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**The effect of environmental regulation on the environmental footprint of foreign direct investment.**

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**Abstract:** This studies analyses the effect of environmental regulation on the environmental footprint of inward FDI in the host country due to the investment decisions of foreign firms. In this study a broad range of countries from varied regions in the world are analysed in the period 2009-2016. Based on a thorough literature review, a theoretical model is proposed which serves as a basis of an estimation using panel data techniques. The study also entails a specific analysis of the energy sector in which the effect of environmental policy on inward FDI in green and brown energy is studied. The hypotheses posed in this studied stating that more stringent environmental regulation would decrease the environmental footprint of FDI by repelling polluting firms and attracting clean firms had to be rejected. This indicates that environmental regulation has an insignificant influence on the investment decisions of firm. This might suggest that foreign firms are not likely to move away from a country that implements more stringent environmental regulations and therefore will abide by the new regulations. Which could cause the environmental footprint to decrease via this mechanism, therefore this might be seen as an incentive to implement more stringent environmental regulations.

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List of Abbreviations

**avh:** Average hours worked per year

**BRIICS**: Brazil, Russia, India, Indonesia, China, South Africa

**cce:** Control of Corruption

**CO2:** Carbon Dioxide

**GDP:** Gross Domestic Product

**EHC**: CO2 emissions from electricity and heat consumption

**EKC:** Environmental Kuznets Curve

**eodb:** Ease of doing business

**EPI**: Environmental Policy Index

**EPS**: Environmental Policy Stringency

**EPSI**: Environmental Policy Stringency Index

**FDI**: Foreign Direct Investment

**GHT:** Green Haven Theory

**IIT:** Induced Innovation Theory

**KL**: Capital-labour ratio

**MNE:** Multinational Enterprise

**OECD**: Organisation for Economic Cooperation and Development

**PHT:** Pollution Haven Theory

**pve:** Political Stability and Absence of Violence/Terrorism

**rle:** Rule of Law

**SDGs:** Sustainable Development Goals

# 1. Introduction

As a part of the increased globalization of the last decades, markets have internationalized. This has encouraged companies to engage in international business resulting in an increase in Foreign Direct Investment (FDI). The general perception of inward FDI is that it can have a positive effect on a country’s economic development (i.e. Borensztein et al., 1998; OECD, 2002; Navaretti & Venables, 2004; Alfaro et al., 2004 & OECD, 2019a). Governments believe that these benefits for society are greater than the benefits that a firm can internalize. This results a sub-optimal level of FDI attraction by the market for society wide utility maximization and thus government intervention can be justified (Alfaro et al., 2004). This government intervention is also seen widely from the 1990’s onwards, as governments have changed their investment regimes in favour of attracting investment from multinational enterprises (MNE’s) (Smeets, 2009). An example of this is the large incentive package that Renault received in 1996 from the Brazilian government to persuade Renault to make a large investment in Brazil. This package included direct financial contributions of $300 million, a series of tax breaks, the donation of a large construction site and favourable loaning conditions (Smeets, 2009). However, empirical evidence for the impact of FDI on economic growth has been mixed – leaving this debate still unresolved. Many scholars now believe that FDI has the potential to positively impact economic growth, but that the extent to which this potential is realised depends on characteristics of the host-country such as the level of human capital (Borensztein et al., 1998 & Solomon, 2011), or level of development of the financial markets (Bengoa and Sanchez-Robles, 2003 & Durham, 2004). Due to these trends both the academic and political debate have been focussed on the implications of FDI on the economic development of a country, the proper way to maximize the benefits from FDI and the appropriate way to attract FDI.

In recent years, however, the policy debate has shifted to other impacts of FDI on the host society. Ever since the launch of the Millennium Development Goals (MDGs) in 2000 and the Sustainable Development Goals (SDGs) in 2015, the focus is no longer solely on economic development. The focus shifted to a multidimensional form of development including factors as environmental quality, quality of labour standards, gender equality and access to food, water and energy. As a part of this increased interest in the broader impacts of investment UNCTAD (2015, p. 6) published its Investment Policy Framework for Sustainable Development in 2015, which states that:

*“Mobilizing investment and ensuring that it contributes to sustainable development is a priority for all countries. A new generation of investment policies is emerging, pursuing a broader and more intricate development policy agenda, while building or maintaining a generally favourable investment climate.”*

This focus on sustainable development is in part a reaction to many scandals involving MNE’s in developing countries. These scandals include the explosions at an Apple factory in China killing and harming the employees (Clarke & Boersma, 2017), the collapse of a clothing factory in Bangladesh producing for European and American firms leaving 134 people dead and more than 1,000 people injured (Manik, & Yardfley, 2013), or the unsustainable water use of Coca-Cola in India leaving many local farmers in severe water-scarcity (Brown, 2003). These are some examples of MNE’s, which might have been good for the economic development, but have had negative effects on other aspects of sustainable development. However, attracting FDI is an objective for many policymakers, nonetheless. Partly due to the fact that economic development still remains a very important objective for many policymakers and partly due to the fact that many scholars and policymakers believe that FDI can also have a positive effect on other aspects of sustainable development, if it is managed well. This rationale is well captured in the following statement of the OECD concerning environmental sustainability (2002, p. 159):

*“While emphasising the need to use inward FDI as a tool for encouraging economic growth, especially in the poorest countries, it is important to recognise that FDI may also affect quality of life beyond the narrowly defined economic context. International investment can impact on the environmental performance of host countries. Such impacts may be positive or negative, and will depend largely on the enforcement of adequate environmental policies and standards in the host country.”*

This raises two questions. First of all, it raises the question to what extent a trade-off exists between the objective to use FDI to encourage economic growth and the objective to create positive environmental impacts of FDI. The second question is to what extent the environmental impact of FDI depends of the enforcement of adequate environmental policies and standards in the host country.

This thesis will contribute to this debate by looking at the environmental aspect of sustainable development. It will focus on what the effect of enforcement of adequate environmental policies and standards in a host country is on the contribution of FDI to the environmental aspects of sustainable development. An important part of this question will prove to be what the effect of the environmental policy is of FDI attraction, more specifically the type of FDI that is attracted. So far FDI has been discussed as if it is one homogeneous form of investment, however, FDI can be an investment from any foreign firm. As firms come in all shapes and sizes, the environmental impact of inward FDI might depend on the type of firm that is investing in the host country. It is not difficult to imagine, for example, that the impact of investment from a large palm-oil producer on the environment might be very different from the impact of a large consultancy firm or again from the impact of a car manufacturer. Those are examples of companies in different sectors, but even within a sector the impact of a firm might be very different. In the energy sector, for example, the impact on the environment of an oil company could be very different from that of a solar park company. This thesis will therefore also discuss how differences in environmental policy might attract different FDI and how this changes the environmental footprint of the inward FDI in a host country. This leads to the following research question:

*How does the environmental policy of a host-country influence the environmental footprint of this country’s inward FDI?*

This is the research question that this thesis will try to answer. To test this question a first set of fixed effects models focusses on the pollution intensity associated with the sectoral composition of FDI in a host country. A panel including 56 countries in the period 2009-2016 in constructed. With this panel the effect of environmental regulation on the FDI-weighted pollution intensity is tested, the specific construction of the FDI-weighted pollution intensity will be elaborated on later in the thesis. Then this panel is also used to directly observe the effect of environmental regulation on the inflow of FDI to sectors with a high pollution intensity and sectors with a low pollution intensity.

Next to the sectoral composition, environmental regulation might also have an effect on the type of firms that are attracted within a sector. In order to analyse this the energy sector is analysed as a case study, due to data availability. Data is available that distinguishes between investment in brown and green energy. A second set of fixed effects models is used to analyse the effect of environmental regulation on the relative inflow of FDI in brown or in green energy. For these models a panel consisting of 74 countries in the period 2013-2017 is used.

The hypotheses that where put forward on the effects of environmental regulation on the environmental footprint of FDI via the attraction of foreign firms into cleaner sectors or via the attraction of more FDI in green energy versus FDI in brown energy had to be rejected. The only significant results showed that more stringent environmental regulations do attract investment in green energy. A possible argument for the lack of significant results is that the environmental regulations in a country might be an insignificant factor in the investment decisions of multinational enterprises.

This thesis is structured as follows: The next section will first provide an overview of the relevant literature on this topic. Furthermore, it will introduce the theoretical model that is put forward in this thesis and the hypotheses that are based on this theoretical model. Chapter three will discuss the empirical method and the data that are used. Chapter four will report on the findings of the empirical analysis. Chapter five will discuss these results, draw conclusions from them and will reflect on the limitations of this thesis and possible future research on this topic.

# 2. Literature Review and Research Problem

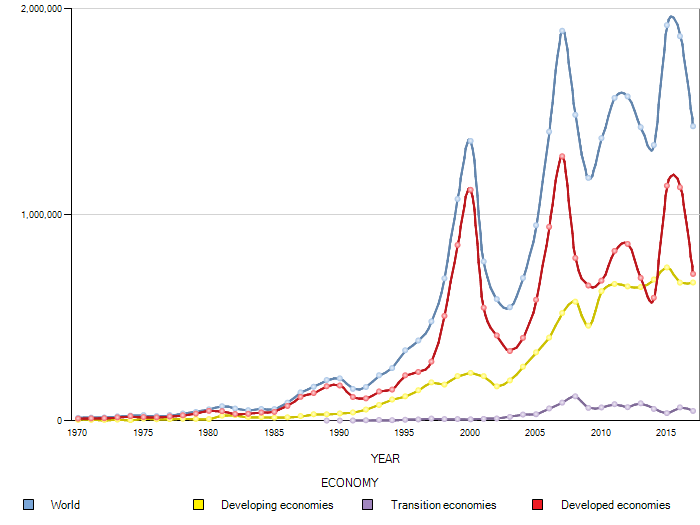
## 2.1 Foreign Direct Investment and the host-country economy

Some different definitions of FDI are around, but this thesis will follow the definition of the OECD (2008, p48) which says that: *“Foreign direct investment reflects the objective of establishing a lasting interest by a resident enterprise in one economy (direct investor) in an enterprise (direct investment enterprise) that is resident in an economy other than that of the direct investor”*. This lasting interest is seen as the existence of a long-term relationship between the two enterprises and a significant degree of influence of the direct investor over the management of the direct investment enterprise. Such a relationship is assumed to be occurring when the investor holds 10% or more of the voting power of the investment enterprise. A firm can engage in FDI by opening a new subsidiary in a different country, which is called a greenfield investment, by buying (a part of) an existing firm in another country, an acquisition, or by merging with a company in another country (Van Marrewijk et al. 2012). A firm can also have different motives to engage in FDI, it can i.) invest in another country in order to tap into the market of this country (market-seeking FDI) ii.) invest in another country to tap into the resources of this country (resource-seeking FDI) iii.) invest in another country to try to optimize the allocation of different subsidiaries based on external factors such as institutional arrangements and economic systems (efficiency-seeking FDI) (Dunning & Lundan, 2008).

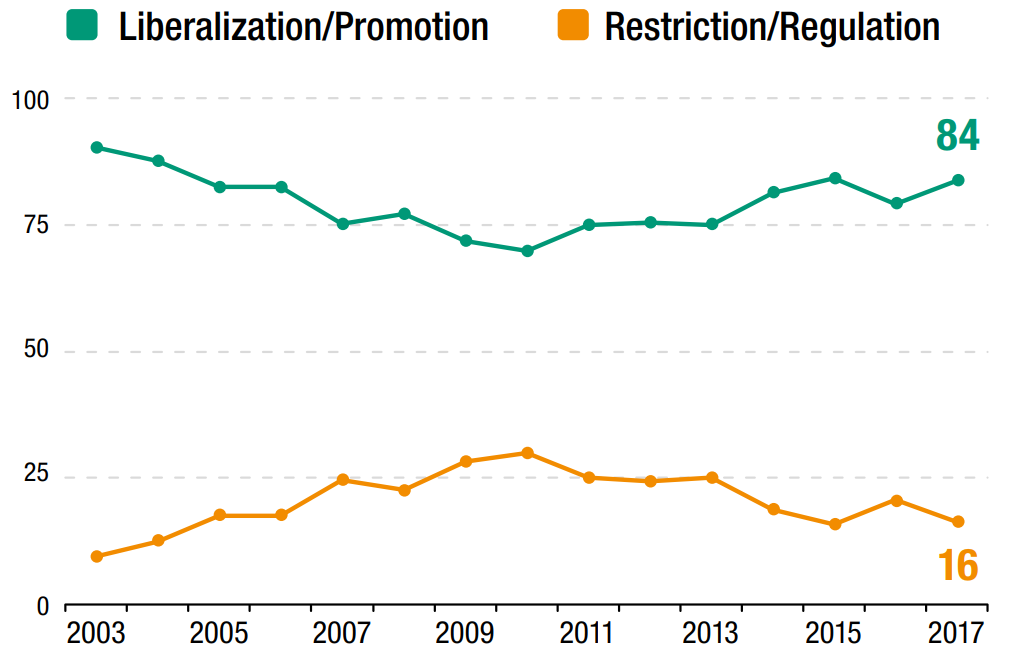
In recent decades FDI gained much importance in the economic reality (Van Marrewijk et al. 2012). As a result also academics have gained interest in the topic and a whole strain of literature has developed that sought to find out what the impact of FDI is on the economy of the host-country. This question gained even more importance when from the 1990’s onwards governments started to change their investment regimes, sometimes at high costs, in order to attract FDI (Smeets, 2009). This is illustrated by Werner (2002) who showed that between 1996 and 2000 FDI was the most researched field in international management. The following section will introduce the strain of literature on the relationship between FDI and the host-country economy.

FDI is commonly associated with many benefits to a host-country’s economy, such as job creation, increased competitiveness, transfer of technology, and crucially also economic growth. Theoretical literature on the topic supports this association, however in empirical research no consensus has been reached (Makiela & Ouattara, 2018). Iamsiraroj & Ulubaşoğlu (2015) concluded the same in a review of 108 published studies on the topic. Of the studies reviewed, they found that 43% show a positive and significant effect of FDI on economic growth, 17% show a negative and significant effect and 40% show statistically insignificant effects. It is therefore suggested that FDI might only contribute to economic growth if the host country has a sufficient absorptive capacity. Different authors have highlighted different host country characteristics as being important in increasing or decreasing this absorptive capacity. Some studies found that the relationship between FDI and economic growth is positively affected by an adequate level of human capital (Borensztein et al., 1998; Zhang, 2001; Bengoa and Sanchez-Robles, 2003; Li and Liu, 2005 & Solomon, 2011), well developed financial markets (Bengoa and Sanchez-Robles, 2003; Alfaro et al., 2004 & Durham, 2004) and an open trade regime (Balasubramanyam et al., 1996 & Zhang, 2001). This relationship is affected negatively by a dependency on foreign investment (Kentor, 1998 & Kentor and Boswell, 2003) and a high technology gap (Li and Liu, 2005). The influence of the income level of the host country (Blomstrom et al., 1994 & Solomon, 2011) and the quality of the political environment (Solomon, 2011) is not yet conclusive, but appear to have an effect as well. Thus, there is no clear empirical consensus yet on the effect of FDI on economic growth and it appears to be the case that this effect can be either positive or negative depending on certain host country characteristics.

#### Figure 1. Inward Foreign Direct Investment Flows, 1970-2017 (in US Dollars at current prices in millions). (UNCTADSTAT, 2019)



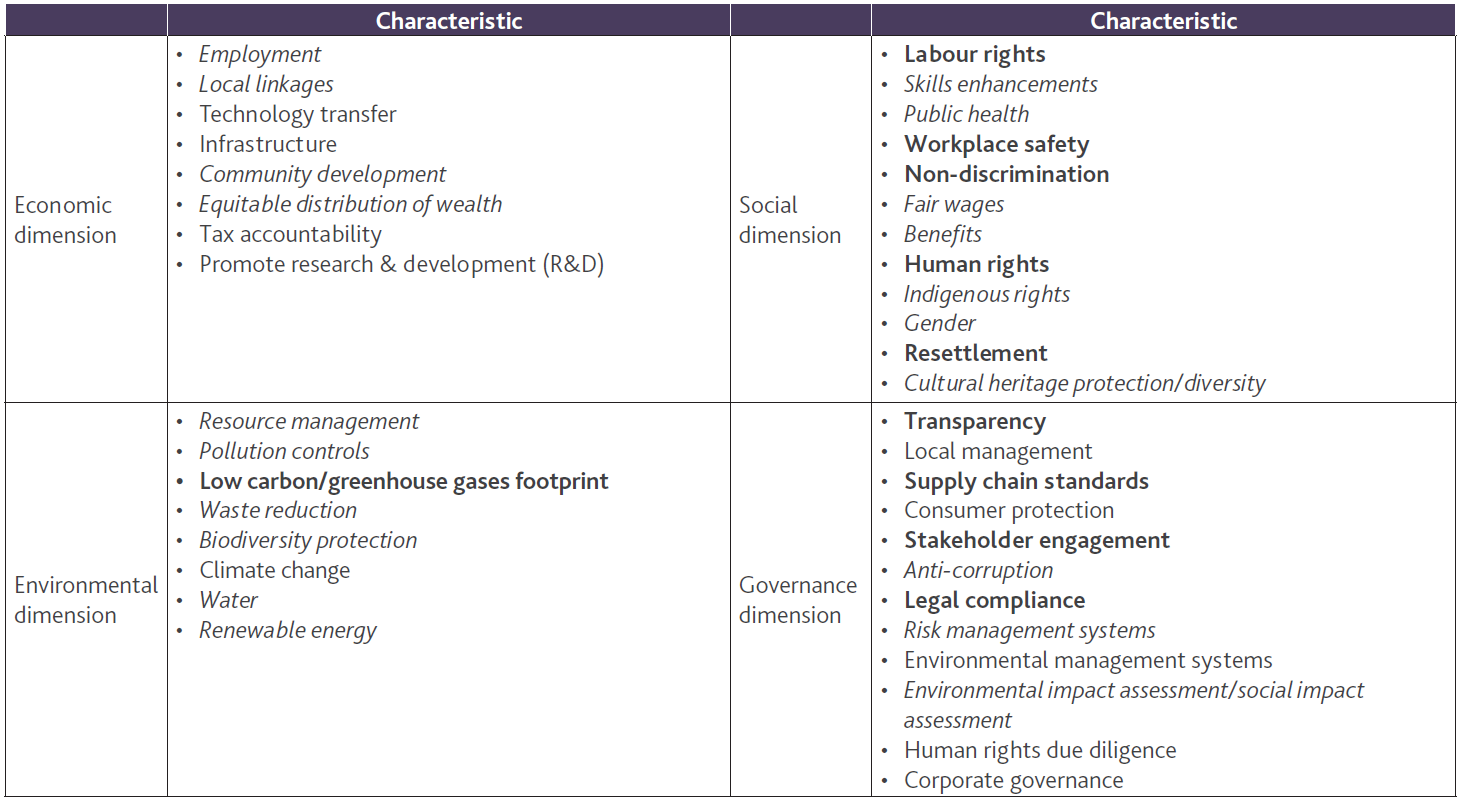
Nonetheless it is certain that FDI has increased tremendously in the last decades. Van Marrewijk et al. (2012) showed that between 1970 and 2009 global real GDP has grown with 3% per year, while in the same period total global FDI flows increased with 7% per year. This illustrates the drastic increase in the importance of FDI in the global economy. Although it must be noted that this growth has not been stable and these FDI flows have also decreased drastically in some years, as can be seen in Figure 1. Interesting as well, is the steep decrease in FDI flows in 2016 and 2017, as during these years global GDP and trade have experienced accelerated growth (UNCTAD, 2018). Still it is clear that the overall trend of FDI is upward. Furthermore, countries continue to actively attract FDI with their national investment policies, as can be seen in Figure 2 which shows the percentage of worldwide national investment policies related to foreign investment that either promotes or restricts FDI. In 2017 84% of the policies promoted FDI which in an increase to 2016. These two graphs thus show that FDI is becoming more important in the global economy and that countries are making efforts to attract FDI to their countries, despite the lack of empirical consensus on the effect of FDI on economic growth.

