The Other Side of the Coins

The Environmental Impact of Greenfield FDI in Sub-Saharan Africa´s Pollution-Intensive Industries and the Role of Governance

Ostermeyer, Vinzent

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The Environmental Impact of Greenfield FDI in Sub-Saharan Africa´s Pollution-Intensive Industries and the Role of Governance

by

Vinzent Leon Ostermeyer

vi.ostermeyer@gmail.com

Abstract: While foreign direct investments (FDI) are promoted as a vehicle for economic development their environmental consequences are less established. This study tests the hypotheses that 1) FDI led to environmental degradation in form of increased greenhouse gas emissions during Sub-Saharan Africa´s recent growth spurt but that 2) this impact was felt to a lesser extent in countries with a higher quality of governance. The study builds its own panel dataset covering 12 countries and the years 2003 to 2012. While due to the research design no causal relationship can be determined, the study suggests that countries with a well-enforced rule of law noticed a lower increase of greenhouse gas emissions growth than countries where it was badly enforced. A fixed-effects model indicates that this difference would have been five percentage points for a country with an average share of FDI in pollution-intensive industries. This result is robust to different specifications. It carries economic significance as the study suggests several channels through which governance can mitigate the environmental impact of FDI. This study advances previous research by focusing on the role of governance, pollution-intensive industries, and greenfield FDI.

Key Words: Greenfield Foreign Direct Investments, FDI, Environmental Degradation, Pollution-Intensive Industries, Greenhouse Gases, Governance, the Rule of Law, Sub-Saharan Africa, Economic Development

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List of Abbreviations

CO_2: Carbon Dioxide

EIA: Energy Information Administration

EPA: Environmental Protection Agency

FDI: Foreign Direct Investment(s)

GDP: Gross Domestic Product

GHG: Greenhouse Gas(es)

IEA: International Energy Agency

ICRG: International Country Risk Guide

IMF: International Monetary Fund

KKM: Kaufman, Kraay and Mastruzzi (authors of the WGI)

MNE: Multinational Enterprise / Firm

M&A: Mergers and Acquisitions

OECD: Organization for Economic Cooperation and Development

WGI: World Governance Indicators

WRI: World Resources Institute

Table of Contents

List of Tables

List of Figures

1 Introduction

Sub-Saharan Africa – usually, this region prompts diverse associations. Often, people think of wild animals or a unique culture. Others point to low living standards and economic stagnation. Formally, Sub-Saharan Africa is a region of approximately 50 countries south of the Sahara (see appendix A for a map). Indeed, the region has been the symbol of development failure (Harttgen, Klasen & Vollmer, 2013) as historically only episodic economic growth occurred (Jerven, 2010). Unlike in Western countries economic development was historically not driven by a successful structural transformation towards industry and services. Instead, growth occurred usually only during export booms of natural resources. These cycles ended again when worldwide economic conditions worsened and the demand for resources decreased. However, since the mid-1990s the region noticed an economic upswing with Sub-Sahara African countries being among the worldwide fastest growing ones (Jerven, 2010; Arndt, McKay & Tarp, 2016). But claiming that these developments resemble a growth miracle leading to sustained economic development in the future (e.g. Young, 2012) might however be optimistic. While the manufacturing industry consisting mostly of textiles, automobiles, and consumer goods increased its output, its share in GDP decreased (Balchin et al., 2016). Recent economic growth was again largely based on producing and exporting natural resources including coal, oil, gas, diamonds, iron, copper, gold, and other minerals. This was facilitated by favorable worldwide economic conditions with higher prices and increased demand. But once these conditions worsen and given the region´s history, it is questionable how long growth in these overall pollution-intensive industries will last (Alden & Alves, 2009; Rodrik, 2016; Deloitte, 2017).

Foreign direct investments (FDI) were one factor contributing to these recent economic developments. FDI denote capital flows that occur when multinational enterprises (MNEs) invest in a country other than their home-base. Importantly, two types of FDI can be distinguished. Mergers / acquisitions (M&As) occur if one MNE merges with or acquires a firm in a different country. While M&As lead to capital flows across borders, they do not automatically increase the capital-intensity of the host economy since only the ownership structure of the company changed. In contrast stand greenfield FDI. They occur when MNEs create new business operations in the FDI-hosting country through transferring assets and capital. Importantly, only greenfield FDI lead per definition to the creation or expansion of business by MNEs abroad (Caldéron, Loayza & Servén, 2004; Weisbrod & Whalley, 2011; UNCTAD, n.d.). FDI are of economic interest since they presumably contribute to economic development and growth even though the magnitude of the impact is debatable. Generally, greenfield FDI are perceived as being more successful in generating economic growth since they increase economic operations and do not merely consist of a changing ownership structure (De Mello Jr, 1997). Thus, developing regions such as Sub-Saharan Africa were urged to use them for financing their recent economic development (see e.g. OECD, 2002).

Sub-Saharan Africa received roughly five percent of the yearly worldwide greenfield FDI flows since 2003. Major receivers were Angola, Nigeria, and South Africa. These FDI came largely from developed high-income Western countries. Seeking to meet an increased internal demand for natural resources, Chinese FDI also played an important role. Other Asian countries were also investors while FDI from Africa itself played a minor role (Sanfilippo, 2010; Renard, 2011; fDiMarkets, 2018, own calculations). Overall, the amount of yearly greenfield FDI into the region ranged between 10 and 40 percent when expressed as the share of domestic capital available for investment (fDiMarkets, 2018; World Bank, 2018; own calculations) suggesting that FDI were one important source of financing. Most of the yearly greenfield FDI went into the overall pollution-intensive industries including mining, quarrying, energy production, and manufacturing underlying the recent Sub-Sahara African growth spurt as identified above. For some countries, even all FDI went into these industries (fDiMarkets, 2018, own calculations). Because FDI were promoted as a pathway to economic development as indicated above, previous research focused on determining whether they increased economic growth. The results are mixed. Barbi and da Costa Jr. (2016) found that FDI increased economic output despite the contribution of other factors such as trade. Weisbrod and Whalley (2011) calculated that Chinese greenfield FDI contributed in many Sub-Sahara African between half and one percentage points to GDP growth. And Adams and Opuku (2015) found an impact on growth especially in countries with effective regulations.

1.1 FDI and the Environment in Sub-Saharan Africa

But while these lines of research are interesting the potential side-effects of FDI have not been thoroughly considered. One such area is their environmental impact, which is according to the theoretical background (chapter 2) ambiguous. Through increasing economic activity, FDI could have foremost led to increased environmental degradation. This is especially likely in Sub-Saharan Africa since FDI were mainly concentrated in pollution-intensive industries such as the extraction of natural resource as outlined above. Thus, analyzing their environmental impact is important as economic development is a worthwhile goal but arguably should not lead to large-scale environmental degradation. However, to the extent that FDI also transferred modern and more energy-saving technologies this negative environmental impact could have been mitigated. If these technologies additionally spread to domestic firms the total environmental impact could have been even beneficial. Again, it is important to consider the difference between M&As and greenfield FDI. Greenfield FDI are generally expected to have a more noticeable environmental impact. After all, they lead per definition to the implementation of new economic activities as well as technological transfers and not just transfers of ownership. Moreover, the environmental impact of FDI is expected to be more benign in countries with a higher quality of governance, which deters MNEs from breaking the law and encourages technological spillovers

In the African context, Assa (2017) and Bokpin (2017) determined that FDI had a negative impact on local environmental degradation such as forest cover conditional on the quality of governance. However, through focusing only on local environmental degradation the researchers likely underestimate the total environmental impact by disregarding global environmental degradation (Dinda, 2004; Kaika & Zervas, 2013b). One aim of this study is to complement this research by focusing on global environmental degradation. This study measures global environmental degradation as greenhouse gas (GHG) emissions. This choice advances also the general research field, which considered so far mostly CO_2 emissions in the context of global environmental degradation (see also the literature review in chapter 3). As CO_2 emissions remain in the atmosphere for a long time contributing to global warming this choice is understandable (Pappas, 2017). But it leaves out other important GHG having larger global warming potentials such as methane and nitrous oxide (Myhre et al., 2013), which are additionally considered in this study.

Moreover, previous studies in general did not consider a sectoral focus on pollution-intensive industries, greenfield FDI, and the presumably mitigating role of governance. This study aims at filling these research gaps by considering the three points in a Sub-Sahara African context. Since greenfield FDI played an important role in Sub-Sahara Africa´s recent growth spurt as outlined above and were concentrated in overall pollution-intensive industries, the aim of this study is therefore to analyze their sectoral environmental impact. Additionally, the study aims at determining whether a better governed country indeed noticed a more beneficial environmental impact due to FDI as posited above. This research is important since economic development is necessary in the region as outlined above albeit it arguably should not come at the cost of large-scale environmental degradation. Thus, the study aims at answering the following research question:

Research Question: What was the impact of greenfield FDI in pollution-intensive industries on GHG emissions growth in Sub-Saharan Africa conditional on the quality of governance?

1.2 Outline and Results of this Study

To answer the research question, chapter 2 presents in more detail how FDI theoretically impact the environment and through which channels a higher quality of governance potentially mitigates this impact. It is hypothesized that 1) FDI increased the growth rate of GHG emissions but 2) to a lesser extent in well-governed countries. Governance is measured using the rule of law indicator published by the Worldwide Governance Indicators (WGI, 2016). Chapter 3 reviews previous research describing its limitations briefly summarized above in more detail. Chapter 4 describes how the study built its underlying dataset from various sources. These different datasets covering twelve Sub-Sahara African countries for the years 2003 to 2012 are critically reviewed. Essentially, country and time coverage of the study is determined by the data availability. While it is therefore not representative for the whole of Sub-Saharan Africa it is nevertheless representative for its southern part and its largest countries, which received most greenfield FDI. Chapter 5 describes the econometric models (pooled OLS, fixed and random effects) employed. Using the fixed effects approach is most supported and the other models serve as robustness checks. Importantly, the study does not claim to derive causality but rather correlations, which need to be interpreted against the theoretical background from chapter 2. It finds in chapter 6 support for both hypotheses. In Sub-Saharan Africa´s pollution-intensive industries a higher quality of governance seems to have been associated with a more benign environmental impact of greenfield FDI. The study estimates that at the mean value of FDI inflow GHG emissions growth would have been five percentage points lower in a Sub-Saharan African country with relatively good governance compared to a country where governance was relatively bad. While these findings are not statistically significant it is argued that they have economic significance. Chapters 7 and 8 conclude by relating the findings to previous research and the theoretical background, sketch how governance can be improved, and discuss limitations as well as areas for further research.

1.3 The Contributions of this Study

By addressing both Sub-Saharan Africa and general methodological issues of the research field this study has manifold contributions to both areas. By focusing on global environmental degradation this study complements the previous literature on the local environmental consequences of FDI in Sub-Saharan Africa. Moreover, it advances the research on global FDI-related environmental degradation by using with GHG emissions a more comprehensive measure for global pollution as indicated above. Additionally, this study advances the research field by considering in contrast to most of the previous studies the potentially mitigating role of governance on the environmental impact of FDI. As such, it contributes to anchoring the importance of governance in the literature, which can be used to give policy recommendations regarding how FDI should be governed in the future. Also, rather than looking at net FDI flows like previous research did this study uses greenfield FDI. This is a novel contribution since especially greenfield FDI impact the environment as argued above and in chapter 2. An additional benefit of using greenfield FDI is that they are available at a sectoral level. While sectoral analyses are theoretically recommended (chapter 2), they have been scarce in previous research. But by focusing on the pollution-intensive industries driving Sub-Saharan Africa´s recent economic development as indicated above this study can estimate where the environmental impact of FDI was largest.

2 Theoretical Background

This chapter sketches how especially greenfield FDI impact the environment conditional on the quality of governance. Figure 1 summarizes the postulated influences and is used to derive hypotheses regarding the environmental impact of greenfield FDI in Sub-Saharan Africa.

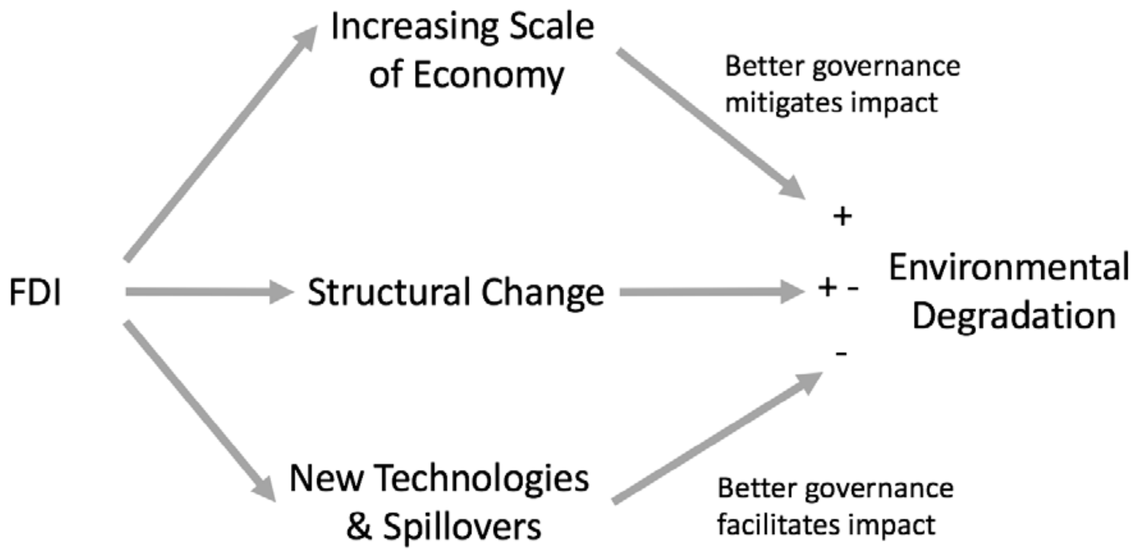

Figure 1: Visualizing the different theoretical channels through which FDI increase (+) and decrease (-) environmental degradation. Additionally, the figure highlights where governance mitigates or facilitates this impact (own representation based on the sources cited in the theoretical background).

2.1 The Environmental Impact of FDI

Theoretically, FDI can have a positive, negative, or neutral impact on the environment of their host country. The reason for this ambiguity is that FDI influence the environment through three different channels portrayed in figure 1, which might have contradictory effects. They are the so-called scale, technological, and structural effects (Araya, 2005; Acharyya, 2009; Wang & Chen, 2014; Cole, Elliott & Zhang, 2017). Each effect is subsequently reviewed.

2.1.1 Scale Effects

Scale effects denote the increased environmental degradation that occurs due to the new economic activity induced through FDI. Importantly, they are a counterfactual since they are measured holding the composition of the economy and its technological level constant. For example, scale effects occur when FDI lead to the setting-up of new plants, increase the production, and lead to the sourcing of e.g. inputs of intermediate products, natural resources, energy, water, and transport from other firms. As such scale effects likely differ in size across industries. Especially in pollution-intensive industries such as oil, gas, mining, and manufacturing they tend to be large. After all, a one unit increase in economic activity is associated here with a relatively large increase in environmental degradation compared to other less pollution-intensive industries. Moreover, it is likely that especially greenfield FDI have larger scale effects than M&As since greenfield FDI increase per definition the economic activity in the host country. Given that M&As involve merely a transfer of ownership, at least in the short-run they must not create new economic activity. Potentially, scale effects are smaller in more economically developed countries since countries might possess more environmentally-friendly production methods. (UNCTAD, 2000; Araya, 2005; Weisbrod & Whalley, 2011; Wang & Chen, 2014; Cole, Elliott & Zhang, 2017).

