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FDI and environmental regulations

Supervisor:
Anna D'Ambrosio

Candidate:
Matteo Bertocchi

ABSTRACT

Nowadays, economic investment and environmental health are two of the most debated topics. Although they seem to belong to different realities, they are actually strictly related and, for some extent, they depend on each other.

The aim of this thesis is to gather and analyze the most important ideas, theories and empirical contributions of that part of literature related to FDI, environmental stringency and the relationship between the two. Today, a huge amount of scientific material investigating on these topics is available but it is accompanied by a great degree of ambiguity and confusion, due to the dispersion of information and the disagreement among the different theoretical hypotheses and empirical evidence. This work seeks to give an order to them and to find the possible reasons behind the ambiguity generated, while navigating throughout empirical evidence from all over the world.

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INTRODUCTION

Every day, concerning about global environmental situation keeps raising. Our world health is negatively affected by our own decisions and behaviours and the continuing deterioration of environment conditions reflects against us. Climate change is a real threat, as highlighted by the increasing frequency and intensity of extreme weather events, and results in a huge number of economic and, most of all, human lives losses.

This is the reason why more and more countries from all over the world are getting involved in serious environmental agreements, in an attempt to limit and reduce the current pollution emissions. Environmental regulations are the main instrument through which they are trying to impose new moderated pollution standards, and most of them are aimed at companies operating in almost all industries.

On the other hand, economic results are always considered to be the first purpose by profit organizations, sometimes leading to a struggle between economic and environmental interests. This is the case of foreign direct investment, a mean for multi-national corporations to invest abroad, chasing for self-specific advantages and generating, at the same time, some benefits for the countries which welcome these investment flows. But at what cost?

Since around the second half of the last century, researchers have been concerned about the overall and country-specific environmental impact of FDI as well as the relationship which links foreign investment flows with the always increasing number of environmental rules imposed by governments. According to some main hypotheses risen in the last decades, indeed, FDI could be used by companies to escape from the additional costs associated with their home country high level environmental stringency, moving their production activities (or only their dirtiest parts) to foreign host countries with laxer environmental policies. Hence, this process would not lead to a reduction in overall pollution, but simply to a shift and a massive concentration of pollution towards specific areas.

Questioning about the truthfulness of this theories, this thesis aims at investigating on the association between FDI flows and environmental regulations, while examining a huge number of theoretical and empirical studies from several researchers almost all over the world and trying to shed light on the reasons behind the general confusion generated by the distance of empirical results found by the literature.

In particular, in the first chapter the FDI topic will be introduced, while in the second one the environmental regulations and the difficulties in measuring them will be explained; after that, the third section will focus on the relationship between the two entities and the last part of the work deals with empirical evidence found in some of the most important countries nowadays speaking in economic terms. Finally, general conclusions will follow, to sum up the most important findings and to definitively end the report.

1. FOREIGN DIRECT INVESTMENT (FDI)

"Foreign direct investment (FDI) is a category of cross-border investment in which an investor resident in one economy establishes a lasting interest in, and a significant degree of influence over an enterprise resident in another economy."[1] A 10% or more of the voting power of a company in one economy hold by a foreign investor from another country is considered to be evidence of this relationship.

From a macroeconomic perspective, FDI is a special form of cross-border capital flow from the source/origin/home country to the host/recipient one, which is reflected in the balance of payments. The variables of interest are capital flows and stocks[2]:

- **FDI Stock**

  The FDI stocks measure the total volume of FDI at a given point in time (usually at the end of a quarter or year). The stock of outward FDI is the sum of equity investment by local investors and net loans toward firms in foreign economies. The stock of inward FDI is the value of foreign investors' equity and net loans towards enterprises in the reporting country.

  FDI stocks are expressed in US dollars and measured as a percentage of GDP.

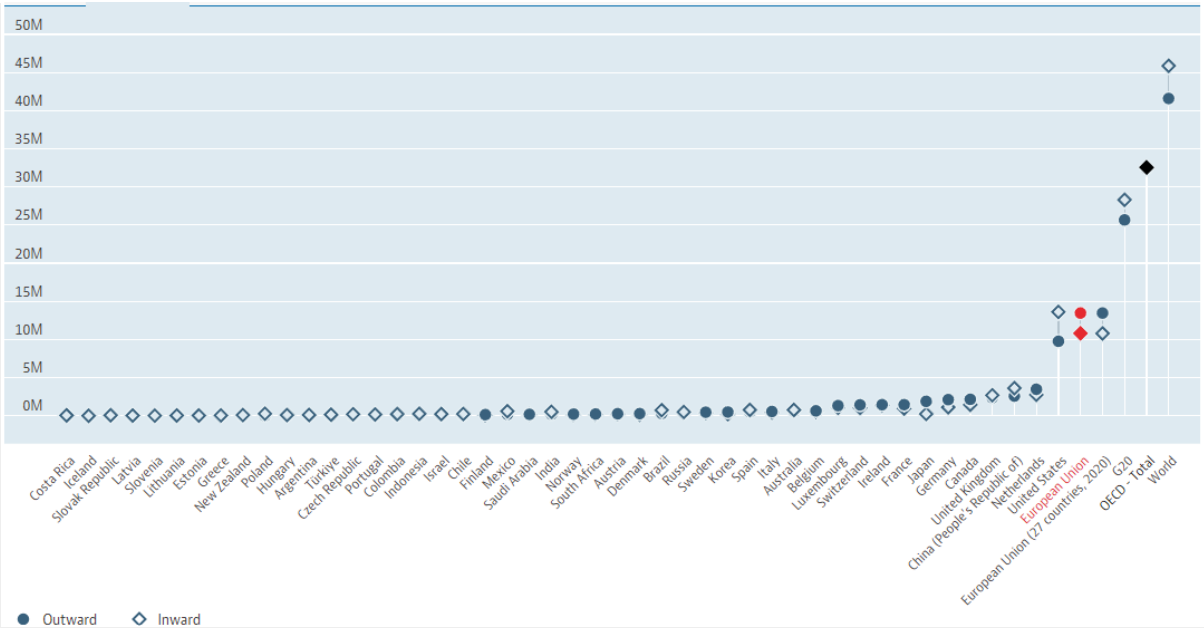

Figure 1 – FDI stocks in 2021 (in millions of US dollars)[1]

- **FDI flows**

  FDI flows record the value of cross-border transactions related to direct investment over a specific period of time (usually a quarter or a year). Financial flows consist of equity transactions, reinvestment of profits and intercompany debt transactions.

  Outward flows consist of transactions that increase the investment made by investors in the reporting economy into enterprises in foreign ones, such as purchases of shares and reinvestment of earnings, minus transactions that decrease the investment made by investors in the reporting economy in enterprises in foreign ones, such as sales of shares and lending by local investors to foreign enterprises.

  Inflows are defined as transactions that increase foreign investors' investment amount in enterprises in the reporting economy minus transactions that decrease foreign investors' investment in domestic enterprises.

  FDI flows are measured in USD and as a share of GDP. FDI flow is the most common and used form for measuring and quantifying FDI.

Outward

Location	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
European Union	349 557	388 452	300 430	693 841	446 216	472 973	411 316	585 604	-1 267	401 869
OECD - Total	934 682	1 002 588	882 058	1 293 347	1 141 336	1 161 134	659 642	960 806	358 801	1 208 001
World	1 296 803	1 393 848	1 435 127	1 728 758	1 561 345	1 609 688	995 862	1 352 425	642 479	1 599 841

Inward

Location	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
European Union	438 691	337 770	346 501	625 639	613 177	380 090	400 166	649 250	173 604	129 067
OECD - Total	823 781	771 919	754 661	1 308 409	1 357 221	979 152	729 484	984 597	444 508	631 301
World	1 663 189	1 600 301	1 607 661	2 154 820	2 068 521	1 723 099	1 466 538	1 750 601	1 101 880	1 593 640

Figure 2 – FDI flows 2012-2021 (in millions of US dollars)[1]

Foreign direct investment can be carried out through a number of ways, such as opening a subsidiary or associate company abroad (greenfield investment), acquiring a controlling share of an existing foreign company, or through a merger or joint venture with a foreign company.

