, involving alliances between origin and destination states. This is particularly relevant since, although the positive externalities of FDI may be country specific, environmental degradation does not follow national boundaries neatly. Most environmental problems are transboundary and impact heavily those who benefit the less from international trade. More governments and more markets may diffuse the responsibility of regulating, but it is their interaction what will determine whether environmental issues are tackled.

By generating knowledge about the impacts of environmental policy stringency over different aspects of economic growth, this research seeks to contribute to the encouragement of undertaking more stringent environmental policy, which could be beneficial for the long-term environmental goals of developing and developed countries.

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Appendix A: Variables and variable construction

Table 6.1: Variable construction

Name	Description	Construction	Type	Number of observations	Source
FDI flow	FDI flow for each year between origin and destination country		Continuous	1642	OECD, 2014a
FDI flow *log*	Log. Transformation of FDI flow for each year between origin and destination country	Rescaled to positive values adding constant to sample	Continuous	1642	OECD, 2014a
EPS Origin	Origin country score on EPS index		Continuous	1529	OECD, 2014b
EPS Destination	Destination country score on EPS index		Continuous	1642	OECD, 2014b
EPS difference	Difference between destination country and origin country' score on EPS index	Origin country EPS – Destination country EPS	Continuous	1529	OECD, 2014b
EPS Destination – lagged	Destination country score on EPS index	Destination country EPS_{t-1}	Continuous	1493	OECD, 2014b
EPS Difference – lagged	Difference between destination country and origin country' score on EPS index	Origin country EPS_{t-1} – Destination country EPS_{t-1}	Continuous	1295	OECD, 2014b
EPS Difference – destination lagged	Difference between destination country and origin country' score on EPS index	Origin country EPS_{t} – Destination country EPS_{t-1}	Continuous	1295	OECD, 2014b
EPS market difference	Difference between destination country and origin country' score on EPS index – only market components	Origin country EPS_{market} – Destination country EPS_{market}	Continuous	1529	OECD, 2014b
EPS non-market difference	Difference between destination country and origin country' score on EPS index – only non-market components	Origin country $EPS_{non-market}$ – Destination country $EPS_{non-market}$ R&D component was excluded	Continuous	1529	OECD, 2014b
Distance	Distance in kilometers between origin and distance country's capitals		Continuous	1642	Google Earth, 2018

Same Language	Dummy variable for country's shared language		Categorical	1642	CEPII, 2018
FDI restrictiveness	Destination country's score on FDI restrictiveness index		Continuous	1642	OECD, 2017b
Natural Resources	Total revenues resulting from natural resources extraction		Continuous	1642	The World Bank, 2018c
Bilateral Investment Treaties	Existence of a bilateral investment treaty		Categorical	1642	UNCTAD, 2018d
Population	Number of inhabitants		Continuous	1642	The World Bank, 2018a
Capital tax rate	Rate applied to foreign capital		Continuous	1642	KPMG, 2018
Tax revenue	Share of GDP resulting from tax collection		Continuous	1642	The World Bank, 2018d
Inflation - destination	Inflation in consumer prices index		Continuous	1642	The World Bank, 2018e
Growth rate - destination	GDP growth rate, destination countries		Continuous	1642	The World Bank, 2018f
Growth rate - origin	GDP growth rate, origin countries		Continuous	1642	The World Bank, 2018f
Tertiary educated population	Share of total population with tertiary education	For missing values, average increase rates were estimated	Continuous	1642	The World Bank, 2018b

Table 6.2: Dispersion of independent variables

	Range	**Mean**	**SD**
EPS Destination	0,38, 2,04	0,75	0,38
EPS Difference	-0,20, 3,71	1,73	0,67
Lagged EPS Difference	-0,16, 3,71	1,71	0,66
Lagged EPS Destination	0,38, 1,75	0,72	0,34
Lagged EPS difference (destination)	-0,02, 3,72	1,83	0,65
EPS Division: Market	-1,20, 3,89	1,23	0,83
EPS Division: Non-market	-2,25, 5,50	2,99	1,11