2.1.2 Technological Effects

Since FDI also lead to technological transfers they can potentially create pollution halos, i.e. countries where FDI increase the technological level to an extent that it helps reducing environmental degradation. Within this context technology encompasses physical equipment (i.e. technologies used in production) as well as knowledge (e.g. environmental management skills, best practice methods, general know-how). Technological effects occur through three channels, i.e. their arrival, intentional diffusion, and unintentional spillovers (Franco, Rentocchini & Marzetti, 2010; Cole, Elliott & Zhang, 2017). Regarding the arrival of new technology, Cole, Elliott and Zhang (2017) argue that MNEs often possess cleaner technologies and are more energy-efficient. Also, they have a better knowledge of how to design production processes in energy-efficient ways. Since MNEs bring these technologies with them into the county when conducting FDI, the environmental degradation resulting from the scale effect is not as harmful as it would have been the case if domestic technologies would have been used (Araya, 2005; Blomström & Kokko, 1998). Greenfield FDI are likely to be more successful in transferring energy-efficient technologies across countries than M&A as only they lead to the implementation of new operations and thus technological transfer. Under M&A only the ownership of the company changes leaving at least in the short-term production processes unchanged (UNCTAD, 2000).

Once new technologies arrived in the host-country their diffusion can bring further benefits to the environment. For example, MNEs might license their technology to domestic firms for imitation. Or they use their knowledge to train domestic firms best practices in environmental management. Unfortunately, there is no guarantee that such direct technological transfer occurs. Overall it depends on the local circumstances whether MNEs find it profitable to license their technologies and knowledge. Moreover, it also depends on whether licensing new technologies is profitable for domestic firms and to what extent they can utilize their newly gained knowledge and technology (Araya, 2005). To some extent technological diffusion might occur more easily under M&A than greenfield FDI since linkages from the acquired firm to domestic companies already exist through which MNEs can pass their knowledge and technologies. However, this assumes that M&A lead to the implementation of new technologies in the first place, which as indicated above is not granted. Importantly, also greenfield FDI can lead to technological diffusion if MNEs connect with domestic firms (UNCTAD, 2000). Additionally, indirect technological spillovers from MNEs to domestic firms might occur when new technologies and knowledge are passed to domestic firms unintentionally. For example, workers might move between MNEs and domestic firms dissipating e.g. the knowledge about best environmental management practices. Also, MNEs might have environmental standards and requirements, which need to be fulfilled when purchasing inputs from domestic firms. To meet these requirements domestic firms would be forced to upgrade their technologies and processes decreasing the environmental impact of production (Araya, 2005; Cole, Elliott & Zhang, 2017).

2.1.3 Structural Effects

Finally, FDI impact the environment through a structural effect. The structural effect accounts for potential changes in the sectoral composition of an economy due to FDI. If FDI help in shifting the sectoral composition of the economy towards sectors with a lower pollution-intensity they have a beneficial environmental impact. Presumably, this occurs if FDI help the economy in becoming more service-oriented. Services are generally perceived to be less pollution-intensive even though this does not hold for all kinds of them (Araya, 2005; Wang & Chen, 2014). Greenfield FDI have likely larger structural effects since they expand the economic activity thereby driving the structural transformation and not only include transfers of ownership (UNCTAD, 2000). Overall, the existence of structural effects implies that analyzing the aggregate economy might yield a misleading picture of the environmental impact of FDI. The reason is that FDI in less pollution-intensive industries could mask a negative environmental impact of FDI in pollution-intensive industries (Blanco, Gonzalez & Ruiz, 2013). This motivates the sectoral focus on pollution-intensive industries in the Sub-Sahara African context. After all, most FDI occurred here as the introduction argued. Thus, the analysis of sectoral instead of total greenfield FDI and GHG emissions is recommended. Since the study does not look at the aggregate economy structural effects are thus of lesser relevance to it.

2.2 A Governance Perspective

The above paragraphs sketched how FDI impact the environment through scale, structural, and technological effects. Since these effects occur simultaneously the researcher usually observes only their net environmental impact. It is the sum of the three effects, which is either positive, neutral, or negative depending on whether the effects reinforce or negate each other. The researcher must consequentially use theory to reason backwards regarding which effect likely outweighed (Araya, 2005). However, as this section argues occur the three effects not in a vacuum. Instead, they are subject to governance. Depending on the quality of governance the environmental impact of FDI can be further mitigated or reinforced.

2.2.1 Defining (Good) Governance

Before sketching how governance shapes the environmental impact of FDI, it is necessary to define the concept. Broadly speaking, governance refers to the act of directing or regulating. Because different subjects can be governed, various disciplines use the concept. Relevant for this study is economic governance (subsequently called governance). While it does not have a universally accepted definition, it can be perceived as the process of exercising power to manage the collective affairs of a country. The study of governance is the study of the institutional structure underpinning an economy. It aims at comparing different institutional arrangements as well as analyzing how they evolved over time and impacted economic development (Williamson, 2005; Dixit, 2008; Bevir, 2012; Gisselquist, 2012). Studying governance is relevant since some researchers argued that poor institutional quality is the root cause of economic underdevelopment. For example, Acemoglu, Johnson and Robinson (2002; 2005) argued that Northern Europe industrialized first because it developed inclusive institutions. Since thereby power was shared by many economic exchange was governed in an inclusive way leading to economic development. Similarly, development agencies promoted the conduct of good governance. Unfortunately, since organizations such as the World Bank, IMF or OECD hold diverse mandates they define good governance in different ways. Thus, it remains unclear what the concept exactly entails (Gisselquist, 2012). Nevertheless, Gisselquist (2012) identifies seven components forming the core of good governance. These are a functioning democracy and representation, secure human rights, the upholding of the rule of law, effective and efficient public management, transparency and accountability of officials, sustainable economic and social development, and the presence of institutions such as elections, legislature, and a free press. Problematic with this list is that it still leaves open the criteria for when each condition is fulfilled (Gisselquist, 2012). However, this is not an important concern for this study as it only focusses on the rule of law as outlined below.

2.2.2 How the Rule of Law Shapes the Environmental Impact of FDI

Especially the rule of law mitigates the environmental impact of FDI according to the theoretical literature. Regarding its definition, the rule of law is of high quality when a legal framework exists within a country, which is clearly formulated and known by the participants throughout the economy. Additionally, it must be enforced through the state and its authorities such as an independent and reliable judiciary. Conversely, countries not meeting these conditions have an insufficient quality of the rule of law (Gisselquist, 2012). This study uses the WGI (2016) to quantify the rule of law. They are reviewed in the data section (chapter 4) in detail.

Foremost, the rule of law can have its own impact on environmental degradation. If for example the rule of law furthers economic growth as the good governance approach generally posits, its environmental impact can be negative due to similar scale effects as presented above.

However, e.g. with higher incomes people´s preferences could change towards demanding better environmental quality. Consequentially, governments would be expected to enforce stricter environmental regulations ameliorating the environmental quality of the country. If these processes detach economic development and environmental degradation the environmental influence of governance can also be beneficial (Dinda, 2004; Kaika & Zervas, 2013a; Magraw, 2014; Wang & Chen, 2014). Since these direct channels do not concern FDI they are not of much interest to this study and for simplicity not portrayed in figure 1.

Of interest are the three linkages proposed in the literature through which the rule of law presumably mitigates the environmental impact of FDI. First, a functioning rule of law secures that a legal framework exists through which firms are regulated in transparent, consistent, and stringent ways. Thereby it can correct for possible opportunistic behavior and sidestepping by firms. For example, the enforcement of rules and laws in a country deters firms from cheating to cut costs during production, which could otherwise lead to environmental degradation. Potentially, this applies to all firms in a country as indicated above. However, it can be expected that MNEs are more affected since experience shows that they often face scrutiny by local governments. This leads them to being regulated, audited, and controlled more. Thus, especially MNEs have an incentive not to sidestep the law when the rule of law is well-enforced (King & Shaver, 2001; Wang & Chen, 2014). This is different e.g. in pollution havens, i.e. countries where environmental regulations are lax and not enforced as to attract FDI. Potentially, MNEs could use here their bargaining power to decrease the quality of the rule of law further (Cole & Fredriksson, 2009). Subsequently, MNEs could use pollution havens as vehicles to offshore their pollution-intensive production without facing strong regulations. A negative environmental impact of FDI increasing the scale effect further is therefore likely in such situations (Araya, 2005; Assa, 2017; Cole, Elliott & Zhang, 2017).

Second, a well-enforced rule of law secures competitive markets. This reduces the likelihood of governments excessively protecting domestic firms. As such FDI can increase competition and consequentially productivity and innovation, which could lead to inefficient domestic firms being crowded out and thereby a cleaner production overall. Especially greenfield FDI are expected to increase competitiveness between domestic firms and MNEs since they increase the number of companies operating in the country. Conversely, in countries with worse governance the well-functioning of markets is likely not secured. Since domestic firms remain protected competition and innovation must not increase when MNEs enter. As there is no incentive for domestic firms to upgrade their presumably older and inefficient technologies, the survival of energy-efficient and thereby lower pollution-intensive firms is not guaranteed. Thus, the level of environmental degradation remains high (Wang & Chen, 2014)

Third, as argued by e.g. North (1991) and Dixit (2008) reduces the presence and enforcement of laws and rules risks in economic exchanges and transaction costs. This has two implications for the environmental impact of FDI. First, it is likely that only when the rule of law is sufficiently good that MNEs transfer more energy-efficient technologies to the FDI-hosting country. The reason is that under insecure property rights MNEs face the risk of expropriation e.g. by the state and lack legal resorts in such a situation. Thus, they might not implement the most energy-efficient technologies since their competitive advantage would be lost when they are expropriated. Second, only when property rights are clearly defined and enforced will technological spillovers occur since it secures that MNEs are open to e.g. license their technologies to domestic firms. The reason is that MNEs must be assured to receive legal help if domestic firms do not adhere to the contracts and misuse their licensed technologies (Hoskisson et al., 2000). Arguably, the rule of law is especially important for technological spillovers to occur under greenfield FDI. Since MNEs conducting greenfield FDI might have few connections to domestic firms when entering the country, they must have assurance that their property is protected (UNCTAD, 2000). Similarly, also domestic firms could find it only profitable to license foreign technology if they can be sure that they cannot be expropriated. In sum, the rule of law can facilitate through these mechanisms the technological effects as posited above further.

2.3 Hypotheses

Based on the previous discussion the study derives two testable hypotheses regarding the likely environmental impact of greenfield FDI in the pollution-intensive industries of Sub-Saharan Africa conditional on the quality of governance. As argued above it uses greenfield FDI since the theoretical background suggested that especially they could lead to environmental degradation or technological spillovers. Additionally, the hypotheses concern only the pollution-intensive industries as they played the largest role in Sub-Saharan Africa and the theoretical background indicated that especially here a negative environmental impact is likely. Crucially, the hypotheses do not aim at testing causality since the empirical models cannot support such claims. Instead, the study aims at finding correlations, which are interpreted against the theoretical background.

Hypothesis 1: Inflows of greenfield FDI in pollution-intensive industries were associated with increases in the growth rate of GHG emissions in Sub-Saharan Africa.

This hypothesis follows from the theoretical background arguing that scale effects are large especially in pollution-intensive industries and developing countries. Thus, they are predicted to overweigh any technological effects. Nevertheless, technological effects could have occurred since FDI came from mostly developed countries as argued in the introduction. If that was the case the estimated net environmental impact of FDI would be smaller. The study analyzes the growth rate of GHG emissions and not their level because 1) countries can be compared more easily using growth rates and 2) analyzing the growth rate is arguably more interesting from a policy perspective. While a high level of GHG emissions is problematic, an increasing GHG emissions growth rate is even more so since it implies a higher level of GHG emissions in the future.

Hypothesis 2: In countries where the rule of law was of higher quality greenfield FDI inflows in pollution-intensive industries were associated with a lower increase of GHG emissions growth than in countries where the quality of the rule of law was low.

This hypothesis follows directly from the discussion above since the rule of law should mitigate scale and encourage technological effects. These mechanisms lead to the expectation that the environmental impact of FDI is more benign in well-governed countries with a well-enforced rule of law.

3 Previous Research

This chapter reviews to which extent previous research reflects the theoretical background and derived hypotheses. To facilitate this review, table 1 summarizes the methodologies and results of previous studies. Overall, it suggests that a substantive amount of studies concerning the environmental impact of FDI already exist. Their geographical coverage is broad spanning across countries in Asia, Europe, America, and Africa. Usually the studies considered years since 1990 given lacking prior data. Since the studies applied similar panel data and time series approaches this study follows suit by mainly relying on fixed effects models (chapter 5). Additionally, table 1 reflects the contributions of this study as sketched in the introduction. While most previous studies considered CO_2 emissions as their measure for environmental degradation this study employs with GHG emissions a more encompassing indicator of global pollution. Table 1 furthermore indicates that most studies did not consider a governance perspective despite its importance according to the theoretical background. Additionally, it suggests that no previous study considered greenfield FDI even though according to the theoretical background especially they impact the environment. Instead, almost all studies including the ones concerning Sub-Saharan Africa relied on FDI data published by the World Bank (2018) or UNCTAD (2018), which are problematic for three reasons. First, they are an aggregate constructed by summing FDI flows across sectors. Thus, any sector-specific analyses of the environmental impact of FDI as motivated in section 2.1.3 cannot be conducted. Second, they reflect net inward FDI flows calculated as the difference between incoming and outgoing FDI for a country in each year. Thereby the actual amount of incoming FDI remains unknown. Also, they exclude small FDI. Therefore, studies using these measures do not estimate strictly speaking the impact of total inward FDI on economic development. Third, traditional FDI data do not distinguish the type of FDI. Instead they add M&As together with greenfield FDI, which however have as argued below different impacts on economic development and particularly the environment. By using data from fDiMarkets (2018, see also chapter 4) this study attempts to solve these problems.

3.1 Results from Studies Not Considering Governance

The remainder of this chapter discusses the results obtained by previous research. This discussion is divided by whether the authors considered the role of governance or not. Results from studies not considering governance suggest that the environmental impact of FDI varies depending on the level of economic development of the FDI-hosting country. For high-income countries, studies by Hoffmann et al. (2005), Lee (2013), Omri, Khuong Nguyen and Rault (2014) as well as Mert and Bölük (2016) found that FDI have generally a beneficial environmental impact. Their explanation is that in high-income countries FDI played in relation to total investments a smaller role limiting their ability to cause large scale effects (Hoffman et al., 2005). Therefore, technological spillover effects overweighed leading to improved energy efficiency and the spread of cleaner technologies (Lee, 2013; Omri, Khuong Nguyen and Rault, 2014; Mert and Bölük, 2016).

