

# **The Effects of FDI on Renewable Energy Consumption**

- a study of the effects of foreign investments in middle-income countries



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## **Abstract**

Today, the discussion regarding the environmental degradation is more active and pressing than ever. In Paris 2015, world leaders signed Agenda 2030, binding them to actively work to keep the global temperature increase below 2 degrees Celsius. This agreement also targets the need for sustainable energy for all humans. The purpose of this paper is to evaluate whether FDI has an effect on the consumption of renewable energy in middle-income countries, with the theory of technology diffusion and pollution havens as a backdrop. To present this research, yearly data on 56 middle-income countries from 1990-2010 have been collected. We use a f panel data model with fixed effects to conduct our regressions. We find that FDI is negatively correlated with the share of renewable energy, but as the negative effect is not all that large, we carefully suggest that technology diffusion takes time. FDI may decrease the share of renewable energy in the present, but could potentially lead to an increase in the future. However, we conclude that more research in the field of Environmental Economics is needed.

**Keywords:** *FDI, middle-income countries, renewable energy, technology diffusion, pollution havens*

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# List of abbreviations

EKC - the Environmental Kuznets Curve

FDI - Foreign Direct Investments

GDP - Gross Domestic Product

IEA - International Energy Agency

IMF - International Monetary Fund

LDC - Least Developed Countries

LMIC - Lower-Middle Income Country

MNC - Multinational Corporations

PHH - Pollution Haven Hypothesis

R&D - Research & Development

SDG7 - Sustainable Development Goal 7

UMIC - Upper-Middle Income Country

USD - US dollars

WB - the World Bank

# 1. Introduction

In the current era of hyper-globalisation, multinational companies are able to trade with and expand across the entire globe (Ravenhill, 2014, p. 3). The effects of foreign investments have been widely researched, and conclusions on several potential outcomes have been reached. Theory suggests that MNCs' investments in other countries can be beneficial for the host country, due to positive externalities stemming from the investments. These include technological diffusion, transfer of human capital, and an overall increase in the output level of the host economy (Lee, 2013, p. 483). But, the opposing view argues that FDI can be a way of outsourcing "dirty industries" to less-developed countries, due to softer environmental regulations, thus leading to the creation of pollution havens.

FDI from developed to less-developed countries is a catalyst for productivity improvements and enhanced output levels in the host economy, allowing the local industry to reinvest its profits into the industry. A more vibrant economy will have to use more energy to keep up with the higher level of production, as well as people's increasing demand for energy following the increased income level (Sadorsky, 2010, p. 2528).

As per capita income increases, and population growth continues to increase in India, Sub-Saharan Africa and other parts of the developing world, more and more people will demand energy to secure their well-being and will depend on reliable energy sources to build a strong and productive economic foundation. To cope with the rise in energy demand together with the environmental issues of today, a change of energy usage is required. Finding ways to increase the usage of more sustainable and clean energy, known as *renewable energy*, is therefore of importance.

With this paper, our aim is to study if FDI inflows in middle-income countries influence the consumption of renewable energy and what this effect might be. A positive effect could signal that FDI allows for technology diffusion of sustainable production, thus easing the global pressure of the increase in energy demand. On the other hand, a negative effect raises the question of whether middle-income countries are acting as pollution havens for high-income investors.

We have chosen to research the effects in middle-income countries, as the theory of technology diffusion suggests that the host country must have reached a certain point of development for diffusion to be successful. Least Developed Countries (LDCs) have not reached the level of industrialisation to be capital-intensive enough to attract this type of FDI (Cole and Elliot, 2005, p. 535), indicating that if we want to find an effect of FDI, we must study countries with higher income than the level in LDCs. As middle-income countries are growing rapidly and will account for an increasing share of the global consumption of energy, we find it appealing to study the following question:

*Does FDI affect the use of renewable energy in middle-income countries? And if so, how?*

With the large increase in FDI since the 1990s (WB, 2017) this area has gained a lot of academic attention. Extensive research has been conducted on the impact of FDI on economic growth and emissions but, to our knowledge, quite few have examined the relationship between FDI and clean energy consumption. This is why we believe that this is an important question to study further and why our study might give new insights for policymakers to consider while debating FDI.

In our study, we have used panel data over 56 middle-income countries. To obtain our results we perform panel data regression with fixed effects. We divide the countries into two groups, upper- or lower-middle income, to test if there are any differences between the two categories. Our results show that FDI is negatively correlated with the share of renewable energy in middle-income countries, indicating that there is some support for the pollution haven hypothesis. To account for the fact that FDI may have a less negative effect in the long run, a lagged variable of FDI inflows is added to the model, which then shows that the negative relationship decreases slightly. This could be an indication that technology diffusion is in fact present, but at a slow rate.

This essay begins with providing a background to the concepts of renewable energy and FDI. Section 3 discusses two possible results of FDI inflows, namely technology diffusion and pollution havens and then continues with a review of previous literature on the subject. Section 4 defines the empirical model, the variables used and the econometric process and issues that have been encountered. In section 5 our results are presented and in section 6 we provide an analysis of the results. Finally, section 7 consists of a few closing remarks and

concludes with possible future research suggestions within this field.

## 2. Background

### 2.1. The rise of renewable energy

To this day, coal is still the largest provider of energy, accounting for approximately 40 % of the world's electricity, and almost the same share of global carbon emissions. Coal is vastly inefficient, with low mass-to-energy ratio, as well as an enormous polluter, making coal neither efficient nor sustainable (Wu, 2015). Diverting economies from the use of coal (and other non-renewable resources) as their primary source of energy is essential. Coal is a prime example of a negative externality, looking at the heavy costs it imposes on societies, both through air pollution and physical stress (Nijhuis, 2014). Together with crude oil, natural gases and nuclear energy, coal is labelled as a non-renewable energy source (IEA, 2016).

According to the International Energy Agency (IEA), world primary energy demand is expected to grow at an annual rate of 1.8 % between 2005 and 2030. In total, emerging countries will contribute with 74 % of the total increase, and as more than 60 % of the world's greenhouse gas emissions come from the energy sector, this further proves the importance of finding a sustainable solution to the increased energy demand (Sadorsky, 2010, p. 2528). Renewable sources of energy entail *biofuel, biomass, geothermal, hydropower, solar, tidal, wave and wind power* (IEA, 2010, p. 276). However, for many emerging economies renewables are not cost competitive under current market structures, but are depending on various subsidies and policies (IEA, 2010, p. 278).

On the 25th of September 2015, the United Nations General Assembly adopted the 2030-agenda, *Transforming Our World: the 2030 Agenda for Sustainable Development*, where goal number 7 is to “Ensure Access to Affordable, Reliable, Sustainable and Modern Energy for All”. The 2030-agenda recognises the need for a prompt increase in renewable energy consumption, as air pollution has grown to become a major public health crisis, and the world's fourth-largest threat to human health<sup>1</sup> (IEA, 2016, p. 1).

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<sup>1</sup> Following high blood pressure, dietary risks and smoking (IEA, 2016, p. 1)

Emission levels of major pollutants (e.g. OECD countries) are falling, mainly because energy demand is decreasing due to an increase of low-carbon alternatives and the introduction of stringent combustion-control regulations. In non-OECD countries, various results have been shown (IEA, 2016, p. 2).