According to the Organisation for Economic Co-operation and Development (OECD), the minimum threshold for an investment to establish a controlling interest over a foreign-based company (and so to be considered as FDI) is set to 10% ownership stake. Below this threshold it is considered just as a portfolio investment. However, this definition is flexible: in some cases

effective controlling interest in a firm can be reached by acquiring less than 10% of the company voting shares.[1]

The phenomenon of transnational corporations and FDI has started gaining importance since the 1960s.

According to Caves (1996) FDI would have several positive effects on the economy of a country which benefits from them, indeed they would increase productivity, technology transfer, managerial skills, knowhow, international production networks, reducing unemployment, and enable access to external markets.[3]

This is the reason why a lot of countries (both developed and developing ones) aim at attracting foreign investors and, in order to do that, they often opt for structural reforms by creating friendly domestic investment policies, ensuring a higher degree of protection and providing different kinds of incentives.

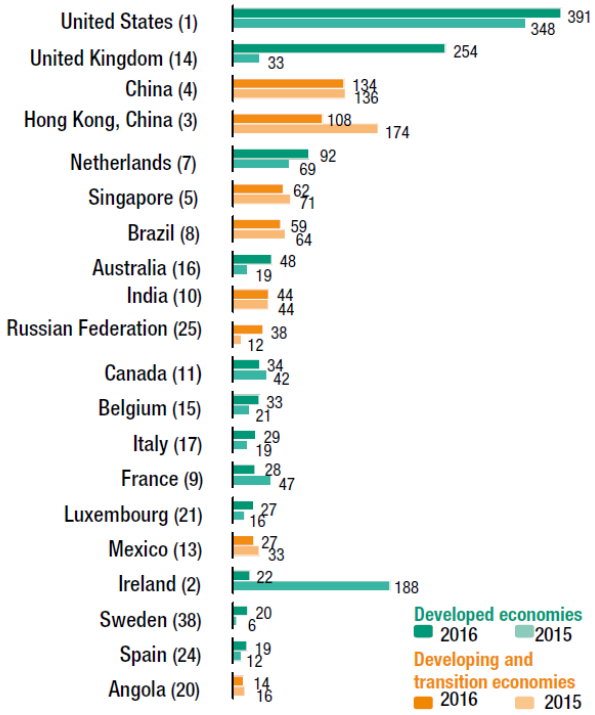

Figure 3 - FDI flows, top 20 economies, 2015 and 2016 ($ Billion)[4]

However, on the other hand, FDI may crowd out local enterprises and have a negative impact on host countries economic development. Hanson considers that positive effects are very few[5], and Greenaway argues that the most of effect is negative[6]. It must be considered that the potential effects (positives or negatives) on the economy may also depend on the specific sector in which investment takes place.

Since the second half of the last century, a lot of theoretical and empirical studies have been carried out in order to find an explanation for the phenomenon of FDI. According to Kindleberger everyone agrees on one point: in a world characterized by perfect competition, foreign direct investment would no longer exist. Indeed, he believes that two conditions must be met for foreign direct investment to take place:

- foreign firms must have certain advantages that make such an investment viable;
- the market for these benefits has to be imperfect.[7]

1.1. ECONOMIC THEORIES ON FDI

Neoclassical trade theories (including Ricardo's comparative advantage theory and portfolio theory) were not able to explain the existence of Multi National Corporations (MNCs) and foreign capital flows.

In general, from the great amount of theories developed about FDI so far, the most important and fitting ones are the following:

1. **Production Cycle Theory of Vernon**

   Vernon in 1966[8] was focused on explaining certain types of foreign direct investment made by US companies in Western Europe after the Second World War. He divided products into three categories based on their stage in the product life cycle: new product, maturity product and standardized product.

   Initially the US transnational companies created new innovative products for local consumption only. After the Second World War, demand for manufactured products like those produced in USA increased in Europe. Thus, American firms began to export, relying on a technological advantage over international competitors (product maturity phase).

   As the product developed also the technology became known, until the product finally turned into a standardized one and European companies were able to copy it (product standardization). The competitiveness of the product decreased the demand for it and US companies were forced to set up production facilities on the local markets to maintain their market shares in those areas (thus the production moved to developing countries).

   The product life cycle theory is not able to explain current trade patterns where innovation and manufacturing occur around the world.

2. **The Theory of Exchange Rates on Imperfect Capital Markets**

   Cushman (1985)[9] showed that real exchange rate increase stimulated FDI in USD, while a foreign currency appreciation tended to reduce them.

   However, currency risk rate theory cannot explain simultaneous foreign direct investment between countries with different currencies.

3. **The Internalisation Theory**

   This theory has been developed thanks to several contributions, ranging from Buckley and Casson[10] to Hennart[11]. Actually, the first satisfying explanation about foreign direct investment and multinational enterprises is due to Hymer's work in 1976[12]. He managed to demonstrate that "FDI takes place only if the benefits of exploiting firm-specific advantages outweigh the relative costs of the operations abroad". He also categorized FDI as a firm-level strategy decision and not as capital-market financial one.

4. **The Eclectic Paradigm of Dunning**

   Among all the existent explanations of FDI, the eclectic theory developed by professor Dunning[13] [14] [15] is the most rated one and it is, actually, a mix of three different theories on the same topic (O-L-I):

   1. "O" as Ownership advantages.

      This is referred to intangible assets: they may be transferred within transnational companies at a low cost, enabling to reduce general costs.

      In order to enter a foreign market successfully, a company must have certain characteristics which make possible to overcome operating costs in that foreign market. These special characteristics are the property competences or the specific benefits of the organization. Taking advantage from them in foreign economies can lead to achieve higher marginal profitability or lower marginal cost than local competitors. The three main types of specific advantages are:

      a. ownership of natural limited resources, patents, trademarks;
      b. technology;
      c. economies of learning, economies of scale and scope, greater access to financial capital.

2. “L” as Location.

   Location advantages are the key factors in the choice determination of which country will become the host for the activities of MNCs.

   Specific location advantages of a country can be split into three classes:

   a. Economic benefits: factors of productions, costs of transport, telecommunications, market size, and so on;
   b. Political advantages: common and specific government policies that affect FDI flows;
   c. Social advantages: distance between home and host countries, cultural diversity, attitude towards strangers, etc.

3. “I” as Internalisation.

   Supposing the first two conditions are met, it must be profitable for the enterprise to exploit the above advantages. This can be done in different ways, ranging from sale of goods and services to various agreements that might be signed among companies.

OLI parameters can vary from firm to firm and depend also on the economic, political and social context of the host country (and sometimes the home one, too). Thus, companies strategies and the magnitude of production are strictly related to the opportunities offered by the different types of countries.[2]

1.2. FDI DETERMINANTS

1.2.1. Outflow motives

The most common classification about FDI motives corresponds to the “classic” taxonomy proposed by John Dunning ([16] [17]). He split FDI motives into four different categories:

a. Natural resource seeking

Natural resource seekers are those firms which invest abroad so as to acquire specific resources that do not exist, or exist but at higher costs, in their home country. These resources range from physical ones (such as oil and gas) to unskilled and semi-skilled labor, including also technological and managerial capabilities.

b. Market seeking

Market seeker companies invest in foreign countries to locally supply goods or services in completely new markets or in the ones they previously served through exports. This

usually happen when the firm believes that entering a foreign market can generate profit, due to the fact that there is room for new entrants in it or because it is expected to grow. A direct presence of a foreign firm on a local market is very important, since companies which are not close to the markets they serve may incur in difficulties in adapting services and goods to the needs, tastes and trends of those markets.

Another possible reason for this event to happen is related to the need of following main suppliers/clients abroad to retain business.

c. **Efficiency seeking**

Efficiency seekers aim at gaining from common governance of geographically dispersed activities through economies of scale, economies of scope and risk diversification or by exploiting the benefits of different factor endowments, cultures, institutional arrangements, and economic systems in foreign countries.

d. **Strategic asset seeking**

Strategic assets are intangible resources linked with the core competences of the company itself. In the specific they are patents, knowledge, employee unique skills and strategic supplies. A quick way to obtain those special resources is by acquiring them from foreign corporations. Another possible solution is to participate in some form of alliance in order to take advantage of them from other companies.