For emerging countries, previous research found mixed results. Many studies considered specifically China. They found that scale-effects outweighed technological effects during the early phase of China´s industrialization. More recently technological spillover effects occurred rendering the environmental impact of FDI beneficial (He, 2006; Zhang & Zhou, 2016; Sung, Song & Pakr, 2018). In other countries, generally a negative environmental impact due to FDI was found. Acharyya (2009) analyzed FDI in India suggesting that they increased CO_2 emissions. Supposedly, this result holds due to a large scale vis-à-vis structural or technological effects. Baek (2016) supports this result for five ASEAN countries. He found that a one percent increase in FDI was associated with an 0.034 percent increase in CO_2 emissions. Supposedly, the fact that FDI were concentrated mainly in pollution-intensive industries led to this result. Hoffman et al. (2005) also found that FDI increased CO_2 emissions in emerging countries. Again, the authors attribute this to a scale effect. Because in developing countries MNEs play a more important role than domestic firms the expansion of their business activity increased CO_2 emissions. Omri, Khuong Nguyen and Rault (2014) additionally argue that not enough technological transfers occurred in emerging countries so that FDI could be beneficial for the environment. Lau, Choong and Eng (2014) support this argument for the case of Malaysia.

However, the notion that FDI unconditionally harmed the environment of emerging countries due to scale effects outweighing technological spillovers has been challenged. Blanco, Gonzalez and Ruiz (2013) analyzed the impact of FDI on Latin American CO_2 emissions but distinguished it by industries. To classify industries as being pollution-intensive they reviewed and combined different classification schemes. Accordingly, pollution-intensive industries are mining, certain kinds of manufacturing including electrical equipment, automobiles, wood, paper, chemicals, minerals, and metal products as well as transport equipment industries. The authors found that a one standard deviation increase of FDI in these industries Granger-caused CO_2 emissions per capita growth to increase by 0.96 percentage points in the following two periods. Interestingly, overall and in the industries not classified as pollution-intensive no such effect was found. Thus, Blanco, Gonzalez and Ruiz (2013) support the theoretical claim of conducting industry-specific analyses. Presumably, if one estimates the environmental impact of all FDI together one understates the negative impact. This is because in less pollution-intensive industries the more benign environmental impact could overshadow the environmental impact in pollution-intensive industries. As motivated above this study follows suit by considering as the first study only Sub-Saharan Africa´s pollution-intensive industries. After all, the mining and manufacturing sectors corresponding to the classification by Blanco, Gonzalez and Ruiz (2013) were also the recipients of most FDI flows in Sub-Saharan Africa as outlined in the introduction. Thus, the largest environmental impact should be found here.

3.2 Results from Studies Considering Governance

Only six out of 22 studies considered the potentially mitigating impact of some form of governance on the environmental consequences of FDI. As the introduction indicated considered two of them (Assa, 2017; Bokpin, 2017) the effect of FDI on local environmental degradation (forest depletion and natural resource availability) in Sub-Saharan Africa. Like this study both authors used the WGI (2018) including the rule of law indicator to measure governance performance. The authors found that FDI prima facie decreased natural resources availability and forest cover in Sub-Sahara Africa thereby increasing environmental degradation. However, in countries with a better enforced rule of law this impact was mitigated. Conversely, in countries with a worse rule of law it was amplified. According to Assa (2017) these findings support the hypothesis that MNEs pollute more when the rule of law is less enforced because they have no incentive to adhere to stringent environmental regulations. Overall, the researchers claim that strengthening particularly the rule of law and generally the quality of governance could help in achieving a beneficial environmental impact due to FDI in the region.

Wang and Chen (2014) obtained similar results for China. Especially governance aimed at enforcing contracts made a benign environmental effect of FDI likely supporting the arguments made in the theoretical background. Chang (2015) as well as Neequaye and Oladi (2015) analyzed the influence of corruption. Arguably, these studies fit somewhat into the research field as corruption could be argued to be the opposite of good governance. The researchers found that higher corruption in a country was associated with a worse environmental impact of FDI. Finally, Zugravu-Soilita (2017) argued that FDI outflows from France, Germany, the UK, and Sweden had a worse environmental impact in countries where environmental regulations were generally laxer. This supports the theoretical claim that MNEs react in their business conduct to stricter governance.

Table 1: Previous research summarized by author, country, time, research design and finding. The table is divided by whether studies considered governance (own representation of the sources cited).

Authors & Year	Countries & Time	Methodology	Governance and Type of FDI Considered	Finding
Studies Not Considering Governance				
Acharyya, 2009	India, 1980-2003	VECM	Net FDI	FDI increased CO2 emissions
Baek, 2016	5 ASEAN countries, 1981-2010	Panel Data Models	Net FDI	FDI increased CO2 emissions per capita
Blanco, Gonzalez & Ruiz, 2013	Latin America, 1980-2007	Panel Granger Causality	Sectoral FDI	FDI Grager-caused the growth rate of CO2 emission per capita to increase only in pollution-intensive industries but not in other industries
Gholipour Fereidouni, 2013	31 emerging economies, 2000-2008	Panel Data Models	FDI in Real Estate Sector	FDI in the real estate sector did not increase CO2 emissions in the sector
He, 2006	China, 1994-2001	Panel Data Models	Regional FDI	FDI increased regional SO2 emissions in China
He & Yao, 2017	China, 1995-2008	Panel Data Models	Regional FDI	FDI increased emissions of the air pollutants soot and dust
Hoffmann, Lee, Ramasamy & Yeung, 2005	112 countries, unbalanced panel of 15 to 28 years	Panel Granger Causality	Net FDI	Only in middle but not low or high income countries did FDI Granger-cause increases in the growth rate of CO2 emissions
Jugurnath & Emrith, 2018	6 small developing island states, 2004-2014	Panel Data Models	Net FDI	FDI did not increase CO2 emissions per capita
Kivyiro & Arminen, 2014	6 countries in Sub-Saharan Africa seperately considered, 1971-2009	VECM & Granger Causality	Net FDI	No universal Granger-causal relationship found across countries, FDI both increased and decreased CO2 emissions per capita in different Sub-Saharan African countries
Lau, Choong & Eng, 2014	Malaysia, 1970-2008	Granger Causality	Net FDI	FDI Granger-caused CO2 per capita emission increases
Lee, 2013	G20 countries, 1971-2009	Panel Data Models	Net FDI	FDI did not change the growth rate of CO2 emissions
Mert & Bölük, 2016	21 Kyoto Annex countries, 2002-2010	Panel ARDL	Net FDI	FDI Granger-caused the growth rate of CO2 emissions per capita to decrease
Omri, Khuoung Nguyen & Rault, 2014	3 regional sub-panels: Europe & Central Asia, Latin America & Carribbean, Middle East & Africa, 1990-2011	Simultaneous-equation Panel Data Models	Net FDI	FDI increased the growth rate of CO2 emissions except in Europe and North Asia
Pao & Tsai, 2011	BRIC countries, 1980-2007	Panel Granger Causality	Net FDI	FDI did not Granger-cause the growth rate of CO2 emissions per capita to increase
Sung, Song & Park, 2018	China, 2002-2015	Panel Data Models	FDI in Manufacturing Sector	FDI in the manufacturing sector reduced the growth rate of CO2 emissions in the sector
Zhang & Zhou, 2016	China, 1995-2010	Panel Data Models	Regional and National FDI	FDI reduced the growth rate of CO2 emissions and the impact was highest in Western China
Studies Considering Governance				
Assa, 2017	Sub-Saharan Africa, 1996-2011	Panel Data Models	World Governance Indicators, Net FDI	FDI increases reduced the growth rate of forest cover per capita while a higher quality of governance mitigated this impact
Bokpin, 2017	Africa, 1990-2013	Panel Data Models	World Governance Indicators, Net FDI	FDI increased the forest and natural resource depletion while a higher quality of governance mitigated this impact
Chang, 2015	65 countries, 1984-2005	Panel Data Models	Corrpution Index, Net FDI	FDI increased CO2 emissions per capita after a threshold of corruption was reached
Neequaye & Oladi, 2015	27 developing countries, 2002-2008	Panel Data Models	Corruption Index, Net FDI	FDI decreased CO2 / NO2 / total Greenhouse Gas emissions but higher corruption increased them
Wang & Chen, 2014	China, 2002-2009	Panel Data Models	Institutional Index developed for China, FDI at City Level	FDI increased SO2 emissions at the city level, however higher institutional quality mitigated this effect
Zugravu-Soilita, 2017	FDI outflows from France, Germany, UK, Sweden, 1995-2008	Panel Data Models	Proxies for Strength of Environmental Regulation, FDI in Manufacturing Sector	FDI increased / decreased pollution (CO2, SO2, NOX, BOD) depending on different combinations of the capital-labor ratio and strength of envrionmental legislation

4 The Data

This section critically reviews the different data sources used to test the two hypotheses arguing that they are reliable, representative, and valid.

4.1 Greenhouse Gas Emissions: The CAIT Database

4.1.1 Presenting the CAIT Database

Data on GHG emissions in pollution-intensive industries were obtained from the World Resources Institute (WRI, 2014), an independent non-profit organization. In their CAIT database they publish country-estimates of GHG emissions between 1990 and 2012. Crucially, data are not collected by the institute itself. Instead it merges existing databases published by international organizations such as the EIA, EPA, and IEA. Each of these organizations measures different gases emitted across various industries. By combining these partial measures, the CAIT database gives a comprehensive overview of how much total GHG were emitted across countries, years, and sectors. In the CAIT database emissions are classified into one of six sectors following the IPCC (1996) guidelines. These are the energy, industrial processes, agriculture, land-use change and forestry, waste, and international bunkers sector. The emissions from industries previously classified as being pollution-intensive correspond to the ones recorded in the energy sector of the CAIT database. It contains the GHG emissions from the following industries:

- Electricity: In these industries, the CAIT database accounts for CO_2 emissions from heat and electricity production. This includes emissions from heat and power plants, the manufacturing of solid fuels, coal mining, and oil as well as gas production.

- Manufacturing: This category records CO_2 emissions from manufacturing diverse metals, minerals, iron, steel, machinery, mining (gold, copper, and other natural resources), textiles, paper, wood, and other industry goods, construction, and transport.

- Other: In this category CAIT records fugitive emissions of CO_2, methane, and nitrous oxide. Fugitive emissions accrue e.g. as byproducts during coal mining and gas flaring. They are measured as CO_2 equivalents and complement the emissions mentioned above to arrive at a comprehensive measure of GHG emissions.

Thus, the energy sector in the CAIT database reflects the emissions from those industries, which attracted most FDI and drove the recent Sub-Sahara African growth spurt as indicated in the introduction. The captured industries also correspond to the ones classified as being pollution-intensive by Blanco, Gonzalez and Ruiz (2013) justifying this study in taking emissions from the energy sector of the CAIT database as object of analysis.

4.1.2 Critical Issues with the CAIT Database

Nevertheless, one might be skeptical regarding the data quality of the CAIT database. First, the accuracy of the data is questionable since they are an aggregate of diverse databases. However, this is likely a small problem because according to the manual of the CAIT database follow its sources the same IPCC (1996) framework (WRI, 2015). As such a unified methodology is applied in collecting the data, which facilitates their comparability over time and space. Nevertheless, the data quality would be compromised if for some reason researchers made mistakes in the sectoral classification of emissions. This could happen if e.g. some emissions, which should have been recorded in the energy-sector, were falsely classified in the industrial processes sector. However, due to classification difficulties the CAIT database rather reports emissions from the latter sector in the energy sector rendering the industrial processes sector negligible (WRI, 2015). Thus, the risk of not capturing relevant emissions is low. More critical is that the data represent not actual emissions but rather estimates. Essentially, local governments report to international organizations the amount of energy used in each industry. Using conversion charts regarding the emission factors and technological levels the EIA, EPA, and IEA then calculate how much GHG each country must have emitted. If countries did not report their energy usage in a specific year these organizations inter- or extrapolated to create a comparable dataset across time and countries. As such, there is an inherent uncertainty in the data. However, the WRI (2015) reports that overall the data are not more than 10 percent inaccurate. Moreover, as similar methodologies are applied they should be comparable over countries and time. Lastly, it might be questioned if all industries included in the energy sector are truly pollution-intensive. For example, Blanco, Gonzalez and Ruiz (2013) do not classify construction and few other manufacturing industries (e.g. textiles) as being pollution-intensive. However, due to the aggregate nature of the data their emissions cannot be excluded. Furthermore, including them is unproblematic since construction attracted only six percent of greenfield FDI (fDiMarkets, 2018, own calculations) and manufacturing played as indicated in the introduction not the largest role. Thus, the CAIT database delivers reliable estimates of GHG emissions in the overall pollution-intensive industries.

4.2 Greenfield FDI: The fDiMarkets Database

4.2.1 Presenting the fDiMarkets Database

Greenfield FDI data were obtained from the fDiMarkets (2018) database, which is the leading data source for greenfield FDI published by the Financial Times since 2003. fDiMarkets (2018) aims at tracking all FDI, which create new projects or expand existing ones. Thereby the database does not suffer from the problems plaguing the FDI data traditionally used as indicated in chapter 3. To create the fDiMarkets (2018) database a team of in-house analysts scan internal information, over thousands of international media sources as well as project data supplied by more than 2000 international organizations, investment agencies and research agencies. Once they identify a newly announced greenfield FDI project in one source they cross-reference it across the other ones. If this is successful they include the investment in their database. For that they record the sector and sub-sector in which the investment was made plus its nominal dollar value. In cases where no public information regarding the value of the investment was made they estimate it using an econometric model (fDiMarkets, 2018).

4.2.2 Critical Issues with the fDiMarkets Database

Overall, the data quality of fDiMarkets (2018) can be regarded as very good. The Financial Times is an internationally renowned organization. With its team of trained researchers, this expertise likely translates into good data quality. However, several issues with the database exist. First, the values of the FDI projects are stated in nominal terms. As such researchers need to find a way to make them comparable across time. As this study focusses on FDI in pollution-intensive industries it expresses FDI in these industries as a share of total FDI. A second issue concerns the comparability of the fDiMarkets (2018) and the CAIT database. Unfortunately, both follow different classification schemes. While the CAIT database follows the IPCC (1996) classification the fDiMarkets (2018) uses the NAICS (2007) system. To make them comparable this study translated both classifications into the ISIC 4 (UN STATS, 2008) system. While extreme care was taken in this transformation errors might have occurred. However, the researcher triple-checked his translation and therefore believes the errors to be negligible.

Three further issues with the fDiMarkets (2018) database are worth mentioning. First, some of the FDI values are as stated above estimates made by the Financial Times researchers. Unfortunately, the econometric model underlying the estimation of the greenfield FDI values remains unknown to the public. But while the estimates are subject to error, it is unlikely that they deviate from the actual investments by large amounts. After all, the Financial Times is highly experienced in the field of international investments so that they can be trusted of delivering sensible estimates. Moreover, even if the estimates err it is likely that they deviate by similar amounts. After all, the same methodology is used in estimating them. The share of FDI in pollution-intensive industries to total FDI is therefore likely not much affected and can be used in this study. The second issue is that fDiMarkets (2018) tracks the announcements of FDI projects. Thereby some time might pass until they are implemented. While the empirical analysis accounts for such a delay, something could still happen and certain projects might be canceled. However, this issue is unlikely to occur on a large scale. After all, FDI projects go through a revision process before being included in the database. Thereby the in-house fDiMarkets (2018) researchers are expected to notice when firms do not follow-up on their announced FDI on a large scale and consequentially remove the projects from the database. Third, the fDiMarkets (2018) database might miss some FDI projects even though they scan lots of resources. However, also this issue seems to be negligible given the large amounts of data reviewed. Thus, also the fDiMarkets (2018) database is reliable and appropriate to use.