## **2.2. Foreign direct investments**

FDI has been defined as “an investment in which the objective of a resident in one economy is to obtain a lasting interest in an enterprise in another economy”. This lasting interest proposes that there is a long-term relationship between the investor and the company, which in turn implies that the investor will have significant influence over the local firm. To be categorised as a direct investment, the investor must acquire 10 % or more of the shares or voting power of the foreign company (IMF, 2003, p. 2).

The role of FDI has seen a large increase during the past four decades. In 1975, the total amount of FDI inflows in the world economy was \$23 billion, which can be compared to \$2.14 trillion in 2015, both in current USD. As a share of GDP, FDI has risen from 0.5% in 1975 to 2.8% (2015), which indicates that FDI has increased at a much faster pace than the economy in general (WB, 2017), and between 1998-2000 the global inflows of FDI increased by nearly 50 %. The curious reader can find a graph displaying this development in the appendix. The IMF explained this large increase as an effect of globalisation. Globalisation has allowed for international integration of capital markets and large cross-border mergers and acquisitions (M&A), spiking up net FDI inflow (IMF, 2003, p. 3).

## **3. Theories on the impact of FDI**

Previous research has failed to establish whether there is a positive or negative relationship between the consumption of renewable energy and inflow of foreign capital. This paper will therefore review two potential outcomes. Either, technology diffusion into middle-income countries is successful, causing FDI to have a positive impact on renewable energy consumption, or FDI leads to a decrease in renewable energy, where we explore the potential existence of pollution havens. The two concepts will be described below.



### 3.1. Technology diffusion

As this paper aims to research if FDI has an effect on the consumption of renewable energy (as well as the development of green production processes), it will focus on one of the most prominent factors of local technological and productivity development - technology diffusion (Ferrier et al., 2016, p. 5). The World Bank (2008) has recognised that technology diffusion in developing countries has been a pillar stone in the economic and technological improvements of these economies, and that FDI has been a driving force in this process (p. 3-4). Therefore we aim to research if this is the case for “green diffusion”.

FDI generally flows from countries where industries tend to uphold high environmental standards, due to strict environmental regulations. These firms are, to a larger extent, devoted to or influenced by the use of clean and efficient energy in their production. Foreign companies can thus fuel an improvement in energy-efficiency in the host economy, as domestic industries can copy the energy-saving production that foreign investments transfer from their home countries. In this context, FDI can improve local environmental performance and raise local environmental standards through the transfer of cleaner technology and better management practices, which in turn leads to a decline in the usage of non-renewable energy (Mabey et al., 2003, p. 7).

Technology diffusion can be described as the “dynamic consequence of adoption” of new technology and is characterised by the accumulation of technology across borders/adopters and over time (Comin and Mestieri, 2013, p. 3). Earlier work has established that FDI is an important channel for technology diffusion and an economically beneficial factor for the host economy. There are several reasons to how foreign capital can drive this change. First, through spillover of know-how, human capital is accumulated in the host economy, i.e. skills acquisition, improving the industry’s productivity level. Secondly, MNCs bring new production, ideas and technology into the host economy, interrupting existing monopolistic structures and equilibriums, therefore pushing existing industries to improve their productivity level, enhancing competition. The spillover effects from FDI also enhance efficiency by “breaking bottlenecks to investments<sup>2</sup>”, allowing for faster industrial development (Lee et al., 2011, p. 3).

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<sup>2</sup> a bottleneck is a major hurdle slowing down an investment process, and could be anything from lack of infrastructure to slow bureaucratic processes due to corruption or the like (Vyas, 2015, p. 27-28)

For successful technology transfer to the host country to take place, the transfer must be locally suitable, with a framework that can be understood by the local population, allowing people to replicate and implement the new technology. This technology transfer is referred to as horizontal transfer<sup>3</sup>, which is characterised by a long-term process of implanting technology within the local economy (Wilkins, 2002, p. 43-44). It seems as if though diffusion is most successful if the host country is at the same technological level (or slightly below) as the foreign company. This has been confirmed while investigating technological diffusion from US investments into LDCs, where it has been concluded that there is no significant diffusion (Xu, 2000, p. 479).

When studying technology diffusion in the host economy, the literature distinguishes between direct and indirect diffusion. Either technology transpires directly through market transactions or indirectly, due to spillovers. The spillover effect is believed to be the stronger of the two, where FDI is serving as a channel for this effect (Ferrier et al., 2016, p. 295-296). In this essay we will therefore examine how FDI serves as a driving force of technology diffusion (“green diffusion”) in middle-income countries by studying the *spillover effect*.

### **3.2. Pollution havens**

The other possible outcome of foreign capital is that FDI in fact does not have a positive impact on the consumption of renewable energy in middle-income countries. This section will present the pollution haven hypothesis (PHH), suggesting that FDI is a channel of outsourcing industries using “dirty” energy to countries with less-functioning environmental regulations (Cole, 2004, p. 73).

The pollution haven hypothesis was created as a counterargument to the Environmental Kuznets Curve (EKC). The EKC, a model used in Development Economics, is built upon the hypothesis that an economy’s pollution level follows an inverted an inverted U-curve, where the poorest and the richest economies emits the least and the industrialising countries the

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<sup>3</sup> the opposite process is called vertical technological transfer, where an MNC sets up its factory in a developing country due to low production costs, which is then fully owned and operated by the MNC. The management and technical staff are employees at the MNC, while the work force while be provided by local, cheap labour (Wilkins, 2002).

most. With increased income follows structural change and increased environmental regulations, causing the curve to reach a turning point, from which the pollution level declines after having reached its “peak” (Suri and Chapman, 1998, p. 195).

The PHH argues that this is in fact not the entire truth, but explains how differences in environmental regulations in developed and developing countries can lead to the deployment of pollution intensive industries. This hypothesis evolved as a criticism to the assumptions behind the EKC and asserts that the reason the U-curve is inverted is that, at a certain income level, the country can export pollution intensive industries, thus “pushing” the issue to a less developed country. The less developed country will then see an increase in income (due to an increase in capital inflow), but also an increase in pollution, due to increased energy demand (Cole, 2004, p. 73).

Countries that are more probable to become pollution havens are capital intensive, thus attracting MNCs with capital-intensive industries. In the host country, capital is cheaper, thus most cost efficient, but capital-intensive industries are also, per definition, more pollution intensive (Cole and Elliot, 2005, p. 531). LDCs have not reached a level of industrialisation to be capital-intensive enough to attract this type of FDI (ibid, p. 535), as is why this paper will look at the effect in middle-income countries. This group has come further in their industrialising process, and some of them are large, growing economies (i.e. Brazil and India).

Empirically, the existence of pollution havens has been studied by looking at changes in trade and investment patterns resulting from tightened environmental regulations. Lucas et al. (1992) saw that the largest growth in pollution intensity in developing countries occurred when the OECD strengthened its environmental regulations. This has also been demonstrated by Birdsall and Wheeler (1993).