Unlike the previous three types, this FDI motive is not focused on exploiting the advantages firms already possess but on obtaining new ones that can contribute to long-term competitiveness.[18] [19]

1.2.2. Inflow attractiveness factors

In the last decades lots of empirical studies have been carried out on different countries all around the world in order to find out and analyze deeper the possible determinants for FDI inflow attractiveness. Nowadays it is possible to classify them as follows:

1. **Trade openness**

Trade openness is measured as the ratio of total trade within the economy of a country, i.e. the sum of total exports and imports to GDP. It is considered as an important variable affecting the level of FDI inflows. Some important factors which can influence trade openness are trade barriers and trade restrictions imposed by host countries, as they tend to discourage MNCs to invest in that economy.

Empirical studies focused on trade openness impact lead to diverging results. While studying the FDI determinants in Nigeria, Nurudeen et al.[20] find a strong link between trade openness and inward FDI; Mateev's research[21], instead, which examines Central and Southeastern Europe (CSE) countries employing the OLI framework, shows that trade openness does not have a statistically significant impact on FDI.

2. **Labour cost**

This variable is usually measured with wage rate and reflects the percentage change of labour cost in a host country. It is a common belief that cheaper labour costs tend to encourage MNCs to invest in foreign markets so as to cut down production costs.

However, heterogeneous effects for the association labour cost - FDI inflows have been found. According to Sahoo[22], FDI is positively associated with wage rates, regarding skilled labour markets in South Asia, where there is a large availability of skilled labour force supply (which is very important for the success of MNCs in the region). Indeed, the price of skilled labour force in this region is far lower than in developed economies. On the other hand, Vijayakumar et al.'s findings[23] point out the negative correlation between labour cost and inward FDI in BRIC (Brazil-Russia-India-China) countries.

3. **Market size**

Market size measurement can be proxied by GNP, GDP per capita or GDP. This is one of the most important FDI determinants. The larger the market in the host country, the higher the probability to attract foreign firms which, in turn, can lead to improve general competitiveness. Furthermore, the larger the market, the more opportunities for MNCs to achieve economies of scale, lowering production costs.

The positive correlation between market size and inward FDI has found confirmation in numerous studies on several countries (see for instance Vijayakumar et al.[23]). However, it must be considered that some countries, such as Singapore and Malaysia, despite their smaller markets if compared to Argentina, Brazil and India, show an high efficiency in attracting foreign investment anyway, because of their more friendly FDI policies[24].

4. **Labour quality**

High-skilled workers are more likely to adapt to changes and are, overall, more productive than low-skilled employees. Usually, MNCs look for the availability of labour quality in the host countries based on their specific strategic goals and the

industry they compete in: MNCs which want to achieve economies of scale are not interested in the quality, in contrast to high-tech industries firms[17].

5. **Infrastructure**

The quality of infrastructure is relevant for the pace of development, production and growth rates. Hence, infrastructure variable can significantly impact foreign firms level of productivity and efficiency in a host country and, therefore, determine the magnitude of FDI attracted.

According to Kumar[25], MNCs carefully consider the availability and the quality of transports, telecommunications, water and power supply in a potential host country. This means that the more governments invest in infrastructure that can match with MNCs strategies, the greater the opportunities to attract foreign investment. According to Baker[26], developed economies are able to attract larger shares of FDI compared to less developed countries thanks to better infrastructure quality. Anyway, this topic will be further analyzed in chapter 4.1, when talking specifically about China.

6. **Tax rate**

Fiscal country policies can affect the attractiveness of FDI flows, too. Firms tend to invest in foreign markets with lower tax rates (usually proxied by corporate tax in empirical studies) with respect to their home countries. Sometimes host countries can establish free trade zones to provide tax relief so as to attract more MNCs.

Unlike the other FDI determinants, tax rates has not been deeply explored, although the few contributions agree in stating that lower tax rates have a positive impact on FDI attractiveness (for example [27]).

7. **Exchange rates**

Exchange rate volatility and currency appreciation/depreciation are two important factors that significantly impact on the level of FDI inflows in a country.

Abbott et al.[28], in an analysis of 70 developing countries from 1985 to 2004, find that countries with fixed currency regimes managed to attract more FDI than the ones with floating currency regimes. Instead, Takagi and Shi[29] conclude that a higher volatility leads to higher FDI inflows in 9 Asian economies. Dewenter's paper[30] shows that depreciation of the USD had a positive effect in attracting higher levels of FDI in the USA.

Among all the possible factors examined, probably labour quality and labour costs represent the most significant incentives for developing countries to attract FDI flows.[31]

1.3. DIFFERENT KINDS OF FDI

FDI can take several different forms. They are mainly split into:

a. **Horizontal FDI**

   A foreign direct investment is considered as horizontal when a business expands its domestic operations to a foreign country, keeping on conducting the same activities and remaining in the same business, but penetrating the new local market. Indeed, the main objective of horizontal FDI is market seeking.

   This kind of FDI exploits the possibility of avoiding transportation costs while having direct access to markets in more than one country.

   Example: McDonald's opening restaurants in Japan.

b. **Vertical FDI**

   Vertical FDI aims at efficiency seeking: export oriented vertical multinationals geographically separate the stages of their production in order to take advantage from production cost differences across countries (inputs costs, workforce costs, etc…).

   A possible drawback of this type of strategy is related to additional transportation costs.

   Example: McDonald's purchases a large-scale farm in Canada to produce meat for their restaurants.

c. **Conglomerate FDI**

   When a business acquires an unrelated business in a foreign country. This is quite uncommon, since it requires overcoming not only the entry barrier of entering in a foreign country but also the one of penetrating a new industry or market.

   Example: Virgin Group, which is based in the United Kingdom, acquires a clothing line in France.

d. **Export-platform FDI**

   Related to multinational corporations which expand into a foreign country but the output from the foreign operations is exported to a third country. Platform FDI tend to locate to low-cost locations inside free-trade areas.

Example: Ford purchases manufacturing plants in Ireland with the purpose of exporting cars to other countries in the EU.

1.4. FDI ECONOMIC SPILLOVERS IN HOST COUNTRIES

As previously mentioned, it is known that FDI flows can provide a number of benefits to local enterprises in a host country and, as direct consequence, to the host country economy itself. The list of these benefits includes increasing in productivity, technological improvements, knowhow transfer, providing international production networks, reducing unemployment and access to external markets[3]. Overall, these positive spillovers can translate into an increase in GDP and an improvement in economic terms for the recipient country.

In the following pages it will be explained how and in which extent the positive effects of FDI inflows can be absorbed by local domestic firms.

- **Spillovers channels**

There are five main channels through which domestic firms may take advantage from FDI spillovers:

1. **Demonstration/imitation**

   Demonstration (by MNCs)/imitation (by domestic firms) is probably the most evident spillover channel. It deals with the fact that, if a certain technology used by a Multi National Enterprises (MNEs) turns out to be very efficient, domestic firms will be encouraged to adopt it. According to Barrios and Strobl[32], in case of spillovers related to product and process technology, the magnitude of this effect is positively correlated with the similarity of the goods produced by the two types of firms. However, also other kinds of technologies may spill over, like management and marketing ones. In these cases, similarity of products may not be so important.

2. **Labor mobility**

   The second channel is related to the possibility for domestic firms of hiring workers who previously worked for MNEs: they can bring an high degree of knowledge and experience to the local firm, also enabling the learning and application of new technologies. A drawback of this channel is the other way round, i.e. that MNCs may attract the best workers from domestic firms by offering higher wages.

3. **Exports**

   Several studies (like [33]) have highlighted the positive impact of FDI on the export capacity of domestic firms. Through imitation or collaboration with MNEs, in fact, they can learn how to reduce entry costs in foreign market.

4. **Competition**

   The increased degree of competition induced by the presence of foreign corporation in the domestic economy is, on the one hand, an incentive for domestic firms to make a more efficient use of existing resources and technology or even to adopt newer and more efficient technologies; on the other hand, it may decrease the market power and market share of local firms.

5. **Backward and forward linkages with domestic firms**

   Last channel is about the relationships that domestic firms establish in local markets as MNCs suppliers (backward linkages) or as customers of intermediate inputs always produced by foreign companies (forward linkages).

   Talking about the case of backward linkages, the presence of MNEs may benefit domestic suppliers if it increases the demand for local inputs. Trying to assure a certain quality pattern, Multi National Enterprises may also help domestic suppliers in several ways: by providing technical support for the improvement of the goods quality or for the introduction of innovations (e.g. through personnel training); by providing support for the creation of new infrastructures and for the acquisition of raw materials; by providing support at organizational and managerial levels[34]. It has to be considered also the possible increase in the production efficiency of local firms due to the competition among them in order to become MNEs suppliers.