4.3 The World Governance Indicators

4.3.1 Presenting the World Governance Indicators

As argued in the theoretical background is governance a multifaceted concept with no unique definition. Thus, multiple governance indicators (e.g. ICRG, Freedom House, Transparency International) exist with specific conceptions of governance. This study uses the WGI (2016) initiated by World Bank economists Daniel Kaufmann and Aart Kraay. They are published since 1996, unlike other indicators freely available for nearly all countries worldwide, and widely used (Kaufmann, Kraay & Mastruzzi, KKM, 2007c) e.g. by Assa (2017) and Bokpin (2017). Kaufmann, Kraay and Mastruzzi (KKM, 2007a, 2007b, 2007c & 2011) give a detailed overview of how the governance indicators are constructed. They begin by defining governance as comprising three topics: a) the process of selecting, monitoring and replacing governments, b) the capacity of governments to formulate and implement sound policies, and c) the extent to which citizens and state respect the institutions governing the social and economic interactions between them. For each category, the researchers develop two governance indicators. These include for a) voice / accountability and political stability, for b) government effectiveness and regulatory quality, and for c) the rule of law and control of corruption. By claiming that governance consists of these different components the authors avoid defining governance in an overly-laden way. Instead, each indicator needs to be defined separately. While this moves the issue of defining what governance constitutes one level lower, it allows researchers to focus on the part of governance most relevant to their study.

Importantly, each of the six indicators is perception-based and constructed from multiple underlying sources. The researchers collected over 300 survey-based indicators from over 30 various sources measuring how different interest groups (firms, households, rating agencies, non-governmental organizations, and public-sector bodies) perceive the quality of governance in specific countries. Next, each of the 300 indicators was assigned to the six corresponding governance measures. Then the researchers applied an unobserved-components model. This weighed its underlying sources to arrive at an overall governance measure. The idea behind this mathematically complex procedure is that each indicator reflects the true underlying governance quality plus noise. Through weighing the underlying sources the researchers remove the noise and keep the (presumably) accurate estimate of the quality of governance. This estimate is reported on a scale from -2.5 to +2.5 with higher values denoting a higher governance-score. Essentially, these values can be interpreted as standard deviations from the world average quality of governance, why by assumption is zero and unchanging over time. This method allows comparisons of governance across countries and over time (KKM, 2007b, 2007c & 2011).

Of the WGI´s (2016) six governance indicators this study uses the rule of law measure. This choice is motivated by the theoretical background. It does not use e.g. the regulatory quality indicator, which focusses mainly on trade, subsidies as well as monetary and tax policies. It might not be appropriate since it does not reflect the theoretical background and higher values might simply denote laxer environmental regulations. In contrast, the rule of law indicator measures the quality of the law and the contract as well as property rights enforcement through the authorities. While there is not enough space to review each underlying indicator, they measure common themes: a) the independence of and the confidence in the judiciary denoting whether fair trials are possible, b) to which extent court orders, contracts, (intellectual) property rights can and are protected and enforced, c) to which extent governance is based on rules and not pure will by the leaders, and d) the risk according to which governments cancel contracts, exercise arbitrary pressures on businesses, or expropriate property. It also includes indicators measuring the occurrences of violence and the extent to which property by individuals is protected (WGI, n.d.). While these latter aspects are not highly relevant to this study, the former ones are as they largely conform to how the rule of law was presented in the theoretical background. This justifies using the WGI´s (2016) rule of law indicator in this study.

4.3.2 Critical Issues with the World Governance Indicators

Three major criticisms against the WGI (2016) exist. First, Arndt and Oman (2006) question KKM´s (2007b & 2007c) claim that the WGI (2016) can be compared across countries and time for two reasons. By combining various data sources into an aggregated measure the WGI (2016) disregards potentially different underlying definitions of governance. Additionally, not all underlying indicators cover all countries and years. Thus, the estimated level of governance of a country depends partially on whether data is available. If new data are added the level of governance of countries could change even though it did not in reality. But KKM (2007c & 2011) test and report that the data availability does not influence the results much. Moreover, they reply that including various data sources with different definitions of governance is unproblematic. Relying on different sources is according to them precisely the strength of the WGI (2016) since it allows measuring governance across the world, which prior indicators did not achieve. The researchers furthermore claim that their unobserved components model extracts the common elements within the different definitions of governance across sources. Thereby their model arrives at a common definition of e.g. the rule of law, which can be compared across countries despite the different underlying sources. However, the downside is that one does not really know what this extracted definition refers to since it is the result of the unobserved components model. Thus, even though one might identify that one of the six indicators of governance needs to be improved, one does not automatically know how to achieve this because different indicators underlie each governance indicator itself. Policy makers therefore only know that the aggregate aspect of governance needs improvements. But knowing how to go about it is a different question. Second, critics argue that in contrast to their claim the WGI (2016) do not measure six different aspects of governance. For example, Langbein and Knack (2009) argue that each of the six indices measures similar things. KKM (2007c & 2011) admit that the different governance-dimensions are interrelated and that they influence each other. As such, high correlation between them should not be surprising. Nevertheless, the authors claim that they have taken extreme care in assigning the different governance-variables across the six indicators so that a difference between them exists.

Third, it is criticized that the WGI (2016) are perception-based. Thus, what is measured is not to which extent e.g. the rule of law is enforced objectively. Instead, the WGI (2016) indicate how the different interest groups mentioned above judge it to be enforced. But perceptions might be imprecise and flawed. Respondents might perceive the meaning of questions differently across countries due to their cultural background. Furthermore, respondents might be influenced by current economic events. As such the indicators do not measure governance itself but outcomes of economic processes. Also, once one organization publishes its assessment of governance for a country other organizations might simply copy it, which would violate the assumptions of the unobserved components model. Lastly, also the choice of the underlying survey-based indicators matters. If the WGI (2016) rely to excessively on business-friendly sources, good governance could simply mean business-friendly governance questioning the data´s representativeness. Overall, the estimates could therefore be biased (Glaeser et al., 2004; Arndt & Oman, 2006; Kurtz & Shrank, 2007)

KKM (2007c & 2011) defend the WGI (2016) against these criticisms. First, they argue that next to surveys of businesspeople the WGI (2016) also include data from non-commercial sources as well as international and non-governmental organizations. Thus, the WGI (2016) denote not simply business-friendly governance. Second, using different test the authors argue empirically that the WGI (2016) are not driven by prior economic performance and that studies finding such correlations are wrongly specified. Third, they find no evidence that the underlying indicators replicate each other´s results. Moreover, they try different weighing schemes between their sources leading to similar and thereby robust results. Also, they publish confidence intervals reflecting the uncertainty in creating the WGI (2016). Lastly, KKM (2007c & 2011) specifically endorse perception-based indicators. Here they refer to the difference between so-called objective and perception-based governance indicators. Objective governance indicators measure the extent to which formal rules and laws are de jure in place. For example, one could measure the de jure environmental stringency of a country by counting the number of environmental regulations. However, obtaining such a quantitative measure is extremely challenging. Moreover, even if it could be attained it is questionable whether it would fit the theoretical background of this study. While one could argue that such a measure on environmental stringency could measure the adherence of MNEs to the law, it likely could not be used to make claims about increasing technological spillovers between MNEs and domestic firms. But since these are important channels mitigating the environmental impact of FDI, an objective measure of governance would badly reflect the theoretical background. Additionally, KKM (2007c & 2011) point out that the de jure implementation of laws does not imply their empirical enforcement. In contrast to de jure measures perception-based indicators therefore aim at additionally measuring if rules are enforced. After all, only their enforcement impacts economic development. And since it is often not guaranteed in regions such as Sub-Saharan Africa (Hallward-Driemeier, Khun-Jush & Pritchett, 2010) a perception-based indicator of the rule of law seems the best choice for this study. Overall, as this section indicated can the criticisms against the WGI (2016) be sufficiently met. Thus, they should be viewed as reliable estimates of the quality of governance justifying their usage in this study.

4.4 Other Data Used as Controls

Furthermore, this study uses GDP growth based on constant GDP, the share of employment in industry (mining, manufacturing, construction, electricity, and gas generation), and the share of fossil fuels in total energy consumption as control variables. Their motivation to be included and postulated impact on GHG emissions growth is stated when discussing the econometric models in chapter 5. The data are obtained from the World Development Indicators by the World Bank (2018). Since they are used only as controls, a detailed critical assessment of these data is not given for space reasons. Overall, since these data are estimates rather than official measures similar problems as already discussed plague them. For example, GDP growth becomes distorted from not including non-market activities, wrongly estimating the contribution of different industries and especially services, and not accounting for the level of technological progress. Similarly, where data is not available extra- and interpolation from known GDP data points might yield misleading results. Data on the share of employment in industry is obtained from national statistics and surveys. Again, they are estimates and based on extra- or interpolation if no sufficient data was available. Since countries differ in their treatment of un- and self-employment they might not be fully comparable across countries. The share of fossil fuels in total energy consumption suffers from the same problems. It is measured by national statistics and harmonized by the IEA across countries but non-reporting by countries can bias the estimates (World Bank, 2018).

4.5 Constructing the Dataset

This discussion implies that the data employed in this study should be viewed as reliable estimates of their respective subject. Each database took extreme care in creating the indicators. By applying unified methodologies, they secure the comparability of data across countries and time. Additionally, the data are valid since they are estimates of the variables of interest of this study. Consequentially, this study used the different data sources to build its own dataset. Unfortunately, given that each indicator is available for different countries and years no complete coverage of Sub-Saharan Africa is possible. Complete data was only available for twelve countries (Angola, Botswana, Democratic Republic of the Congo, Ethiopia, Ghana, Kenya, Namibia, Nigeria, South Africa, Tanzania, Zambia, Zimbabwe) over ten years (2003-2012). The results of the study should therefore be regarded as being representative for these twelve countries. They are additionally somewhat representative for the southern part of Sub-Saharan Africa since most of these countries are found here. Moreover, as the database contains the important producers of natural resources (Deloitte, 2017) and major destinations for greenfield FDI as sketched in the introduction the results are also somewhat representative for the region overall. Additionally, the yearly coverage is representative by coinciding with most years of the recent Sub-Sahara African growth spurt as indicated in the introduction. But even though the data are thereby reliable, valid, and representative they remain estimates. As such, this study is cautious by claiming to derive only correlations but not causality.

5 Methods

To test the two hypotheses and deliver reliable results this study uses three econometric models based on pooled OLS, random, and fixed effects regressions as reviewed below. Since theory and statistical tests support the usage of the fixed effects model it is reviewed more extensively. Consequentially, the pooled OLS and random effects model serve as comparisons. Since they deliver similar results the findings are well-supported and robust. The discussion draws if not otherwise stated on Wooldridge (2009).

5.1 Pooled OLS

Formula A shows the econometric model underlying the pooled OLS approach.

$$(A)\ GHG\ Growth_i = ß_0 + ß_1 FDI_i + ß_2 FDI_i^2 + ß_3 Rule\ of\ Law_i + ß_4 FDI_i * Rule\ of\ Law_i + ß_5 GDP\ Growth_i + ß_6 Employment\ Industry_i + ß_7 Fossil\ Fuels_i + \varepsilon_i$$

The discussion regarding the anticipated signs of the coefficients is deferred to section 5.3 presenting the fixed effects model. Suffice to note that the pooled OLS approach treats each observation i as independent thereby disregarding the country and time dimensions of the dataset. Importantly, the pooled OLS model provides only consistent and unbiased estimates if the zero-conditional mean assumption is fulfilled, i.e. the distribution of the error term ε_i has a mean of zero conditional on the independent variables. Usually the error term captures omitted variables, which are correlated with the independent ones included in the model. For example, the quality of infrastructure could be one determinant of FDI. It could also be associated with lower GHG emissions growth since a better infrastructure is presumable more energy-efficient. The existence of such omitted variables violates the zero-conditional mean assumption. Thus, pooled OLS estimates are generally viewed as biased and inconsistent and therefore used only as comparisons in this study.

5.2 Random Effects

One way to account for unobserved variables is the random effects model:

$$(B)\ GHG\ Growth_{it} = ß_0 + ß_1 FDI_{it} + ß_2 FDI_{it}^2 + ß_3 Rule\ of\ Law_{it} + ß_4 FDI_{it} * Rule\ of\ Law_{it} + ß_5 GDP\ Growth_{it} + ß_6 Employment\ Industry_{it} + ß_7 Fossil\ Fuels_{it} + z_t + \varepsilon_{it}\ where\ \varepsilon_{it} = v_i + w_{it}$$

Again, the expected signs for each coefficient are motivated in section 5.3. Different to the pooled OLS model is that the random effects model considers the panel structure of the dataset. Thus, the subscripts i and t denote observations for country i in year t (i=12 and t=10). Additionally, year dummies (z_t) are included accounting for influences specific to one period but common across countries such as e.g. economic crises or sudden drops in demand. Crucially, the random effects model differs to the pooled OLS model in its assumptions about the error term ε_{it} by splitting it into two different parts. The term v_i represents all unobserved time-invariant factors while w_{it} measures the remaining influences changing over time. Comparable to the pooled OLS model is that for w_{it} the zero-conditional mean assumption holds. But the critical assumption in the random effects model is that also the unobserved time-invariant factors represented by v_i are independent and thus uncorrelated from other variables included in the model. If this holds the random effects model calculates an appropriate error structure for ε_{it}, which in contrast to the pooled OLS considers the influence of these unobserved variables. Intuitively, this is achieved by modeling the intercept for each country as being drawn randomly from an underlying population of countries. But the assumption that v_i is independent of its covariates is very strong. As argued above could e.g. the quality of infrastructure be one time-invariant omitted variable influencing GHG emissions growth (at least in the short-run the quality of infrastructure is likely constant). However, the quality of infrastructure is unlikely independent of FDI since a better infrastructure potentially attracts more FDI. The violation of this assumption leading to biased estimates therefore motivates the fixed effects model.

5.3 Fixed Effects

Formula C states the fixed effects model:

$$(C)\ GHG\ Growth_{it} = ß_0 + ß_1 FDI_{it} + ß_2 FDI_{it}^2 + ß_3 Rule\ of\ Law_{it} + ß_4 FDI_{it} * Rule\ of\ Law_{it} + ß_5 GDP\ Growth_{it} + ß_6 Employment\ Industry_{it} + ß_7 Fossil\ Fuels_{it} + z_t + \varepsilon_{it}\ where\ \varepsilon_{it} = v_i + w_{it}$$

Like the random effects model the fixed effects approach considers the panel-structure of the dataset (i=12 countries and t=10 years). The model estimates the growth rate of GHG emissions by regressing it on the value of the sectoral greenfield FDI inflow in the same year, its squared value to account for non-linearity, the quality of the rule of law, the interaction between FDI and the rule of law, and three other controls. According to hypothesis 1 should the coefficient $ß_1$ for FDI be positive because scale effects likely outweighed technological effects. The coefficient $ß_2$ is presumably negative since hypothesis 1 might hold to a decreasing extent for larger FDI values. According to section 2.2.2 can the coefficient $ß_3$ for the rule of law either be positive or negative. The coefficient for the interaction term ($ß_4$) should be negative according to hypothesis 2 since the association between a large share of pollution-intensive FDI and GHG emissions growth could hold to a lesser extent in countries with a higher quality of governance.