### **3.3. Previous research**

With the theoretical framework on FDI, technology diffusion and pollution havens as a springboard, the succeeding step will be to investigate what has been written and concluded in the past. Naturally, the effects of FDI are not identical in every country, which is why many studies categorise countries into different income groups to differentiate the effects

(e.g. North, South, Developing countries, East Asia, OECD, G20, etc.) (Lee et al., 2011, p. 2-4).

Previous literature has, in large, focused on the economic and financial effects of FDI, but more recently the environmental impact of FDI has been accounted for as well. Researchers have begun to consider negative externalities in the form of environmental degradation, e.g. measured as the levels of emission stemming from the investment.

Doytch and Narayan (2016) studied the environmental outcomes of FDI inflows and suggested that there is empirical support for the *FDI halo effect*, i.e. the assumption that foreign capital brings improved local environmental performance, due to “green spillovers”. The halo effect brings down the cost of production, making the local firms more internationally competitive. The local industry has consequently benefited from copying the foreign technology. Doytch and Narayan also argue that FDI is an important driver of the increase in renewable energy consumption in upper middle-income countries (UMICs), whereas the effect in lower middle-income countries (LMICs) is not as large, when studying the effects of sectoral FDI (p. 300).

Several authors have tried to map out the relationship between net inflows of foreign investments and the domestic consumption of energy. It has been concluded that FDI inflows increase the demand for energy, as FDI allows for cheaper and easier access to capital. This can, in turn, be used for expanding production, thus increasing energy demand and consumption (Mielnik and Goldemberg, 2002). But, as Lee (2013) puts forward, and to our own knowledge, a statistically significant relationship between total net FDI inflow and increased *renewable energy consumption* has not yet been proven.

As the correlation between FDI and clean energy consumption has been hard to confirm, scholars have used CO<sub>2</sub> emissions and energy intensity<sup>4</sup> as proxies for improvements in the use of each country’s source of energy. It has then been shown that FDI has a positive effect on CO<sub>2</sub> emissions, i.e. as net FDI inflows increase, the host economy is responsible for a larger share of CO<sub>2</sub> pollution, but that FDI has a negative effect on energy intensity. This indicates that even though FDI inflows have been shown to increase a country’s CO<sub>2</sub>

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<sup>4</sup> Energy intensity measures how much one unit of energy is benefitting the economy. It is calculated by dividing energy use in the economy over GDP (Hanania, et. al. n.d.)

emission, the efficiency of the economy has improved: more output per primary unit of energy (Lee, 2013 and Mielnik and Goldemberg, 2002).

In this study, we differentiate between upper-middle and lower-middle income countries, as we expect the effects of FDI to differ between these two groups. This follows the conclusion of Ciruelos and Wang (2005), who acknowledged that technology diffusion would be dissimilar in developed countries and LDCs. They argued that a pooled sample of individuals with distinctive characteristics and conditions might not show accurate results and it is concluded that a minimum threshold of human capital is needed for technology diffusion to be successful (p. 438).

One way to measure the technology spillover effect is to study the effects of FDI on productivity of domestic firms. From previous studies, little empirical evidence to confirm these effects has been shown, and few studies have explicitly examined the spillover effect on the host country (Blomström and Kokko, 1998, p. 10). In a literature overview by Görg and Greenaway (2004) no unambiguous results on productivity spillovers from FDI inflows can be found. However, when studying disaggregated data there are some indicators of positive spillover effects on productivity. Hanson (2001) finds weak evidence that FDI generates positive spillovers for host economies, while arguing that country specific characteristics play a large role.

## 4. Method and data

This section will present the empirical model that has been used and a full description of all variables. It will also explain which boundaries have been set for our data, how it is limited and how these limitations could potentially affect our results.

### 4.1. Empirical model

To test the hypotheses, a panel data model with fixed effects is used. By using panel data, consisting of multiple entities which all hold data over several time periods, we can get more detailed information and increased efficiency in our models (Park, 2011, p. 1). Panel data methods also reduce the risk of biased results by controlling for the individual, country-

specific, heterogeneity (Tamazian and Rao, 2010, p.139). The baseline model is constructed as follows:

$$(1) y_{it} = \alpha + \beta_1 FDI\ inflows_{it} + \beta_2 control\ variables_{it} + u_i + \varepsilon_{it}$$

Where  $i$  and  $t$  are subscripts for country ( $i=1, \dots, 56$ ) and year ( $t=1990, \dots, 2010$ ) respectively.  $u_i$  is the unobserved country specific effect (Park, 2011, p. 8) and  $\varepsilon_{it}$  are IID(0,  $\sigma_\varepsilon$ )<sup>5</sup>.

Renewable energy consumption is our dependent variable,  $y_{it}$ . We run one regression with FDI inflows and GDP per capita as explanatory variables and then expand the model by including other control variables that have been used in previous studies. By adding control variables, we take into consideration other factors that we believe affect the share of renewable energy consumption. In doing so, we aim to obtain more accurate estimates. The control variables are; financial development, political rights, inflation and trade openness.

$$(2) y_{it} = \alpha + \beta_1 FDI\ inflows + \beta_2 control\ variables_{it} + \beta_3 interactive\ terms_{it} + u_i + \varepsilon_{it}$$

We then expand our model (2) by including interaction terms. By adding interaction terms to our model, we want to study if there are differences in the effect of FDI inflows depending on the following two factors; income group and combined FDI inflow and GDP per capita.

Finally, we run a regression with *lagged* FDI inflows ( $FDI\ inflows_{i,t-1}$ ) instead of the basic FDI inflows variable. Here, the control variables are the same as before and no interaction variables are included. This regression is performed to study differences in the effect of the lagged variable versus the level one.

Ultimately, we cannot disregard the limitations that stem from our econometric shortcomings

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<sup>5</sup> for a multiple regression to generate efficient results, there are three assumptions that must hold regarding the error term; the error terms must have zero expectation, must be homoscedastic and have independent distributions. IID(0,  $\sigma_\varepsilon$ ) thus indicates that the error term is independent and identically distributed random variables, with zero mean and finite variance (Dougherty, 2011, p. 159-160).

and the time constraints. With unrestricted time resources these models could have been improved, but here we have used methods that are within our econometric comprehension and are in line with the scope of the essay. This matter must be taken into account when studying the results.

#### **4.1.1. Fixed effects**

When dealing with panel data, it is fair to believe that individual, country specific, effects do exist. These could be differences in; FDI promotion, environmental regulations, trade partners, location and climate in the host country. If country specific effects are present, i.e. the panel data suffers from unobserved heterogeneity, the fixed or random effect methods are preferred as estimators (Park, 2011). To choose between the two methods we use the “Hausman specification test”. We can reject the null hypothesis at the 0.01 level, which indicates that the fixed effects model provides the best estimates. By running all our regressions with fixed effects on countries we correct for individual specific effects.

#### **4.2. Variables and hypotheses**

This section includes our hypotheses and a description of the variables we use in this essay. After presenting our hypotheses below, we will define our variables further and discuss the possible relationship between our dependent variable (share of renewable energy consumption) and the independent variables in our model. The variables are presented in Table 1. The variables used in this paper are inspired by the work of Tamazian and Rao (2010), Doytch and Narayan (2016) and Sbia et.al (2014).