   Regarding forward linkages, the most evident one is related to the MNCs supply of higher quality inputs and/or at a lower price toward domestic producers of end-user consumer goods[35].[36]

- **Spillovers determinants**

The magnitude of FDI spillovers absorbed by domestic firms depend on a set of factors related to the characteristics of the MNEs and of foreign investment, as well as on the characteristics of the host countries, sectors, and local firms themselves:

a. **Absorptive capacity and technological gap**

The absorptive capacity of domestic firms is one of the most analyzed factors of FDI spillovers, alongside the influence of the technological gap between foreign and domestic firms.

According to several authors like Wang & Blomstrom[37], the magnitude of FDI spillovers increases with the technological gap: a greater gap increases the opportunities for domestic firms to obtain higher levels of efficiency via imitation of foreign technology. However, if the gap is too wide, it may prevent domestic firms from understanding and absorbing the MNEs technological advantage. The point is that technology diffusion does not happen automatically due to the sole existence of a higher knowledge base of foreign companies, but it also requires that the recipient organization have the capacity to absorb and adopt such technology. A commonly used indicator to measure the absorptive capacity of domestic firms is their level of R&D spending.

b. Domestic firm characteristics

Two main firm characteristics may affect the magnitude of foreign investment spillovers: the export capacity and the size.

About the former, those domestic firms with a past experience in exporting abroad and hence already exposed to foreign competition, can probably suffer less from the pressure of MNCs entrance in the host market[38] and can, moreover, have greater opportunities to absorb new foreign technologies from MNCs located in the host country.

The size of domestic firms, instead, could be significant since smaller firms may be less capable of adapting to the competition with MNEs in terms of employment or production, ending up in suffering from significant losses[39]. Furthermore, such firms may not have a sufficient production scale to imitate successfully the foreign technologies. On the other way round, larger firms are expected to benefit more from the presence of foreign companies.

c. FDI characteristics

The different sources (origin country) of FDI are associated to several factors, such as culture, language, levels of technology, modes of technology transfer, distance and the sectoral structures of FDI.

According to Rodriguez-Clare[40], backward linkages depend positively on transport costs (hence on distance) between the home and host countries. If these costs are too high, MNEs may have an incentive to buy inputs directly in the host country.

Differences in cultures and languages may limit the domestic firms capacity to assimilate the new technologies.

About the entry mode of FDI, it has been demonstrated that, when an MNC enters the local market through a merger or acquisition, technological transfer occurs gradually, delaying spillovers. The other side of the coin is that, being the starting point the host country lower technology, there is a wide potential for FDI spillovers to happen through demonstration. On the contrary, when FDI occurs through greenfield investment, the introduction of the new technology is instantaneous (Braconier et al.[41]) but it could differ substantially from that in the host country, thus limiting the spillovers effect.

Another relevant factor for FDI spillovers to take place is the degree of foreign ownership of the investment project. A lower foreign ownership percentage reduces the incentive for the parent firm to transfer advanced technology to its affiliate, due to its small control over the management. Hence, overall the possibility for the technological transfer to occur increases with the degree of foreign ownership[42].

d. Other factors

Some researchers have found out a strict relation between the host country trade policy and the indirect benefits from FDI. In particular, Bhagwati, in 1978[43], hypothesized that an outward-oriented regime is more likely to attract a greater share of FDI compared to an import substituting regime.

Intellectual property rights are another important factor for spillovers occurrence: the weaker the protection, the higher the chances to attract FDI of a low-technology level[44]. Furthermore, intellectual property rights can be considered as an additional cost for local firms which attempt to imitate foreign ones and, thus, they could represent a limitation on the potential benefits of FDI spillovers on domestic firms.

There are two other factors which can determine the existence of FDI spillovers, which are linked to labor mobility: the type of training received by workers at MNEs and the existence of restrictions on labor mobility[45]. About the former, if a worker has received training in a firm-specific technology, for local firms could be less advantageous to hire him, as it is more costly to adapt him to their own production process. The last point concerns the fact that restrictions on labor mobility limit the transfer of workers from MNEs to domestic firms and, as such, the occurrence of spillovers through the related channel.[36]

1.4.1. FDI - income inequality in developing - developed countries

In this final section the focus is on a specific study lately carried out by Van Bon Nguyen[46], which investigates on the possibility that FDI inflows have a different influence on income inequality between countries with good institutional environments and countries with poor ones.

The hypothesis is that under the good institutional environment in developed countries, policies and regulations are designed in a manner that allows to selectively receive certain types of FDI inflows so as to avoid possible negative impacts, both from an economic and environmental point of view. Indeed, in this way high-quality FDI inflows, i.e. those related to advanced-green technology and high management level, are more likely to be attracted and are strictly monitored. The characteristic of these FDI flows is that they mostly employ highly qualified and skilled workers, who are high-income people in most cases. Consequently, this kind of FDI makes income of high-income people increase further, widening the income gap between high-income and low-income people, thus stimulating income inequality.

Instead, under the poor institutional environment belonging to developing countries, policies and regulations are drawn to attract all FDI inflow types, in order to deal with the shortage of domestic investment capital and unemployment. Therefore, also low-quality FDI inflows, which imply outdated technology and low management level, are quite often welcomed. They usually employ many unqualified and unskilled workers, most of whom are low-income people. Hence, these FDI inflows tend to increase the income of low-income people, narrowing the income gap between high-income and low-income people, and, in turn, reducing income inequality. However, low-quality FDI inflows can bring along adverse effects, especially in terms of environmental pollution, as it will be shown later in this thesis.

Van Bon Nguyen's work, by using governance indicators and FDI index data from 24 developed countries with a good governance environment and 37 developing countries with a poor governance environment over the period of 2005–2018, manages to find empirical confirmation of the theoretical framework described above: FDI flows attracted by the two different groups of countries tend to increase income inequality in developed countries while to decrease it in developing ones.[46]

2. ENVIRONMENTAL REGULATIONS

The world is getting more and more threatened by increasing environmental pressures that affect human lives and economies, especially climate change and air pollution. Climate change is a real danger, as highlighted by the increasing frequency and intensity of extreme weather events. Economic losses incurred from weather-related disasters amounted to an estimated 470 billion dollars in 2017, and these numbers are expected to grow substantially in the near future[47]. About the air pollution issue, it is known that high levels of air pollution are a major threat to human health, being responsible for 7 million deaths annually (one in eight deaths globally).

In order to address these challenges, countries have always being more involved in environmental targets and policy action. The issue of climate change came to international attention with the United Nations (UN) Conference on Environment and Development held in Rio de Janeiro in 1992. The main result of the summit was the agreement of the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC was followed by the Kyoto Protocol of 1997, then by the non-binding Copenhagen Accord of 2009, the legally binding Cancun agreement of 2010, the Durban Platform for Enhanced Action in 2011, and finally the Paris Agreement of 2015, with which the international community pledged to limit global warming to well below 2°C [48]. In the meanwhile, countries representing 70% of the world global carbon emissions have already announced net zero emission targets.
However, it seems not enough and further policy actions are necessary. With the currently implemented policies, average global temperatures are expected to raise of about 2.7°C by end of the century, increasing the likelihood of catastrophic impacts for our economies and societies[49].

Policy stringency is defined as a higher cost (explicit or implicit) of polluting or environmentally harmful behaviour. For instruments like taxes, a higher price on a unit of pollutant implies higher stringency; lower (stricter) emission limit values have a similar interpretation. Instead, for subsidising instruments (such as feed-in tariffs or subsidies to R&D), a higher subsidy implies more stringent environmental policy as such subsidies increase the opportunity costs of polluting and can be assumed to be paid by the most of tax payers or consumers (externality), providing an advantage to “cleaner” activity[50].

As countries implement stricter environmental policies, the need for tools to measure, compare and evaluate their impacts is urgently rising. Measuring policy stringency across countries and time is useful mainly to three purposes:

1. to monitor and track environmental countries progress;
2. to compare environmental policy stringency across countries, since benchmarking can help countries learn from each other in adopting more ambitious environmental policies;
3. to evaluate the impact of environmental policies on pollution, economic and social outcomes; indeed, understanding the impacts of environmental policies on workers, firms and households is necessary to protect and compensate particularly affected and vulnerable groups and to avoid regressive policy effects[49].