The model controls additionally for GDP growth, employment in industry, and the share of fossil fuels in total energy consumption. Previous studies motivated the inclusion of these control variables (e.g. Wang & Chen, 2014; Chang, 2015; Neequaye & Oladi, 2015; Assa, 2017; Bokpin, 2017; Zugravu-Soilita, 2017). GDP growth is used as a proxy for the economic development in general. It is included as e.g. more FDI could flow into countries when general economic development is good. Its coefficient $ß_5$ should be positive since a growing economy is likely associated with pollution increases at least in early stages of its development (Kaika & Zervas, 2013a). The share of employment in industry is used as a proxy to control for how large and thus important the industrial sector is across countries. Its coefficient $ß_6$ will likely be positive since increasing the pollution-intensive industrial sector should be accompanied by increased GHG emissions growth. Finally, the share of fossil fuel in total energy consumption is used as a proxy for how pollution-intensive a country generally is. Since fossil fuels are more pollution-intensive than other energy carriers their increased usage could have a positive effect on GHG emissions growth. Consequentially, $ß_7$ is expected to be positive. As argued above, hold these expectations also for the pooled OLS and random effects model. Again, year dummies (z_t) were included to account for common shocks across countries.

As in the random effects model, the fixed effects model also splits the error term ε_{it} into two parts. Again, v_i denotes unobserved time-invariant omitted variables while w_{it} captures time-varying unobserved variables. The zero-conditional mean assumption still holds for w_{it}. The main difference between the fixed and the random effects model is the assumption about v_i. Importantly, the fixed effects model allows for correlation between time-invariant unobserved and the independent variables. From the reasoning above it thereby comes closer to reality since it allows e.g. the unobserved quality of infrastructure to be correlated with FDI. The crux of the fixed effects model is that it controls for the influence of such time-invariant factors by removing them from the model. This is achieved through a within-transformation. It deducts the value of each observation from the mean value of the series. Mathematically, this yields the same result as including a dummy variable for each country. Thus, practically one can think of the fixed effects model estimating a specific intercept estimated for each i.

The downside of the fixed effects model is that it considers only this within-variation. By not fully removing the unobserved time-invariant variables the random effects model considers in contrast also the variation between countries. The Hausman test uses these two types of variation to derive a suggestion whether a random or fixed effects model should be applied. It tests the null-hypothesis that there are no fixed effects present (i.e. v_i is uncorrelated with its covariates). As such it estimates the random effects model under its assumptions and determines if the coefficients from the fixed effects model are statistically significantly different from it. If not, both estimators are assumed to be consistent but only the random effects estimator is additionally efficient since it considers the between-variation. Thus, it should be used. Conversely, if the null-hypothesis is rejected using the fixed effects estimator is recommended. It is unlike the random effects estimator assumed to be consistent even though both do not need to be efficient. In this study, the Hausman test recommends using the fixed effects model.

5.4 Limitations of the Approach

This section reviews the limitations of the approach concerning its specification, biased coefficients, the inclusion of control variables, and the calculation of the standard errors.

5.4.1 Limitations Regarding the Specification

Three econometric limitations concern the specification of the model and its controls. First, comparable to previous studies is that the research design does not allow for estimating the individual size of the scale or technology effects as well as denoting through which channels they occurred. But estimating the size of each effect individually is generally difficult as they are counterfactuals. Thus, like previous studies this one can only estimate the sum of the different effects and use theory to interpret these findings. Second, a threat to the model would be if GDP growth and the share of employment in industry remove the scale effect of FDI. This could happen since FDI impact the environment precisely through increasing economic activity increasing GDP growth and the industrial sector. Similarly, including the share of fossil fuels in energy consumption could to some extent remove the technological effect if the presence of more energy-efficient technology helps reducing the share of fossil fuels in energy consumption. However, including the control variables is necessary on theoretical grounds as argued above. Moreover, the previous research cited above used similar control variables and found no evidence that they removed the effects of interest. Also, it is important to remember that the control variables are estimates. As such, it is questionable if they practically reflect the scale and technology effects of FDI as they would in theory. Additionally, the scale and technology effects of FDI operate at least partially on a sectoral level where MNEs produce intermediate products or demand them from suppliers. These growth rates might be different and are not directly measured by the control variables. Therefore, it is unlikely that the control variables remove the effects of interest. Nevertheless, this econometric limitation is accounted for and further discussed in the results section. Third, since fDiMarkets (2018) tracks the time when a FDI project was announced it might take some time to implement (see also section 4.2.2). By not considering a lagged influence of FDI the model might miss these lagged effects. Thus, the study uses as robustness check a lagged version of the fixed effects model.

5.4.2 Endogeneity Issues

The resulting coefficients could however still be biased e.g. due endogeneity. It arises when the zero-conditional mean assumption does not hold e.g. due to omitted variables, simultaneity, and measurement errors (Wooldridge, 2009). Fortunately, the fixed approach controls for time-invariant omitted variables thereby removing large parts of the omitted variable bias as sketched above. But if time-varying omitted variables correlated with the independent ones exist the coefficients will still be biased. Such variables could be the general level of know-how and technology in a country, which are difficult to measure and thus not included. However, to the extent that they are roughly constant over the short time span their influence might at least partly be removed by the fixed effects. Thus, omitted variables are not much of a concern. Regarding the simultaneity bias it can be argued that GHG emissions growth and FDI are unlikely to be simultaneously determined. After all, it is questionable if GHG emissions growth leads to changes in FDI flows. Similarly, any influence from GHG emissions growth on the rule of law occurs likely only very slowly over time since e.g. citizens must first organize and lobby to strengthen it. However, measurement errors are likely to occur since the underlying data are essentially estimates as argued above. While in principle these endogeneity issues could be mitigated through an instrumental variables approach, good instruments are difficult to find while weak ones can instead increase the bias. Therefore, this study does not use instrumental variables but reinforces that the results should be interpreted as correlations rather than causality.

5.4.3 Limitations Regarding the Standard Errors

Furthermore, four limitations concerning the standard errors and thus implications for achieving statistical significance must be discussed. First, due to the small sample size of only 120 observations per variable the standard errors and confidence intervals will likely be larger than in large samples. Consequentially statistical significance is potentially not achieved. But finding statistically insignificant results is no drawback since they might be economically significant (McCloskey & Ziliak, 1996). Second, FDI and the rule of law might be determined simultaneously potentially leading to multicollinearity. After all, countries could according to the previously mentioned pollution haven hypothesis lower their quality of governance to attract potentially environmentally-harmful FDI (Araya, 2005; Assa, 2017; Cole, Elliott & Zhang, 2017). Conversely, a higher quality of governance could increase FDI since MNEs favor investing in countries where their FDI are presumably safe (Bénassy-Quéré, Coupet & Mayer, 2007; Buchanan, Le & Rishi, 2012). Additionally, the quality of governance might be determined through FDI when MNEs use their bargaining power to lobby for less stringent environmental regulations (Cole & Fredriksson, 2009). Fortunately, these interdependencies result only in multicollinearity potentially decreasing statistical significance but do not bias the coefficients.

Two further econometric issues not biasing the estimates but the standard errors are heteroscedasticity (the errors do not have a common variance) and autocorrelation (the error terms are correlated across time). After testing for both this study corrects for heteroscedasticity using Stata´s robust option in the pooled OLS context. However, similar corrections are more complex in a panel context. Unfortunately, accounting only for heteroscedasticity is not possible here as the resulting standard errors would be inconsistent (Stock & Watson, 2006). Solutions could be Newey-West standard errors correcting for heteroscedasticity and autocorrelation or Driscoll-Kraay standard errors, which consider additionally cross-sectional dependence. However, these modifications rely on large T-asymptotics, which are not given in this study. Moreover, they are somewhat difficult to implement with random as well as fixed effects models and Stata´s default Hausman test does not work on them (Hoechle, 2007; Baum, Nichols & Schaffer, 2011). This leaves the application of Stata´s robust-option also for the panel context. To not deliver inconsistent estimates as discussed above by Stock & Watson (2006) using Stata´s robust-option leads automatically to clustering at the country level in this situation. While this corrects the standard errors for autocorrelation and groupwise heteroscedasticity (the errors are homoscedastic within units but heteroskedastic across) clustering might yield downward-biased standard errors when using few clusters. In a balanced panel context, less than 20 clusters are considered few (Cameron & Miller, 2010). Since this study has 12 countries to cluster at the researcher faces a difficult choice. Either one clusters even though the standard errors might be biased or one does not account for heteroscedasticity and autocorrelation at all. Since in this study econometric tests indicated the presence of groupwise heteroscedasticity and autocorrelation, the researcher deemed it to be a safer choice to use clustering but interpret the standard errors cautiously than not accounting for heteroscedasticity and autocorrelation even though they are present.

6 Results

This section first discusses the descriptive statistics of the data and then states the results from the econometric models.

6.1 Descriptive Statistics

Table 2: Descriptive statistics (own calculations based on the cited sources).

Variable	Definition	N	Mean	SD	Min.	Max.	25% Quantile	Median	75% Quantile
GHG Emissions Growth	Growth Rate of GHG emissions in percent	120	3.518	5.509	-16.8	16.107	1.047	3.687	6.419
Share of Sectoral FDI	FDI in pollution-intensive industries as percentage of total FDI	120	82.184	21.394	0.344	100	74.872	89.452	97.487
Rule of Law	See World Governance Indicators	120	-0.631	0.747	-1.852	0.731	-1.267	-0.594	0.045
GDP Growth	GDP growth per year in percent	120	6.311	6.032	-17.669	33.736	4.505	6.236	8.358
Employment in Industry	The share of employment in industry in percent	120	13.818	8.948	3.3	38.9	7.8	11.55	14.95
Share of Fossil Fuels	Fossil fuel energy consumption in percent of total energy consumption	120	32.354	26.784	2.015	88.149	9.747	22.689	57.439

Table 2 states the descriptive statistics (see appendix B, figure 4 for a graphical representation). The yearly growth in GHG emissions is roughly normally distributed with a mean of 3.5 percent. Seven out of twelve countries noticed both positive and negative GHG emissions growth, which could partially be explained by differences in FDI inflows. The share of FDI in pollution-intensive industries is skewed to the right indicating that FDI in pollution-intensive industries played the largest role in Sub-Saharan Africa. After all, only 25 percent of the observations had a share of FDI in pollution-intensive industries lower than 75 percent. The mean value of the rule of law is -0.6. This reflects Sub-Saharan Africa´s low quality of governance since it is below the world average of zero. Even though Botswana, Ghana, Namibia, and South Africa had an above world average performance is the maximum value attained (0.7, Botswana in 2003) still far from the overall maximum score (+2.5) possible in the WGI (2016). The mean GDP growth rate of six percent reflects the recent Sub-Sahara African growth spurt. Few countries achieved especially high growth rates above eight percent with Nigeria in 2004 being the leader (34 percent). However, in some years GDP growth was also negative with Zimbabwe in 2008 being the extreme (minus 18 percent). Overall, the share of employment in industry was rather small (for 75 percent of the observations it is below 15 percent) reflecting Sub-Saharan Africa´s lacking structural transformation (Rodrik, 2016). The difference of 86 percentage points between the minimum and maximum value in the share of fossil fuels in total energy consumption signals that some countries in Sub-Saharan

Africa rely on fossil fuels much more than others. An inspection by country signaled that all variables vary sufficiently within countries across years so that they can be employed especially in the fixed effects model relying on the within-variation.

Table 3: Correlation coefficients between the variables of interest (own calculations).

	GHG Emissions Growth	Share of Sectoral FDI	Rule of Law	GDP Growth	Employment in Industry	Share of Fossil Fuels
GHG Emissions Growth	1.000					
Share of Sectoral FDI	-0.037	1.000				
Rule of Law	0.043	-0.109	1.000			
GDP Growth	0.424	-0.006	-0.053	1.000		
Employment in Industry	0.211	-0.083	0.082	0.106	1.000	
Share of Fossil Fuels	0.003	-0.074	0.655	-0.186	0.547	1.000

Table 3 states the correlation coefficients between each variable (see appendix B, figures 5 and 6 for a graphical representation). The first observation is that between the variables of interests (GHG emissions growth, FDI, rule of law) the correlation coefficients are overall low implying that no strong associations exist. Especially Zimbabwe seems to be an outlier in these relationships (appendix B, figure 6). Since outliers can be influential especially in small samples the analysis must account for them. GDP growth and GHG emissions growth are unsurprisingly strongly correlated suggesting that general economic development goes in hand with emission growth. Other large correlations are found only between the share of fossil fuels in energy consumption and the rule of law / share of employment in industry potentially leading to multicollinearity. The strong positive correlation between fossil fuels and the rule of law is somewhat surprising. The correlation matrix (appendix B, figure 5) suggests that it is due the data being split into two groups, i.e. one group of countries with a low quality of rule of law and share of fossil fuels and one group for which the opposite holds. Furthermore, Stata´s Levin-Lin-Chu unit root indicated that all series are stationary at the one percent significance level (for the share of fossil fuel in energy consumption p=0.048) and therefore likely do not lead to potentially spurious results.

6.2 Results

Table 4 at the end of this chapter states the regression results, which are interpreted in chapter 7. Specification 1 states the results from the pooled OLS model. The coefficients of interest ($ß_1, ß_2, ß_4$) are not statistically significant but have the anticipated signs supporting the hypotheses. While the coefficient for FDI ($ß_1$) in specification 1 is comparable in size to the subsequent specifications, the interaction term ($ß_4$) is small. However, by omitting time-invariant variables the pooled OLS estimates are likely biased as argued above. Especially the interaction term is almost ten times larger in the subsequent specifications suggesting that it is necessary to account for time-invariant factors. Thus, the pooled OLS results are only used for comparison.