Figure 2. Changes in national investment policies, 2003−2017 (Percent). (UNCTAD, 2018)**

## 2.2 Foreign Direct Investment and Sustainable Development

As explained in the introduction, the policy debate has seen an increased focus on the impact of FDI on a more multidimensional form of development, as envisioned by the Sustainable Development Goals (SDGs). With this in mind Sauvant and Mann (2017) developed a first indicative list of FDI sustainability characteristics. They state that in order to reach the SDGs and climate change commitments (such as the Paris Agreement), a tremendous amount of investment is needed and an important part of these investments could be in the form of FDI. These characteristics of investment then, are important in determining if it is a sustainable investment, which according to their definition is a “commercially viable investment that makes a maximum contribution to the economic, social and environmental development of host countries and takes place in the framework of fair governance mechanisms”. After reading such a definition the question may arise if such an investment exists or if there might be trade-offs between the contribution of an investment to economic, social and environmental development. To get an idea of the complexity of this issue, Table 1 shows the list of characteristics that Sauvant and Mann consider to be important, ordered along the four dimensions of sustainable investment as identified in the definition above. The characteristics in **bold** are commonly recognized in the investment instruments, the *italicised* characteristics are emerging common characteristics and the rest is not yet commonly recognized as an FDI sustainability characteristics. The focus within this thesis is on the environmental dimension of sustainable investment. Thus it has to be kept in mind that this is only one perspective on sustainable investment, which can hopefully give insights in the dynamics of sustainable investment, but is only one part of discussion.

##### Table 1. An indicative list of FDI Sustainability Characteristics (Sauvant and Mann, 2017).



Within discussions on investment policy the OECD is a big source of knowledge, writing many papers and reports on the effect of (international) investment on the economy and the society as a whole. Furthermore, the OECD recommends national governments on policies to maximize the benefits of investment. One of the tools with which the OECD advises national governments is the Policy Framework for Investment (OECD, 2015) which materializes in the OECD Investment Policy Reviews to *“assess the climate for domestic and foreign investment at sub-national, national or regional levels. They then propose actions for improving the framework conditions for investment and discuss challenges and opportunities for further reforms.”* (OECD, 2019b). Since the adoption of the SDGs in 2015, the OECD has been working to incorporate the SDGs into their work. After the 2016 Ministerial Council meeting the OECD published an action plan for the SDGs (OECD, 2016). In this action plan the OECD commits itself to different areas for action of which one is to ‘Apply an SDG lens to the OECD’s strategies and policy tools’. More specifically the OECD will do this by mainstreaming the SDGs across the OECD’s work, by integrating the SDG framework into the OECD reviews and by disseminating the updated OECD Policy Framework on Investment (PFI) and giving further consideration to methodologies and indicators based on the PFI. In line with these commitments the Investment Committee of the OECD launched a project called *FDI Qualities Toolkit: Investment for inclusive and sustainable growth* in March 2018 (OECD, 2019a). The objective of the project is to *“to equip policymakers with an actionable tool to mobilise FDI that maximises inclusive and sustainable growth.”* (OECD, 2019a p. 1) and it will consist of two components. The first component, which is currently being developed, is a set of FDI qualities indicators which describe how FDI relates to specific aspects of sustainable development. The second component is an FDI qualities policy framework which will offer countries tailor-made policy options to maximise the development impact of FDI. The indicators made for the first component of this FDI qualities toolkit are ordered in five clusters, namely productivity-innovation, skills, job quality, gender, and environment.

Within this thesis the focus will be on the relationship between FDI and environmental pollution and the data used to construct the indicators of the last cluster on environment will be used in this analysis.

## 2.3 Foreign Direct Investment and the host-country environment

The academic debate on the environmental impact of FDI had started long before the introduction of the SDGs and many scholars (Eskeland & Harrison 2003; Wheeler, 2000; Letchumanan & Kodama, 2000; Beladi et al., 1999; Talukdar & Meisner, 2001 and Smarzynska & Wei, 2001) have linked environmental pollution with inward foreign direct investment (Hoffmann et al. 2005). This attention from academia has led to a large number of hypotheses concerning this topic. The next section will briefly introduce the relevant hypotheses and from now on this thesis will refer to them as theories, in order to avoid confusion with the hypotheses that this thesis will later put forward itself. Afterwards the effects on the environmental footprint of FDI that these theories predict will be discussed.

### 2.3.1 Previous theories

The first theory tries to identify the effect of domestic environmental policy on the attraction of FDI. The rationale is that a less stringent environmental policy can attract (the dirty components of) MNE’s that seek to circumvent costly regulatory compliance in their home country. This mechanism is referred to as the *pollution haven theory* (PHT) (Jensen, 1996, Birdsall & Wheeler, 1993 and Zarsky, 1999). This theory also predicts the risk that due to the drive to remain or become competitive as a location for MNE’s, countries with initially stringent environmental policy may also relax their environmental regulation, creating a global race to the bottom (Zarsky, 1999).

More recently an opposing rationale was introduced which says that more stringent environmental regulation may attract FDI. The first theory for this rationale is that in some sectors a firm’s reputation on sustainable management practices and Corporate Social Responsibility (CSR) is more important than circumventing costs due to stringent environmental regulation. In these sectors firms will not be attracted to countries with lax environmental regulations as this might affect their sustainable reputation, thus these firms will be attracted to countries with more stringent environmental regulations. This argument is called the *green haven theory* (GHT) (Poelhekke & Van der Ploeg, 2015). A second theory is that as a country increases its environmental policy stringency (EPS), firms with high environmental capabilities will have a competitive advantage in this country. This advantage arises as these firms already have the capabilities, such as technological innovation, know-how or management practices, that are needed to abide by the more stringent environmental policies. These firms will be compelled to invest in this country to exploit this competitive advantage; this argument is called the *induced innovation theory* (IIT) (Bu & Wagner, 2016). The concept of environmental capabilities will be discussed in more detail later. Although not relevant to inward FDI, it is worth mentioning that this *induced innovation theory* also predicts that the home country firms will develop environmental capabilities when a country increases its EPS (Bu & Wagner, 2016). Therefore firms can achieve experienced-based scale economies in environmental innovations and pollution prevention or a first-mover advantage, which can give them a competitive advantages in other countries which also increase their EPS (Rivera & Oh, 2013).

Another related theory is the pollution halo theory, which does not discuss FDI attraction, but the impact of FDI on the home economy and environment. This theory suggests that in general MNE’s will have newer and cleaner technologies and/or universally abide by more stringent environmental standards than the domestic firms. Therefore it makes the case for general FDI attraction, the effects of this will be discussed in the next section.

A last theory is the *factor-endowments theory* (Zugravu-Soilita, 2017), which helps to explain that no consensus has been found on one of the previous theories. Zugravu-Soilita (2017) states that, as capital intensive activities are generally assumed to also be pollution intensive, capital abundant countries will be pollution intensive under free trade and openness to FDI. This means that firms might choose to locate in capital abundant countries with stringent environmental regulations, despite these regulation and not because of them, as the green haven theory might suggest. As capital abundant countries tend to have more stringent environmental policies, the green haven effect might appear true if relative capital abundance is not taken into account.

### 2.3.2 Effects of the environmental footprint of FDI

This section will discuss the different effects that inward FDI can have on a host-country’s environment. These effects are rather similar to the effects of economic growth on pollution as described by Grossman (1995). He described three effects that may take place as an economy grows, which are also applicable to the inflow of FDI. First is the *scale effect,* which means that FDI increases a country’s economic output therefore ceteris paribus the total pollution from the economic output will increase as well. This particularly applies to greenfield FDI, but possibly also to brownfield FDI by increasing productivity and total production. The second effect is the *composition effect*, which means that the average pollution per unit of output of the country will increase if FDI flows to pollution intensive sectors and vice versa. Thus the average pollution per unit of output can change due to a change in composition of the economy. The last effect is the *technique effect,* which suggests that the inflow of FDI may introduce newer, more productive and cleaner production techniques or management practices and therefore reduce the average pollution per unit of output. This technique effect is already present when a foreign firm itself uses these newer techniques, but will be even greater when the foreign firm diffuses these techniques among other firms as well via spill overs. This can occur via vertical spillovers, i.e. from foreign firms to domestic suppliers (backward linkages) or from foreign suppliers to domestic firms (forward linkages). Or this can occur via horizontal spillovers, i.e. from foreign firms to domestic competitors (Navaretti & Venables, 2004).

Even though the before mentioned *scale* *effect* of FDI on the environment (Grossman, 1995 & Zarsky, 1999), might sound rather unambiguous, there is some debate as to what extent an increase in economic output also increases the environmental pollution. The OECD (1997) pointed out that these negative scale effect might be limited due to the existence of the “inverted U-shape” relationship between pollution and economic development known as the Environmental Kuznets curve (EKC) (Shafik & Bandyopadhyay, 1992; Panayotou, 1993 and Grossman & Krueger, 1995). According to the EKC an increase in FDI might first increase the environmental impact. However, as FDI can also increase national income this will increase the national demand for environmental quality which will cause pollution to level off and eventually even decline. Thus far, no consensus has been reached on the existence of the EKC, also it seems to depend on the type of environmental impact that is researched (Uchiyama, 2016 & Dinda, 2004). The OECD (1997) also concludes that due to a lack of consensus around this phenomenon it is difficult to draw meaningful conclusions on the influence of the EKC on the scale effects of inward FDI.

The pollution haven theory predicts an increase in FDI when a country lowers its EPS. A low EPS is especially important in polluting sectors, as abiding by more stringent regulations can be very costly in these sectors. Therefore, countries with a low EPS are predicted to attract pollution intensive FDI. In terms of the effects on the environmental footprint of Grossman (1995), this represents a negative scale effect and a negative composition effect. To the contrary, the green haven theory predicts an increase in FDI when a country increases its EPS. This increase is expected in sectors where a sustainable reputation is highly valued and therefore are expected to have relatively sustainable practices. Hence this represents a negative scale effect, but a positive composition effect. Similarly, the induced innovation theory predicts an increase in FDI when a country increases its EPS. The argument is slightly different, however, as the focus is on firm-level heterogeneity. A higher EPS could attract firms which have high environmental capabilities relative to other firms in their sector, because the higher EPS will give these firms a competitive advantage over their competitors. With the factor-endowments theory Zugravu-Soilita (2017) states that capital intensity might be a bigger factor of consideration for many pollution intensive firms than the level of EPS, therefore no straightforward effects of a change in the level of EPS can be predicted by this theory. Lastly the pollution halo theory says that MNE’s are generally cleaner than domestic firms. Therefore, these multinational firms may displace the less efficient and dirtier local firms (Cole et al. 2017), diffuse their best practices of both management and production among their local counterparts and suppliers (Hoffmann et al. 2005 & Cole et al. 2017) and push for more stringent environmental regulation and/or more enforcement in order to reduce the cost advantage of the dirtier local firms. This points to a positive composition effect and a positive technology effect. Table 2 gives an overview of the theories and their effects discussed in the previous sections.

##### Table 2. Overview of Theories and their Effects.

|  |  |  |  |
| --- | --- | --- | --- |
| **Theory name** | **Concerning** | **Theory prediction** | **Effects** |
| Pollution haven theory | EPS -> FDI Attraction | Low EPS -> increase of (polluting) FDI | Negative scale effect, negative composition effect |
| Green haven theory | EPS -> FDI Attraction | High EPS -> increase of (clean) FDI | Negative scale effect, positive composition effect, positive technique effect |
| Induced innovation theory | EPS -> FDI Attraction | High EPS -> increase of (clean) FDI | Negative scale effect, positive composition effect, positive technique effect |
| Induced innovation theory | Home country firms | High EPS -> increase environmental capabilities of home country firms -> potentially increase competitive advantage of home country firms abroad. | N/A |
| Factor-endowments theory | C intensity -> FDI Attraction | Capital intense firms are also pollution intense firms. Capital abundant (rich) countries, possibly with high EPS, attract "polluting" FDI with capital abundance. | N/A |
| Pollution halo theory | FDI Impact | MNE's in general use cleaner techniques or universally abide to more stringent environmental standards. Therefore FDI may displace "dirtier" local firms and diffuse best practices of management and production among peers and suppliers. | Positive composition effect, positive technique effect. |

As is shown in the theories discussed above, there have been two main perspectives on the relationship between FDI and environment (Cole et al. 2017).

### 2.3.3 Perspective 1: Environmental regulation and FDI attraction

The first perspective tries to identify the effect of domestic environmental policy on the attraction of FDI. In this perspective the pollution haven theory, the green haven theory and the induced innovation theory can be categorized. The pollution haven theory proposes exactly the opposite rationale as the green haven theory and the induced innovation theory. This might also explain why no decisive answer is found in the empirical work on this topic (Cole et al. 2017). As a result of the lack of empirical evidence, some authors (Poelhekke & van der Ploeg, 2015; Bu & Wagner, 2017) have suggested that the effect of stringent environmental regulation of the attraction of FDI might be either positive or negative depending on sector or firm characteristics.

The idea of sector level heterogeneity with respect to preferences of environmental stringency of host countries is put forward by Poelhekke and van der Ploeg (2015). They state that in many developed countries the integration of sustainable development concepts into real business practice and CSR are gaining ground. Therefore, many firms also report on these issues in order to establish the reputation to take action towards the achievement of sustainable development. As a part of this effort firms try to reduce their environmental footprint. These firms might undertake FDI in countries with stricter and more strongly enforced environmental regulations in order to achieve a good reputation or to avoid having to deal with difficult environmental issues themselves, such as how to deal with waste products. Poelhekke and van der Ploeg have shown that this argument is consistent with empirical evidence in relatively footloose sectors such as machines, electronics and automotive, and ICT and communication. Other sectors, such as natural resource extraction and refining, construction, retail, food processing, beverages and tobacco and utilities, are shown to display pollution haven effects and settle in countries with less strict environmental regulations. Thus there appears to be heterogeneity on sector level.

On a firm level, Bu and Wagner (2016) have also shown that there appears to be heterogeneity in the preference for stringent or lax environmental regulations. This analysis was based on the rationale by Madsen (2009) about the environmental capabilities of firms as a competitive advantage. The environmental capabilities of a firm are defined by Hart (1995) as a firm’s ability to carry out its productive activities in ways that limit damage to the natural environment. This stems for a resource-based view, in which the resource is the basic building block of firms and can be described as an asset controlled by a firm. Differences in resources are part of the explanation for heterogeneous performance among firms (Barney, 1991). Firms gain and hold competitive advantage by controlling and utilizing resources that are rare, valuable, inimitable, and non-substitutable. These resources serve as inputs in the production processes that transform bundles of complementary resources into valuable outputs. These production processes are called capabilities (Grant, 1991) and they are an important step in exploiting the resources to create a competitive advantage. According to Madsen (2009, p. 1301) *“environmental capabilities constitute the utilization of bundles of resources and routines that allow a firm to minimize its environmental impact. Such environmental resources may include pollution prevention experience, environmentally benign technologies, environmental accounting systems, environmental engineering expertise, and employee commitment to protecting the natural environment”.* These environmental capabilities can create a competitive advantage for firms when certain conditions are met, for example when consumers value environmental protection (Baker and Sinkula, 2005). Environmental capabilities are developed in the context of the institutions in which the firm operates, such as regulations or the prevailing norms among the firm’s consumers, suppliers and other actors in the firm’s community. Hence the differences in institutional context and the prevailing norms will create heterogeneous environmental capabilities among firms which will give some firms a competitive advantage over others. Environmental capabilities are not necessarily static over time, but developing new capabilities is very time-consuming. Firms that have developed their environmental capabilities in a context of strict environmental regulations and norms can therefore not easily set aside these capabilities when operating in a context of weaker regulations and norms. To do so would also require them to give up the advantage of uniform production processes across plants. Therefore, MNE’s often choose to standardize production processes in a way that they meet the strictest environmental standards to which they are subjected instead of differentiating between the production processes of plants to meet the standards that the specific plant is subjected to (Christmann, 2004). This standardization causes firms with high environmental capabilities to have relatively stable production costs in countries with strict or lax environmental regulations. Hence firms that lack environmental capabilities will have a cost advantage in countries with lax environmental regulations and firms with strong environmental capabilities will have a cost advantage in countries with strict environmental capabilities. These differences in cost advantages will, ceteris paribus, cause firms with strong environmental capabilities to prefer countries with strict environmental regulations and firms with weak environmental capabilities to prefer countries with lax environmental regulations.