An ideal measure of environmental regulatory stringency should meet several requirements. In particular, it should be simple to calculate, produced annually, show a cardinal form, be suitable for measuring various pollutants and media, and related to industry costs without being mechanically determined by industry composition[51].

2.1. MEASURING ENVIRONMENTAL STRINGENCY

2.1.1. Issues in measuring environmental stringency

Real obstacles in measuring stringency, apart from ordinary difficulties of data collection, are related to deep conceptual issues that can be grouped into four main categories: multidimensionality, simultaneity, industrial composition, and capital vintage.

1. **Multidimensionality**

   The point is that environmental regulations cannot be easily captured by a single measure of stringency. Governments regulate several environmental media: air, water, solid and hazardous waste. There exist different regulations for controlling the level of different pollutants (such as sulphur dioxide, sewage, toxic chemicals, etc.) into the different media. These regulations set standards for total emissions, emissions concentrations, ambient environmental quality, or for the technologies employed by producers[52].

   Multidimensionality negatively affects stringency measurement by posing several problems.

The first is that some regulations may be irrelevant to some of the policy questions asked, because either they target the wrong sector or they target emissions when ambient quality matters or vice versa. An example for the latter case is represented by the US Clean Air Act, which sets uniform National Ambient Air Quality Standards (NAAQS) for six criteria pollutants. This implies that, in terms of ambient standards, every county in the US faces the same level of stringency but, in order to meet those standards, some counties must impose costly emissions requirements while others do not. For instance, in Los Angeles, where the local mountains trap air pollution over the city for days at a time, the NAAQS are costly to meet, while in Honolulu, where trade winds quickly blow air pollution out over the Pacific, air quality easily meets the NAAQS. So does this mean that air quality regulations in Los Angeles are more stringent than in Honolulu? It is quite ambiguous to answer this question, since on the one hand the ambient standards in both cities are equal to the uniform NAAQS but on the other hand they impose higher costs for those businesses located in Los Angeles.

A second problem related to multidimensionality is that complex regulations are not easy to compare. Example: the US standards for toxic emissions from industrial boilers (issued in 2012) are 2.0-3.0 short tons per year of mercury and 580 000 short tons per year of sulphur dioxide. It is not trivial to suddenly understand which is more stringent.

To deal with multidimensionality issue, two different ways can be followed:

- Some scholars address multidimensionality by focusing on one specific narrow environmental problem with directly comparable stringency measures. For instance, Levinson[53] narrowed the multidimensionality by focusing on taxes on the disposal of hazardous waste, hence a single dimension along which countries might compete and which is easily measurable, comparable, and targeted.

  This focused approach show two main advantages: a high degree of accuracy in identifying the appropriate regulations and allowing comparability across regulations. The drawback, instead, is that the results might not be generalizable.
- The second way implies avoiding multidimensionality problem by constructing composite indexes of or proxies for environmental stringency. An example can be the study carried out by Cole and Elliott[54], who created an index based on a survey sent to each UN member country asking for details about their environmental policies, legislation and enforcement.

The advantages of using composite indexes are significant, since they can summarize a multidimensional concept in one number, they can be applied to entire economies, and they are generalizable. However, while they may be useful to rank countries stringency levels, they cannot assess their intensity, i.e. they are ordinal rather than cardinal.

2. **Simultaneity**

Simultaneity concerns with the fact that, if it is true that the level of regulatory stringency determines some consequences, at the same time also its vice-versa may be true, that is sometimes also consequences can contribute to determine the level of regulations. A fitting example is the following one: countries which are home of lots of polluting industries may react by imposing stringent standards to solve their environmental problems but, according to the simultaneity effect, if these pollution-intensive industries have a great share in the economy of those countries, they may pressure their governments to enact less stringent regulations. In few words, it is not simple to know the effect of regulations on economic outcomes, since they cannot be easily separated from the effect of those outcomes on environmental regulations.

Researchers have found out two ways to deal with simultaneity obstacle: natural experiments and instrumental variables.

- Natural experiments involve situations in which the stringency of regulations is determined by external forces. The best examples of this approach are linked to McConnell and Schwab's[55] and Henderson's[56] works. They made use of the US Clean Air Act, which imposed uniform national ambient standards (the NAAQS mentioned earlier) on every county in the US. When the standards were imposed, those counties whose air quality fell below the minimum permitted level were forced to impose stricter emissions regulations. While state and local air-pollution emissions regulations could have been simultaneously determined by local economic activities, the *changes* in local regulations forced by the federal Clean Air Act could not. And, consequently, changes in economic activity that followed federal law changes were interpreted as causal results of changes in regulatory stringency.

  The problem with this solution to the simultaneity problem is that natural experiments are scarce in number. Indeed, there are very few examples of

jurisdictions which have been forced by outside circumstances to adopt regulations with varying levels of stringency.

- An alternative solution is represented by a statistical approximation of natural experiments: instrumental variables. It deals with finding some specific observable variables correlated with regulatory stringency but uncorrelated with the measure of economic activity, if not indirectly through its relationship to stringency. Unfortunately, examples of such instrumental variables are very few as well, and are subject to the criticism that they are invalid since they affect economic outcomes also in a direct way.

3. Industrial composition

This problem is related to a fundamental economic principle dating back to Adam Smith and David Ricardo, namely the "comparative advantage". Countries usually specialize in the production and export of those goods that they can produce relatively inexpensively (importing all the other needed ones), thanks to some factors, like natural resources, labour skills, proximity to transportation, agricultural conditions and regulatory stringency. Consequently, countries differ in the mix of products they manufacture and export. While some of these differences in industrial composition depend on regulatory stringency, others arise from the other sources of comparative advantage, and some of them may be correlated with stringency itself but cannot be measured.

The problem here is that, differing in industrial compositions across the different states, it becomes complicated to measure stringency based on pollution abatement costs: countries with relatively more pollution-intensive industries will spend more on pollution abatement, even if every country has exactly the same regulations, and hence countries with more polluting industries will appear to be more stringent.

This issue is, actually, a particular example of simultaneity. In fact, supposing that a researcher wants to measure the effect of environmental regulatory stringency on net imports of goods from pollution-intensive industries, these imports can be affected by the various sources of comparative advantage; if some unknown measure of comparative advantage attracts polluting industries, the jurisdiction could both have high average pollution abatement costs even if its stringency is the same as elsewhere, and react to the resulting pollution by enacting more stringent environmental regulations than elsewhere.

4. **Capital vintage**

   Capital vintage is related to a particular characteristic of several environmental regulations: they are "grandfathered" or "vintage-differentiated" if they are more stringent for new sources of pollution rather than for existing ones.

   An example to clarify this point is about automobile emissions rules. All around the world governments have imposed standards on allowable vehicle emissions, but the strictest ones apply only to new cars. This can end up with people keeping their existing cars longer than they would have otherwise, resulting in higher aggregate emissions[57].

   "Grandfathering rule" applies to a huge number of industrial pollution regulations. The US Clean Air Act defines "New Source Performance Standards" for large industrial sources of pollution that are new or significantly modified. This generates a disincentive for new development and, at the same time, a protection for existing industries against new competitors.

   "Grandfathering" can significantly bias measurements of regulatory stringency. For instance, if the measurement is based on pollution-abatement costs incurred, a strict regulation which grandfathers existing sources may result in no new development and low abatement costs. A less stringent regulation or one that does not grandfather existing sources might result, instead, in new development and higher abatement expenditures.

These four obstacles make it harder to measure environmental regulations and they should never be ignored while carrying out such a measurement, interpreting carefully the obtained results.[51]

2.1.2. Approaches to measure environmental stringency

Now that the possible obstacles in measuring environmental regulation stringency have been explained, the main methodologies used for measurements will be analyzed, by splitting them in different categories:

1. **Private sector cost measures**

   For this category it is possible to identify two different methods used from researchers.

   a. **Surveys of businesses abatement expenditures**

      In this first group, measurements based on surveys of industries about their pollution abatement expenditures are gathered. The earliest example dates back to the US Pollution Abatement Costs and Expenditures (PACE) survey, conducted annually by the US Census Bureau from 1973 until 1994, when it was discontinued.

PACE surveys have been used to construct measures of regulatory stringency for US states by a lot of researchers, such as Levinson[58], who exploited it to estimate how much more (or less) manufacturers spent on pollution abatement in each county, controlling for other characteristics of the manufacturers in that state, including the book value of capital, the number of production workers, value added, an indicator for new plants, industry dummies, and dummies for each US state.