To control for time-invariant unobserved factors the fixed effects model is estimated (specification 2). As all subsequent specifications, it includes year dummies since they are jointly statistically significant at the one percent level. Specification 2 is first calculated disregarding the robust standard errors mentioned in section 5.4.3. Since this does not affect the coefficients the results from this regression are not shown in table 4. However, estimating the model first without robust standard errors is useful for testing several properties of the residuals. First, the residuals are normally distributed according to both a graphical inspection (appendix C, figure 7) and the Jarque-Bera test (p=0.98, i.e. the null hypothesis of normality is not rejected) thereby satisfying one assumption of the classical linear regression model. Furthermore, the errors are not cross-sectional dependent since the null hypothesis of the Pesaran test of cross-sectional independence is not rejected (p=0.29). Thus, no further adjustments need to account for it. Also, the residual plot shows no problematic patterns indicating that a linear specification of the model seems appropriate (appendix C, figure 8). Only Zimbabwe seems to be an outlier again at least for certain observations, which must be accounted for in subsequent specifications. However, the modified Wald test suggests that groupwise heteroscedasticity is present since it rejects the null hypothesis of groupwise homoscedasticity at the one percent significance level. As discussed in section 5.4.3, this implies that the errors are homoscedastic within units but heteroscedastic across. Also, autocorrelation in the error term seems likely according to the Wooldrige test. Its null hypothesis of no autocorrelation is rejected at the one percent significance level. As argued above is clustering therefore the only feasible option accounting for both autocorrelation and groupwise heteroscedasticity. Thus, clustered standard errors are subsequently used and stated in specification 2. Its mean variance inflation factor is with 40 relatively high. However, it is driven by the rule of law (138) and the share of fossil fuels (116). Given their strong correlation (table 3) multicollinearity is no surprise. But it is not problematic since it inflates only the standard errors of the control variables and does not influence the variables of interest.

Crucially, specification 2 supports the two hypotheses. As $ß_1>0$ and $ß_4<0$ it can be concluded that increases in the share of pollution-intensive FDI are associated with increases in GHG emissions growth in Sub-Saharan Africa but to a lesser extent in countries with a higher quality of governance. For example, when the rule of law is insufficient (at a value of -2) / sufficient (at a value of +2) an increase in the share of FDI in pollution-intensive industries by one percentage point is associated with an increased GHG emissions growth of 0.12 / 0.06 percentage points respectively (e.g. when the rule of law equals -2 the calculation is 0.0894-2*0.000739--2*0.0159=0.12 where the second term represents the derivative of the squared FDI value). Figure 2 shows these changes in GHG emissions growth when FDI increases by one percentage point for different values of governance. To some extent this is a stretch since no country in the sample achieved a quality of governance of e.g. +2. But since the WGI´s (2016) scale runs from -2.5 to +2.5 this is an adequate comparison motivating where countries with good governance would stand. Moreover, figure 2 is informative as it reflects the changes in GHG emission growth also for governance levels in between.

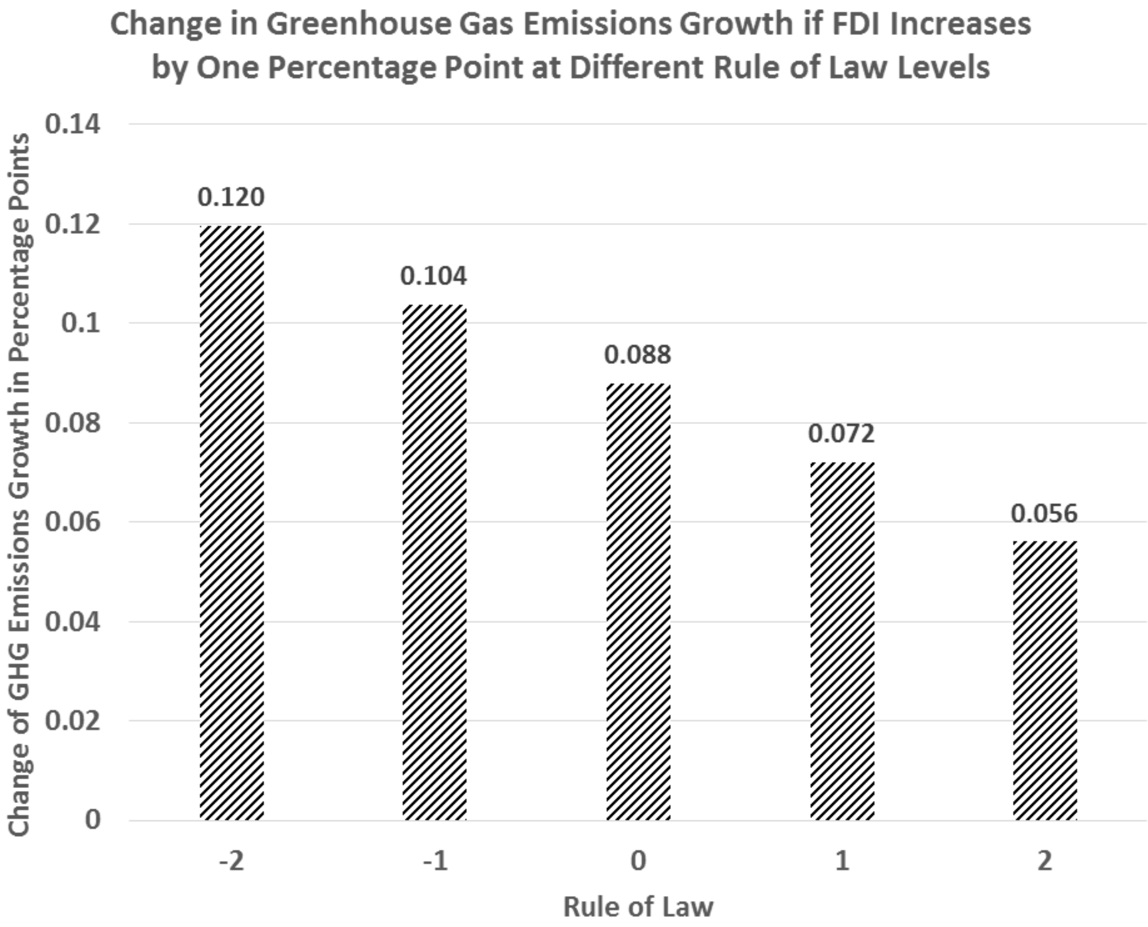

Figure 2: Visualization of the results (own calculations and representation).

The fact that the coefficients are not statistically significant should not be discouraging. After all, it is a small sample where statistical significance is often not achieved. But at least $ß_1$ and $ß_2$ are somewhat close to statistical significance with p-values of 0.12 and 0.18 respectively (the interaction term has a p-value of 0.6). However, these standard errors should not be over-interpreted since as argued above they might be downward biased when using few clusters. Instead, economic significance is often more important as previously suggested (McCloskey & Ziliak, 1996). And indeed, the results carry economic significance: From the calculations above one can conclude that the difference in GHG emissions growth rates between a relatively well-governed country (+2) and a country where the rule of law is insufficient (-2) when FDI increase by one percentage point is 0.06 percentage points. At the mean value of the share of FDI in pollution-intensive industries (82 percent) this association would translate into a difference of five percentage points (82*0.06) in GHG emissions growth between countries differing in governance. Given the long-term consequences of GHG emissions for global warming this difference is a large price to pay due to the presence of insufficient governance.

The coefficients of the control variables support also the expectations. Noteworthy is the coefficient $ß_3$ for the rule of law itself. Its positive sign suggests that the channels through which the rule of law leads to emission increases as posited in the theoretical background likely overweighed. However, not too much weight should be given to this conclusion as the coefficient is statistically insignificant (p=0.7). Its size is not troublesome since an increase in the rule of law by one unit represents a major improvement given the small range of the data. A one percentage point increase in GDP growth / the share of employment in industry / the share of fossil fuel in total energy consumption is associated with an increase of GHG emissions growth of 0.37 / 0.22 / 0.38 percentage points respectively. By the same standards as above have also these coefficients economic significance. Regarding statistical significance at the ten percent level only GDP growth is noteworthy. This serves as evidence that the general economic development is related to the development of environmental degradation as expected. But again, the standard errors must be cautiously interpreted due to the few clusters available.

Specification 3 depicts the random effects model as a comparison to the fixed effects model. Regarding its results, it suffices to say that the coefficients for FDI ($ß_1, ß_2$) decrease a bit while $ß_1$ is statistically significant at the ten percent level. The interaction term ($ß_4$) decreases in value denoting a lower association between good governance and benign FDI-related effects on the environment. The other coefficients are similar except for the share of fossil fuels in energy consumption, which unlike expected turned negative. Maybe this is due to multicollinearity issues as posited above or the small sample size. But since its coefficient is insignificant (p=0.52) not too much attention should be given to the result. The observation that the pooled OLS, random and fixed effects model deliver similar results strengthens the claim that the environmental impact of FDI was indeed lower in countries with a higher-quality rule of law even though the environmental degradation still increased. Nevertheless, the fixed effects model remains preferred since it is recommended by the Hausman test. Its null hypothesis suggesting the usage of the random effects model is rejected at the one percent significance level. The test was conducted using its robust-version in form of the xtoverid command since Stata´s traditional version is invalid when heteroscedasticity is present (Adkins et al., 2012).

Since the fixed effects model is recommended, the researcher conducted several robustness checks on specification 2. They are reported in specifications 4-9. The results strengthen the previous conclusions since excluding one or even all control variable(s) is not associated with noticeable changes in the coefficients of interest. Using a Wald test it is determined that no coefficient of interest ($ß_1, ß_2, ß_4$) is significantly different in specifications 4-9 from the ones obtained in specification 2 (the p-values of the test were above 0.28). Nevertheless, certain points are worth mentioning. When excluding GDP growth as a proxy of general economic development $ß_1$ becomes a little bit larger and statistically significant at the ten percent level (specification 4). As argued in section 5.4.2, this result could suggest that including GDP growth as a control potentially removed partially the induced scale-effect of FDI. However, this removal was likely not large since the study found with GDP growth included nevertheless a negative environmental impact of FDI. And since the scale effect is the only theoretical reasoning available for finding a negative environmental impact due FDI it is unlikely that including GDP growth completely removed it. A similar reasoning applies to specifications 5 and 6 when the other control variables are excluded. The observation that $ß_1$ is smaller in specification 6 when excluding the share of fossil fuels in energy consumption than in specification 2 can be explained by the negative / positive correlation between the share of fossil fuels and FDI / GHG emissions growth biasing the coefficient $ß_1$ downwards. When excluding all control variables (specification 7) $ß_1$ and $ß_2$ are of similar size to specification 5. However, the coefficient on the interaction term ($ß_4$) is somewhat lower suggesting that the controls were especially necessary to accurately estimate the interaction term. Moreover, the controls and especially GDP growth add in explanatory power since the within R-squared is much lower in specification 7.

According to the previous discussion might Zimbabwe be an outlier potentially driving the results. Thus, the country is excluded in specification 8. The coefficients of interest get larger suggesting that Zimbabwe biased them indeed somewhat downwards and $ß_1$ is statistically significant at the ten percent level. Specification 8 suggests that when the rule of law is -2 a one percentage point increase in FDI is associated with a 0.15 percentage point increase in GHG emissions growth. Similarly, when the rule of law is +2 this increase is only 0.06 percent. Since the difference between both values gets slightly larger, the benign impact of better governance on the environmental consequences of FDI becomes even more economically significant. Obtaining these results is sensible as Zimbabwe has an insufficient rule of law, high FDI in pollution-intensive industries but low GHG emissions growth (appendix B, figure 6). This unusual combination distinguishes Zimbabwe from other countries thereby slightly influencing the results.

Finally, the data review motivated that it might take time to implement FDI since fDiMarkets (2018) tracks the date of their announcement. Blanco, Gonzalez and Ruiz (2013) also accounted for potential lags. Specification 9 includes the FDI, rule of law, and interaction term with a lag of one year reflecting this presumed delay. Still, FDI has on its own a negative impact on the environment, which is larger than in specification 2. But the result is further away from statistical significance (for $ß_1$ / $ß_2$ the p-values are now 0.45 instead of 0.12 and 0.67 instead of 0.18). The interaction term is interestingly positive implying that increasing FDI is associated with larger increases of GHG emissions growth in countries with better governance vis-à-vis badly governed ones in the period after the investment was announced. Three possible explanations for this somewhat surprising result come to mind. First, maybe the problem with a lagged implementation of FDI does not exist and the model correctly delivers insignificant results (the p-value of $ß_4$ equals 0.4). Second, maybe FDI are more environmentally-benign in countries with a higher quality of governance but the model fails to detect this impact due the small sample size. Thereby the model has low power potentially leading to type II errors (not rejecting the null-hypothesis even if it should be rejected). Third, maybe $ß_4$ is also in reality positive but the sample size is too small to deliver a statistically significant result. A theoretically-oriented interpretation of this claim could be that unlike expected better governance encouraged maybe over time scale effects but not technological and regulation effects. As such, increasing the rule of law would have provided a more fruitful environment for conducting business, which was not associated with better regulations or a more stringent regulatory environment. However, these claims and observations have not yet been made in previous research. Thus, specification 9 can equally be viewed as simply delivering insignificant results implying that not accounting for lagged effects is unproblematic.

Table 4: The regression results from pooled OLS (OLS), fixed (FE) and random effects (RE) regressions (own calculations).

GHG Emissions Growth	(1) OLS	(2) FE	(3) RE	(4) FE excl. GDP	(5) FE excl. Employ.	(6) FE excl. Fossil.	(7) FE excl. Controls	(8) FE excl. Zimb.	(9) FE incl. Lag
Share of Sectoral FDI, β_1	0.101	**0.0894**	0.0771*	0.0971*	0.0927	0.0750	0.0879	0.107*	0.17
	(0.0745)	**(0.0531)**	(0.0458)	(0.0512)	(0.0564)	(0.0624)	(0.0549)	(0.0577)	(0.1493)
Share of Sectoral FDI Squared, β_2	-0.000832	**-0.000739**	-0.000600	-0.000732	-0.000776	-0.000558	-0.000621	-0.000924	-0.000591
	(0.000628)	**(0.000520)**	(0.000425)	(0.000501)	(0.000527)	(0.000569)	(0.000507)	(0.000568)	(0.0014)
Rule of Law, β_3	1.157	**2.592**	1.395	-1.961	1.750	3.014	-1.746	1.696	-3.710
	(3.314)	**(6.794)**	(3.032)	(8.118)	(6.780)	(7.684)	(8.505)	(7.072)	(6.561)
Interaction, β_4	-0.00164	**-0.0159**	-0.00624	-0.00636	-0.0126	-0.0130	-0.00340	-0.0209	0.0264
	(0.0356)	**(0.0297)**	(0.0328)	(0.0346)	(0.0313)	(0.0311)	(0.0347)	(0.0276)	(0.0303)
GDP Growth, β_5	0.348***	**0.368***	0.337**		0.362*	0.335*		0.0992	0.334
	(0.124)	**(0.186)**	(0.168)		(0.189)	(0.166)		(0.141)	(0.187)
Employment in Industry, β_6	0.158**	**0.216**	0.148	0.0565		0.269		0.217	0.309
	(0.0734)	**(0.361)**	(0.0923)	(0.381)		(0.298)		(0.421)	(0.475)
Share of Fossil Fuels, β_7	-0.0352	**0.380**	-0.0251	0.260	0.387*			0.380	0.383**
	(0.0278)	**(0.216)**	(0.0291)	(0.314)	(0.214)			(0.308)	(0.158)
Constant	-1.354	**-14.99***	-1.673	-10.91	-12.41*	-3.731	-1.880	-13.82	-21.77*
	(3.049)	**(7.287)**	(2.278)	(10.55)	(6.621)	(6.045)	(5.308)	(10.78)	(10.08)
Observations	120	**120**	120	120	120	120	120	110	108
(Within) R-Squared	0.225	**0.215**	0.172	0.085	0.212	0.179	0.067	0.127	0.235
Robust SE	Yes	**Yes**	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	**Yes**	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	**Yes**	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Countries	n.a.	**12**	12	12	12	12	12	11	12

Robust standard errors in parentheses

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

7 Discussion

This section discusses the results by relating them to previous research, interpreting them using the theoretical background, and indicating their relevance for development.