Our aim is to study if FDI inflows is positively or negatively related to the share of renewable energy in the sample countries. With the provided framework, the hypotheses that will be tested are:

- (1) FDI is significantly related to the consumption of renewable energy*
- (2) There are significant differences in the FDI – share of renewable energy consumption relationship between upper- and lower-middle income countries*

##### **4.2.1 FDI inflows**

*FDI\_inflows*. FDI inflows is the independent variable of main interest. It shows how inflows

of FDI into a host country effects its share of renewable energy consumption. Depending on which sign the coefficient shows, we will be able to see which of the two theories presented in chapter 3 (technology diffusion and PHH) that best describe the relationship between FDI inflows and the share of renewable energy consumption. If the relationship is positive ( $\beta_1 > 0$ ), this can be an indication that increased FDI inflows leads to an increase in the share of renewables by facilitating the production and usage of clean energy. If this is the case, the theory of technology diffusion best describes our results. If the relationship is negative ( $\beta_1 < 0$ ), it could be the case that the PHH is the dominant theory since it argues that FDI inflows are allocated to dirty industries in countries with low environmental regulations (Cole and Elliot, 2005). To account for skewness in the distribution of the variable we take the logarithm of FDI inflows ( $\ln\_FDI\_inflows$ ). To research the possibility of FDI having a prolonged effect on the share of renewable energy, we add a lagged term of the FDI variable, with a one-year lag ( $lag\_ln\_FDI\_inflow$ ). It could be that technology diffusion does not occur over night, but through a longer process of accumulation. If so, the lagged variable will have a more positive, or less negative, effect on the share of renewables compared to the *level* FDI variable.

#### 4.2.2 Control Variables

$\Delta \ln\_GDP/capita$ . GDP per capita is included in the model since the economic level of a country is believed to influence the renewable energy consumption. For more developed countries, the effect of this variable is thought to be positive, as they may have reached the economic level needed to focus on the use of clean energy (Suri and Chapman, 1998, p. 195). Less-developed countries have not yet reached this level of income per capita, why GDP per capita is therefore thought to be negatively related with the share of renewable energy in this group. These countries have not reached the development level needed to focus on the promotion of clean industries. Where this “turning point” occurs is unknown why it is difficult to predict the effect of GDP per capita on the share of renewable energy consumption. GDP per capita is logarithmized to follow a normal distribution. We also take the first difference of the variable to correct for non-stationarity (see section 4.4.4), labelling the variable with a  $\Delta$ -symbol.

*financial\_dev*. Financial development is inspired by Tamazian and Rao (2010) and Sbia et.al (2014). In their research on CO<sub>2</sub> emissions, Tamazian and Rao (2010) argued that financial



development may play a part in improving the environment. It is measure on how able the private sector is to invest in (environmentally) sustainable projects and induce technological change (p. 138-139). Financial development is therefore expected to be positively related to the share of renewable energy consumption, *if* it is accompanied by proper legislation, as was established by Tamazian and Rao (2010, p. 137). To correct for non-stationarity a lagged financial development variable is created (*lag\_financial\_dev*) and included in all regressions (see section 4.4.4).

*political\_rights*. Political rights is used as a proxy for institutional quality and governmental functionality. Tamazian and Rao (2010) argue that this variable can affect environmental quality, and the share of renewable energy consumption, since well-functioning governments are more likely to induce environmental policies. A more equal society, which we presume is present in countries with strong political rights, has also been shown to have a positive impact on environmental degradation. As this variable goes from high to low, i.e. lower values indicates wider civil liberties, the political rights coefficient is expected to be negative.

*inflation*. Inflation is included in the model to serve as a proxy for macroeconomic stability (Tamazian and Rao, 2010). This is added to balance the results.

*trade\_openness*. Trade openness is used by Tamazian and Rao (2010) and Sbia et.al. (2014), among others. As in the case with FDI inflows and GDP per capita, the relationship between trade openness and renewable energy consumption will depend on which of the two presented theories in chapter three that explains the situation for middle income countries best. If technology diffusion is assumed to be the dominant theory an increase in trade openness, i.e. increased imports, should increase renewable energy consumption. If the relationship is negative, i.e. increased trade openness leads to a decrease in the share of renewable energy, the PHH might be the more correct theory. In this case, increased imports into middle-income countries bring heavy, capital intensive, industries and increase the use of “dirty” energy, thus lowering the share of renewables.

### **4.2.3 Interactions**

*FDI\_income*. FDI inflows and income group are interacted to create *FDI\_income* ( $\ln\_FDI\_flow * Incomegroup$ ). *Incomegroup* is a dummy-variable, which categorises the

studied countries into lower- and upper-middle income countries (see table 3 in appendix for full country classification). This categorisation is made to see if FDI inflows has a different impact on the share of renewable energy consumption depending on which group a country belongs to. Since *Incomegroup* = 0 for all lower middle-income countries, the interaction term will take the value of zero for this group. Adding this variable therefore allows us to study potential differences between LMICs and UMICs. The coefficient is expected to be positive since upper middle-income countries are assumed to be better equipped to utilize the benefits of FDI inflows than lower middle-income countries. With more successful technology diffusion into upper middle-income countries, the share of renewable energy consumption is believed to be more positive, or less negative, in this group compared to in the lower middle-income country group when FDI inflows increase.

*FDI\_GDP/capita*. To examine the correlation between FDI inflows and GDP per capita in combination and the share of renewable energy consumption we create an interaction where FDI inflows and GDP per capita are multiplied:  $FDI\_GDP/capita = \ln\_FDI\_inflows * \Delta \ln\_GDP/capita$ . Following the ambiguity in expecting how FDI inflows and GDP per capita will behave, the relationship between the interaction and the share of renewables is hard to forecast. As we are uncertain of both the effect of FDI inflows and GDP per capita on the share of renewable energy consumption, the relationship between the interaction and the share of renewables is hard to forecast. What we can expect is that if FDI flows and GDP per capita affect the share of renewable energy consumption in the same direction, the interaction variable will have a larger impact than the two interacted variables (FDI flows and GDP per capita) have separately. This impact could be either positive or negative. If the results of FDI flows and GDP per capita go in different directions the coefficient sign can be either positive or negative. It is therefore hard to project the relationship between this interaction variable and renewable energy consumption.

**Table 1.***Overview of variables*

<b>Name</b>	<b>Definition</b>	<b>Unit of measure</b>	<b>Source</b>
<i>Renewable_energy</i>	Renewable energy as a share of total energy consumption	%	SE4ALL
<i>ln_FDI_inflows</i>	The logarithm of net FDI inflows in current USD	Current USD	WB
<i>Δln_GDP/capita</i>	The first difference and logarithm of gross domestic product per capita	Current USD	WB
<i>financial_dev</i>	Financial development measured as domestic credit to private sector as a share of total GDP	%	WB
<i>political_rights</i>	A proxy for institutional quality. 1-7 score, where 1 is wide civil liberties and 7 is total oppression	Numeric value	Freedom House
<i>inflation</i>	Inflation, measured using the GDP deflator	%	WB
<i>trade_openness</i>	Imports of goods and services as a share of GDP	%	WB
<i>income_group</i>	A dummy-variable where 1=UMIC and 0=LMIC	-	WB

**4.3. Boundaries and limitations**

The time period (1990-2010) is chosen mainly due to consistency in data. Before 1990, there was little focus on the use of renewable energy, and few countries had made the shift from coal-powered industries to wind or solar. The data from Sustainable Energy 4 All (supplied by the World Bank) are built upon ten-year periods, as is why our period of study ends at 2010.