Apparently, the PACE survey might appear to be the right solution needed to measure stringency since it reports the costs incurred to abate pollution. However, it actually collects data by asking managers of industrial firms to provide information, and those survey questions have become more and more difficult to be answered in time. Indeed, while in the 1970s, when the survey was launched, standards set by regulations were often met by "end-of-pipe" solutions (scrubbers on smokestacks, filters on wastewater outlets, and proper disposal of hazardous waste) and was not so hard to reasonably assess expenditures for new capital equipment and operating costs due to the new environmental efforts, today environmental objectives have become integrated into the design of products and processes. Firms, in order to comply with regulations, have completely changed their manufacturing technologies, switched to energy sources, increased recycling, and changed the whole design of their products. Therefore, nowadays it is no more so trivial for respondents to answer to these survey questions. To answer properly, they would have to report how much less their businesses would have spent on capital equipment and operating expenses if there had been no environmental considerations. Moreover, even if respondents were able to accurately report environmental costs, those costs would be different from place to place, due to many factors unrelated to regulatory stringency and even states facing the same regulations might face very different costs.

It must be mentioned that, about the time the US stopped collecting PACE data, then Canada and the EU began their own surveys (the Canada's Survey of Environmental Protection Expenditures (SEPE) and the joint OECD/Eurostat Questionnaire on Environmental Protection Expenditure and Revenues).

Overall, surveys of businesses abatement expenditures benefit from the advantage of varying over time, and across industries and countries. But surveys are not limited to costs related to environmental regulations, and they only measure incumbent firms costs, which may differ from potential new entrants costs if regulations are

vintage-differentiated (see later). Moreover, as previously mentioned, these surveys ask respondents to distinguish costs incurred for environmental reasons from those incurred for other goals, a task they may not be able to accomplish.

b. Shadow price approach

Taking advantage of the "shadow price" function, a lot of research managed to avoid the issue related to surveys, relying on the use of economic theory and choices made by firms to calculate pollution abatement costs indirectly. Van Soest[59] defined the shadow price of an input as "the potential reduction in expenditures on other variable inputs that can be achieved by using an additional unit of the input under consideration (while maintaining the level of output)."

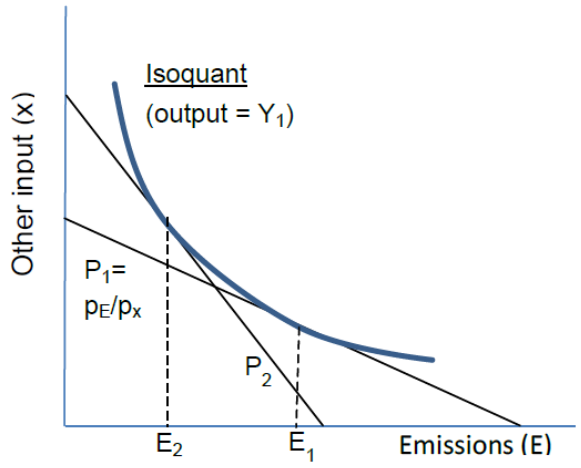

Figure 4 – The shadow price approach[51]

Following the graph in Figure 4, it is possible to observe how the curved isoquant depicts all the combinations of inputs that can be used to produce output Y_1. The two inputs taken into account are emissions (E) and one other generic input (X). When there is no regulation, the price of emissions (p_E) is zero (or very low). In the situation in which the emissions price is low and the prices of other inputs (p_X) are high, as the price ratio P_1 indicates, a profit maximizing firm will choose to use more emissions (E_1) and less of other inputs. When, instead, the price of emissions is higher (maybe due to stringent regulations), the firm will choose lower emissions (E_2). The aim of this function is to estimate the price of emissions (p_E). That price could be an explicit tax, but it is more likely to be a hidden cost resulting from the different direct and indirect regulations imposed in each country. This is the reason why it is called the "shadow price" of pollution.

The key point in using this approach is that all of the prices and quantities in Figure 4 except for the price of emissions can be found in government files. Considering that the firms are profit maximizing, that the output (Y) is known, as well as the amounts of all inputs used (X), the amount of emissions (E) and the prices of all the other inputs (p_x), then it is possible to calculate the implicit or "shadow" price of emissions (p_E).

This method to measure environmental regulatory stringency show several advantages. In fact, it studies firms actual production decisions and deduces the emissions price under which these decisions would be profit-maximizing, incorporating all of the various regulations and incentives into one cardinal measure of costs. Plus, the shadow cost of pollution can be used as measure of regulatory stringency, across countries, industries, years and pollutants.

On the other hand, the shadow price approach is more complex than surveys. Furthermore, as surveys, it takes into account expenditures that are not necessarily the result of regulatory stringency and they measure costs only for existing firms, which may be differ from the costs that would be faced by new entrants.

2. Regulation-based measures

A possible alternative to the use of costs imposed by the regulations as a measure of stringency is to use some direct assessments of the regulation itself. However, it is quite complex since such a measure would be affected by both multidimensionality (there is no a single measure of national regulatory stringency) and simultaneity. For these problems, very few studies have followed this path.

Most of these works exploited the already mentioned US Clean Air Act as a natural experiment (see for instance [60]), since its standardized air quality standards (the NAAQS) can solve both problems: as said, they apply generally to six common air pollutants, so that they can be seen as a general measure of multidimensional stringency and, at the same time, they are set by the federal government and applied to every state in the US, hence they are not simultaneously determined by any county economic or environmental conditions. Counties which fail to meet the NAAQS requirements are forced to impose more stringent policies and several studies used the binary measure of "whether or not the country is in compliance with the NAAQS", as an indicator of regulatory stringency.

But the problem is always that there is a little number of examples around the world of externally imposed environmental regulations like the NAAQS. Moreover, the results from research focused to NAAQS standards cannot be generalized to standards imposed for other pollutants or by other countries.

Another possible regulation-based approach is to use a narrow regulation-based measure, like in case of Berman and Bui[61], but also in this case results cannot be generalized beyond the conditions and outcomes of the specific examples they explore.

3. **General composite indexes**

Composite indexes can be used as indicators of countries overall environmental regulatory stringency. They are useful to rank countries by compressing the multidimensional problem down to one number.

For cross-country comparisons, a very huge number of these types of indexes have been examined. Among the earliest was a 1976 survey sent by the United Nations Conference on Trade and Development (UNCTAD) to 145 countries, asking government officials details about their environmental policies. From that moment on, those indexes have become more and more sophisticated. Several examples will be found in this thesis.

The concern with this method is that slight deviations in indexes construction might lead to large differences in rankings and findings. Moreover, they do not allow to understand the real magnitude, since usually regulations are weighed equally regardless of the actual burden they impose. For example, with these indexes it is not possible to assess whether a sector with twice the regulatory coverage faces twice the level of stringency.

See **b.** further in this paragraph for a deepening on one specific and widely-used indicator.

4. **Emissions, pollution, or energy use**

Another possible way to measure environmental stringency implies the use of emissions, ambient pollution, or energy use as measures of stringency (see later [62]). But, since regulations are designed precisely to reduce emissions, pollution and energy use, then it could be questionable if those are indicators of regulatory stringency or laxity. It depends on the situation.

For instance, some studies consider high levels of pollution as evidence that regulations are relatively lax, while others use high levels of pollution as a measure of stringency,

relying on the fact that governments will be forced to tighten regulations to deal with the problem. This ambiguity takes back to the issue of simultaneity.

Later, a particular emission-based approach is introduced (see **a.**)

5. Enforcement or public expenditures

It is possible to use some variables serving as a proxy for governmental effort (not the regulations themselves), to measure stringency.

Gray in 1997[63] exploited US states budgets for environmental and natural resources. This methodology has the advantage of including enforcement, which is an important part of stringency application, but it requires caution, as some public expenditures impose costs on the private sector (like regulatory staff and budgets for inspection and enforcement) while others relieve them (tax incentives and public clean-up efforts). A tax incentive to abate pollution can have different effects on the used approach to measure stringency: on the one hand, it increases the marginal cost of polluting and a profit-maximizing firm would respond by abating more, which would make the country policy appear more stringent for a PACE-type measure, a shadow-cost measure, and a public expenditure measure; on the other hand, it increases the profitability of pollution-intensive industries, meaning that this way of measurement would provide an ambiguous proxy for stringency since some types of public expenditures can decrease private-sector costs.