### 2.3.4 Perspective 2: Environmental footprint of inward FDI

The second perspective on this issue focusses on the effect of FDI on the environment of the host country, which is sometimes found to be positive and sometimes found to be negative. This is also shown in the different positive and negative effects of the different theories. The pollution haven theory, green haven theory and induced innovation theory discuss how the environmental footprint of inward FDI is affected indirectly by the FDI that is attracted due to the level of EPS. The pollution halo theory does not focus on the firm’s location decision, but on the environmental performance of foreign firms compared to domestic firms (Zarksy, 1999). It states that MNE’s will perform better and even influence the domestic firms to perform better on environmental issues as well.

As was to be expected from the theories that were discussed, empirical studies have found mixed results on the relationship between FDI and the environment. The OECD (2019a) show an overview of 20 empirical studies of which 11 find that FDI increases CO2 emissions (of which two find this to be true only in low- and middle income countries) and nine studies do not find that FDI increases CO2 emissions. These mixed results could be explained by the simultaneous and opposing effects of the pollution haven theory, green haven theory, the induced innovation theory and the pollution halo theory, as one or the other effect could preponderate depending on the country, time, context or industry that is studied. A similar rationale is suggested and researched by Zugravu-Soilita (2017), although in her analysis the opposing theory to the pollution haven theory, is the factor-endowment theory. Her research shows that these theories together with the pollution halo theory are occurring simultaneously and with opposing effects. Furthermore, she concludes that inward FDI is associated with pollution reductions in countries with average capital endowments and not too lax environmental regulations, as here the pollution halo theory predominates. While in countries with average capital endowment and lax environmental regulations inward FDI is associated with an increase in pollution as the pollution haven theory and/or the factor endowments theory predominate here. In capital abundant countries the factor-endowments theory, causes FDI to increase pollution as capital attracts pollution intense firms. Although this effect is mediated by stringent environmental regulations, these regulation will not reverse the effect of FDI on pollution. From this it can be concluded that the effect of a change in EPS may depend on the capital abundancy of a country.

## 2.4 Research Problem

In this thesis the focus will be on the relationship between the EPS of a country with the environmental footprint of this country’s inward FDI. As the signing of the Sustainable Development Goals and the Paris Agreement has shown, a clean environment, both locally and globally, has become an important objective for policy makers. In the scale effect that was discussed before there appears to be a trade-off between increasing economic output and decreasing the environmental footprint. This trade-off is a very important and difficult policy debate at the moment. A focus on the composition effect and technique effect could offer policy makers with easier options. Because a positive composition and / or technique effect means that ceteris paribus at least economic output can stay equal while the environmental impact decreases. In the most optimal scenario economic output could even increase while the environmental impact decreases. The latter could occur if the positive composition effect and the technique effect more than offset the negative scale effect. Therefore, it is interesting to know what the effect of environmental policy is on the environmental footprint of FDI per unit of output. This will be the focus of this thesis. The insights of this research can potentially help policy makers to make decisions in the difficult trade-offs that might exist or might be experienced by policy makers between economic, social and environmental development.

To understand the effect of EPS on the environmental footprint of FDI per unit of output, we need to look at the theories of FDI attraction in relation to EPS that where discussed in the literature review. There are two opposing views, one that says that lax environmental policies will attract FDI and one that says that stringent environmental policies will attract FDI. These two views were then unified by the statement that there might be firm-level heterogeneity or sector-level heterogeneity and that some firms or firms in some sectors will be attracted to countries with lax environmental policies and some will be attracted to countries with stringent environmental policies, as explained in the previous section. This thesis will argue similarly that both views can be true at the same time, due to these sector- and firm-level heterogeneity. The argument that sector and / or firm level heterogeneity will have an influence here, will be elaborated with an analogy to the Melitz-model. Melitz (2003) uses a dynamic industry model with heterogeneous firms to analyse the effect of international trade on the markets that firms will serve. He describes that when confronted with international trade, heterogeneity among firms in terms of productivity will cause different firms to serve different markets. Figure 3 shows this relationship. It can be seen that the least productive firms have to exit the market, firms with a modest productivity will produce for the domestic market, firms with a high productivity will export and only the firms with the highest productivity will become multinationals (Van Marrewijk et al. 2012). This means that all MNE’s have a high productivity level, otherwise they would not have been able to become an MNE.

#### Figure 3. Melitz-model modes of entry (Van Marrewijk et al. 2012)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Mode of entry** | |  |  |
|  |  |  |  |  |
| Exit | Domestic | Export | FDI Multinational | |
| low | modest | high | very high |  |
|  |  |  |  |  |
|  | **Firm productivity** | |  |  |

More relevant to this thesis, however, is the heterogeneity in terms of environmental capabilities instead of productivity. Just as productivity is a continuum in the Melitz-model, this thesis proposes that the level of environmental capabilities of a firm is also a continuum. This level of environmental capabilities will influence the competitive advantage that a firm has in a certain country depending on the environmental regulation in that country. Stringent environmental regulation will entail higher costs for firms with less environmental capabilities, as compared to firms with more environmental capabilities. The opposite might also be true, because a firm with a high level of environmental capabilities will usually uphold these capabilities even if it enters a country with lax environmental regulations. As these environmental capabilities are usually associated with higher costs, this will decrease the competitive advantage of this firm. This will cause firms with a high level of environmental capabilities to be attracted to countries with stringent environmental policy and vice versa. This is visualized in Figure 4.

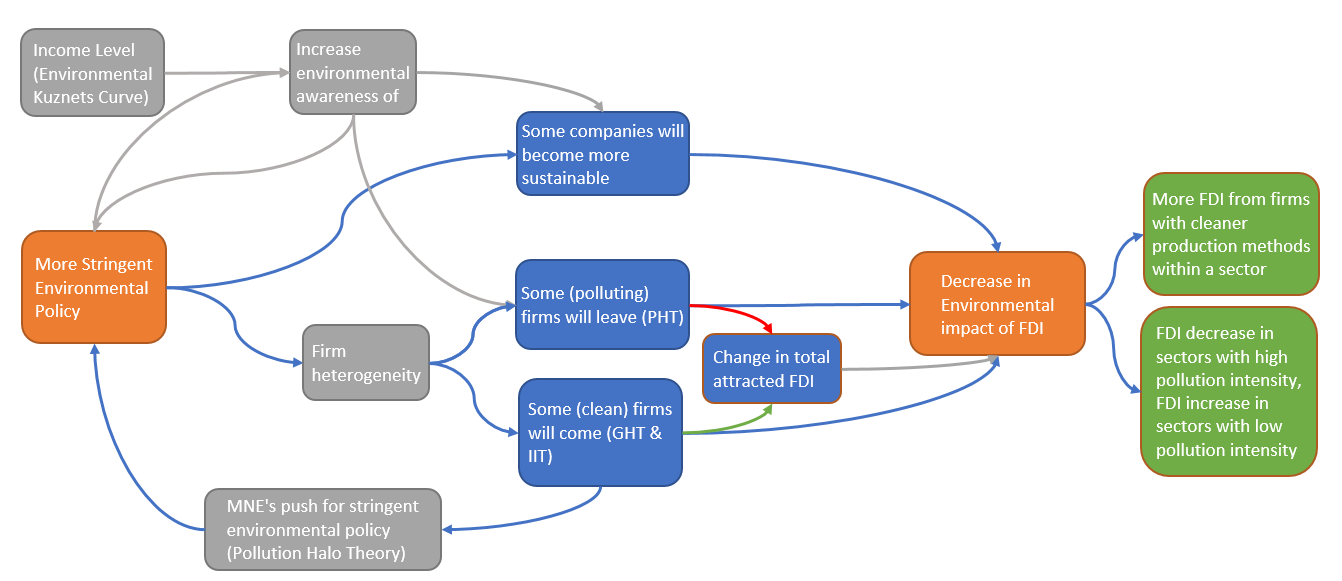
#### Figure 4. Attraction to environmental regulation

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Type of environmental regulation the firm is attracted to** | | | | | | |
|  |  |  |  |  |  |  |
|  | very lax | lax | stringent | very stringent | |  |
|  | low | modest | high | very high |  |  |
|  |  |  |  |  |  |  |
|  | **Level of environmental capabilities** | | | |  |  |

From this understanding of firm and / or sector level heterogeneity the theoretical model of Figure 5 arises.

This model describes the effects of a country increasing its EPS. One effect will be that some foreign firms remain in the country as the costs of abiding to the more stringent regulation are off-set by other factors in the location decision of the firm, such as the fixed costs of moving the company, the capital intensity of the host country, the level of human capital of the host country or other factors. These firms will then have to abide by the more stringent regulations and thus incorporate more sustainable practices. Another effect is that for pollution intense firms, these more stringent environmental regulations might entail such high costs that these are not off-set by other factors. These pollution intense firms will then move their operations to a country with less stringent environmental policies (pollution haven theory). A third effect is that firms with high environmental capabilities will now invest in the country in order to exploit their competitive advantage due to their high environmental capabilities (induced innovation theory). Similarly firms in sectors in which a sustainable reputation is very important might also invest in this country because this has now become an option as it will no longer harm their sustainable reputation (green haven theory). All three of these effects will decrease the environmental footprint of the FDI per unit of output in this country.

#### Figure 5. Theoretical Model



This thesis will research whether these effects mentioned above take place and thus whether and to what extent a more stringent environmental regulation will decrease the environmental footprint of a country’s inward FDI per unit of output. In the first hypotheses, environmental footprint will be measured as pollution intensity. Hypothesis 1 is related to the sectoral composition of the inward FDI of a country, the composition effect. Here I expect that as the EPS of a country increases i.) some firms in pollution intense sectors will exit the country and ii.) some firms in less pollution intense sectors will enter the country. Following from this is the first hypothesis.

***Hypothesis 1:*** *An increase in a country’s EPS will result in the country’s inward FDI to flow more to sectors with a smaller pollution intensity.*

This hypothesis can reveal an overall effect, but it cannot disentangle if firms in more polluting sectors are leaving, firms in more sustainable sectors are entering or both. In order to be able to disentangle these effects two sub-hypotheses are put forward. For these hypotheses sectors in a host country will be divided into sectors with a pollution intensity above the mean value of that country and sectors with a pollution intensity below the mean value of that country.

***Hypothesis 1.1:*** *An increase in a country’s EPS will result in a decrease of FDI to sectors that have a high pollution intensity.*

***Hypothesis 1.2:*** *An increase in a country’s EPS will result in an increase of FDI to sectors that have a low pollution intensity.*

These hypotheses can give insight in whether the two described effects take place and to what extent both of them do.

Hypothesis 2 relates to the firm-level heterogeneity and looks at the effect of the level of EPS on the environmental capabilities of the attracted FDI, this is the technique effect. Here I expect that as the EPS of a country increases i.) some firms will abide by the new regulations and incorporate more sustainable practices, ii.) some firms with low environmental capabilities will exit the country and iii.) some firms with high environmental capabilities will enter the country. As the environmental capabilities of a firm are difficult to measure and no data is available to measure this directly, a sort of case-study in performed in the energy sector. As a clean energy sector is also vitally important for the transition to an environmentally sustainable society, it is interesting to take a closer look at this sector. In this sector, data is available that distinguishes FDI into the coal, oil and gas sector (brown energy) and FDI into renewable energy sector (green energy). This analysis will view investments in the coal, oil and gas sector as investment from firms with low environmental capabilities and investment in renewable energy sector as investment from firm with high environmental capabilities. It is also assumed that the environmental footprint of an investment in the renewable energy sector is lower than that of an investment in the coal, oil and gas sector. I expect that as the EPS of a country increases i.) some firms will decrease investment in fossil fuels and instead invest in renewable energy, ii.) some firms in the fossil fuel industry will exit the country and iii.) some firms in the renewable energy industry will enter the country. Thus, the following hypothesis is formulated.

***Hypothesis 2:*** *An increase in a country’s EPS will increase the FDI in renewable energy relative to the FDI in fossil fuels.*

As was the case for Hypothesis 1, it is difficult to disentangle the different effects that might take place simultaneously with this hypothesis. However, it is possible to do so by introducing the following sub-hypotheses.

***Hypothesis 2.1:*** *An increase in a country’s EPS will decrease the FDI in fossil fuels.*

***Hypothesis 2.a.2:*** *An increase in a country’s EPS will increase the FDI in renewable energy.*

These hypotheses can give insight in whether the two described effects take place and to what extent both of them do.

# 3. Methodological Approach

In order to test the hypotheses that were put forward in the previous chapter an empirical analysis will be performed. First the data that will be used for the different variables will be discussed after which the empirical methods that will be used to perform this test will be elaborated on.

## 3.1 Data Description

To answer our two main hypotheses, slightly different datasets are used. For the first hypothesis data is available for 54 countries from many different regions of the world for the eight-year period from 2009-2016. For hypothesis 2 data is available for 71 countries for the five-year period from 2013-2017. For the Hypotheses 2.1 and 2.2 data is available for 74 countries for the same period. Tables 6, 7 and 8 in the appendix show all the countries used in every model.

### 3.1.1 Dependent variable

The dependent variable for the hypothesis 1, looking at changes in sectoral composition, is the CO2 intensity of FDI based on the sectoral composition of FDI. This is an indicator based on the CO2 emissions that are generated in a sector per USD of value added in that sector and the incoming greenfield FDI that this sector receives. It is chosen to focus on greenfield FDI due to data availability. To construct this indicator sector-level data on CO2 emissions from the International Energy Agency (IEA, 2018) is combined with value added estimates from OECD input-output tables (OECD, 2019c) and greenfield FDI statistics from fDi Markets database of the Financial Times (Financial Times, 2019). This indicator measures the FDI weighted CO2 emissions per value added. It is called the *CO2\_FDIweighted* and is constructed in the following manner:

Where is the pollution intensity of sector , measured as the CO2 emissions in that sector divided by the value-added in that sector . is the FDI weight of that sector, which is measured as the FDI inflow in that sector divided by the total FDI into the country. Multiplying these two per sector and then taking the sum over all sectors in a country will yield an FDI weighted pollution intensity for that country. When FDI flows more to sectors with relatively high pollution intensity, this indicator will increase and vice versa. It is good to note that the measure of pollution intensity is the pollution intensity of a sector as a whole and not that of foreign firms specifically. Thus this indicator only measures the changes in the environmental footprint of FDI via changes in the sectoral composition. By using this sector wide pollution intensity, this analysis assumes that the pollution intensity of foreign firms is similar to that of the sector average. There is much literature suggesting that FDI is more or less pollution intensive then domestic firms, such as the multiple theories discussed in the literature overview. However, by making this assumption the sector composition effect is observed in isolation. This dependent variable is sensitive to overall changes in the pollution intensity of a country. This is controlled for by including the overall pollution intensity of a country as a control variable, causing the dependent variable to only measure changes in the sectoral composition of FDI.

For Hypotheses 1.1 and 1.2 the dependent variable will be the incoming FDI to sectors with a pollution intensity that is above the mean value and to sectors with a pollution intensity that is below the mean value of a country, respectively. This will again be tested using CO2 emissions as the measure for pollution intensity. This results in the dependent variable *FDI\_total\_high\_CO2*for Model 1.1, which is the total incoming FDI to sectors with above mean CO2 emissions per USD of value added. For Model 1.2 the dependent variable is *FDI\_total\_low\_CO2,* which is the total incoming FDI to sector with below mean CO2 emissions per USD of value added.

For the construction of the dependent variables for the analyses of the first hypothesis sector level data is used. Because the FDI data, value-added data and CO2 data all use different sector definitions these had to be combined. This is done using a method that was recommended by the OECD, which converted the FDI data and value-added data to the IEA sector division, in which the CO2 data was provided. After converting, 14 sectors remain for which all data is available, these are used in this analysis. The manner in which this sector data is converted can be found in the appendix.

For Hypothesis 2, looking at changes within a sector, the analysis will focus on one important sector – the energy sector. For this sector data is available for FDI flowing into brown energy and FDI flowing into green energy, this makes relatively easy to analyse the effect of environmental regulations on the attraction of FDI from polluting versus less polluting firms. The dependent variable in this analysis will be the ratio between FDI to green energy and FDI to brown energy. In order to also be able to analyse the cases in which no FDI flowed to either brown or green energy 1 will be added to each observation. This results in the following indicator:

For this indicator data is available for 71 countries for the years 2013-2017. The second hypothesis suggests that as the EPS increases, the investment in renewable energy will increase relative to the investment in fossil fuels, as both investments in green energy increase and investments in fossil fuels decrease. To establish which of these two effects is present to what extent, two more analyses are done. The first one uses the total FDI in brown energy (FDI\_brown) as the dependent variable and the second one uses the total FDI in green energy (FDI\_green) as the dependent variable.