Since 2010 is the final year, we use the World Bank's classification over middle-income countries for this year to select our sample. In total, 109 countries were classified as middle-income countries in 2010 (WB, 2017). Out of these countries, 56 are included in this study. 53 countries have been omitted from the data set, as they in some way lack sufficient data and/or are not consistent over the period of time. The reasons for the data-shortage among these countries could, but not exclusively, be due to lack of inflow of FDI, non-existent focus on renewable energy consumption, owing to relatively low GDP per capita, war or conflict (impeding data gathering), merging or separation of existing countries, or political instability. A full list of all middle-income countries can be found in the appendix.

Omitting these countries in an attempt to improve the data set causes the data to suffer from sample selection bias. Having biased estimators mean that the sample of 56 countries are not the true population of the World Bank's middle-income countries, which causes the effect of FDI to be over- or undervalued. This is a restriction we must consider, but also accept that some degree of error is inescapable (Dougherty, 2011, p. 27).

All studies that rely on the openness and transparency of reporting countries will face problems with measurement errors, as some countries will not know the exact value of all variables, such as the share of renewables. Not all countries have well-functioning statistical institutions keeping track of energy consumption, which could cause our data to be misleading.

Worth noting is that a few previous papers have divided net FDI inflows into sectoral flows, i.e. institutional, manufacturing, service, etc., (see for example Doytch and Narayan, 2016) whereas, due to inaccessible data, this paper only looks at total net inflow without regarding different sectors. Further, the countries are divided into subgroups according to the 2010 division. This means that countries that are LMICs in 2010 could potentially have been UMICS a few years earlier, but have dropped in GDP-level due to war or economic stagnation. As these perspectives are not taken into account in our model, this could cause our results to be over- or undervalued. A supplementary analysis regarding this issue can be found in section 7.1.

## 4.4. Econometric issues

When running regressions on macroeconomic variables in a panel data setting, one is likely to encounter some econometric difficulties. If these are not taken into consideration the given estimates might lose their consistency or efficiency. With inconsistent and/or non-efficient results our analysis will not be valid. Here follows a more detailed explanation of the econometric issues that can cause incorrect results. Further, we present which tests we have conducted to see if these issues are present in our data and how they have been dealt with in our model.

As we are studying a period of 20 years, many countries do not have data for each and every year, causing our data to be unbalanced. When using an unbalanced panel, one must consider that the missing observations could be endogenous to the model, which might provide incorrect estimates (Dougherty, 2011, p. 515). However, as we have omitted the countries lacking a large share of data, we do not believe that this is a significant issue.

### 4.4.1. Heteroscedasticity

In heteroscedastic data, there are individual effects within each entity, which cause the variance of the error terms to be imbalanced (Dougherty, 2011). This leads to the OLS estimates being *non-efficient*. Moreover, if the data shows signs of heteroscedasticity we can no longer rely on the standard error estimates and the following test statistics risk to be invalid. Analysing these results could therefore cause false conclusions (Dougherty, 2011, p. 283). To test for heteroscedasticity, we perform a “modified Wald statistic for groupwise heteroskedasticity in fixed effect models”. The test allows for unbalanced panels and the null hypothesis is that the data is homoscedastic (Baum, 2000). We find that our data is heteroscedastic and correct for this by clustering the standard errors on our panel variable, country, in all regressions.

### 4.4.2. Autocorrelation

Autocorrelation appears when the error terms are correlated over time. Then the error terms are not independently distributed (Baum, 2006, p. 154). When autocorrelation is present, the OLS once again is *non-efficient* and the standard error estimates are incorrect (Dougherty, 2011, p. 431). To test for autocorrelation, we perform a “Wooldridge test”. The null hypothesis is rejected at the 0.01 level which signals that autocorrelation is present. As stated

by Hochle, and in line with the treatment of heteroscedasticity, autocorrelation can also be corrected for by clustering the standard errors. By doing so we therefore obtain robust standard error estimates, which are needed for the regression results to provide accurate significance tests (2007, p. 285).

#### 4.4.3. Additional tests

If there is sufficient correlation between the explanatory variables the regression model might suffer from multicollinearity. If the issue of multicollinearity is present, the variable variance will increase which in turn affects the model's reliability in estimating coefficients (Dougherty, 2011, p.165). To identify if our model suffers from multicollinearity, we look at a correlation matrix. According to Dougherty (2011, p. 168), conclusions regarding multicollinearity cannot be drawn from a correlations matrix if a model consists of more than two variables, which is the case in our models. Therefore, we apply a more formal method for testing multicollinearity: measuring the Variance Inflation Factor (VIF). It is stated that a VIF value of 10 or greater might indicate multicollinearity (Baum, 2006, p. 85). Since all our variables have low VIF-values we see no sign of multicollinearity in our model. Both the correlation matrix and the VIF-test results can be found in the appendix.

In regression modelling it is of importance that each variable is stationary, as non-stationary data violates the assumptions made in section 5.1 (Dougherty, 2011, p. 469-470). Since we have unbalanced panel data, we conduct Fisher-type unit root tests to determine whether our variables have unit roots (Stata, 2017). The GDP per capita variable shows signs of non-stationarity why we take the first difference of it (indicated by  $\Delta$ ). The differenced GDP per capita variable is the one used in our regressions. The financial development variable is also non-stationary, but becomes stationary in first lag. Therefore, a lag of the financial development variable (*lag\_financial\_dev*) is created and added to all our regressions.

## 5. Results

The table below presents our regression results. In all five regressions, we correct for heteroscedasticity and autocorrelation. As our main variable of interest, *ln\_FDI\_inflow*, is a logarithm, its coefficients are interpreted as follows: a 10 % increase in FDI inflows cause a

change in the dependent variable with  $\beta_1 * \log(1,10)$ .

**Table 2.**

*Panel data regression results*

Dependent variable: Renewable\_energy\_consumption

Variable	1	2	3	4	5
<i>ln_FDI_inflow</i>	-1.096*** (0.303)	-0.721*** (0.266)	-0.785** (0.348)	-0.715** (0.266)	
<i>lag_ln_FDI_inflow</i>					-0.675** (0.288)
$\Delta \ln\_GDP/capita$	2.102* (1.150)	0.751 (1.002)	0.777 (1.035)	0.402 (0.984)	-0.882 (1.067)
<i>financional_dev</i>		-0.00716 (0.0320)	-0.00719 (0.0318)	-0.00689 (0.0322)	-0.00143 (0.0323)
<i>lag_financional_dev</i>		-0.0536* (0.0298)	-0.0535* (0.0294)	-0.0537* (0.0299)	-0.0585* (0.0308)
<i>political_rights</i>		0.277 (0.494)	0.273 (0.493)	0.272 (0.492)	0.271 (0.491)
<i>inflation</i>		0.00133 (0.000935)	0.00133 (0.000942)	0.00130 (0.000929)	0.00116 (0.000956)
<i>trade_openness</i>		-0.127** (0.0476)	-0.127** (0.0475)	-0.125** (0.0477)	-0.137*** (0.0476)
<i>FDI_income</i>			0.205 (0.582)		
<i>FDI_GDP/capita</i>				-0.442 (0.355)	
<i>_cons</i>	34.518*** (0.289)	41.299*** (3.294)	41.259*** (3.302)	41.269*** (3.288)	41.760*** (3.414)
<b>R<sup>2</sup></b>	0.0716	0.119	0.120	0.120	0.123
<b>Countries</b>	56	56	56	56	56
<b>Total no. obs.</b>	1030	1019	1019	1019	1017