7.1 Comparing the Results with Previous Research

As stated in the literature review is the consensus of previous research that FDI in developing countries are generally associated with increased environmental degradation. This study supports this consensus as it finds that a larger share of pollution-intensive FDI is associated with increased growth of GHG emissions but to a lesser extent in well-governed Sub-Saharan African countries. Regarding previous research on Sub-Saharan Africa this study contributes by suggesting that additionally to affecting the environment locally (Assa, 2017; Bokpin, 2017) increasing pollution-intensive FDI is also associated with a global environmental impact on GHG emissions growth. Comparing the size of this study´s results with previous research is somewhat complicated since the environmental indicators, FDI data, and country as well as time coverage are different. Presumably closest to this study come Blaco, Gonzalez and Ruiz (2013) since they similarly analyzed pollution-intensive industries in Latin America. They estimated that a one standard deviation increase in FDI was associated with CO_2 emissions growth per capita by 0.96 percentage points in the next two periods (see chapter 2). When expressing the results from the main fixed-effects model (specification 2) in similar units, increasing FDI by one standard deviation is associated with an increase in GHG emissions growth of 2.6 / 1.2 percentage points in countries with an insufficient (-2) / a sufficient (+2) quality of governance.

Of course, comparing both studies is somewhat misleading since Blanco, Gonzalez and Ruiz (2013) used per capita CO_2 growth rates, expressed FDI as a share of GDP, considered only lagged effects, and did not take a governance-related perspective. Nevertheless, it is questionable if these differences in the research design can fully explain why especially in insufficiently-governed Sub-Saharan African countries the immediate environmental impact of FDI was much larger than in Latin America in the following two periods. After all, this difference (2.6 vs. 0.96 percentage points) cannot have been driven by country- and time-specific fixed effects since both studies accounted for them. Therefore, it is possible that to some extent the larger result obtained in this study is due to the usage of GHG emissions rather than CO_2 emissions growth and greenfield FDI rather than the traditional FDI data. First, to the extent that other types of GHG emissions grew faster than CO_2, studies considering only CO_2 emissions understate the total global environmental impact of FDI. Second, other non-greenfield types of FDI could have smoothed the variation across total yearly FDI inflows. Given both effects previous studies could have underestimated the association between FDI and its environmental impact. This supports the claim that subsequent research should use GHG instead of only CO_2 emissions and greenfield instead of traditional FDI data as they presumably allow for estimating more accurately the environmental impact of FDI.

7.2 Potential Explanations for the Results

While the study found support for its hypotheses the underlying mechanisms leading to the results must be explained. Unfortunately, as argued before is the limitation of the study that the econometric model can only suggest the existence of an association between higher FDI and increased GHG emissions growth. Since it does neither indicate causality nor the underlying reasons there is uncertainty when interpreting the results according to the theoretical background. Overall, an interpretation of the results using the theoretical background suggests that the scale effect through which greenfield FDI in pollution-intensive industries stipulated economic activity in Sub-Saharan Africa likely outweighed as anticipated the environmentally-friendly technological effect. Importantly, the technological effect comprises the implementation of more environmentally-friendly technology, their intentional spillover to domestic firms through e.g. licensing, and unintentional spillovers (e.g. workers move between firms or the environmental requirements by MNEs lead to a technological upgrading of domestic firms when supplying MNEs). Unfortunately, the study cannot state which of these channels was most important for the technological effects to occur as only the net difference between scale and technology effect is observed. But presumably, the arrival of foreign technology had the largest impact since the other technological effects depend on it. However, this should not discourage one from considering all three when seeking to improve the technological effects to decrease the environmental impact of FDI further. Overall, the interpretation that the scale effect outweighed the benign environmental influences from these channels makes sense as according to the theoretical background scale effects are especially large in pollution-intensive industries. Moreover, this result is in line with previous research as indicated in the literature review, which found that scale effects dominated in pollution-intensive industries and across developing countries.

Crucially, the association between higher FDI and larger environmental degradation seems to have held to a lesser extent in countries with better governance. According to the theoretical background this can be due to three reasons. First, the stronger the rule of law was implemented and enforced the more MNEs were presumably deterred from side-stepping it. Thereby e.g. cost-advantages resulting in higher pollution did not necessarily occur. Thus, the scale effects were likely lower in well-governed countries thereby outweighing the environmentally-benign technological effects to a lesser extent. Maybe it was additionally the case that in countries with a well-enforced rule of law the environmental regulations were also higher. However, this study lacks data to test this claim. But as KKM (2007; 2011) argued might this not be very important anyway since what matters is not primarily the stringency of regulations but rather their enforcement. And according to the results the rule of law seems to have been effective here.

Additionally, a higher-quality rule of law could have reduced the environmental impact of FDI through the two other channels discussed in the theoretical background. First, as a stronger rule of law likely secured competitive markets energy-inefficient firms could have been driven out leading to the survival of less-polluting firms and thereby lower environmental degradation. Second, a stronger rule of law likely improved technological spillovers. Among other things measures the rule of law how secure property rights are. As the theoretical background highlighted have MNEs a higher incentive to install new technologies when the property rights are secure since they can be sure that their equipment will not be expropriated e.g. by the state. Furthermore, secure property rights enable MNEs also to license their technologies to local firms since MNEs can be sure that their knowledge and technologies remain in safe hands and obtain legal help if local firms misuse them. Additionally, domestic firms in well-governed countries could have also had a better adaptive capacity of the new technologies since the rule of law similarly granted them their ownership if they acquired them. To the extent that these mechanisms occurred the technological effects would have been larger in well-governed countries so that the scale effect would not have overweighed by the same amount as it did in insufficiently-governed countries.

Even though causality cannot be established this interpretation of the results suggests that overall the rule of law was effective in shaping the environmental impact of FDI through these mechanisms. Of course, it would be desirable to know which of these channels was most effective. But unfortunately, the research design of this study cannot give a definite answer here. It can only suggest that some combination of them seemed to have occurred. Of course, it could be speculated that the channel through which the rule of law encouraged technological spillovers was to some extent more important than regulating MNEs since they have often their own environmental standards anyway (Araya, 2005). As such, they are expected to adhere to them irrespective of local regulations and oversight. But it is questionable if such speculations should be used for policy advice. Thus, the practical implication of the findings is rather the need for strengthening the rule of law overall in the region since then a more environmentally-friendly impact of FDI could become possible even though we do not know through which theoretically-posited channels this impact takes exactly place. Nevertheless, this insight is important as it is likely that Sub-Saharan governments want to rely on FDI in the future.

7.3 Improving the Rule of Law

Since a higher quality rule of law seems to mitigate the environmental impact of FDI according to the interpretation of the results pathways to improve it must be discussed. After all, even in well-governed countries was the environmental impact of FDI still negative. But highlighting pathways to improve the rule of law is again difficult for this study as the WGI (2016) used multiple underlying sources to construct the rule of law indicator. Since they measure different aspects of the rule of law and define it in different ways, the challenge for policy makers is to find out where exactly the rule of law needs improvements. For example, are more formal laws for securing property rights needed? Or are they already in place but need to be more strongly enforced? Or should the state try reducing the costs of MNEs to gather information about their business partners? All these mechanisms could facilitate e.g. the interaction between MNEs and domestic firms potentially leading to technological spillovers. But since the WGI (2016) only deliver an aggregate measure of governance based on these different underlying sources this study cannot identify concrete areas for improving governance. However, this does not need to be a drawback since searching for areas to improve governance is likely futile in the first place. The reason is that even if one could identify areas for improvement the institutional structures in developing countries are often deadlocked and large fixed costs are connected to institutional reform. Thus, the likelihood that institutional reform will be successful is low (Rodrik, 2008).

Considering these uncertainties, it might therefore be better to take a practical approach in improving the quality of governance. For example, improving technological spillovers could also be achieved through other ways than official institutional reform. So-far the discussion regarding the technological effects concerned the formal governance of contracts, which e.g. motivates MNEs to license their technologies to domestic firms. But according to Rodrik (2008) can at least in principle and conversely to what is currently thought the same technological dissipation be achieved through informal contracting. His argument is that for contracts and thereby property rights to be enforced courts are not necessary in the early stages of a country´s economic development. Instead, if sufficient trusts between firms exists contracts can be enforced even without having a formal legal system in place. Thus, to build this trust governments could instead of promoting formal aspects of governance focus on reducing e.g. the information cost firms face in finding and evaluating potential business partners. While this is no easy task, governments could e.g. create platforms where firms can find information about other firms and their reputation. This could improve trust-building between firms so that they potentially start working together irrespective of the formal governance structure in the country and a well-enforced rule of law. Potentially, also through these channels could technological spillovers subsequently occur. Importantly, for a successful technological dissipation governments must secure that MNEs have access to these networks. This is necessary so that especially greenfield FDI lead to technological spillovers. After all, MNEs might not have strong ties to the domestic economy upon entering the country as outlined in section 2.1.2. Since Rodrik (2008) observes that informal contracting has not yet properly worked in Sub-Saharan Africa much room for immediate improvements in governance and research on how to conduct them exists.

8 Conclusion

This section summarizes the study and indicates areas for further research.

8.1 Research Aims and Findings

Traditionally, FDI-related research focused on the question whether FDI promote economic growth. Thereby it neglected the side-effects of FDI such as potentially increased environmental degradation. An important recent recipient of FDI was Sub-Saharan Africa. Here FDI occurred especially in pollution-intensive industries including e.g. the extraction of natural resources, mining, and manufacturing. Consequentially, this study aimed at determining the impact of these FDI flows on the growth of GHG emissions conditional on the quality of governance. In doing so its objective was to contribute to the literature in manifold ways. First, the study focused on pollution-intensive industries. Thereby it could estimate the environmental impact where it is likely largest since the estimates are not mitigated by developments in less-pollution intensive industries. Also, the study used with GHG emissions a more comprehensive measure of global environmental degradation. Additionally, it is the first study considering greenfield FDI. Thereby it considered the type of FDI that matters most for an environmental impact. Ultimately, the motivation of this study to analyze GHG emissions and greenfield FDI in pollution-intensive industries was to deliver a more accurate estimation of how FDI impact environmental degradation. Thereby it hoped to establish these more accurate data in the research field. Related to this was the consideration of governance, which as this study motivated should be included in subsequent research.

To test the hypotheses that 1) FDI are related with increased environmental degradation but 2) to a lesser extent so in better governed countries this the study build a panel dataset of greenfield FDI in pollution-intensive industries for twelve Sub-Saharan African countries between 2003 and 2012. The hypotheses were tested using different econometric specifications with the fixed effects model being the most supported one. Since all specifications point in similar directions the study finds support for its hypotheses. Crucially, they carry economic significance. It was estimated that the growth of GHG emissions would have been lower by five percentage points in a country with a mean FDI inflow where the rule of law is well enforced (+2) compared to a country where the governance score is low (-2). While no country in Sub-Saharan Africa obtained either value, looking at the extremes strengthens the claim that good governance matters. After all, economic development is a desirable goal for an underdeveloped region such as Sub-Saharan Africa but should not come at the cost of massive environmental degradation. Consequentially, this study discussed several pathways to institutional reform aiming at decreasing the environmental impact of FDI further.

8.2 Limitations and Future Research

Overall, the discussion in chapter 7 indicated that the study met its objectives. Crucially, the study highlighted the importance of considering greenfield FDI, GHG emissions, and the role of governance. Together they seem to yield the most accurate estimates of the environmental impact of FDI, which in this study was somewhat larger than established by previous research. However, ample room for further research remains. Empirically, future research could create more comparable greenfield FDI data across time. As indicated in chapter 5 are greenfield FDI until now only available in nominal values so that they had to be expressed in percentages of total FDI in this study. Research would greatly benefit if indices to deflate them into real values are developed. These data could then be used to re-run previous research using traditional FDI data to check if their environmental impact gets larger. Also, they could be used to test whether the environmental degradation of FDI depends on their source country. As stated in the introduction came FDI from various but overall developed countries. Potentially, firms have different technological levels across these countries leading to a different environmental impact in Sub-Saharan Africa. Subsequent research could test these ideas.

Additionally, subsequent research can focus more on the role of governance and estimating the different channels through which FDI affected the environment. After all, this study highlighted their relevance but could neither estimate them in size nor deliver causal results. Thus, while this study had to rely on theory to explain its findings, subsequent research could aim at determining their underlying causality. Thereby subsequent research can try to determine 1) the size of scale and technological effects, 2) through which channels technological effects occurred most, and 3) how governance exactly mitigated the environmental impact of FDI. Arguably, these questions could be better answered through case-study research since the effects get easily conflated when using aggregate data as in this study. But by using case-study approaches researchers could accompany FDI projects, analyze to what extent they cause scale effects, how beneficial new technologies really are for the environment, if the rule of law is successful in deterring MNEs from side-stepping regulations, and how and to what extent technology spreads between MNEs and domestic firms when the rule of law improves. Of course, this type of research cannot be done on a large scale comparable to this study, which tracked FDI projects across multiple countries and years. However, even by analyzing few cases fruitful policy recommendations going beyond the ones given in this study could be achieved. These could potentially strengthen the proposed ways through which governance should be improved as outlined in the discussion section. Thereby subsequent research can help in establishing further the concept of governance in FDI-related research. In these studies, researchers can also test whether the results are robust to using other aspects of the good governance approach. While this study used the rule of law indicator other parts of the good governance approach might be relevant for determining the environmental impact of FDI as well. However, these are still absent from the theoretical literature as the theoretical background highlighted. Thus, much work remains for the future.

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Appendix A: Sub-Saharan Africa

Figure 3: A map of Sub-Saharan Africa (dark grey area) as defined by different bodies of the United Nations. Sudan is of a lighter dark grey since it is classified as North Africa by the United Nations Statistics Division (Wikipedia, 2018, own coloring).