### 3.1.2 Independent variable

The independent variable in all the analyses is a measure of the EPS of a country. The measure used in this thesis follows Kellenberg (2009) and Poelhekke and van der Ploeg (2015) and is constructed from data from the Executive Opinion Survey which is conducted by the World Economic Forum and which are published in the Travel and Tourism Competitiveness Reports (e.g. Blanke & Chiesa, 2013). This survey data is available from 2009-2017. In this survey, business executives are asked a multitude of questions concerning the economy they operate in. In 2015 the survey included 13,213 observations over 134 countries, thus with on average 98.6 observations per country. The minimum number of observations that is required to be taken into account in the survey is 30 per country. More descriptive statistics on the Executive Opinion Survey of 2015 can be found in the appendix Figure 7, for other years the numbers vary slightly, but are generally similar.

Thus far this thesis has discussed environmental policy stringency, however multiple authors (Kellenberg, 2009 & Poelhekke and van der Ploeg, 2015) suggest that next the stringency of the policies also the enforcement is an important factor. The reasoning is that a country with a set of very strict environmental policies, but no enforcement will not cause firms to abide by the regulations. Therefore two of the questions asked in this survey are relevant for the measure of environmental policy for this analysis. The first questions asks business executives about the stringency of environmental regulations in the relevant country and the second question asks about the enforcement of these regulations. Both questions have been rephrased slightly from 2009 to 2011, however this rephrasing is not expected to create a difference in the results. Both the original and the rephrased version of the questions can be found in the appendix. The answers to both the questions are a number between 1 and 7 is which 1 is the least strict or the least enforced and 7 is the most strict or the most enforced. The scores of the two questions are combined into a single indicator by multiplying the stringency of environmental regulations score and the enforcement of environmental regulation score. This method captures the idea that stringent environmental policy is only relevant if it is enforced. This creates what previous authors (Kellenberg 2009, Poelhekke & van der Ploeg 2015) have called the Environmental Policy Index, which can potentially range from 1 to 49.

### 3.1.3 Control variables

Based on the literature review provided in the second chapter of this thesis a number of control variables are included in the analysis as there is reason to believe that these variables influence the relationship between EPI and the environmental impact of FDI in the host country.

* **Economy wide pollution intensity (CO2\_intensity)**, is included in order to control for changes in the pollution intensity of a country as a whole in Model 1. The dependent variable in Model 1 is chosen to measure the environmental impact of FDI due to the sectoral composition of FDI in a country. If, for example, all sectors in a country become less pollution intensive. This will be reflected in the dependent variable of Model 1 as a decrease of pollution intensity of FDI unless it is controlled for. By including this control variable in Model 1, the dependent variable only measures the changes in pollution intensity due to changes in the sectoral composition of FDI. This measure is created by dividing the total CO2 emissions of a country by the total value added of the country, (). With data form the IEA and the OECD input-output tables.

Then some variables are included that partly describe the host-country economy and therefore might influence the investment decisions of MNE’s.

* **Gross Domestic Product** **(rgdpna),** is included as a proxy for the host country’s market size. The size of a country’s market can be an important factor in the location decisions of MNE’s, mainly for market seeking FDI (Dunning & Lundan, 2008). This type of FDI invests in a country in order to produce for the domestic demand. A bigger domestic market will, ceteris paribus mean a bigger domestic demand. Thus an increased market size will increase the incentive for MNE’s to invest in a country. For this indicator data from the Penn World Tables is used on real GDP at constant 2011 national prices (in mil 2011 USD) (Feenstra, Inklaar & Timmer, 2015).
* **The share of enrolment in tertiary education (SE-terX)**, is included as a proxy for human capital. This indicator is calculated by dividing the number of students enrolled in tertiary education regardless of age by the population of the age group which officially corresponds to tertiary education, and multiplying by 100. Human capital can also be an important factor in the location decisions of MNE’s, and the level of human capital will affect the type of FDI that is attracted by a country (Borensztein et al., 1998 & Solomon, 2011). The level of human capital is also expected to influence the public perception of sustainability and therefore can influence our analysis as well (Šlaus & Jacobs, 2011). Data for this variable is retrieved from the World Bank Database.
* **The ease of doing business score (eodb1),** which covers aspects of the ease of starting a business related to investment facilitation, as well as other policy areas. The ease of doing business in a host-country is an important factor for the location decision of MNE’s (Corcoran & Gillanders, 2015), therefore it is included in this analysis. This score is constructed to capture the gap between the regulatory performance of the country in question and the best regulatory performance observed on each of the indicators across all economies in the *Doing Business* sample. The values of the score can range from 0-100, where 100 means the country scores the best on every indicator that is included. The data is retrieved from the World Bank (World Bank, 2019)

The political environment of a country can also have influence on the investment decision of a firm. Therefore, some variables of the World Bank’s Worldwide Governance Indicators are included. They range from -2.5 (weak performance) to 2.5 (strong performance). The Worldwide Governance Indicators (WGI) are a research dataset summarizing the views on the quality of governance provided by a large number of enterprise, citizen and expert survey respondents in industrial and developing countries. These data are gathered from a number of survey institutes, think tanks, non-governmental organizations, international organizations, and private sector firms (World Bank, 2019b).

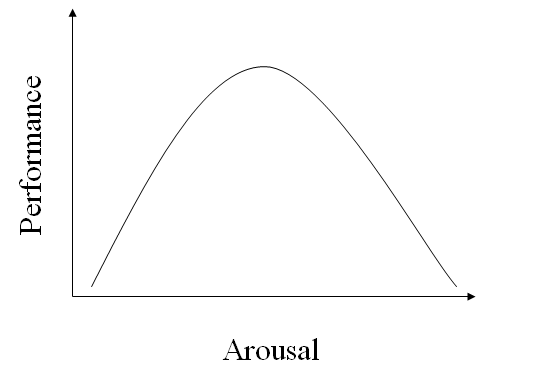
* **Control of Corruption (cce)** is the level of corruption in a country might be a moderating factor between the increase of EPS and the exit of polluting firms. A high level of corruption creates an opportunity for polluting firms to remain in the country without abiding to the more stringent policies. Moreover, a high level of corruption might cause a lower level of EPS as these policies are being stopped by the influence of firms (Cole et al. 2006; Candau & Dienesch, 2017). This indicator reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.
* **Political Stability and Absence of Violence/Terrorism (pve)** measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism.
* **Rule of Law (rle):** Reflects the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Which is also important because sustainable practices often involve innovative technologies and thus the strength of intellectual property right can also be of influence for firm to invest in a country, therefore this indicator is also included.

As the indicators of the political environment listed above are found to correlate strongly with one another, it is chosen to combine them into a single indicator by adding the three values together. This will decrease the multicollinearity in the model. The value of this indicator can theoretically be between -7.5 and 7.5. The new indicator will be called *governance* and will be a reflection of the three governance indicators described above. This technique of combining multiple highly correlated variable into one index is more often used in literature (O’brien, 2007).

Following the factor-endowments theory of Zugravu-Soilita (2017) the capital-labour ratio is also included as a control variable. And as Zugravu-Soulita (2017) showed in her research that the capital-labour ratio might influence the effect that environmental policy has on the existence of the pollution haven effects, also an interaction term between the capital-labour ratio and the EPI is included.

* **Capital-Labour ratio (KL)** is generated by data from the Penn World Tables (Feenstra, Inklaar & Timmer, 2015). The capital stock is measured by the capital stock at current PPP’s (in millions of USD) (cn). The labour is measured as the number of persons engage in employment (in millions) (emp) multiplied by the average hours worked per year (avh) in this country. The ratio is generated by dividing the capital stock by the labour.
* **Interaction term** **between EPI and Capital-Labour ratio** is used because the research of Zugravu-Soulita (2017) suggests that the EPI of a country with a low or high capital-labour ratio has a limited effect on the investment decisions of firms, while it might have a big effect in a country with a capital-labour ratio around average. This effect is visualised in Figure 6. As this is a quadratic interaction term, first KL will be squared and then multiplied with EPI. In order to still have a meaningful interpretation of variables the interaction term consists of, the variables in the interaction are first demeaned. This way the coefficient of for example EPI can be interpreted as the effect of one unit increase in EPI when KL has the average value. This generates the interaction terms EPI\_KL\_cen and EPI\_KL\_2\_cen, which are included in the model. The initial variables of an interaction term should always be present in a model that uses interaction terms. Thus also the squared KL, KL\_2, variable is included in the model.

#### Figure 6. Interaction between capital-labour ratio and EPI



**Capital-labour ratio**

**Effect of EPI on the dependent variable**

## 3.2 Empirical method

The data discussed above is panel data, meaning that it includes multiple entities, in this case countries, which are observed over time. In this analysis of the effect of EPI on the environmental impact of FDI in a host country a fixed-effects model will be conducted. This is not an uncommon approach for analysing the relationship of EPI with FDI, as it has been used in a multitude of studies (e.g. Birdsall & Wheeler, 1993; Eskeland & Harrison, 1997; Keller & Levinson, 2002). The rationale of the fixed-effects model is to account for omitted variables, as observations may not be independent from one another and it is possible to expect more similarity within observations of a country than between the countries. Therefore, a fixed-effects model uses each country as its own control (Allison, 2009). However, finally, a Hausman test will determine whether to prefer a fixed-effects approach above a random-effects model.

For the first hypothesis this model that is constructed is:

In which is the first indicator as described in the previous section for country in year . is the Environmental Policy Index. represents the selection of control variables that where described in the previous section. represents the selection of interaction variables that where described in the previous section. is the set of country dummies and is an error term. This model will be referred to as Model 1.

For hypotheses 1.1 and 1.2 the dependent variable will be the total incoming FDI to sectors in which the CO2 emissions per USD of value added are higher or lower than the mean value, respectively. Creating Models 1.1 and 1.2:

For hypothesis two also a similar model will be used, but with as the dependent variable:

This model will be referred to as Model 2. Hypotheses 2.1 and 2.2 will analysed with models that use the total FDI to the brown and the green energy sector, respectively:

## 3.3 Missing Data and data management

For the dependent variables no values are missing. However, the value added data of the OECD input output tables that are used to construct the dependent variable of Model 1 are only available from 1995 to 2011. This value-added data was constructed by using the average growth rate over this period to project the value-added forwards to 2016, this method is also used by the OECD (2019a) and was recommended for this research.

For the independent variable, the Environmental Policy Index, data is available for 2009, 2011, 2013, 2015 and 2017. In order to fully exploit the availability of the dependent variable in the period under research, the EPI data for the years 2010, 2012, 2014 and 2016 are computed as the average value between the previous and the following year. As the values of the perceived stringency and enforcement of environmental policy is not expected to change drastically in one year this method is thought to generate representative values for the independent variable. Four countries in the dataset are missing one value of EPI as they were not included in the survey that year, these countries are Ecuador (2015), Lebanon (2009), Tunisia (2013) and Ukraine (2015). In these cases the values for the missing year is first estimated by taking the average between the values of two year before and two years after the missing year, after which the values for the two years in between are estimated using the same method as before. Also five countries are dropped from the database because values for two or more years for environmental policy stringency and/or enforcement of environmental policy where missing. These countries where Angola, Myanmar, Seychelles, Uzbekistan and Yemen.

For the control variables data is missing for three variables, namely for the share of enrolment in tertiary education (SE-ter), the ease of doing business index (eodb) and the average hours worked (avh). For SE\_ter some countries are missing one or more values, here the average value of SE\_ter for that country is imputed. For the countries that have no values for SE\_ter at all, the average value of countries from the same region in the same income group for that year is imputed. For the eodb all countries lack data for 2009, 1 country also lacks data for 2010 and 2011 and 7 countries also lack data for 2010-2013. To fill these missing data the value of the following year is divided by the average growth rate of the relevant country for the years that are available. For the countries that only lack one year this can be expected to be a rather accurate technique to estimate the missing data values. For the 8 countries for which 3 years or more are missing the technique might be less accurate because an average growth rate over a shorter period is used to estimate values over a longer period. This is a limitation of this technique, but I still trust this to be the best way to estimate these missing values. The values of avh are used to create the capital-labour ratio, but in the first three models these values are missing for three countries, namely Morocco, Saudi Arabia and Tunisia. As for these countries the values are missing for all years, the techniques used previously cannot be used here. Therefore another method has to be chosen to estimate the avh in these countries. One way to do this is to impute the average avh for a year of the region these countries are in. However, these countries are all from the region “Middle East & North Africa” and the only other country from this region in the database used is Malta. So to use the average avh of the region would mean to assume the avh in these three countries is the same as Malta and this is an assumption I am not confident to make. Therefore it is chosen to impute the average avh for all the countries in the dataset for a certain year. For the last three models data on avh is missing for more countries, but as also more countries from different regions are included, here it is chosen to impute the average value for a year of the region a country is in. Only for the region “Middle East & North Africa” still not enough countries are included to use this method, but now more countries from similar income groups as these countries are included. Therefore for this region the average avh of countries in the same income group for the relevant year is imputed.

All the data is checked for skewness by analysing histograms of each variable. Most variable that are strictly positive, such as the dependent variables in all the models, the capital-labour ratio and the CO2 intensity control, that is used in Model 1, are skewed to the right. Therefore the natural logarithm of these variables are taken in order to solve this problem and achieve normality. This log transformation also solves some possible order of magnitude problems between different variables. The quadratic variable of capital-labour ratio and the interaction terms between EPI and capital-labour ratio are constructed with the log transformed capital-labour ratio. Table 3 gives the descriptive statistics for all the variables used in the analyses, after the data management described above has been performed.

Some diagnostic tests are performed on the data before estimating with a fixed effects model, these tests indicate some issues which are then appropriately addressed. The results of these tests can be found in the appendix Table 12. First a Modified Wald test for groupwise heteroscedasticity is performed. The null-hypothesis, that there is presence of homoscedasticity, is rejected for all models which implies the presence of heteroscedasticity. The data is also tested for autocorrelation using the program written by Drukker (2003) based on the Wooldridge test (Wooldridge, 2002), which is a specific test for autocorrelation in panel data. This test suggests the presence of autocorrelation in most of the models. In order to control for both these data issues, most models are estimated with standard errors that are robust to both heteroscedasticity and autocorrelation (*vce (cluster cou1)*) (Hoechle, 2007). Furthermore the data is tested for cross-sectional dependence, when T >N the Breusch-Pagan LM test is often used (De Hoyos & Sarafidis 2006). In this analysis however, N>T therefore an alternative program, written by De Hoyos & Sarafidis (2006) to test for cross-sectional dependence when N>T, is used. This program includes the Pesaran’s CD test, the Friedman’s test and the Frees’ test. In some model cross sectional dependence is also found, in this case the robust standard errors created with the *vce(cluster cou1)* option cannot be used as they are not robust to cross-sectional dependence.

##### Table 3. Descriptive statistics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Variable*** | ***Obs*** | ***Mean*** | ***Std. Dev.*** | ***Min*** | ***Max*** |
| **Models 1, 1.1 & 1.2** |  |  |  |  |  |
| *ln\_CO2g\_FDIweighted1* | 448 | 5.673 | 1.460 | 0.000 | 9.803 |
| *EPI* | 448 | 22.665 | 9.069 | 7.540 | 42.240 |
| *ln\_CO2g\_intensity* | 448 | 5.069 | 0.603 | 3.556 | 6.763 |
| *ln\_rgdpna* | 448 | 12.915 | 1.649 | 9.134 | 16.716 |
| *SE\_terX* | 448 | 61.225 | 23.027 | 11.772 | 126.383 |
| *eodb1* | 448 | 70.705 | 9.191 | 45.325 | 91.255 |
| *governance* | 448 | 1.927 | 2.547 | -3.066 | 5.802 |
| *ln\_KL* | 448 | 4.841 | 0.895 | 1.302 | 6.023 |
| *ln\_KL\_2* | 448 | 24.234 | 7.801 | 1.694 | 36.279 |
| *EPI\_ln\_KL\_cen* | 448 | 5.335 | 7.697 | -9.323 | 50.596 |
| *EPI\_ln\_KL2\_cen* | 448 | 48.335 | 62.897 | -88.015 | 322.216 |
| **Model 2** |  |  |  |  |  |
| *ln\_ratio1* | 502 | 0.179 | 3.998 | -10.541 | 8.376 |
| *EPI* | 502 | 20.622 | 9.174 | 7.250 | 42.240 |
| *ln\_rgdpna* | 502 | 12.987 | 1.615 | 9.410 | 16.759 |
| *SE\_terX* | 502 | 56.527 | 25.837 | 3.830 | 126.383 |
| *eodb1* | 502 | 68.454 | 10.344 | 36.569 | 91.023 |
| *governance* | 502 | 1.117 | 2.744 | -4.296 | 5.681 |
| *ln\_KL* | 502 | 4.528 | 1.100 | 0.371 | 6.023 |
| *ln\_KL\_2* | 502 | 21.714 | 8.885 | 0.137 | 36.279 |
| *EPI\_ln\_KL\_cen* | 502 | 7.015 | 8.980 | -10.820 | 51.148 |
| *EPI\_ln\_KL2\_cen* | 502 | 60.500 | 69.035 | -97.878 | 265.431 |
| **Models 2.1 & 2.2** |  |  |  |  |  |
| *ln\_fdi\_brown1* | 664 | 3.351 | 3.135 | 0.000 | 10.546 |
| *ln\_fdi\_green1* | 664 | 3.486 | 3.225 | 0.000 | 9.627 |
| *EPI* | 664 | 20.077 | 9.361 | 3.420 | 42.240 |
| *ln\_rgdpna* | 664 | 12.522 | 1.741 | 8.435 | 16.759 |
| *SE\_terX* | 664 | 53.365 | 26.401 | 3.495 | 126.383 |
| *eodb1* | 664 | 67.787 | 10.591 | 36.569 | 91.023 |
| *governance* | 664 | 1.049 | 2.770 | -4.375 | 5.802 |
| *ln\_KL* | 664 | 4.449 | 1.135 | 0.371 | 6.023 |
| *ln\_KL\_2* | 664 | 21.082 | 9.067 | 0.137 | 36.279 |
| *EPI\_ln\_KL\_cen* | 664 | 7.254 | 9.319 | -10.962 | 47.954 |
| *EPI\_ln\_KL2\_cen* | 664 | 61.936 | 72.658 | -98.392 | 247.682 |

A method that is robust against cross-sectional dependence is a fixed effects model with Driscoll and Kraay standard errors. These standard errors are robust against heteroscedasticity, autocorrelation and cross-sectional dependence and can be used in Stata with the command *xtscc.* (Hoechle, 2007).This method will be used when cross-sectional dependence is found. The results section will specify for each model which estimation method is used, and the results of the diagnostic tests can be found in the appendix. Hoechle (2007) explains that xtscc can be used when N>T, but one has to be cautious in using this method when analysis a short period of time. Our analysis is concerning a relatively short period of time, therefore the results of the same model estimates with xtreg, fe vce(cluster cou1) will be reported if different results our found.