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

Robust standard errors to correct for autocorrelation and heteroscedasticity in parenthesis

The reported R<sup>2</sup> is the "within R<sup>2</sup>" from the regression statistics

Regression (1) is run with only two independent variables: FDI inflows and GDP per capita. The coefficient for FDI flows is significant at the 0.01 level and negative. If the levels of FDI inflows into a country increase, the share of renewable energy consumption will decrease. A 10 % increase in FDI inflows is related to a change in the share of renewable energy with - 0.104 percentage points. The coefficient of GDP per capita is positive and significant at 0.1

level, which indicates that higher GDP per capita is related to higher share of renewable energy consumption. This is in line with our expectations. The R-squared, which shows the goodness of fit of our model, is 0.0716, indicating that our model explains 7.16% of the variance in the dependent variable. Although high R-squared values are desirable as they confirm that the model fits the data well, conclusions regarding the relationship between our dependent variable and significant independent variables can still be made when the R-squared is low.

When adding the other control variables in regression (2) our R-squared increases to 0.119. With control variables included in the regression, the negative relationship between FDI inflow and the share of renewable energy consumption decreases but is still negative. This can potentially cause us to deny the theory of technology diffusion, and instead consider the pollution havens hypothesis. GDP per capita is still positive but no longer significant, why we can not draw any assumptions from this result.

Regarding the other control variables only two show significance; *lag\_financial\_dev* and (at 0.1 level) and *trade\_openness* (at 0.05 level). The coefficient of the lagged financial development variable is negative. This shows that increased financial development is negatively correlated the share of renewable energy consumption, which contradicts our expectations. Although, as confirmed by Tamazian and Rao (2010), financial development can, without the company of proper environmental legislation, cause CO<sub>2</sub> emissions to rise.

Trade openness is negatively related to the share of renewable energy, as was also found by Tamazian and Rao (2010). Since trade openness and the share of renewable energy consumption are not measured in the same units the coefficient value cannot be easily interpreted. However, a significant relationship can be seen. The variables GDP per capita, financial development, political rights and inflation are not significantly correlated with the share of renewable energy in the regression (2) results. Although not significant, the coefficient of GDP per capita shows the sign we expected. The political rights coefficient is positive, which is the opposite of what we thought. However, this variable is not significant and therefore we will not dwell on it further.

Regressions (3) and (4) contain the same variables as regression (2) but includes an interaction term. Not surprising, the results from the two last regressions therefore closely



follow the results from regression (2). The R-squared is also similar, showing that the models used for regression (3) and (4) explain 12% of the variance in the share of renewable energy consumption. FDI inflows, lagged financial development and trade openness are once again the only significant variables with coefficient values that are similar to earlier ones.

In regression (3), the included interaction term is *FDI\_income*, which shows the extra result for UMICs compared to LMICs. The coefficient for this interaction variable is positive, indicating that there is a difference in the FDI - share of renewable energy consumption relationship between lower- and upper middle-countries. This is in line with our expectations. The positive impact of the interaction variable therefore *reduces* the negative relationship between FDI inflows and the share of renewable energy consumption for the upper middle-income country group. But, as the interaction variable is not significant, we cannot conclude that the relationship is less negative in the UMIC group than in the LMIC group.

Regression (4) includes the interaction term *FDI\_GDP/capita*. This interaction shows a negative result on the share of renewable energy consumption. The two variables that are multiplied to create the interaction (FDI inflows and GDP per capita) are differing in their correlation with our dependent variable ( $\beta_{FDI\ inflows} < 0$ ) and ( $\beta_{GDP\ per\ capita} > 0$ ). Therefore, the negative coefficient of the interaction term suggests that the negative result of FDI inflows is larger than the positive result of GDP per capita. But, since the variables included in the interaction term are not processed in similar ways, the values of the coefficient cannot be easily interpreted. Further, as the interaction term is insignificant we cannot make any statistically proven conclusions regarding this variable.

When studying the lagged FDI inflow variable in regression (5) we find that this variable is negatively correlated to the share of renewable energy negatively and that the estimate is significant at the 0.05 level. This is an expected outcome as the results from the earlier regressions (1)-(4) showed that FDI inflows were negatively related with the share of renewable energy consumption. In regression (5) it is notable that the coefficient of lagged FDI inflows is less negative than the coefficients of FDI inflows in the earlier regressions. Although the difference is small, these results can indicate that the utilisation of technology increases over time. Except for GDP per capita, which changes from positive to negative impact, the control variables show similar results.

## 6. Analysis

As presented in table 2, we have found that FDI flows into middle-income countries are negatively correlated with the share of renewable energy consumed. As these results are significant, we can confirm our hypothesis that an effect is present. With these results, the pollution haven hypothesis appears to explain the relationship between FDI inflows and the share of renewable energy consumption in a slightly more sensible way than the theory of technology diffusion. However, like Cole and Elliot (2005), we will not claim that the existence of pollution havens is outspread. But, although the negative effect is not all too large, and may not be reason for worry, it is indeed worth noting this decline.

From the methods used in this essay, we have not been able to define a causal direction of our results. We cannot determine whether FDI is affecting the share of renewables, or if the share of renewables is affecting the net FDI inflows. We will build our analysis on the assumption that FDI influences the share of renewable energy in middle-income countries, although we are aware that this may be a two-way relationship.

Why then are we not seeing clearer evidence of spillovers of green technology? First, as the decline in the share of clean energy is not very large, but only approximately 0.07 percentage points when FDI increases with 10 %, it could be that technology diffusion is in fact successful, but that the share of non-renewables is increasing slightly more, causing the ratio to decline. It would be preferable to study diffusion in itself but in our search for data we could not find any diffusion measures. With no way to measure diffusion per se, we cannot deny that some diffusion may in fact be present.

It is also probable that the utilisation of new technology takes time. Local industries do not copy advanced technology overnight, but through the accumulation of human capital and know-how, which can be observed by analysing the effects of the lagged FDI inflows variable. Although the net effect of FDI is still negative, it is closer to zero. Therefore, we carefully suggest that when the accumulation of technology and know-how has reached a certain point, the share of renewables could potentially start to increase. It could take longer for FDI inflows to show significant positive results than the time given in our models.

Second, the theory of technology diffusion indicates that diffusion is prone to be more successful in countries on the same level of human capital (or slightly below). If the model had been improved with a measure on the host country's human capital level, maybe the effect would have been different.