Other studies, instead, made use of state enforcement and inspection budgets, avoiding the concern that some public expenditure reduces business costs.

Overall, public-sector effort has not been widely used to measure regulatory stringency, probably because its drawbacks outweigh its advantages and because as more emissions and cost data have become available in time, the need for it as a proxy has declined.

a. A new emissions-based approach

This approach is proposed by Brunel, C. and A. Levinson[51] and it is inspired to the same microeconomic principle behind the shadow-price approach discussed previously. Considering emitting pollution as a factor of production like the others and reminding that profit-maximizing firms would use each factor of production until the marginal revenue is equal to its price, then the more environmental regulations raise the cost of emissions, the less firms will emit pollution. Therefore, it is possible to compare emissions across countries using the emissions per dollar of value added - emissions intensity - averaged across the industries of each country, as measure of regulatory

stringency. If emissions intensity in a country is high then it could be concluded that the cost of polluting is low and hence regulations are lax. On the other way round, if emissions intensity is lower, regulations must be more stringent. In details:

Calling e_j the emissions per dollar of value added in jurisdiction *j*, averaged across all industries:

$$e_j = \frac{E_j}{V_j}$$

(where E_j = total emissions added in jurisdiction *j* summed across all industries; V_j = value added in jurisdiction *j*, summed across all industries);

calling e_i the emissions per dollar of value added in industry *i*, averaged across all jurisdictions:

$$e_i = \frac{E_i}{V_i}$$

(where E_i = total emissions added in industry *i* summed across all jurisdictions; V_i = value added industry *i* summed across all jurisdictions);

then it is possible to compute $\widehat{e_j}$, the *predicted* emissions per dollar of value added in jurisdiction *j*, assuming each of its industries uses the average emissions intensity for all jurisdictions.

$$\widehat{e_j} = \frac{1}{V_j} \sum_i V_{ij}\, e_i$$

This is a prediction of jurisdiction *j*'s emissions intensity, based on its industrial composition (the V_{ij}'s) and the average emissions intensities of those industries in other jurisdictions.

If a country has a lot of high-emitting industries, we would expect it to have a high value of $\widehat{e_j}$; if its mix of industries is relatively clean, we would expect a low $\widehat{e_j}$.

From that it is possible to derive a measure for the stringency of regulations, R_j, which is just the ratio of predicted emissions intensity on actual emissions intensity:

$$R_j = \frac{\widehat{e_j}}{e_j}$$

Countries that impose higher pollution abatement costs on their industries will have actual emissions smaller than predicted ones, and hence higher levels of R_j, no matter what their industrial composition is.

The index R_j could be constructed for particular pollutants or particular media. Or it could be summed across various pollutants and media to construct a general measure of regulatory stringency. This measure could also be performed annually to observe changes over time.

The construction of this index is feasible, since only two sets of data are necessary to do it: the value added by industry and jurisdiction, which is already available, and the emissions by industry and jurisdiction, which is starting to be.

Thanks to this new stringency measure based on emissions ratios, it becomes possible to overcome three of the four conceptual obstacles previously discussed. Such a measure is strictly linked to pollution-abatement costs and can be divisible by pollutant, therefore it can be used either as a summary measure for all the multidimensional aspects of environmental policy in a country, or it can be disaggregated for particular pollutants or media. Moreover, dealing with panel data, examinations of changes in economic outcomes in response to changes in this measure can help address simultaneity issues. Finally, it can handle control for industrial composition. However, it is only informative about environmental costs faced by already existing sources of pollution. This obstacle may be unavoidable for any empirical cost-based measure of regulatory stringency.[51]

b. OECD's environmental policy stringency (EPS) indicator

Proposed by Botta and Kozluk[50] this specific approach worths a stand-alone analysis for its importance. The EPS index benefits from a number of characteristics which make it suitable for cross-country analysis:

- It constitutes the first tangible effort to measure environmental policy stringency internationally over a relatively long-time horizon.
- It shows high correlation with measures of perceived stringency, implying these policy-based measures are quite in line with business perceptions on environmental policy stringency. Moreover, it also shows high correlations with several measures in specific environmental domains, such as wastewater management and landfill rates.
- It appears to include the expected correlation signs with GDP, a number of environmental performance measures and environmental innovation proxies.

This indicator focuses initially on the energy sector (a sector that is present and of similar importance in all countries and which is a key contributor to the emissions of greenhouse gases and air pollution in most countries). In a second step, the first indicator

is extended to include three additional policy instruments from outside the energy sector in an attempt to proxy the entire economy measure of environmental policy stringency. The construction of the indicator starts with the selection and scoring of single instruments and goes on with the aggregation of the information. All variables considered in the analysis represent law-based elements of regulations, except for emission trading schemes of CO2 and Sox and for government R&D expenditures, while, for the extended indicator, additional instruments are taken into account. In the specific, they are tax on diesel for industry, deposit and refund scheme, and maximum content of sulphur allowed in diesel. This allows to extend the results to a broader coverage of the economy.

The process of scoring begins with the creation cardinal measures, which increase in value as the stringency increases and range from 0 (not existing) to 6 (most stringent), for each variable.

The scoring procedure is based on the comparison between the stringency of each instrument and the distribution of values for the same instrument across countries (and time). Therefore, it reflects the relative stringency, i.e. the country position on each instrument relative to the other countries (and years).

The second phase of the indicator construction involves the aggregation of the instrument-specific indicators into mid-level indicators according to their type. After that, the obtained mid-level indicators are grouped into the two broad categories of market-based and non-market instruments.

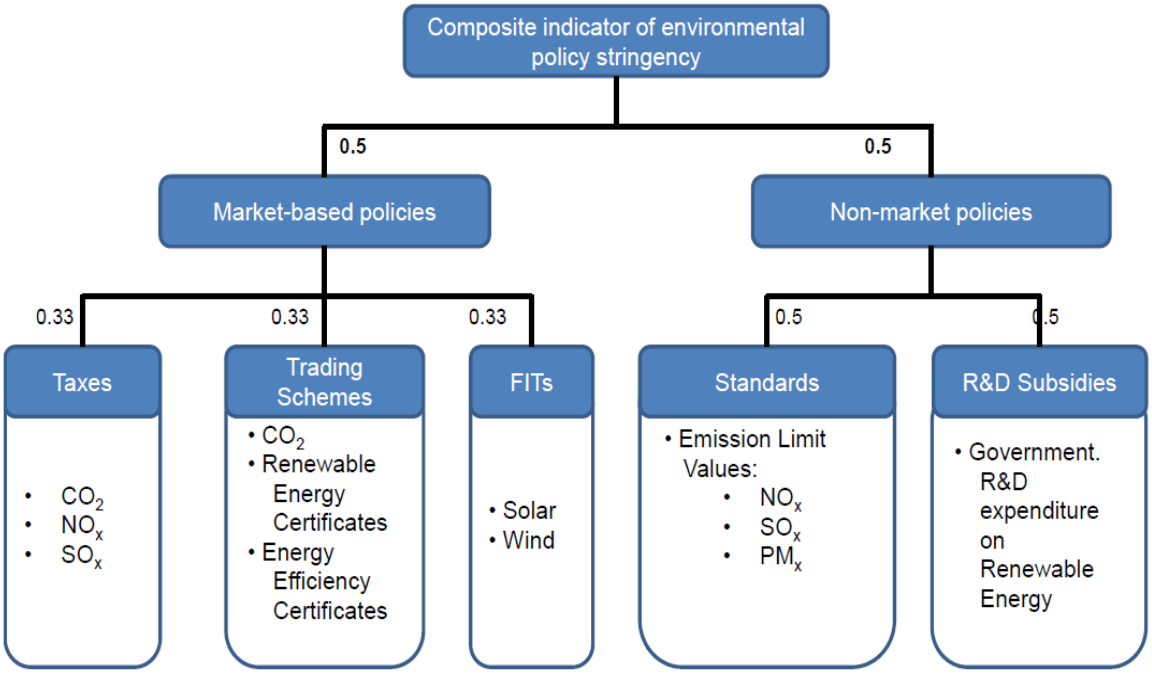

Figure 5 - Structure of the energy sector indicator[50]