Lastly, multicollinearity has to be given some attention. Multicollinearity can become an issue when two or more independent (or control) variables are highly correlated. In panel-data multicollinearity is much less of a problem compared to cross-sectional or time-series data (Hsiao, 2014). Furthermore multicollinearity can only a problem if there is a high correlation between a control variable and the variable of interest, because multicollinearity between two control variables does not affect the coefficient or standard errors of the variable of interest. The correlation matrices of the data in Models 1, 1.1 & 1.2, Model 2 and Models 2.1 & 2.2 is shown in the appendix. The models need separate correlation matrices, because they use different sets of countries and years. In these correlation matrices the correlation between the different variables can be studied. Only the correlation between EPI and governance gives a value (0.8821) which can even in panel data be seen as problematic, therefore a robustness check will be done that excludes governance from the analysis.

# 4. Empirical Results

In this chapter the results of all the described models will be discussed and will be used to reject or accept the hypotheses that were made while describing the research problem. The Hausman test was performed to determine whether a fixed-effects model or a random-effects model is appropriate. As the Hausman test yielded different results for different models, it was chosen to use the fixed-effects model for all the models in this thesis in order to increase comparability. Furthermore the fixed-effects model is recognized to be a more robust model when compared to the random-effects model. Therefore the use of the fixed-effects model will increase the confidence in the results of the analysis. The results of the Hausman test can be found in the appendix Table 12 together with other tests on the data.

For all the models used in this empirical analysis, some robustness checks are performed in order to guarantee the robustness of the presented results. The first robustness test only includes the years for which EPI is directly measured, this halves the amount of observations that are used in the analyses. Secondly, all the models are estimated without the governance indicator, this is to check whether or not the high correlation between governance and EPI affects the results. Thirdly all models are estimated without the observations that had missing variables for *SE\_terX, eodb* or *avh*. Fourthly, the independent variable EPI is replaced with an alternative measure of the stringency of environmental policy, namely the Environmental Policy Stringency Index (EPSI) of the OECD. This index is a country-specific and internationally-comparable measure of the stringency of environmental policy. In this index stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behaviour. The index is based on the degree of stringency of 14 environmental policy instruments, primarily related to climate and air pollution (Botta & Kozluk, 2014). This indicator is only available for 33 countries (OECD countries and the BRIICS), all of which have data for a different amount of year between 2009 and 2015. In Model 1, 1.1 and 1.2 these add up to 127 observations and in the other models they add up to 120 observations that match with data of the dependent variables. The last robustness test is only performed for Models 1, 1.1 and 1.2 and uses a different measure of pollution intensity in constructing the dependent variables. In the main analysis the pollution intensity is measured as the CO2 emissions from production per USD of value added in a sector. There could however also be sectors that do not emit much CO2 from production, but instead use a lot of energy which in turn causes CO2 emissions. As data is also available on CO2 emissions from electricity and heat consumption, this can be used as an alternative measure of pollution intensity in Model 1, 1.1 and 1.2. For the construction of the dependent variables with CO2 emissions from electricity and heat consumption the same method is used as in the original dependent variable. However, the data from the IEA is separated into less detailed sector definitions, which causes the dependent variables in these analyses to be based on a division into only four sectors, namely: Other energy industry own use, Commercial and public services, Transport and Industry. This has to be taken into account when analysing the results from these models, but it is not a big issue as these models are only used as robustness checks for the models using CO2 emissions from production as the dependent variable. The robustness checks for each model can be found in de appendix. When interesting results are found in the robustness checks they will also be discussed in the next section.

## 4.1 EPI and the pollution intensity of FDI

This section will describe the results that are found using Model 1, Model 1.1 and Model 1.2. These models help to shed a light on the effect of the Environmental Policy Index on the sectoral composition of FDI and more importantly the CO2 emissions related to that sectoral composition. The results can be found in Table 4. The first hypothesis posed on this topic is:

*“An increase in a country’s EPS will result in the country’s inward FDI to flow more to sectors with a smaller pollution intensity.”*

This hypothesis is tested using Model 1, which utilises the dependent variable *CO2\_FDIweighted* as explained in chapter 3. The first thing to see in the table is the fact that EPI does not have a significant effect in the model. Therefore the first hypothesis has to be rejected as no evidence has been provided that more stringent and/or more strictly enforced environmental policy will cause FDI to flow more to sectors with a smaller pollution intensity. Still it is interesting to see what control variables have a significant effect in this model.

First CO2g\_intensity is highly significant. This is to be expected as it is directly related to the dependent variable and it is added to the model to control for changes in the overall CO2 intensity of the country, which influence the dependent variable. The capital-labour ratio (KL) and the quadratic term of KL are both significant at a 1% level. This indicates the existence of a quadratic relationship between KL and the FDI-weighted CO2 intensity. The linear variable has a positive coefficient and the quadratic term has a negative coefficient, thus the relationship is an inverted U-shape. The turning point of such a quadratic relationship can be calculated by dividing the negative value of the coefficient of the linear variable by the value of the quadratic variable times two (Wooldridge, 2002). Based on the results of Model 1 this turning point is at -7.767/(2\*-0.780)=4.979. This value is around the mean capital-labour ratio in the sample used, as roughly 46% of the cases in the database used have a lower value for KL and 54% of the cases have a higher value. If the initial KL is below the turning point, an increase in KL is expected to attract FDI to sectors with a high pollution intensity. When the initial KL is higher than the turning point an increase is expected to attract more FDI to sectors with a lower pollution intensity. Finally, the interaction terms between EPI and KL and EPI and KL2 are insignificant suggesting that the expected quadratic interaction between EPI and KL is not found. In the robustness checks, no surprising results were found. EPI and EPSI remained insignificant, KL and KL2 were significant in most of the models and some control variables were significant in one of the robustness checks. This suggests that the results are robust to decisions made in the modelling process and to alternative measures of environmental policy stringency and pollution intensity.

##### Table 4. Results from Model 1, Model 1.1 & Model 1.2

|  |  |  |  |
| --- | --- | --- | --- |
|  | (1) | (2) | (3) |
| VARIABLES  Dependent variable | Model 1  CO2\_FDIweigthed | Model 1.1  FDI-high CO2 | Model 1.2  FDI-low CO2 |
|  |  |  |  |
| EPI | 0.0320 | 0.0495 | 0.0221 |
|  | (0.0351) | (0.0304) | (0.0213) |
| ln\_CO2g\_intensity | 2.083\*\*\* |  |  |
|  | (0.745) |  |  |
| ln\_rgdpna | 0.404 | 0.0623 | 0.714 |
|  | (0.939) | (0.506) | (0.481) |
| SE\_terX | -0.00568 | -0.0176\*\*\* | 0.00593 |
|  | (0.00850) | (0.00459) | (0.00687) |
| eodb1 | -0.0164 | -0.0343 | -0.000308 |
|  | (0.0179) | (0.0184) | (0.0147) |
| governance | -0.118 | -0.0766 | 0.174 |
|  | (0.268) | (0.132) | (0.148) |
| ln\_KL | 7.767\*\*\* | 4.676\* | -2.096 |
|  | (2.150) | (2.126) | (1.871) |
| ln\_KL\_2 | -0.780\*\*\* | -0.587\*\* | 0.0895 |
|  | (0.235) | (0.194) | (0.172) |
| EPI\_ln\_KL\_cen | 0.211 | 0.136\*\* | -0.120 |
|  | (0.144) | (0.0559) | (0.120) |
| EPI\_ln\_KL\_2\_cen | -0.0210 | -0.0132\*\* | 0.0155 |
|  | (0.0164) | (0.00523) | (0.0123) |
| Constant | -27.90\* | 0.0902 | 5.023 |
|  | (16.09) | (6.697) | (6.114) |
|  |  |  |  |
| Observations | 448 | 448 | 448 |
| R-squared | 0.174 | 0.078 | 0.059 |
| Method | xtreg | xtscc | xtreg |
| Number of cou1 | 56 | 56 | 56 |

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The second hypothesis (1.1) is concerning FDI to sectors with a high CO2 intensity:

*“An increase in a country’s EPS will result in a decrease of FDI to sectors that have a high pollution intensity.”*

This hypothesis is tested using Model 1.1, column 2 of Table 4 shows the results of this model. The dependent variable in this model is the amount of FDI flowing to sectors with a pollution intensity that is above the mean value of that country. The effect of EPI on the total FDI to sectors with a high CO2 intensity does not have a significant coefficient, thus the hypothesis has to be rejected. As control variables are concerned, SE-terX is significant at a 1% level with a negative coefficient. This suggests that as the human capital of a country grows, FDI flows less to sectors with a pollution intensity above the mean value. KL and KL2 again shows significant results at a 10% and 5% level, respectively, suggesting a quadratic effect of KL on the inflow of FDI to sectors with a high pollution intensity. Based on the coefficients of the variables this effect again is an inverted U-shaped one. The turning point in this U-shape, according to the coefficients is at -4.676/(2\*-0.587)=3.983. This is a rather low KL, as only 17% of the cases in the database have a lower KL. When the initial KL is below this turning point and increases this will increase the inflow of FDI to sectors with a high pollution intensity until the turning point from where an increase in KL will have the opposite effect. The interaction terms between EPI and KL and EPI and KL2 also both have a significant coefficient in Model 1.1. This suggests that the effect of EPI on the inflow of FDI to sectors with a high pollution intensity increases with KL up until a turning point is reach. After this point the effect of EPI on the inflow of FDI to sectors with a high pollution intensity decreases as KL increases.

Some changes occur in the robustness checks for Model 1.1. EPI remains insignificant in almost all models, but does have positive significant coefficient when CO2 emissions from electricity and heat consumption is used to measure pollution intensity in the dependent variable. The positive sign of the coefficient is opposite to the expectation, indicating that an increase in EPI will increase the FDI to sectors which emit more CO2 per value added via the consumption of electricity and heat than the mean value in the economy. The effect of human capital remains highly significant throughout the robustness tests. KL and KL2 lose their significance in two of the robustness test, namely the one where only the years in which EPI is measured directly are taken into account and the one that uses EPSI as independent variable. The interaction terms lose their significance in three of the tests. So for both the quadratic relation as the interaction term, some caution has to be exercised when interpreting the results.

The third hypothesis (1.2) is concerning FDI to sectors with a low CO2 intensity:

*“An increase in a country’s EPS will result in an increase of FDI to sectors that have a low pollution intensity*.”

This hypothesis is tested using Model 1.2, the results are shown in column 3 of Table 4. The dependent variable in this model is the amount of FDI flowing to sectors with a pollution intensity which is below the mean value of that country. In this model none of the variables have a significant effect on the dependent variable. Thus also this hypothesis has to be rejected, as no evidence of the proposed effect has been found. In the robustness checks for this model, most checks did not bring surprising results. The check in which the observations with missing values were not included, did bring a surprising result. In this check, EPI and the interaction terms became significant. The coefficient of EPI is positive as expected by the hypothesis. The coefficients of the interaction term indicate a U-shaped quadratic interaction between KL and EPI, which is the opposite of what was expected.

Finally it is noteworthy that the R-squared of the three models is not very high. They are 0.174, 0.0780 and 0.059. These low values indicate that a small portion of the variation in the dependent variable is explained by the model. In social science however, low values of r-squared are generally expected, because relationships are often very complex. The R-squared in cross-sectional data is also expected to be lower than in time-series data due to heterogeneity among countries. The same is true for panel data, especially panel data is which the cross sectional part is dominant over the time part, as is the case in our data.

## 4.2 EPI and FDI in the energy sector

This section will take a closer look at the results found in the energy sector. The focus is on the effect of EPI on the composition of FDI in the energy sector. The energy sector is used in this hypothesis due to its interesting role in the transition to a more sustainable society and due to data availability. The energy sector is particularly suited for this purpose, because there is a clear distinction between green and brown energy. The data from fDi markets also separates investment in either green or brown energy.

Three different models are constructed in order to analyse FDI in the energy sector. The results can be found in Table 5. The first hypothesis posed on the topic is:

*“An increase in a country’s EPS will increase the FDI in renewable energy relative to the FDI in fossil fuels.”*

The dependent variable to analyse this hypothesis is the ratio between FDI to green energy and FDI to brown energy. The diagnostics tests concerning cross-sectional dependence were unable to be performed, because the panel in this model is too unbalanced. Therefore both the results with the xtscc, fe method (robust to cross-sectional dependence, but asks for caution when T is small) and the xtreg, fe vce (cluster cou1) method (not robust to cross-sectional dependence) are reported. Both models report the same coefficient, as expected as only different standard errors are constructed by the different methods. The different standard errors also do not change the significance levels of any of the variables. The effect of EPI is insignificant, thus the hypothesis has to be rejected based on this analysis. The only significant variable is GDP, which had a positive coefficient and is significant at the 1% level. This indicates that as GDP increases relatively more FDI will flow to green energy than to brown energy.

The robustness checks for Model 2 showed that the coefficient of GDP lost its significance in two of the tests. Human capital became a significant variable when all observations with missings were deleted. Furthermore no surprising results were found.

The second and third hypotheses focus on the total FDI in brown and green energy respectively. The second hypothesis is:

*“An increase in a country’s EPS will decrease the FDI in fossil fuels.”*

For this analysis the dependent variable is the total amount of FDI into brown energy. The results of the analysis are found in column 3 of Table 5. EPI does not have a significant effect on the total FDI into brown energy. The hypothesis therefore has to be rejected. Again GDP has a significant coefficient at the 1% level. The coefficient is negative which is consistent with the positive coefficient in Model 2. No surprising results were found in the robustness tests.

##### Table 5. Results from Model 2, Model 2.1 & Model 2.2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) |
| VARIABLES | Model 2 | Model 2 | Model 2.1 | Model 2.2 |
| Dependent variable | ln\_ratio | ln\_ratio | FDI\_brown | FDI\_green |
|  |  |  |  |  |
| EPI | 0.177 | 0.177 | 0.0106 | 0.0809\* |
|  | (0.128) | (0.107) | (0.0258) | (0.0414) |
| ln\_rgdpna | 6.736\*\*\* | 6.736\*\*\* | -2.846\*\*\* | 1.397 |
|  | (2.153) | (1.304) | (0.409) | (0.942) |
| SE\_terX | 0.0336 | 0.0336 | -0.0294\*\* | 0.0145 |
|  | (0.0290) | (0.0223) | (0.00980) | (0.0158) |
| eodb1 | 0.00984 | 0.00984 | -0.0398 | -0.0273 |
|  | (0.0609) | (0.0381) | (0.0334) | (0.0217) |
| governance | -0.513 | -0.513 | -0.00111 | -0.238 |
|  | (0.495) | (0.346) | (0.309) | (0.136) |
| ln\_KL | -5.055 | -5.055 | 2.049 | 1.296 |
|  | (3.353) | (4.133) | (1.528) | (1.990) |
| ln\_KL\_2 | 0.325 | 0.325 | -0.407\*\* | -0.440 |
|  | (0.405) | (0.470) | (0.131) | (0.251) |
| EPI\_ln\_KL\_cen | -0.517 | -0.517 | 0.217 | -0.105 |
|  | (0.432) | (0.468) | (0.129) | (0.209) |
| EPI\_ln\_KL\_2\_cen | 0.0572 | 0.0572 | -0.0270 | 0.0150 |
|  | (0.0499) | (0.0512) | (0.0152) | (0.0236) |
| Constant | -76.95\*\*\* | -76.95\*\*\* | 42.60\*\*\* | -10.96 |
|  | (25.20) | (19.36) | (7.721) | (12.67) |
|  |  |  |  |  |
| Observations | 502 | 502 | 664 | 664 |
| R-squared | 0.0480 | 0.0480 | 0.0804 | 0.0245 |
| Number of cou1 | 71 | 71 | 74 | 74 |
| Method | xtreg | xtscc | xtscc | xtscc |

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The third hypothesis is:

*“An increase in a country’s EPS will increase the FDI in renewable energy.”*

For this analysis the dependent variable is the total amount of FDI into green energy and here the coefficient for EPI is positive and significant at a 10% level. As can be seen in column 4 of Table 5. The positive coefficient is as expected, indicating that more stringent or more strictly enforced environmental regulation does attract investment from firms with high environmental capabilities. Therefore Hypothesis 2.2 can be accepted, based on this analysis. However, because the significance level is only 10% the result is not very strong. Besides EPI, no variable has a significant coefficient. In all the robustness tests EPI is insignificant, when EPSI is used as independent variable it is significant. Therefore the effect of EPI found in this model cannot be judged to be very robust.

The R-squared of all the models again is rather low, as they are all below 0.1. As in the previous analysis, however, these low values of R-squared are not seen as a problem in social sciences, especially when using panel data.

In an attempt to also contribute to the debate on the general effect of EPS on the attraction of FDI, all models have also been used to estimate the total inflow of FDI into the country or into the energy sector. However, no significant coefficients of EPI were found in these analyses.