In our model, we have not been able to differentiate between sectoral flows of FDI. Naturally, FDI to the manufacturing sector has a larger effect on energy consumption than FDI in the service sector, which can cause our results to be slightly misguided. But, combining this result with the negative relation derived from imports (seen in the negative results of trade openness), we can establish that, like e.g. Feridun (2006) and Cole and Elliot (2005) have done before us, there seems to be a lack of environmental legislation in middle-income countries controlling the inflow of "dirty" goods and industries. The negative impact of trade openness is not all too surprising, as imports of capital-intensive industries and intermediate goods will increase the demand for energy. Due to insufficient, or complete lack of, environmental regulations, this can decrease the share of renewables (Feridun, 2006, p. 40).

The negative relationship between trade openness and the share of renewable energy proposes that the PHH is the more relevant theoretical approach when analysing our results. The analysis would be enhanced and truer to reality if it could be combined with a good measure on environmental legislation. There are, to our knowledge, quite few established measures on the environmental performance of a country, and the ones that do exist are rather new. The World Bank began computing CPIA (country policy and institutional assessment) for policy and institutions for environmental sustainability in 2005, and has, to this day, still scarce data on low- and middle-income countries (WB, 2017).

It is also worth noting that a vast share of people in developing countries still depend on the burning of biomass to satisfy their need for energy (Birol, 2007, p. 1). Biofuel is developed from organic material, and in a properly ventilated environment, it is a sustainable source of energy. But, in several developing countries, the biomass fuel available is a major pollutant and consists of wood, cowdung, charcoal and kerosene (WHO, 2016, p. 7). This biomass fuel is categorised as a renewable energy source, whilst it is far from sustainable, as it bears enormous health risks. Therefore, it is possible that the decrease in share of renewables can be explained by FDI, globalisation and economic growth *increasing* the burning of fossil

fuels, due to an increased use and dependency on motor vehicles. This possible explanation has been suggested in India, a country heavily affected by air pollution from particulate matter. The burning of biomass fuel is still increasing, but the reliance on road transportation and petroleum fuel has increased exponentially, putting a large strain on the environment (Singh, 2006, p. 398). This further indicates the need for strict environmental legislation in middle-income countries.

The term which interacts FDI inflows and income group, *FDI\_income*, has the expected result and indicates that FDI is less negatively related with the share of renewable energy consumption in upper-middle income countries. This supports the hypothesis that technology diffusion is more successful if the source and the host country are somewhat similar. However, this can not be said with statistical certainty. It clearly is not enough to only divide countries into upper- and lower-middle income groups to determine the diverse effects, but more information is needed. This will be further discussed in section 7.1.

With regards to policy formulations, this paper indicates that there is a need for proper environmental legislation in developing countries, in order to hinder the probability of a country becoming a pollution haven, as well as ensuring the environmental sustainability of imported goods. Pressure of environmental performance should also be put on the exporting economies, ensuring that they are unable to export pollution intensive industries across borders without proper reprisals. Policies to ensure the sustainable development of developing states are crucial, as many of them are home to a large, growing population with increasing energy demand. The international community must find a way to come together on this issue, since many developing countries cannot afford to ensure the upkeep of environmental standards on their own. Renewable energy is more cost-effective and with the help of foreign investors working under a regulated framework, a sustainable future could be ensured.

## 7. Conclusion

The aim of this essay was to study if FDI was correlated with the share of renewable energy in middle-income countries, and whether this effect, if existing, was positive or negative. According to differing theoretical views, this paper has researched the theory of technology

diffusion and the pollution haven hypothesis in order to establish which of the two approaches that is more prominent in middle-income countries. This has been done by collecting data on 56 middle-income countries and running panel based regressions with share of renewable energy as dependent variable and FDI inflows, several controls and two interactions as independent variables.

From the results, we see that FDI is negatively correlated with the share of renewables. Hence, the pollution haven hypothesis may better describe this issue. However, when adding a lagged independent variable on FDI inflows the negative effect decreased somewhat, which could indicate that technology diffusion takes time, and is not something that happens overnight. To account for the possibility of FDI having a different impact on LMICs and UMICs, an integration variable was created by integrating FDI inflows with the value 0 for low-middle income countries, and 1 for upper-middle income countries. This, unfortunately, came out to be insignificant, suggesting that more information than a rough categorisation according to income groups is needed to examine differences among the middle-income countries.

Our results further showed that without the company of proper environmental legislation, the inflow of imports and foreign capital might be negatively correlated with the share of renewable energy consumption. This was in line with the findings of Tamazian and Rao (2010), who demonstrated that proper institutional quality is of importance for CO<sub>2</sub> emissions not to increase because of increased trade openness.

This essay finally argued that continued policy formulation regarding environmental performance is crucial. Like Tamazian and Rao (2010), the paper proposed that environmental regulation in middle-income countries prohibits high-income economies to outsource their pollution intensive industries, thus forcing manufacturers to improve environmental standards.

As of policies regarding FDI and the questions whether governments are to promote and support FDI activities, the results from this essay could add some insights. With no positive relationship between FDI inflows and the share of renewable energy consumption being found, the incentives for FDI promotion in this matter are low. As the environmental issues are becoming a greater concern for all governments and institutions, focus should not be on

FDI as a way of reaching sustainable solutions. With this said, middle-income countries can be believed to be more interested in other economic attributes than sustainability, such as growth and GDP per capita, why this group might continue to promote FDI.

## **7.1. Further research**

In 2010, UNCTAD (United Nations' Conference on Trade and Development) confirmed that in 2008-2009, developing and transitioning economies attracted the majority of all green investments made in the two-year period. Still, the larger part of all cross-border M&As still took place in the developed world. But, the relative share of similar deals in the less-developed country is increasing (UNCTAD, 2010, p. 4). This time-period is too short to affect our data substantially, as is why we ask for a similar study to be conducted again, with updated figures studying the effects from 2010 to today, when new data is available.

Further, as we were not been able to include data on sectoral flows of FDI, proper environmental regulations or human capital, future research could incorporate these factors into the model. We were also been unable to account for the fact that during the observed time period, several countries may have shifted between the two income groups that we base our interaction variable upon. LMICs may have been UMICs in the past, but have, due to war or economic stagnation, been bumped down to the low-middle income category. This could have caused the data to show misrepresentative results, as these countries take on "upper-middle income values" for certain years and "low-middle income values" for others, but are coded to solely belong to one of the two groups. If future research can find a way to better account for differences within the middle-income country group the results would probably be more accurate.

This paper was unable to prove with statistical significance that upper-middle income countries are less negatively affected than lower-middle income countries, showing that the rough categorisation of LMIC and UMIC is not enough to provide statistically verified proof. The possibility of disaggregating data into different groups is also in question regarding FDI sectors. As Görg and Greenaway (2004) put forward in their literature review, the usage of disaggregated data on FDI generally provides more significant results (p. 186). Therefore we believe it would be interesting to conduct future research with more narrow sub-groups where the entities have more homogenous characteristics.