Appendix B: Graphical Descriptive Statistics

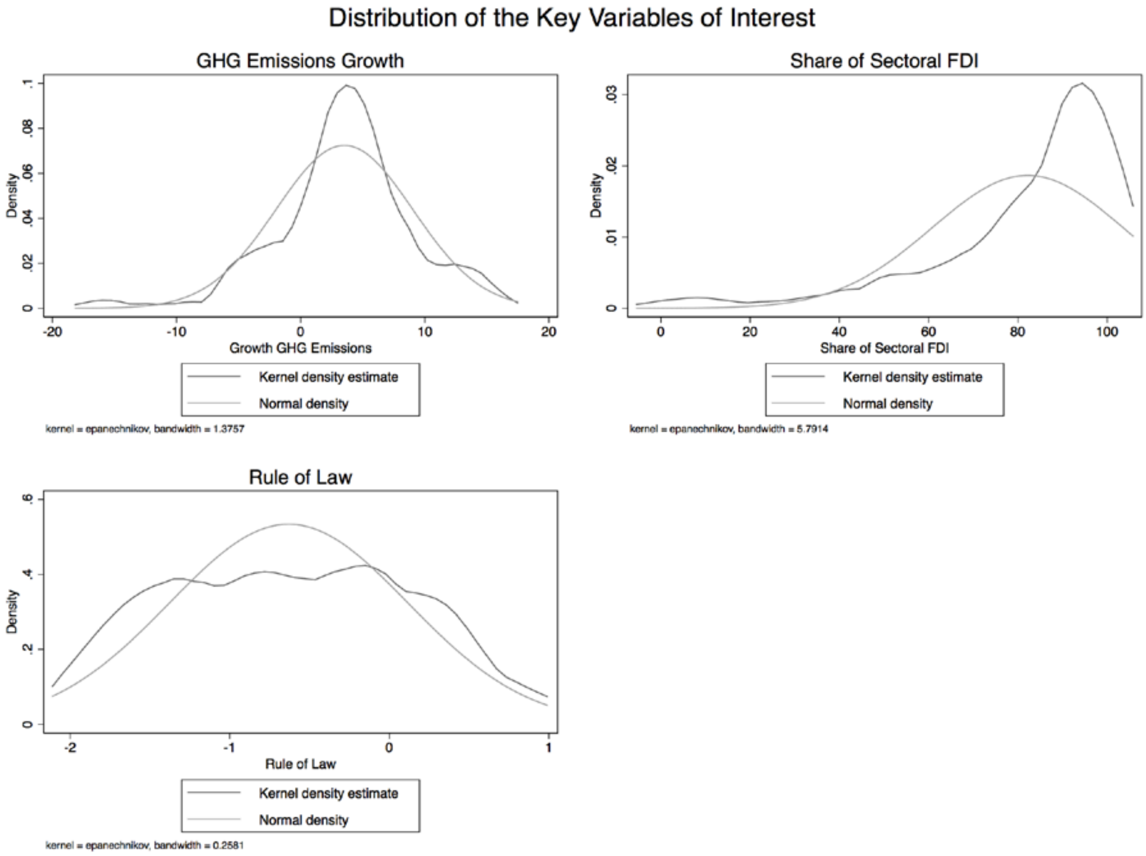

Figure 4: Graphical representation of the distribution of the key variables of interest with an overlay of the normal distribution (own representation).

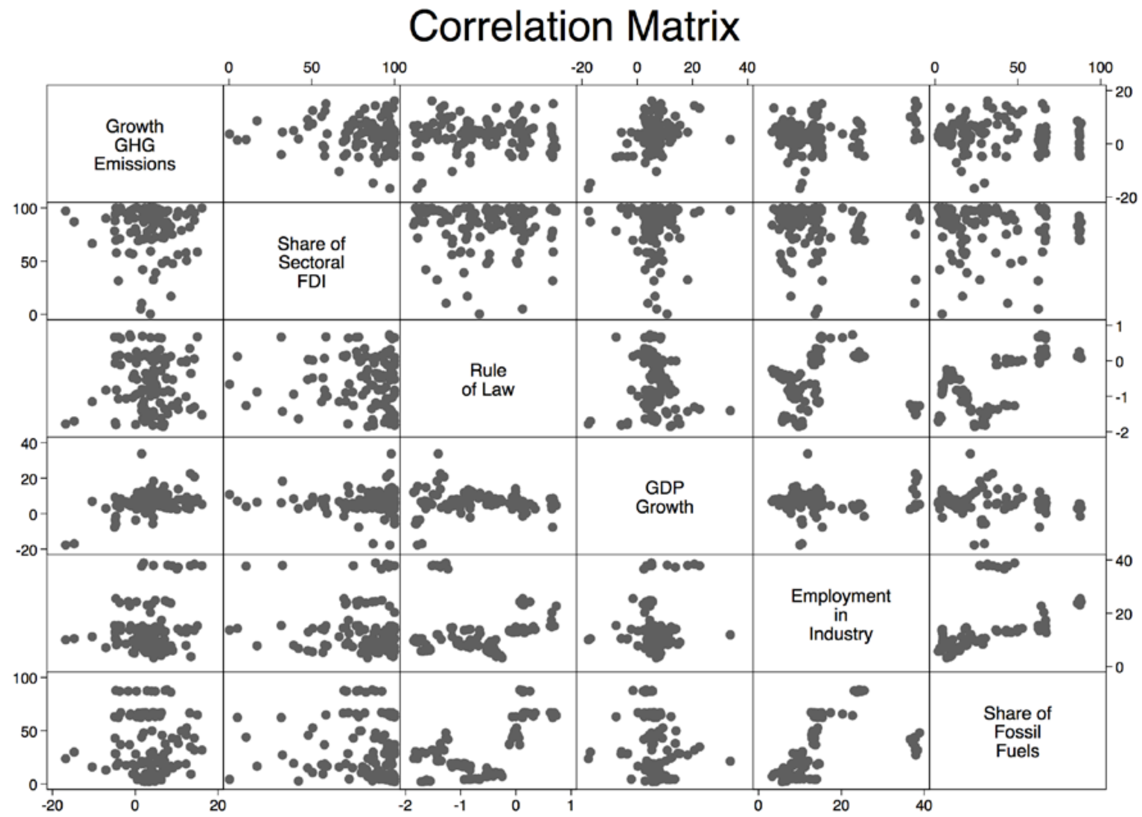

Figure 5: Graphical representation of the correlations between the variables (own representation).

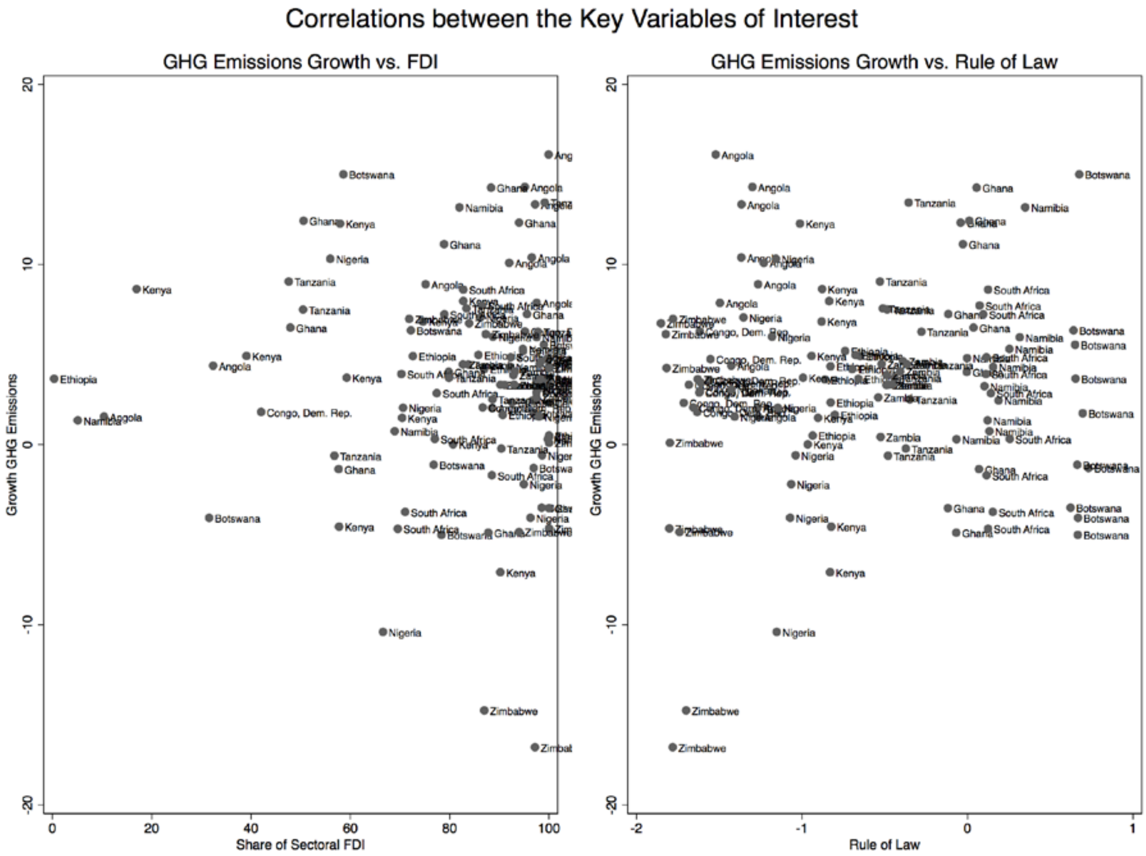

Figure 6: A graphical representation of the correlation between the key variables of interest including the name of the country of the observation (own representation).

Appendix C: Residual Diagnostics

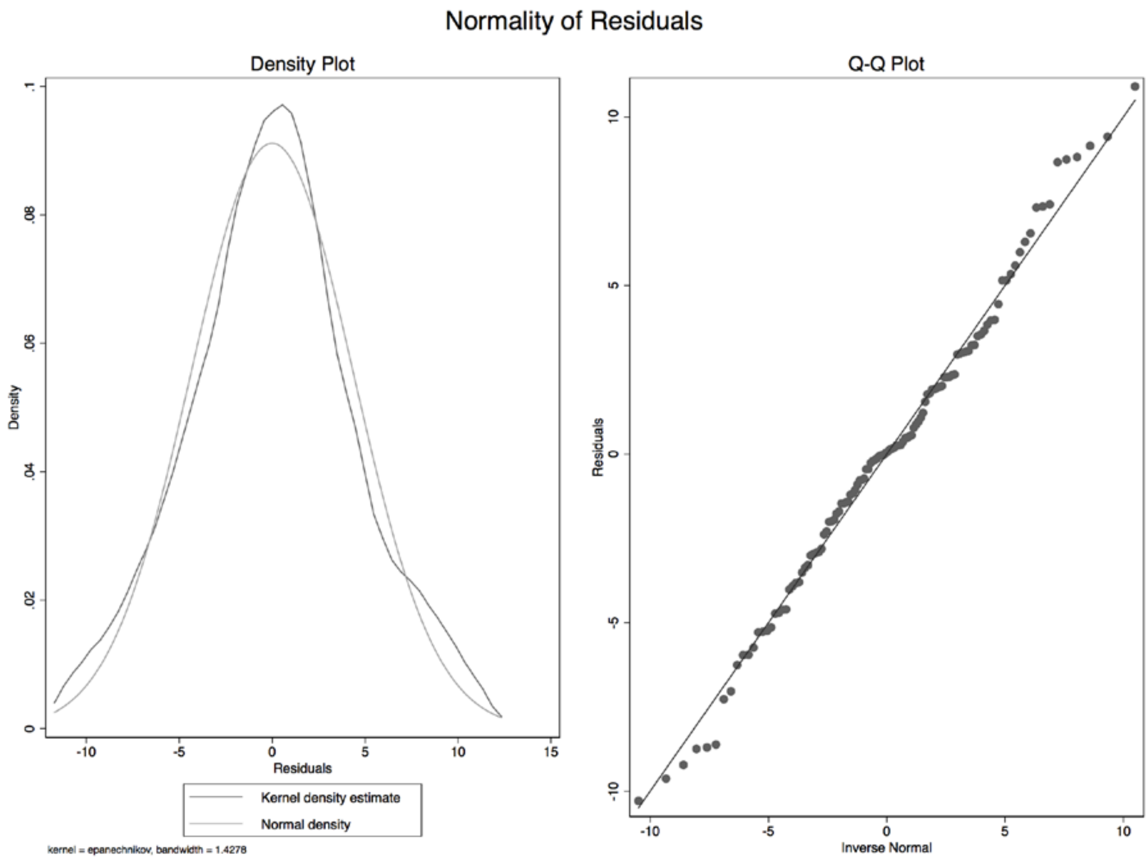

Figure 7: The diagnostics of the residuals reveal that they are roughly normally distributed.

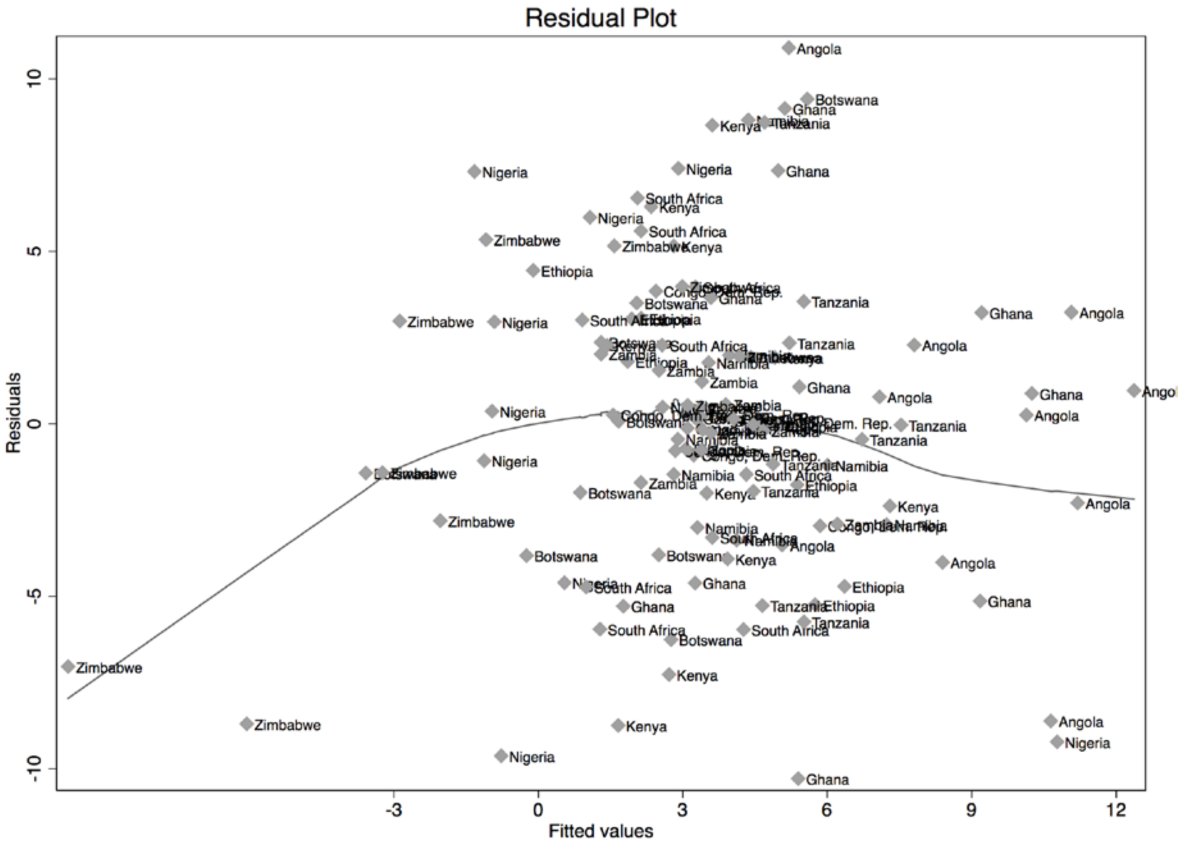

Figure 8: Residual plot of specification 2 with a fitted lowess line indicating how equally the residuals are spread around zero (own calculation).