# 5. Discussion and Conclusion

The present study was conducted to gain more insight in the relation between environmental policy and the environmental impact of multinationals. Based on an extensive literature review multiple hypotheses where constructed which predicted certain effects of an increasing stringency of environmental policy on the environmental impact of multinationals. Most of the models used lead to a rejection of the hypothesis it was meant to test. Still some significant results were found and the overall conclusions from these results will be discussed here.

In the first hypothesis, Model 1 did not find significant results for EPI. Hypotheses 1.1 and 1.2, which were essentially subdivisions of Hypothesis 1, also did not find significant coefficients for EPI. These hypotheses were based on the idea that more stringent or more strictly enforced environmental regulations will repel pollution intensive firms and attract firms with high environmental capabilities. As the hypotheses are rejected this idea cannot be confirmed in this analysis. Then the question arises what causes the expected results to be lacking. The most obvious explanation might be that factors other than environmental policy, have a much stronger effect on the investment decisions of multinational enterprises. Based on a literature review, Dechezleprêtre & Sato (2017) came to the same conclusion. They stated that stringent environmental regulations are associated with a small, but significant, cost burden on firms. However, they state that this impact is very small compared to other factors determining trade and investment location choices. Other more determining factors are transport costs, proximity to demand, local workers, raw material availability, sunk capital costs and agglomeration. Zugravu-Soilita (2017) has made a similar argument, stating that factor endowment motives usually offset motives based on pollution policy. The significant results of human capital and the capital-labour ratio in some models confirm these arguments. This lack of a significant effect of EPI on the pollution intensity of FDI via changes in the sectoral composition does not mean that environmental policy has no effect at all. Moreover, if EPI does not significantly influence the investment decisions of multinationals, this can also be interpreted as an incentive to increase the stringency and/or enforcement of environmental regulation. Because MNE’s that do not leave after an increase in EPS or MNE’s that are not deterred from investment due to an increase in EPS, have to abide by the more stringent regulations. Therefore their environmental footprint is expected to decrease. Of course, the actual reduction of the environmental footprint then depends on the specific regulations and the enforcement of those regulations.

For Hypothesis 2 also no significant results were found, indicating that also within the energy sector EPI does not influence the type of firms that are attracted. Although it is found that an increase in EPI increases the investment in green energy. This results is rather weak and the fact that no significant result is found in the Model 2 that uses the ratio between FDI in green energy and FDI in brown energy as a dependent variable indicates that the increase in EPI does not necessarily decrease the environmental footprint of the energy sector as a whole. The lack of results in the energy sector might also be influenced by the high political interest in the energy sector. When the OECD presented their data on relative investments in fossil fuels versus renewable energy, a representative of a member country mentioned that foreign investments in the energy sector are sometimes restricted. The reason for this restriction is the particular importance that mainly fossil fuels still have for the self-sufficiency of many countries. Therefore this might influence the results found in the energy sector.

A limitation of the current research is that the pollution intensity of FDI in the first three models and the environmental capabilities of FDI in the other models are not measured directly. To estimate the pollution intensity of FDI in the first three models, the assumption is made that the pollution intensity of a foreign firms is the same as the average pollution intensity of the sector it operates in. If this pollution intensity could be directly measured on a firm level, this would increase the validity of the research. In the last three models it is assumed that firms investing in renewable energy have higher environmental capabilities than firms investing in fossil fuels. This is a fair assumption, however, also between the firms investing fossil fuels or the firms investing in renewable energy there most likely are differences in environmental capabilities. Therefore again, if this were to be measures directly on a firm level the validity of the results would increase.

Furthermore, the theoretical model used in this thesis identified that as more clean MNE’s invest in a country they may push for more stringent environmental regulation. They would do so because they have a cost disadvantage compared to the domestic firms when they uphold higher environmental standards than the national environmental regulations require. From this relationship some endogeneity problems may arise which are not taken into account in this thesis.

Another limitation involves data availability, overall the limited availability of EPI over time causes the analyses to incorporate a relatively short time span. If the data were available over a longer period more variation in EPI could have been observed, which might have led to more convincing results. Furthermore the data of EPI is only available every other year, in order to utilize the available data of the dependent variables the EPI was computed for the missing year by taking the average value of the two adjacent years. This method causes halve of the observations of EPI to be constructed in this manner. Also the missing values in some of the control variables can been seen as a limitation, although they have been dealt with in an appropriate manner.

There are multiple ways in which future research can complement this research. The analyses of the first three hypotheses only focusses on CO2 emissions, while environmental regulation can concern all types of pollution. Therefore future research could try to analyse the effect of EPI on other global pollutants or on different types of local pollution, such as air pollution, water pollution or even land degradation or loss of biodiversity. Also research of a more qualitative nature could complement this research, as it would be possible to analyse the specific environmental regulations in a country and the effect is has on the investment decisions of specific firms. This would give a deeper understanding of the effects of concrete regulations and could help to gain an understanding of how to design the most effective environmental regulations. Another interesting complementation to this research could be to analyse the effect of EPI on the different types of FDI that were discussed in the literature review. In this analysis only greenfield FDI is taken into account, so a comparison between the effect of EPI on greenfield and brownfield FDI would be interesting. Furthermore if FDI could be subdivided into the different motives that drive the investment, it would for example be possible to see if EPI affects market-seeking FDI differently from efficiency-seeking FDI.

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# Appendix

##### Table 6. Countries in Models 1, 1.1 & 1.2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Region** |  | **Country** | **Region** |
| Cambodia | East Asia & Pacific |  | Italy | OECD |
| China | East Asia & Pacific |  | Japan | OECD |
| Indonesia | East Asia & Pacific |  | Latvia | OECD |
| Malaysia | East Asia & Pacific |  | Lithuania | OECD |
| Philippines | East Asia & Pacific |  | Luxembourg | OECD |
| Singapore | East Asia & Pacific |  | Netherlands | OECD |
| Thailand | East Asia & Pacific |  | New Zealand | OECD |
| Bulgaria | Europe & Central Asia |  | Norway | OECD |
| Croatia | Europe & Central Asia |  | Poland | OECD |
| Cyprus | Europe & Central Asia |  | Portugal | OECD |
| Romania | Europe & Central Asia |  | Slovenia | OECD |
| Turkey | Europe & Central Asia |  | Spain | OECD |
| Australia | OECD |  | Sweden | OECD |
| Austria | OECD |  | Switzerland | OECD |
| Belgium | OECD |  | United Kingdom | OECD |
| Canada | OECD |  | United States | OECD |
| Chile | OECD |  | Argentina | Latin America & Caribbean |
| Czech Republic | OECD |  | Brazil | Latin America & Caribbean |
| Denmark | OECD |  | Colombia | Latin America & Caribbean |
| Estonia | OECD |  | Costa Rica | Latin America & Caribbean |
| Finland | OECD |  | Mexico | Latin America & Caribbean |
| France | OECD |  | Peru | Latin America & Caribbean |
| Germany | OECD |  | Malta | Middle East & North Africa |
| Greece | OECD |  | Morocco | Middle East & North Africa |
| Hungary | OECD |  | Saudi Arabia | Middle East & North Africa |
| Iceland | OECD |  | Tunisia | Middle East & North Africa |
| Ireland | OECD |  | India | South Asia |
| Israel | OECD |  | South Africa | Sub-Saharan Africa |

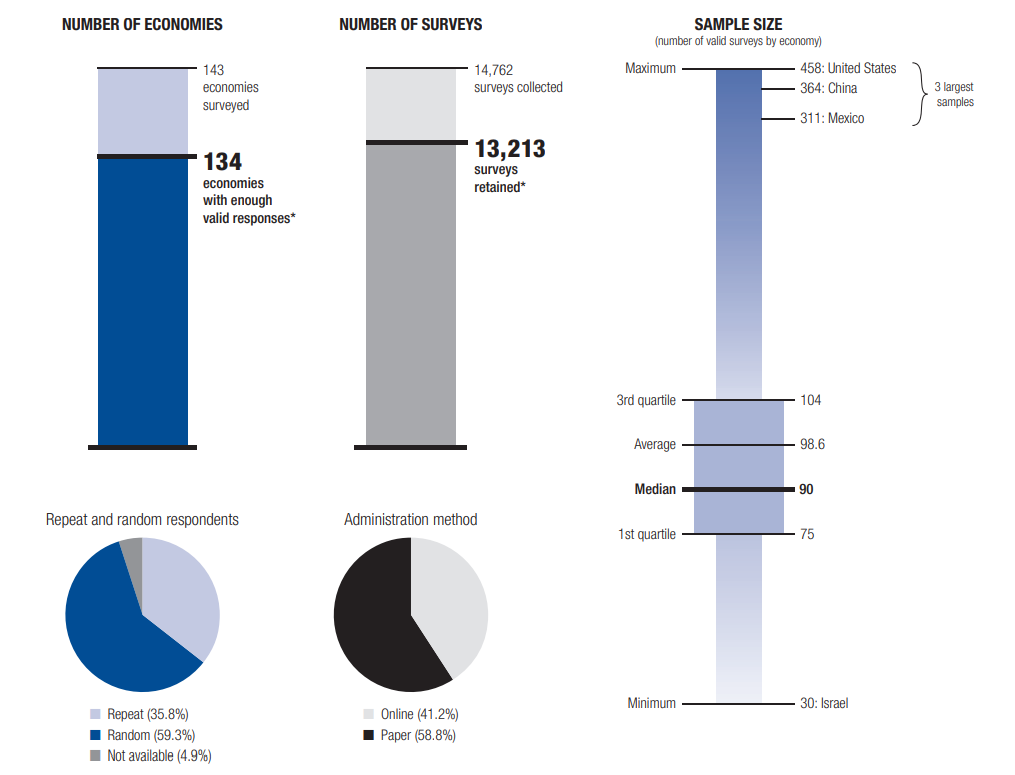
##### Table 7. Countries in Model 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Country*** | ***Region*** |  | ***Country*** | ***Region*** |
| Cambodia | East Asia & Pacific |  | Czech Republic | OECD |
| China | East Asia & Pacific |  | Denmark | OECD |
| Indonesia | East Asia & Pacific |  | Estonia | OECD |
| Malaysia | East Asia & Pacific |  | Finland | OECD |
| Philippines | East Asia & Pacific |  | France | OECD |
| Singapore | East Asia & Pacific |  | Germany | OECD |
| Thailand | East Asia & Pacific |  | Greece | OECD |
| Armenia | Europe & Cental Asia |  | Hungary | OECD |
| Azerbaijan | Europe & Cental Asia |  | Iceland | OECD |
| Georgia | Europe & Cental Asia |  | Ireland | OECD |
| Kazakhstan | Europe & Cental Asia |  | Israel | OECD |
| Russian Federation | Europe & Cental Asia |  | Italy | OECD |
| Turkey | Europe & Cental Asia |  | Japan | OECD |
| Ukraine | Europe & Cental Asia |  | Latvia | OECD |
| Argentina | Latin America & Caribbean |  | Lithuania | OECD |
| Brazil | Latin America & Caribbean |  | Luxembourg | OECD |
| Colombia | Latin America & Caribbean |  | Netherlands | OECD |
| Costa Rica | Latin America & Caribbean |  | New Zealand | OECD |
| Ecuador | Latin America & Caribbean |  | Norway | OECD |
| El Salvador | Latin America & Caribbean |  | Poland | OECD |
| Guatemala | Latin America & Caribbean |  | Portugal | OECD |
| Mexico | Latin America & Caribbean |  | Slovenia | OECD |
| Panama | Latin America & Caribbean |  | Spain | OECD |
| Paraguay | Latin America & Caribbean |  | Sweden | OECD |
| Peru | Latin America & Caribbean |  | Switzerland | OECD |
| Uruguay | Latin America & Caribbean |  | United Kingdom | OECD |
| Algeria | Middle East & North Africa |  | United States | OECD |
| Jordan | Middle East & North Africa |  | India | South Asia |
| Morocco | Middle East & North Africa |  | Botswana | Sub-Saharan Africa |
| Saudi Arabia | Middle East & North Africa |  | Mauritius | Sub-Saharan Africa |
| Tunisia | Middle East & North Africa |  | Mozambique | Sub-Saharan Africa |
| Australia | OECD |  | Namibia | Sub-Saharan Africa |
| Austria | OECD |  | South Africa | Sub-Saharan Africa |
| Belgium | OECD |  | Zambia | Sub-Saharan Africa |
| Canada | OECD |  | Zimbabwe | Sub-Saharan Africa |
| Chile | OECD |  |  |  |

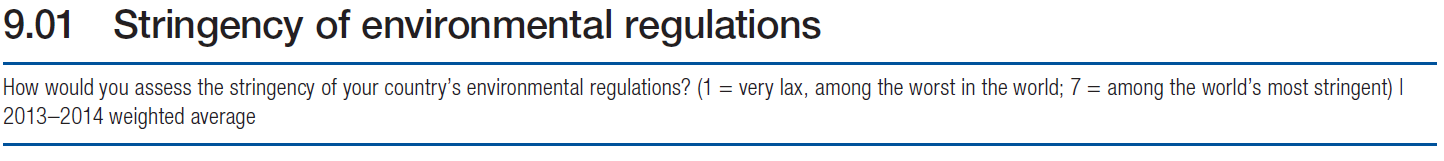
##### Table 8. Countries in Models 2.1 & 2.2

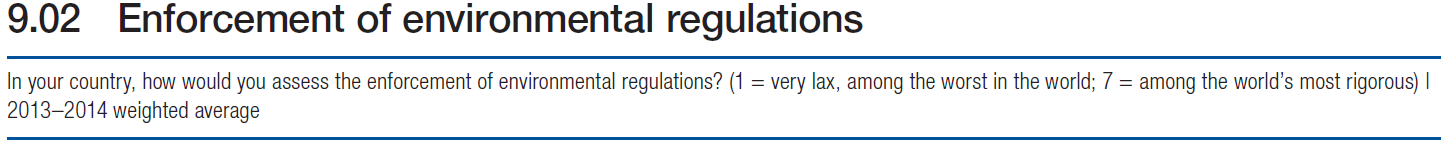
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Country*** | ***Region*** |  | ***Country*** | ***Region*** |
| Cambodia | East Asia & Pacific |  | Czech Republic | OECD |
| China | East Asia & Pacific |  | Denmark | OECD |
| Indonesia | East Asia & Pacific |  | Estonia | OECD |
| Malaysia | East Asia & Pacific |  | Finland | OECD |
| Philippines | East Asia & Pacific |  | France | OECD |
| Singapore | East Asia & Pacific |  | Germany | OECD |
| Thailand | East Asia & Pacific |  | Greece | OECD |
| Armenia | Europe & Cental Asia |  | Hungary | OECD |
| Azerbaijan | Europe & Cental Asia |  | Iceland | OECD |
| Georgia | Europe & Cental Asia |  | Ireland | OECD |
| Kazakhstan | Europe & Cental Asia |  | Israel | OECD |
| Russian Federation | Europe & Cental Asia |  | Italy | OECD |
| Turkey | Europe & Cental Asia |  | Japan | OECD |
| Ukraine | Europe & Cental Asia |  | Latvia | OECD |
| Argentina | Latin America & Caribbean |  | Lithuania | OECD |
| Brazil | Latin America & Caribbean |  | Luxembourg | OECD |
| Colombia | Latin America & Caribbean |  | Netherlands | OECD |
| Costa Rica | Latin America & Caribbean |  | New Zealand | OECD |
| Ecuador | Latin America & Caribbean |  | Norway | OECD |
| El Salvador | Latin America & Caribbean |  | Poland | OECD |
| Guatemala | Latin America & Caribbean |  | Portugal | OECD |
| Mexico | Latin America & Caribbean |  | Slovenia | OECD |
| Panama | Latin America & Caribbean |  | Spain | OECD |
| Paraguay | Latin America & Caribbean |  | Sweden | OECD |
| Peru | Latin America & Caribbean |  | Switzerland | OECD |
| Uruguay | Latin America & Caribbean |  | United Kingdom | OECD |
| Algeria | Middle East & North Africa |  | United States | OECD |
| Jordan | Middle East & North Africa |  | India | South Asia |
| Lebanon | Middle East & North Africa |  | Botswana | Sub-Saharan Africa |
| Morocco | Middle East & North Africa |  | Lesotho | Sub-Saharan Africa |
| Saudi Arabia | Middle East & North Africa |  | Madagascar | Sub-Saharan Africa |
| Tunisia | Middle East & North Africa |  | Mauritius | Sub-Saharan Africa |
| Australia | OECD |  | Mozambique | Sub-Saharan Africa |
| Austria | OECD |  | Namibia | Sub-Saharan Africa |
| Belgium | OECD |  | South Africa | Sub-Saharan Africa |
| Canada | OECD |  | Zambia | Sub-Saharan Africa |
| Chile | OECD |  | Zimbabwe | Sub-Saharan Africa |

#### Figure 7. Descriptive statistics of the Executive Opinion Survey 2015

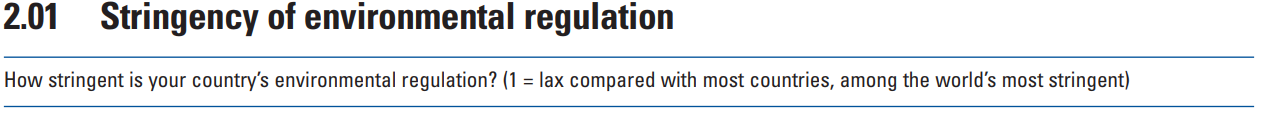
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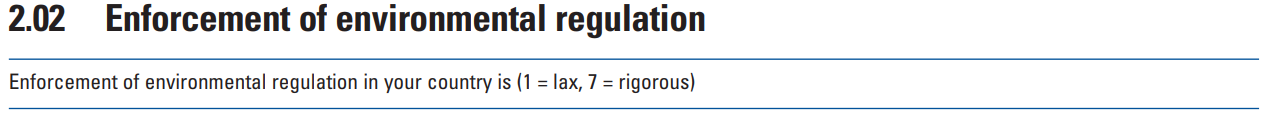
*Figure 8. Relevant questions from the Executive Opinion Survey in 2011-2017:*

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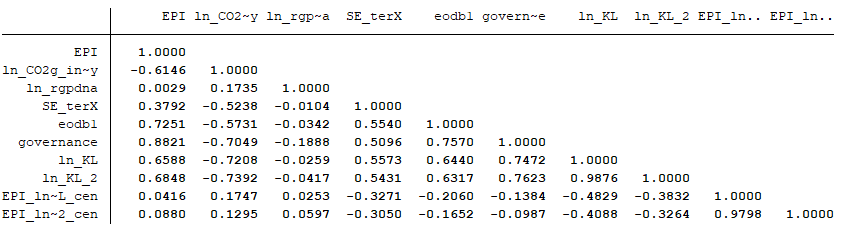
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*The slightly rephrased questions in the Executive Opinion Survey of 2009:*

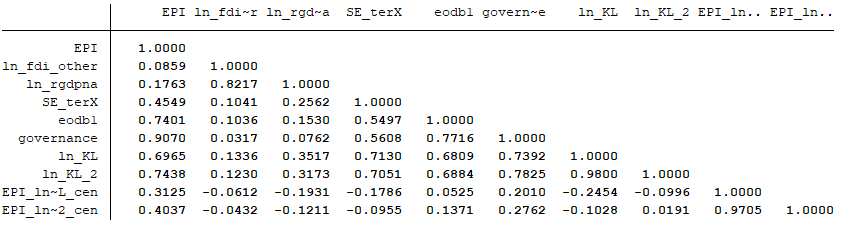
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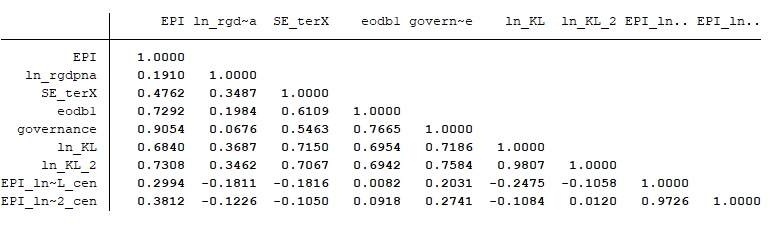
##### Table 9. Correlation Matrix hypothesis 1.