Table 6.3: Environmental Policy Stringency Index - full indicator

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Australia	1,2	1,2	1,2	1,5	2,0	2,0	2,3	2,7	2,5	3,3	3,7
Austria	2,2	2,5	2,4	2,9	2,8	2,4	2,9	3,3	3,3	3,1	2,9
Belgium	1,2	1,2	2,0	2,4	2,4	2,2	2,3	2,6	2,6	2,5	2,5
Canada	0,9	1,6	1,6	1,5	2,2	3,3	3,3	3,9	3,4	3,7	3,4
Czech Republic	1,6	1,6	1,6	2,0	2,9	2,5	2,7	2,9	2,9	2,4	2,4
Denmark	2,1	2,1	2,6	3,1	3,2	2,8	3,0	4,1	4,0	4,0	3,8
Finland	2,0	2,5	2,5	2,4	3,2	2,8	3,1	3,3	3,2	3,5	3,4
France	1,6	1,6	2,1	2,7	3,3	2,9	2,9	3,7	3,2	3,7	3,6
Germany	2,5	2,5	2,7	3,0	3,0	2,7	2,6	3,1	3,0	3,1	2,9
Greece	1,8	1,8	1,7	1,8	1,8	1,9	1,8	2,1	2,3	2,3	2,1
Hungary	2,0	2,1	2,3	2,6	2,6	2,3	2,6	2,7	2,8	2,7	2,6
Ireland	0,9	1,4	1,5	1,9	2,2	1,7	2,1	2,2	2,2	2,4	2,0
Italy	1,4	1,4	1,5	2,2	2,7	2,3	2,6	2,7	2,8	2,8	2,8
Japan	1,6	1,6	1,9	1,7	1,6	1,7	1,7	1,7	2,0	3,0	3,5
Korea	1,1	2,0	2,3	2,9	3,0	3,0	3,4	3,5	3,5	3,4	2,6
Netherlands	1,8	2,2	1,9	2,8	2,8	2,6	3,2	3,7	4,1	3,5	3,6
Norway	1,7	1,4	1,4	1,9	2,1	2,0	2,3	3,2	3,2	3,2	3,3
Poland	1,2	1,2	1,3	2,1	2,3	2,1	2,3	3,0	3,0	3,0	2,6
Portugal	1,6	2,1	2,1	2,7	2,7	2,2	2,3	2,5	2,5	2,3	2,1
Slovak Republic	1,1	1,1	1,1	1,8	1,8	1,4	1,5	2,4	2,3	3,1	3,0
Slovenia	-	-	-	-	-	-	1,6	1,9	2,5	2,4	2,3
Spain	2,2	2,2	2,8	3,0	3,0	2,8	2,7	3,0	2,7	2,8	2,2
Sweden	2,6	2,4	2,8	2,7	3,0	2,7	2,9	3,3	3,1	3,2	3,1
Switzerland	1,9	1,9	1,7	2,4	2,1	2,1	2,7	3,2	3,3	3,3	3,3
Turkey	0,7	0,7	0,9	0,8	1,5	1,5	1,5	1,5	2,1	2,2	1,8
United Kingdom	1,1	1,7	1,7	2,2	2,3	2,0	2,4	2,6	3,6	3,5	3,3
United States	1,3	1,3	1,0	1,1	2,1	2,3	2,5	2,9	2,7	2,5	3,2
Brazil	0,6	0,6	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4
China (People's Republic of)	0,6	0,9	0,9	0,9	0,8	0,8	0,8	1,0	1,1	1,4	2,0
India	0,6	0,6	0,6	0,7	0,7	0,6	0,6	1,1	1,2	1,3	1,3
Indonesia	0,4	0,4	0,4	0,4	0,5	0,5	0,5	0,5	1,2	1,2	1,2
Russia	0,5	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6
South Africa	0,4	0,4	0,4	0,4	0,5	0,5	0,5	1,5	1,8	1,7	0,7

Source: Based on Environmental Policy Stringency Index Dataset (OECD, 2014)
Note: Scores have been approximated to one decimal for readability. The full indicator comprehends measurements from year 1990 to 2012, with some countries being measured for later years.

Appendix B: Assumption tests for fixed effects models

Hausman test for systematic difference in coefficients

H_0: The difference in coefficients is not systematic.