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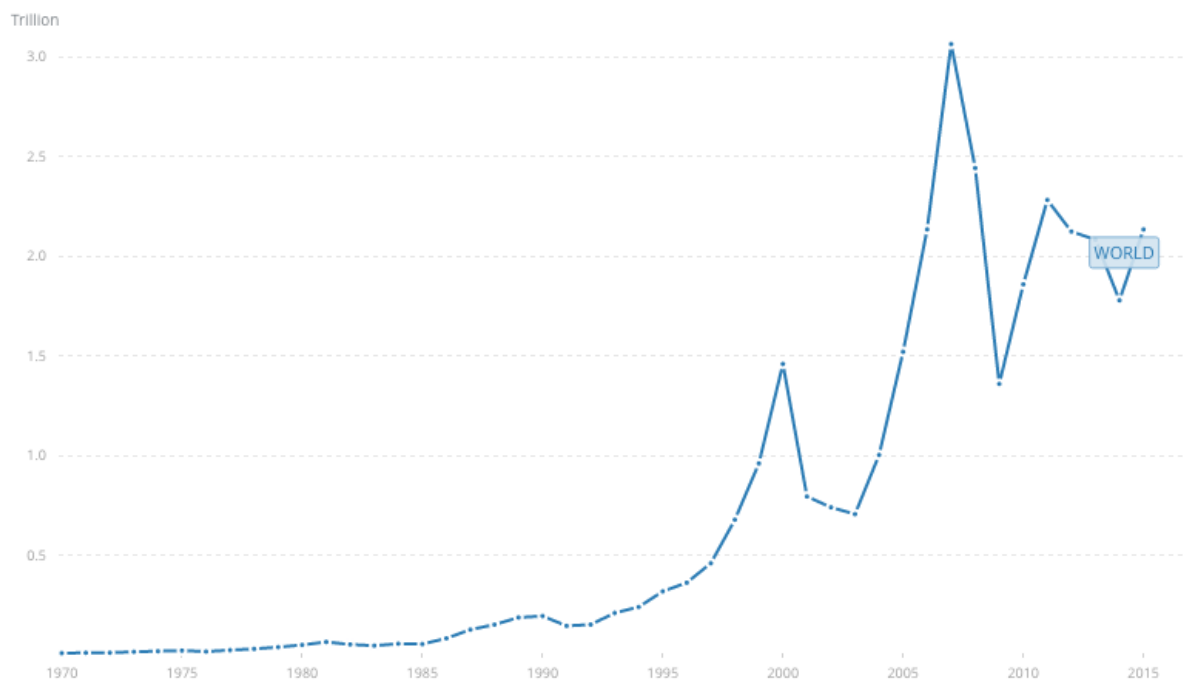
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# Appendix

**Graph 1.** Foreign direct investment, net inflows (BoP, current US\$)



Available at: <http://data.worldbank.org/indicator/BX.KLT.DINV.CD.WD> Accessed: [2017-05-08]

**Table 3.**

*This table categorizes the countries covered in this study under the two sub-categories within the World Banks classification: 1 = Upper middle-income country, 0 = lower middle-income country.*

<b>Country</b>	<b>Income Group</b>	<b>Country</b>	<b>Income Group</b>	<b>Country</b>	<b>Income Group</b>
Argentina	1	Gabon	1	Pakistan	0
Armenia	0	Ghana	0	Paraguay	0
Belize	0	Grenada	1	Peru	1
Bhutan	0	Guatemala	0	Philippines	0
Bolivia	0	Guyana	0	South Africa	1
Botswana	1	Honduras	0	Sri Lanka	0
Brazil	1	India	0	Sudan	0
Bulgaria	1	Indonesia	0	Suriname	1
Cameroon	0	Iran	1	Swaziland	0
Cape Verde	0	Jordan	1	Thailand	1
China	1	Kazakhstan	1	Tunisia	1
Colombia	1	Lao PDR	0	Turkey	1
Congo, Rep.	0	Malaysia	1	Ukraine	0
Costa Rica	1	Mauritius	1	Venezuela	1
Cote d'Ivoire	0	Mexico	1	Vietnam	0
Dominican Republic	1	Mongolia	0	Yemen, Rep.	0
Ecuador	1	Morocco	0		
Egypt	0	Namibia	1		
El Salvador	0	Nicaragua	0		
Fiji	0	Nigeria	0		

**Number of covered Countries: 56**

**Number of upper middle-income countries in study: 25**

**Number of lower middle-income countries in study: 31**

*Source: the World Bank*

**Table 4.***Classification over middle-income countries in 2010*

<b>Covered</b>	<b>Covered continued</b>	<b>Omitted</b>	<b>Omitted continued</b>
Argentina	Iran	Albania	Montenegro
Armenia	Jordan	Algeria	Palau
Belize	Kazakhstan	American Samoa	Panama
Bhutan	Lao PDR	Angola	Papa New Guinea
Bolivia	Malaysia	Antiga	Romania
Botswana	Mauritius	Azerbaijan	Russian Federation
Brazil	Mexico	Belarus	Samoa
Bulgaria	Mongolia	Bosnia - Herzegovina	Sao Tome and Principe
Cameroon	Morocco	Chile	Senegal
Cape Verde	Namibia	Cuba	Serbia
China	Nicaragua	Djibouti	Seychelles
Colombia	Nigeria	Dominica	Solomon Islands
Congo, Rep.	Pakistan	Georgia	St Kitts and Nevis
Costa Rica	Paraguay	Iraq	St Lucia
Cote d'Ivoire	Peru	Jamaica	St Vincent and the Grenadines
Dominican Republic	Philippines	Kiribati	Syria
Ecuador	South Africa	Kosovo	Timor Leste
Egypt	Sri Lanka	Latvia	Tonga
El Salvador	Sudan	Lebanon	Turkmenistan
Fiji	Suriname	Lesotho	Tuvalu
Gabon	Swaziland	Libya	Uruguay
Ghana	Thailand	Lithuania	Uzbekistan
Grenada	Tunisia	Macedonia	Vanuatu
Guatemala	Turkey	Maldives	West Bank and Gaza
Guyana	Ukraine	Marshall Islands	Zambia
Honduras	Venezuela	Mauritania	
India	Vietnam	Micronesia	
Indonesia	Yemen, Rep.	Moldova	
<b>Covered countries: 56</b>			
<b>Omitted countries: 53</b>			
<b>Total middle-income countries: 109</b>			

*Source: the World Bank*

**Table 5.***Correlation matrix*

Included observations: 1143

<b>Variable</b>	<i>Renewable energy consumption</i>	<i>FDI inflow</i>	<i>GDP/capita</i>	<i>Financial development</i>	<i>Political rights</i>	<i>Inflation</i>	<i>Trade openness</i>
<i>Renewable energy consumption</i>	1.000						
<i>FDI inflow</i>	-0.095	1.000					
<i>GDP/capita</i>	-0.363	0.179	1.000				
<i>Financial development</i>	-0.364	0.291	0.239	1.000			
<i>Political rights</i>	-0.281	0.114	-0.296	-0.090	1.000		
<i>Inflation</i>	-0.009	-0.027	-0.057	-0.038	-0.038	1.000	
<i>Trade openness</i>	-0.133	-0.161	-0.055	0.261	-0.116	-0.049	1.000

**Table 6.***Variance Inflation Factors*

<b>Variable</b>	VIF-value
<i>FDI inflow</i>	1.22
<i>GDP/capita</i>	1.31
<i>Financial development</i>	1.30
<i>Political rights</i>	1.18
<i>Inflation</i>	1.02
<i>Trade openness</i>	1.25