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##### Table 10. Correlation Matrix hypothesis 2.

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##### Table 11. Correlation Matrix hypothesis 2.1/2.2

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##### Table 12. Outcomes of Diagnostic tests.

##### Table 13. Sector conversion from ISIC and NIACS sectors to IEA sectors



*Model build-up and robustness checks.*

##### Table 14. Build-up Model 1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Model 1 | Model 1 | Model 1 | Model 1 | Model 1 | Model 1 |
|  |  |  |  |  |  |  |
| EPI | -0.0466 | 0.0353 | 0.0379 | 0.0387 | 0.0331 | 0.0320 |
|  | (0.0345) | (0.0313) | (0.0350) | (0.0346) | (0.0348) | (0.0351) |
| ln\_CO2g\_intensity |  | 2.009\*\*\* | 2.429\*\*\* | 2.487\*\*\* | 2.004\*\*\* | 2.083\*\*\* |
|  |  | (0.285) | (0.469) | (0.734) | (0.745) | (0.745) |
| ln\_rgdpna |  |  | 1.703\* | 1.668\*\* | 0.235 | 0.404 |
|  |  |  | (0.886) | (0.806) | (0.905) | (0.939) |
| SE\_terX |  |  | -0.00596 | -0.00627 | -0.00442 | -0.00568 |
|  |  |  | (0.00777) | (0.00843) | (0.00827) | (0.00850) |
| eodb1 |  |  | 0.00185 | 0.000868 | -0.0140 | -0.0164 |
|  |  |  | (0.0206) | (0.0195) | (0.0176) | (0.0179) |
| governance |  |  | -0.0715 | -0.0684 | -0.157 | -0.118 |
|  |  |  | (0.233) | (0.234) | (0.268) | (0.268) |
| ln\_KL |  |  |  | 0.136 | 5.955\*\*\* | 7.767\*\*\* |
|  |  |  |  | (1.006) | (1.980) | (2.150) |
| ln\_KL\_2 |  |  |  |  | -0.622\*\*\* | -0.780\*\*\* |
|  |  |  |  |  | (0.226) | (0.235) |
| EPI\_ln\_KL\_cen |  |  |  |  |  | 0.211 |
|  |  |  |  |  |  | (0.144) |
| EPI\_ln\_KL\_2\_cen |  |  |  |  |  | -0.0210 |
|  |  |  |  |  |  | (0.0164) |
| Constant | 6.729\*\*\* | -5.312\*\*\* | -29.12\*\* | -29.55\* | -20.45 | -27.90\* |
|  | (0.781) | (1.916) | (13.91) | (15.58) | (15.16) | (16.09) |
|  |  |  |  |  |  |  |
| Observations | 448 | 448 | 448 | 448 | 448 | 448 |
| R-squared | 0.005 | 0.148 | 0.156 | 0.156 | 0.170 | 0.174 |
| Number of cou1 | 56 | 56 | 56 | 56 | 56 | 56 |

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Dependent variable: ln\_CO2\_FDI\_weighted

##### Table 15. Robustness-checks Model 1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) |
| VARIABLES | Model 1 - EPI years | Model 1 - no governance | Model 1 - no missings | Model 1 - EPSI | Model 1 - EHC |
|  |  |  |  |  |  |
| EPI | 0.0396 | 0.0282 | 0.0377 |  | 0.0171 |
|  | (0.0476) | (0.0310) | (0.0496) |  | (0.0235) |
| ln\_CO2g\_intensity | 0.681 | 2.100\*\*\* | 2.482\*\*\* | 1.415 |  |
|  | (1.308) | (0.740) | (0.781) | (1.057) |  |
| ln\_rgdpna | -0.967 | 0.304 | 0.517 | -3.214\* | -0.526 |
|  | (1.063) | (1.049) | (1.324) | (1.779) | (0.547) |
| SE\_terX | -0.00949 | -0.00441 | -0.0165 | 0.0222 | -0.00118 |
|  | (0.0107) | (0.00909) | (0.0121) | (0.0288) | (0.00734) |
| eodb1 | -0.0522 | -0.0159 | -0.0258 | -0.107\* | -0.0262 |
|  | (0.0344) | (0.0181) | (0.0323) | (0.0546) | (0.0186) |
| governance | -0.205 |  | -0.145 | -0.639 | -0.310\*\* |
|  | (0.373) |  | (0.260) | (0.483) | (0.142) |
| ln\_KL | 6.691\* | 7.704\*\*\* | 11.14\* | -5.425 | 5.146\*\*\* |
|  | (3.869) | (2.101) | (5.668) | (6.750) | (1.768) |
| ln\_KL\_2 | -0.784\*\* | -0.769\*\*\* | -0.972\* | 0.348 | -0.647\*\*\* |
|  | (0.380) | (0.223) | (0.516) | (0.615) | (0.179) |
| EPI\_ln\_KL\_cen | 0.228 | 0.221 | 0.588\* |  | 0.125 |
|  | (0.213) | (0.143) | (0.307) |  | (0.108) |
| EPI\_ln\_KL\_2\_cen | -0.0263 | -0.0219 | -0.0608\* |  | -0.0141 |
|  | (0.0231) | (0.0162) | (0.0305) |  | (0.0122) |
| EPSI |  |  |  | 0.903 |  |
|  |  |  |  | (0.981) |  |
| EPSI\_ln\_KL\_cen |  |  |  | -13.67 |  |
|  |  |  |  | (11.80) |  |
| EPSI\_ln\_KL\_2\_cen |  |  |  | 1.379 |  |
|  |  |  |  | (1.140) |  |
| ln\_EHCg\_intensity |  |  |  |  | 0.752 |
|  |  |  |  |  | (0.514) |
| Constant | 5.101 | -26.93 | -41.97\* | 68.26\* | 1.681 |
|  | (24.98) | (16.85) | (23.20) | (35.58) | (9.544) |
|  |  |  |  |  |  |
| Observations | 224 | 448 | 315 | 127 | 448 |
| R-squared | 0.154 | 0.174 | 0.150 | 25 | 0.210 |
| Number of cou1 | 56 | 56 | 55 | 0.332 | 56 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

##### Table 16. Build-up Model 1.1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Model 1.1 | Model 1.1 | Model 1.1 | Model 1.1 | Model 1.1 | Model 1.1 |
|  |  |  |  |  |  |  |
| EPI | 0.00984 | 0.0267 | 0.0528 | 0.0504 | 0.0504 | 0.0495 |
|  | (0.0240) | (0.0314) | (0.0320) | (0.0324) | (0.0317) | (0.0304) |
| ln\_rgdpna |  | -1.359\*\* | -0.356 | 0.864 | 0.0101 | 0.0623 |
|  |  | (0.401) | (0.288) | (0.490) | (0.514) | (0.506) |
| SE\_terX |  |  | -0.0234\*\*\* | -0.0182\*\*\* | -0.0169\*\*\* | -0.0176\*\*\* |
|  |  |  | (0.00421) | (0.00414) | (0.00438) | (0.00459) |
| eodb1 |  |  | -0.0499\*\* | -0.0243 | -0.0324 | -0.0343 |
|  |  |  | (0.0165) | (0.0187) | (0.0173) | (0.0184) |
| governance |  |  | 0.0218 | -0.0340 | -0.101 | -0.0766 |
|  |  |  | (0.104) | (0.137) | (0.129) | (0.132) |
| ln\_KL |  |  |  | -1.358\* | 3.372\* | 4.676\* |
|  |  |  |  | (0.603) | (1.595) | (2.126) |
| ln\_KL\_2 |  |  |  |  | -0.467\*\* | -0.587\*\* |
|  |  |  |  |  | (0.144) | (0.194) |
| EPI\_ln\_KL\_cen |  |  |  |  |  | 0.136\*\* |
|  |  |  |  |  |  | (0.0559) |
| EPI\_ln\_KL\_2\_cen |  |  |  |  |  | -0.0132\*\* |
|  |  |  |  |  |  | (0.00523) |
| Constant | 6.636\*\*\* | 23.80\*\*\* | 15.18\*\*\* | 4.029 | 4.111 | 0.0902 |
|  | (0.467) | (4.750) | (4.009) | (5.409) | (5.655) | (6.697) |
|  |  |  |  |  |  |  |
| Observations | 448 | 448 | 448 | 448 | 448 | 448 |
| R-squared | 0.0003 | 0.0151 | 0.0447 | 0.0619 | 0.0753 | 0.0780 |
| Number of groups | 56 | 56 | 56 | 56 | 56 | 56 |

Driscoll-Kraay Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

##### Table 17. Robustness-checks Model 1.1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) |
| VARIABLES | Model 1.2 - EPI years | Model 1.2 - no governance | Model 1.1 - no missings | Model 1.1 - EPSI | Model 1 - EHC |
|  |  |  |  |  |  |
| EPI | 0.0643 | 0.0470 | 0.0809 |  | 0.0744\*\* |
|  | (0.0382) | (0.0268) | (0.0463) |  | (0.0292) |
| ln\_rgdpna | -0.434 | -0.0122 | -0.830 | 0.208 | -0.120 |
|  | (1.084) | (0.430) | (0.526) | (1.401) | (0.679) |
| SE\_terX | -0.0190\*\* | -0.0168\*\*\* | -0.0282\*\*\* | -0.0235\*\*\* | -0.0347\*\* |
|  | (0.00440) | (0.00439) | (0.00720) | (0.00567) | (0.0117) |
| eodb1 | -0.0500\* | -0.0341 | -0.0591\*\* | -0.0668\*\*\* | -0.0256 |
|  | (0.0188) | (0.0187) | (0.0177) | (0.0166) | (0.0366) |
| governance | 0.150 |  | -0.209 | -0.833 | -0.392 |
|  | (0.159) |  | (0.369) | (0.432) | (0.210) |
| ln\_KL | 2.603 | 4.638\* | 3.511\* | -0.766 | 9.360\*\*\* |
|  | (2.757) | (2.068) | (1.495) | (3.294) | (2.196) |
| ln\_KL\_2 | -0.353 | -0.581\*\* | -0.405\* | -0.0973 | -1.100\*\*\* |
|  | (0.224) | (0.188) | (0.177) | (0.269) | (0.174) |
| EPI\_ln\_KL\_cen | 0.213\*\*\* | 0.142\*\* | -0.172 |  | 0.0467 |
|  | (0.0126) | (0.0515) | (0.136) |  | (0.0637) |
| EPI\_ln\_KL\_2\_cen | -0.0233\*\*\* | -0.0138\*\* | 0.0138 |  | -0.00169 |
|  | (0.00348) | (0.00479) | (0.0131) |  | (0.00774) |
| EPSI |  |  |  | 0.175 |  |
|  |  |  |  | (0.647) |  |
| EPSI\_ln\_KL\_cen |  |  |  | -7.876 |  |
|  |  |  |  | (8.227) |  |
| EPSI\_ln\_KL\_2\_cen |  |  |  | 0.817 |  |
|  |  |  |  | (0.810) |  |
| Constant | 11.33 | 0.932 | 14.74\*\* | 20.49 | -8.332 |
|  | (8.415) | (6.256) | (4.510) | (13.58) | (7.585) |
|  |  |  |  |  |  |
| Observations | 224 | 448 | 315 | 127 | 448 |
| R-squared |  |  |  |  |  |
| Number of cou1 | 56 | 56 | 55 | 25 | 56 |
|  |  |  |  |  |  |

Driscoll-Kraay standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

##### Table 18. Build-up Model 1.2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Model 1.2 | Model 1.2 | Model 1.2 | Model 1.2 | Model 1.2 | Model 1.2 |
|  |  |  |  |  |  |  |
| EPI | 0.0104 | 0.0155 | 0.0178 | 0.0157 | 0.0157 | 0.0221 |
|  | (0.0259) | (0.0258) | (0.0242) | (0.0224) | (0.0222) | (0.0213) |
| ln\_rgdpna |  | -0.405 | -0.332 | 0.693 | 0.882\* | 0.714 |
|  |  | (0.430) | (0.491) | (0.467) | (0.508) | (0.481) |
| SE\_terX |  |  | 0.000589 | 0.00500 | 0.00471 | 0.00593 |
|  |  |  | (0.00622) | (0.00690) | (0.00698) | (0.00687) |
| eodb1 |  |  | -0.0280\*\* | -0.00655 | -0.00476 | -0.000308 |
|  |  |  | (0.0117) | (0.0138) | (0.0140) | (0.0147) |
| governance |  |  | 0.221 | 0.174 | 0.189 | 0.174 |
|  |  |  | (0.158) | (0.143) | (0.147) | (0.148) |
| ln\_KL |  |  |  | -1.141\*\*\* | -2.190 | -2.096 |
|  |  |  |  | (0.344) | (1.455) | (1.871) |
| ln\_KL\_2 |  |  |  |  | 0.104 | 0.0895 |
|  |  |  |  |  | (0.138) | (0.172) |
| EPI\_ln\_KL\_cen |  |  |  |  |  | -0.120 |
|  |  |  |  |  |  | (0.120) |
| EPI\_ln\_KL\_2\_cen |  |  |  |  |  | 0.0155 |
|  |  |  |  |  |  | (0.0123) |
| Constant | 7.316\*\*\* | 12.43\*\* | 12.96\*\* | 3.591 | 3.572 | 5.023 |
|  | (0.587) | (5.434) | (5.908) | (5.603) | (5.626) | (6.114) |
|  |  |  |  |  |  |  |
| Observations | 448 | 448 | 448 | 448 | 448 | 448 |
| R-squared | 0.001 | 0.004 | 0.022 | 0.050 | 0.051 | 0.059 |
| Number of cou1 | 56 | 56 | 56 | 56 | 56 | 56 |

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

##### Table 19. Robustness-checks Model 1.2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) |
| VARIABLES | Model 1.2 - EPI years | Model 1.2 - no governance | Model 1.2 - no missings | Model 1.2 - EPSI | Model 1.2 - EHC |
|  |  |  |  |  |  |
| EPI | 0.0170 | 0.0279 | 0.0489\* |  | 0.0334 |
|  | (0.0252) | (0.0235) | (0.0254) |  | (0.0260) |
| ln\_rgdpna | -0.0815 | 0.883\* | 0.508 | 3.585\*\*\* | -0.407 |
|  | (0.750) | (0.473) | (0.688) | (1.092) | (1.402) |
| SE\_terX | 0.00940 | 0.00404 | 0.00658 | -0.00637 | 0.0193\* |
|  | (0.00845) | (0.00701) | (0.00818) | (0.0137) | (0.0111) |
| eodb1 | 0.000245 | -0.000736 | 0.00477 | -0.00334 | -0.0164 |
|  | (0.0226) | (0.0150) | (0.0194) | (0.0253) | (0.0239) |
| governance | 0.268 |  | 0.00340 | -0.156 | 0.145 |
|  | (0.258) |  | (0.155) | (0.176) | (0.181) |
| ln\_KL | -0.365 | -2.009 | -5.931\* | -6.490 | -12.04\* |
|  | (2.533) | (1.907) | (3.201) | (4.034) | (6.498) |
| ln\_KL\_2 | -0.0890 | 0.0756 | 0.446 | 0.477 | 1.100\* |
|  | (0.232) | (0.173) | (0.293) | (0.373) | (0.643) |
| EPI\_ln\_KL\_cen | -0.123 | -0.134 | -0.663\*\*\* |  | -0.155\* |
|  | (0.140) | (0.124) | (0.177) |  | (0.0793) |
| EPI\_ln\_KL\_2\_cen | 0.0183 | 0.0168 | 0.0679\*\*\* |  | 0.00683 |
|  | (0.0147) | (0.0126) | (0.0178) |  | (0.0109) |
| EPSI |  |  |  | -1.114\* |  |
|  |  |  |  | (0.578) |  |
| EPSI\_ln\_KL\_cen |  |  |  | 10.86 |  |
|  |  |  |  | (7.062) |  |
| EPSI\_ln\_KL\_2\_cen |  |  |  | -0.989 |  |
|  |  |  |  | (0.689) |  |
| Constant | 10.77 | 3.111 | 17.29\* | -15.51 | 43.90\*\* |
|  | (8.464) | (5.939) | (9.481) | (15.12) | (20.16) |
|  |  |  |  |  |  |
| Observations | 224 | 448 | 315 | 127 | 448 |
| R-squared | 0.096 | 0.055 | 0.059 | 0.234 | 0.129 |
| Number of cou1 | 56 | 56 | 55 | 25 | 56 |