Table 6.4: Hausman test results

	Chi-square	**P|t|**
Model 1	38,49	0,0001
Model 2	36,37	0,0003
Model 3	37,84	0,0003
Model 4	31,59	0,0016
Model 5	32,02	0,0014
Model 6	31,86	0,0015

As shown in Table 6.1, it is possible to reject the null hypothesis. Therefore, there is evidence for the difference in coefficients not being systematic, and a fixed effects approach may be a better fit for the model than a random effects approach.

Clustered Robust Standard Errors

One of the limitations of using a double-identifying panel (origin-destination country as identifiers) is that adding a time dimension to it would artificially create more groups than there should be. For example: the pair Australia-Brazil and the pair Austria-Brazil are categorized as different groups, so a time dimension would mean that, instead of the necessary 6 fixed effects, 186 would be stated. This creates a problem of serial correlation between the groups, since all pairs with the same destination country that are treated as different groups are correlated in their error terms.

Therefore, for panels that have only an identifier variable, Abadie et al (2017) suggest working with clustered standard errors, which work when the assignment mechanism for identifiers is clustered. Overall, the conditions for this method to be applied are: (i) there are few clusters over the total population; (ii) there is no heterogeneity in the treatment of clusters; (iii), more than one unit is sampled per cluster. In the case of this sample, all conditions hold, so a clustered standard errors control is introduced to the regression model.

The result of this method is the robustization of both heteroscedasticity in the error terms and serial correlation, which diminish the estimator's bias (Abadie et al, 2017).

Correlation matrix

	Dist.	Nat. Res	Sam. Lang.	BIT	Pop.	Educ.	Cap. Tax	Tax. Rev	FDI Rest	Inf.	Growth	Growth	EPS Dest	EPS Dif	EPS Market	Non Markets	EPS – lag1	EPS- lag2
Distance	1,00																	
Natural resources	-0,38	1,00																
Same Language	0,13	-0,15	1,00															
BIT	-0,25	0,25	-0,04	1,00														
Population	-0,20	0,36	0,02	0,02	1,00													
Tertiary educated	-0,53	0,43	-0,16	0,07	-0,33	1,00												
Capita tax rate	0,44	-0,64	0,21	-0,18	0,06	-0,74	1,00											
Tax revenue	0,21	-0,33	0,15	0,21	-0,64	-0,12	0,37	1,00										
FDI Restrictiveness	-0,27	0,38	-0,13	0,07	0,71	-0,03	-0,36	-0,75	1,00									
Inflation (dest)	-0,27	-0,04	0,00	-0,04	-0,24	0,39	-0,24	0,03	-0,07	1,00								
Growth (dest)	-0,12	0,26	-0,04	0,02	0,66	-0,22	0,04	-0,46	0,62	-0,26	1,00							
Growth (origin)	0,00	-0,08	0,00	-0,05	-0,01	-0,06	0,14	0,04	0,05	-0,03	0,34	1,00						
EPS Destination	-0,05	0,27	0,05	0,24	0,38	-0,21	-0,14	-0,06	0,22	-0,14	0,13	-0,18	1,00					
EPS Difference	0,00	0,00	-0,12	0,03	-0,22	0,20	-0,07	0,01	-0,23	0,08	-0,21	-0,14	-0,34	1,00				
EPS Market	-0,03	-0,02	-0,14	-0,02	-0,17	0,17	-0,02	-0,04	-0,11	0,07	-0,08	-0,02	-0,55	0,69	1,00			
EPS Nonmarket	0,06	-0,13	0,06	-0,06	-0,28	0,16	0,01	0,13	-0,32	0,12	-0,24	-0,15	-0,25	0,60	0,22	1,00		
EPS Lag1	-0,06	0,19	0,06	0,23	0,31	-0,18	-0,08	0,03	0,14	-0,13	0,15	-0,07	0,77	-0,24	-0,41	-0,21	1,00	
EPS Lag2	-0,01	0,10	-0,13	0,07	-0,15	0,18	-0,13	-0,03	-0,20	0,03	-0,15	-0,17	-0,10	0,81	0,48	0,53	-0,21	1,00
EPS Lag3	0,01	0,06	-0,12	0,06	-0,15	0,17	-0,12	-0,04	-0,17	0,07	-0,21	-0,21	-0,14	0,93	0,57	0,56	-0,30	0,86