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

##### Table 20. Build-up Model 2 with Driscoll-Kraay standard errors (xtscc, fe)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Model 2 | Model 2 | Model 2 | Model 2 | Model 2 | Model 2 |
|  |  |  |  |  |  |  |
| EPI | 0.231\*\* | 0.140 | 0.155 | 0.160 | 0.160 | 0.177 |
|  | (0.0778) | (0.0830) | (0.101) | (0.102) | (0.100) | (0.107) |
| ln\_rgdpna |  | 5.820\*\*\* | 5.600\*\*\* | 7.216\*\*\* | 7.140\*\*\* | 6.736\*\*\* |
|  |  | (0.708) | (0.812) | (1.381) | (1.254) | (1.304) |
| SE\_terX |  |  | 0.0214 | 0.0270 | 0.0287 | 0.0336 |
|  |  |  | (0.0268) | (0.0258) | (0.0264) | (0.0223) |
| eodb1 |  |  | -0.0158 | -0.000640 | 0.000367 | 0.00984 |
|  |  |  | (0.0479) | (0.0462) | (0.0469) | (0.0381) |
| governance |  |  | -0.453 | -0.578 | -0.558 | -0.513 |
|  |  |  | (0.384) | (0.382) | (0.347) | (0.346) |
| ln\_KL |  |  |  | -1.541\* | -0.998 | -5.055 |
|  |  |  |  | (0.669) | (1.969) | (4.133) |
| ln\_KL\_2 |  |  |  |  | -0.0713 | 0.325 |
|  |  |  |  |  | (0.293) | (0.470) |
| EPI\_ln\_KL\_cen |  |  |  |  |  | -0.517 |
|  |  |  |  |  |  | (0.468) |
| EPI\_ln\_KL\_2\_cen |  |  |  |  |  | 0.0572 |
|  |  |  |  |  |  | (0.0512) |
| Constant | -4.581\*\* | -78.29\*\*\* | -75.37\*\*\* | -90.71\*\*\* | -90.80\*\*\* | -76.95\*\*\* |
|  | (1.622) | (9.021) | (10.61) | (15.59) | (15.62) | (19.36) |
|  |  |  |  |  |  |  |
| Observations | 502 | 502 | 502 | 502 | 502 | 502 |
| Number of groups | 71 | 71 | 71 | 71 | 71 | 71 |

Driscoll-Kraay standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

##### Table 21. Build-up Model 2 with robust standard errors (xtreg, fe vce(cluster cou1))

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Model 2 | Model 2 | Model 2 | Model 2 | Model 2 | Model 2 |
|  |  |  |  |  |  |  |
| EPI | 0.231\* | 0.140 | 0.155 | 0.160 | 0.160 | 0.177 |
|  | (0.130) | (0.125) | (0.128) | (0.129) | (0.129) | (0.128) |
| ln\_rgdpna |  | 5.820\*\*\* | 5.600\*\*\* | 7.216\*\*\* | 7.140\*\*\* | 6.736\*\*\* |
|  |  | (1.420) | (1.812) | (2.208) | (2.192) | (2.153) |
| SE\_terX |  |  | 0.0214 | 0.0270 | 0.0287 | 0.0336 |
|  |  |  | (0.0278) | (0.0284) | (0.0291) | (0.0290) |
| eodb1 |  |  | -0.0158 | -0.000640 | 0.000367 | 0.00984 |
|  |  |  | (0.0572) | (0.0555) | (0.0561) | (0.0609) |
| governance |  |  | -0.453 | -0.578 | -0.558 | -0.513 |
|  |  |  | (0.456) | (0.457) | (0.474) | (0.495) |
| ln\_KL |  |  |  | -1.541 | -0.998 | -5.055 |
|  |  |  |  | (1.384) | (2.446) | (3.353) |
| ln\_KL\_2 |  |  |  |  | -0.0713 | 0.325 |
|  |  |  |  |  | (0.314) | (0.405) |
| EPI\_ln\_KL\_cen |  |  |  |  |  | -0.517 |
|  |  |  |  |  |  | (0.432) |
| EPI\_ln\_KL\_2\_cen |  |  |  |  |  | 0.0572 |
|  |  |  |  |  |  | (0.0499) |
| Constant | -4.581\* | -78.29\*\*\* | -75.37\*\*\* | -90.71\*\*\* | -90.80\*\*\* | -76.95\*\*\* |
|  | (2.672) | (17.82) | (21.13) | (24.01) | (23.95) | (25.20) |
|  |  |  |  |  |  |  |
| Observations | 502 | 502 | 502 | 502 | 502 | 502 |
| R-squared | 0.012 | 0.039 | 0.042 | 0.044 | 0.044 | 0.048 |
| Number of cou1 | 71 | 71 | 71 | 71 | 71 | 71 |

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

##### Table 22. Robustness-checks Model 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) |
| VARIABLES | Model 2 - EPI years | Model 2 - no governance | Model 2 - no missings | Model 2 - EPSI |
|  |  |  |  |  |
| EPI | 0.0943 | 0.160 | 0.173 |  |
|  | (0.176) | (0.128) | (0.254) |  |
| ln\_rgdpna | 8.524\*\* | 5.973\*\*\* | 1.210 | 7.389 |
|  | (3.249) | (2.179) | (4.147) | (11.43) |
| SE\_terX | 0.0492 | 0.0354 | 0.106\*\* | 0.118 |
|  | (0.0450) | (0.0289) | (0.0419) | (0.140) |
| eodb1 | 0.00228 | 0.0165 | -0.0738 | 0.0285 |
|  | (0.0715) | (0.0635) | (0.176) | (0.264) |
| governance | 0.608 |  | -0.483 | 2.888 |
|  | (0.664) |  | (0.907) | (2.069) |
| ln\_KL | -3.359 | -4.169 | 2.749 | -8.648 |
|  | (4.639) | (3.171) | (15.52) | (29.33) |
| ln\_KL\_2 | 0.0171 | 0.262 | -0.459 | 0.690 |
|  | (0.498) | (0.390) | (1.367) | (2.591) |
| EPI\_ln\_KL\_cen | -0.439 | -0.536 | -1.777 |  |
|  | (0.543) | (0.423) | (1.383) |  |
| EPI\_ln\_KL\_2\_cen | 0.0512 | 0.0604 | 0.200 |  |
|  | (0.0613) | (0.0486) | (0.144) |  |
| EPSI |  |  |  | -10.08 |
|  |  |  |  | (6.204) |
| EPSI\_ln\_KL\_cen |  |  |  | 82.10\* |
|  |  |  |  | (40.70) |
| EPSI\_ln\_KL\_2\_cen |  |  |  | -8.120\*\* |
|  |  |  |  | (3.927) |
| Constant | -101.4\*\*\* | -70.54\*\*\* | -22.30 | -66.05 |
|  | (36.88) | (25.80) | (57.45) | (128.1) |
|  |  |  |  |  |
| Observations | 276 | 502 | 235 | 120 |
| R-squared | 0.077 | 0.046 | 0.056 | 0.120 |
| Number of cou1 | 69 | 71 | 49 | 25 |

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

##### Table 23. Build-up Model 2.1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Model 2.1 | Model 2.1 | Model 2.1 | Model 2.1 | Model 2.1 | Model 2.1 |
|  |  |  |  |  |  |  |
| EPI | -0.0822\*\* | 0.00130 | 0.0237 | 0.0238 | 0.0205 | 0.0106 |
|  | (0.0305) | (0.0310) | (0.0272) | (0.0276) | (0.0263) | (0.0258) |
| ln\_rgdpna |  | -5.289\*\*\* | -4.205\*\*\* | -2.623\*\*\* | -2.891\*\*\* | -2.846\*\*\* |
|  |  | (1.006) | (0.769) | (0.353) | (0.388) | (0.409) |
| SE\_terX |  |  | -0.0381\*\* | -0.0325\*\* | -0.0278\*\* | -0.0294\*\* |
|  |  |  | (0.0134) | (0.0115) | (0.0108) | (0.00980) |
| eodb1 |  |  | -0.0553\* | -0.0373 | -0.0332 | -0.0398 |
|  |  |  | (0.0283) | (0.0327) | (0.0330) | (0.0334) |
| governance |  |  | 0.0816 | -0.0458 | 0.0294 | -0.00111 |
|  |  |  | (0.263) | (0.327) | (0.312) | (0.309) |
| ln\_KL |  |  |  | -1.560\*\* | 0.858 | 2.049 |
|  |  |  |  | (0.624) | (0.952) | (1.528) |
| ln\_KL\_2 |  |  |  |  | -0.304\*\* | -0.407\*\* |
|  |  |  |  |  | (0.102) | (0.131) |
| EPI\_ln\_KL\_cen |  |  |  |  |  | 0.217 |
|  |  |  |  |  |  | (0.129) |
| EPI\_ln\_KL\_2\_cen |  |  |  |  |  | -0.0270 |
|  |  |  |  |  |  | (0.0152) |
| Constant | 5.002\*\*\* | 69.55\*\*\* | 61.22\*\*\* | 46.97\*\*\* | 45.44\*\*\* | 42.60\*\*\* |
|  | (0.852) | (12.24) | (8.920) | (4.829) | (6.035) | (7.721) |
|  |  |  |  |  |  |  |
| Observations | 664 | 664 | 664 | 664 | 664 | 664 |
| R-squared | 0.0046 | 0.0585 | 0.0701 | 0.0743 | 0.0776 | 0.0804 |
| Number of groups | 74 | 74 | 74 | 74 | 74 | 74 |

Driscoll-Kraay standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

##### Table 24. Robustness checks Model 2.1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) |
| VARIABLES | Model 2.1 - EPI years | Model 2.1 - no governance | Model 2.1 - no missings | Model 2.1 - EPSI |
|  |  |  |  |  |
| EPI | 0.0246 | 0.0106 | -0.0285 |  |
|  | (0.0562) | (0.0216) | (0.147) |  |
| ln\_rgdpna | -2.558\*\* | -2.848\*\*\* | -2.515\* | -9.946\* |
|  | (0.687) | (0.713) | (1.109) | (4.975) |
| SE\_terX | -0.0523\*\*\* | -0.0294\*\* | -0.00614 | -0.00542 |
|  | (0.00564) | (0.00961) | (0.0158) | (0.00657) |
| eodb1 | 0.0320 | -0.0398 | -0.167\*\* | -0.132 |
|  | (0.0246) | (0.0349) | (0.0543) | (0.116) |
| governance | -0.274 |  | 0.499 | -1.412 |
|  | (0.281) |  | (0.859) | (0.751) |
| ln\_KL | -0.785 | 2.051 | 1.846 | 9.916 |
|  | (0.974) | (1.271) | (2.412) | (20.11) |
| ln\_KL\_2 | -0.225 | -0.407\*\* | -0.429\*\* | -1.209 |
|  | (0.116) | (0.126) | (0.156) | (1.817) |
| EPI\_ln\_KL\_cen | 0.130 | 0.217 | 0.372 |  |
|  | (0.0871) | (0.138) | (0.524) |  |
| EPI\_ln\_KL\_2\_cen | -0.0147 | -0.0270 | -0.0308 |  |
|  | (0.00997) | (0.0162) | (0.0495) |  |
| EPSI |  |  |  | 3.843 |
|  |  |  |  | (2.597) |
| EPSI\_ln\_KL\_cen |  |  |  | -21.07 |
|  |  |  |  | (10.98) |
| EPSI\_ln\_KL\_2\_cen |  |  |  | 2.016\* |
|  |  |  |  | (0.943) |
| Constant | 43.95\*\*\* | 42.61\*\*\* | 49.06\*\* | 127.2\*\* |
|  | (9.465) | (10.51) | (14.40) | (41.32) |
|  |  |  |  |  |
| Observations | 369 | 664 | 289 | 127 |
| R-squared | 0.1373 | 0.0804 | 0.1084 | 0.1534 |
| Number of groups | 74 | 74 | 50 | 25 |

Driscoll-Kraay standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

##### Table 25. Build-up Model 2.2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Model 2.2 | Model 2.2 | Model  2.2 | Model 2.2 | Model 2.2 | Model 2.2 |
|  |  |  |  |  |  |  |
| EPI | 0.0348 | 0.0480 | 0.0761\* | 0.0762\* | 0.0711\* | 0.0809\* |
|  | (0.0376) | (0.0297) | (0.0358) | (0.0359) | (0.0363) | (0.0414) |
| ln\_rgdpna |  | -0.836 | -0.284 | 1.747 | 1.338 | 1.397 |
|  |  | (0.696) | (0.936) | (1.029) | (0.929) | (0.942) |
| SE\_terX |  |  | -0.000380 | 0.00683 | 0.0141 | 0.0145 |
|  |  |  | (0.0160) | (0.0169) | (0.0181) | (0.0158) |
| eodb1 |  |  | -0.0626\*\* | -0.0394 | -0.0332 | -0.0273 |
|  |  |  | (0.0237) | (0.0230) | (0.0221) | (0.0217) |
| governance |  |  | -0.209 | -0.373\*\* | -0.258\* | -0.238 |
|  |  |  | (0.148) | (0.145) | (0.128) | (0.136) |
| ln\_KL |  |  |  | -2.004\*\* | 1.685 | 1.296 |
|  |  |  |  | (0.612) | (1.893) | (1.990) |
| ln\_KL\_2 |  |  |  |  | -0.464\* | -0.440 |
|  |  |  |  |  | (0.214) | (0.251) |
| EPI\_ln\_KL\_cen |  |  |  |  |  | -0.105 |
|  |  |  |  |  |  | (0.209) |
| EPI\_ln\_KL\_2\_cen |  |  |  |  |  | 0.0150 |
|  |  |  |  |  |  | (0.0236) |
| Constant | 2.788\*\*\* | 12.99 | 10.00 | -8.300 | -10.64 | -10.96 |
|  | (0.793) | (9.042) | (10.79) | (11.34) | (12.03) | (12.67) |
|  |  |  |  |  |  |  |
| Observations | 664 | 664 | 664 | 664 | 664 | 664 |
| R-squared | 0.0008 | 0.0022 | 0.0084 | 0.0156 | 0.0234 | 0.0245 |
| Number of groups | 74 | 74 | 74 | 74 | 74 | 74 |

Driscoll-Kraay standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

##### Table 26. Robustness checks Model 2.2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) |
| VARIABLES | Model 2.2 - EPI years | Model 2.2 - no governance | Model 2.2 - no missings | Model 2.2 - EPSI |
|  |  |  |  |  |
| EPI | 0.0756 | 0.0763 | 0.135 |  |
|  | (0.0428) | (0.0423) | (0.122) |  |
| ln\_rgdpna | 1.699\*\* | 1.042 | -1.444 | -1.507 |
|  | (0.512) | (1.019) | (2.714) | (5.204) |
| SE\_terX | -0.0101 | 0.0146 | 0.0891\*\*\* | 0.122\*\* |
|  | (0.0180) | (0.0164) | (0.0145) | (0.0400) |
| eodb1 | 0.00714 | -0.0248 | -0.200\*\* | -0.168\*\* |
|  | (0.00873) | (0.0213) | (0.0661) | (0.0636) |
| governance | 0.253 |  | 0.0408 | 1.476\*\* |
|  | (0.245) |  | (0.332) | (0.558) |
| ln\_KL | 0.713 | 1.684 | 4.419 | 0.666 |
|  | (2.780) | (2.046) | (8.585) | (6.558) |
| ln\_KL\_2 | -0.391 | -0.467 | -1.008 | -0.524 |
|  | (0.312) | (0.255) | (0.661) | (0.603) |
| EPI\_ln\_KL\_cen | -0.120 | -0.114 | -1.415 |  |
|  | (0.288) | (0.212) | (0.999) |  |
| EPI\_ln\_KL\_2\_cen | 0.0204 | 0.0163 | 0.169 |  |
|  | (0.0358) | (0.0239) | (0.0971) |  |
| EPSI |  |  |  | -7.132\* |
|  |  |  |  | (3.014) |
| EPSI\_ln\_KL\_cen |  |  |  | 52.59\*\* |
|  |  |  |  | (19.54) |
| EPSI\_ln\_KL\_2\_cen |  |  |  | -5.189\*\* |
|  |  |  |  | (1.917) |
| Constant | -14.81 | -8.026 | 30.83 | 57.32 |
|  | (11.87) | (12.94) | (25.92) | (52.38) |
|  |  |  |  |  |
| Observations | 369 | 664 | 289 | 127 |
| R-squared | 0.0325 | 0.0235 | 0.1556 | 0.2008 |
| Number of groups | 74 | 74 | 50 | 25 |
|  |  |  |  |  |

Driscoll-Kraay standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1