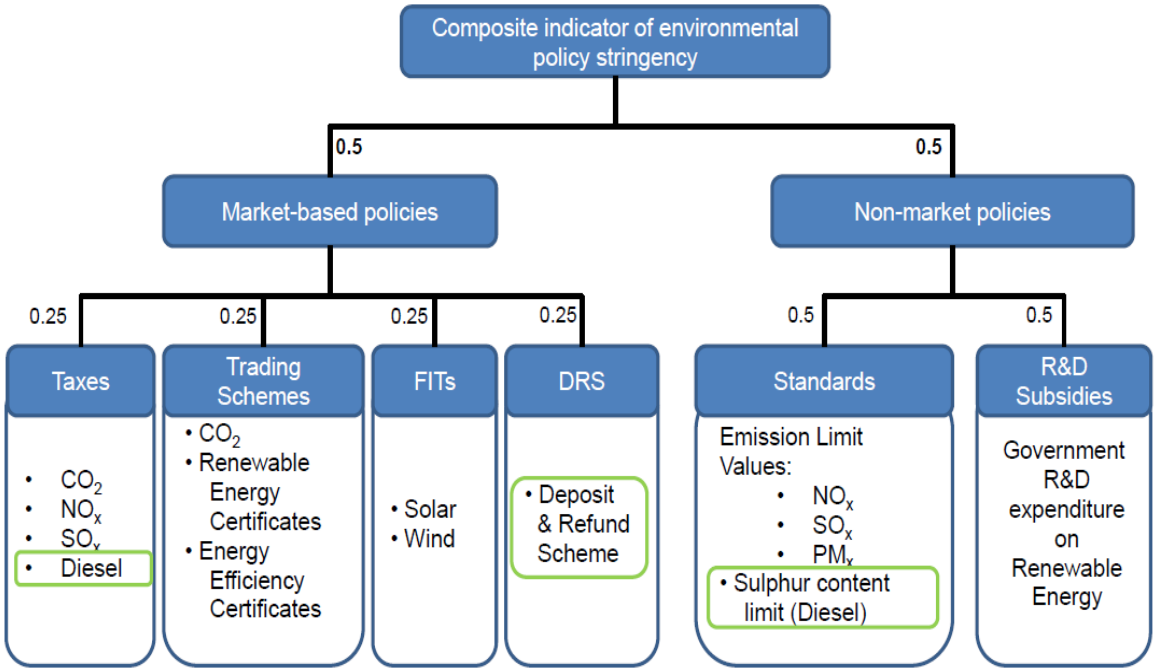

Figure 6 - Structure of the extended (economy-wide) indicator[50]

The new indicators obtained represent the stringency of environmental policy on a scale from 0 to 6, where higher numbers are associated to more stringent environmental regulations. The following graphs show the rankings obtained according to the two indexes.

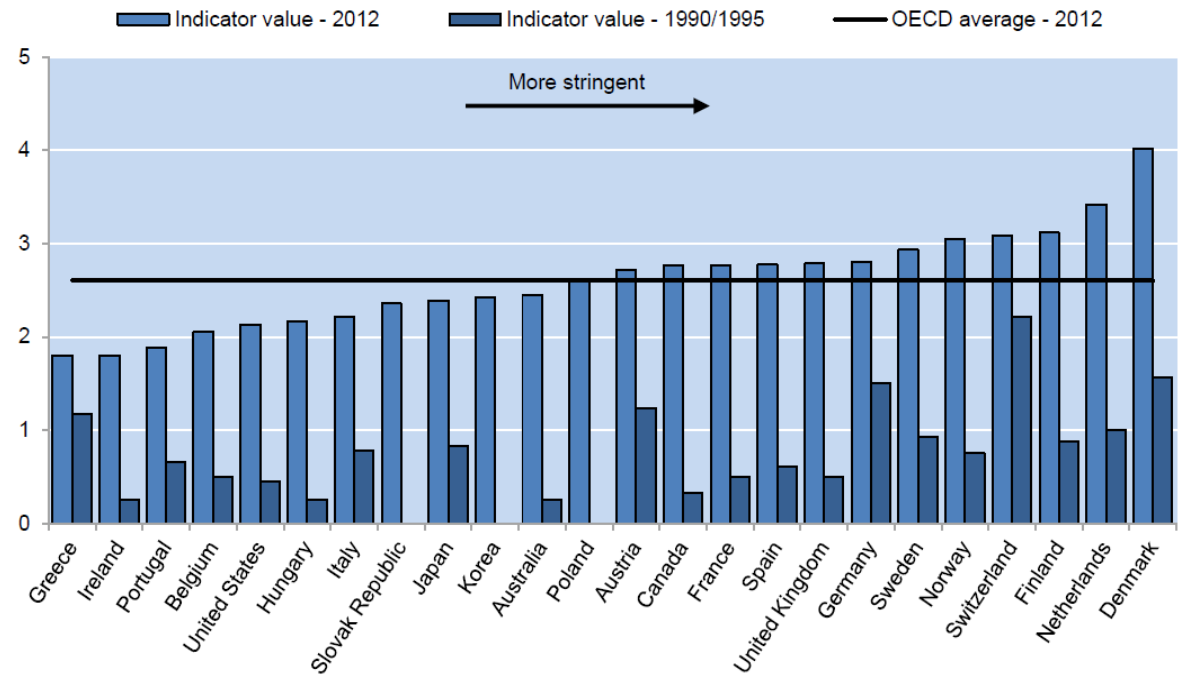

Figure 7 - Environmental policy stringency in 2012 – Energy Sector[50]

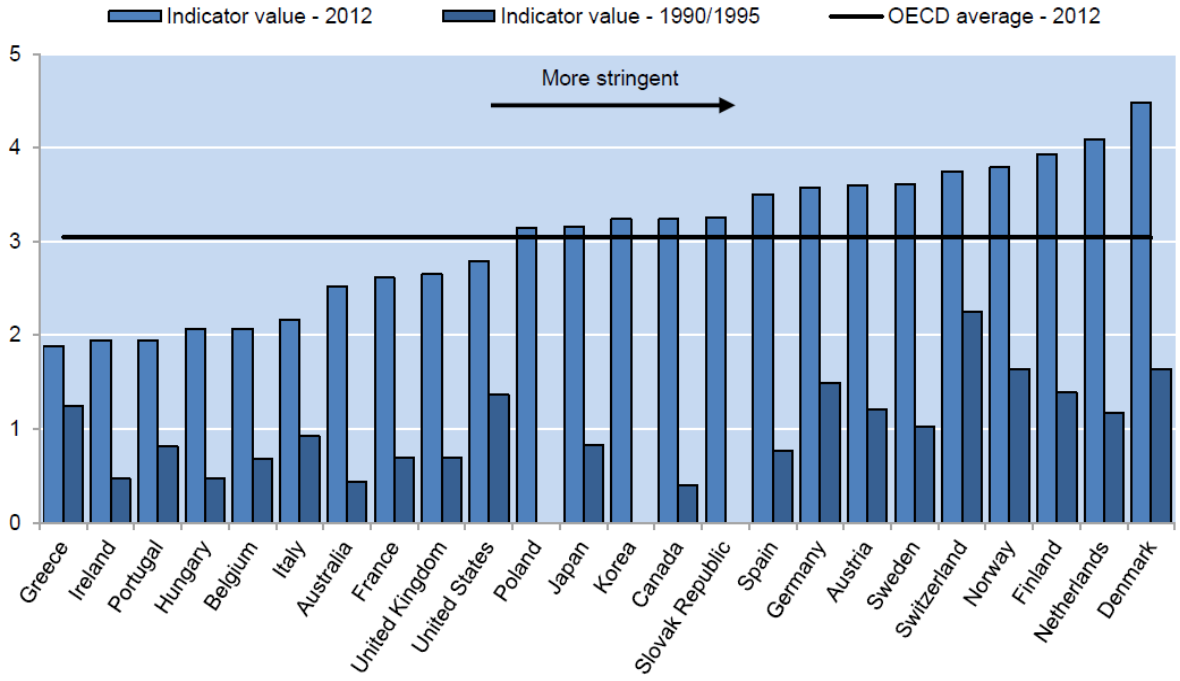

Figure 8 - Environmental policy stringency in 2012 – Extended (economy-wide) indicator[50]

As shown above, the extended indicator is strongly correlated with the energy sector one. Nevertheless, it provides some additional information especially regarding the market-based side of regulation:

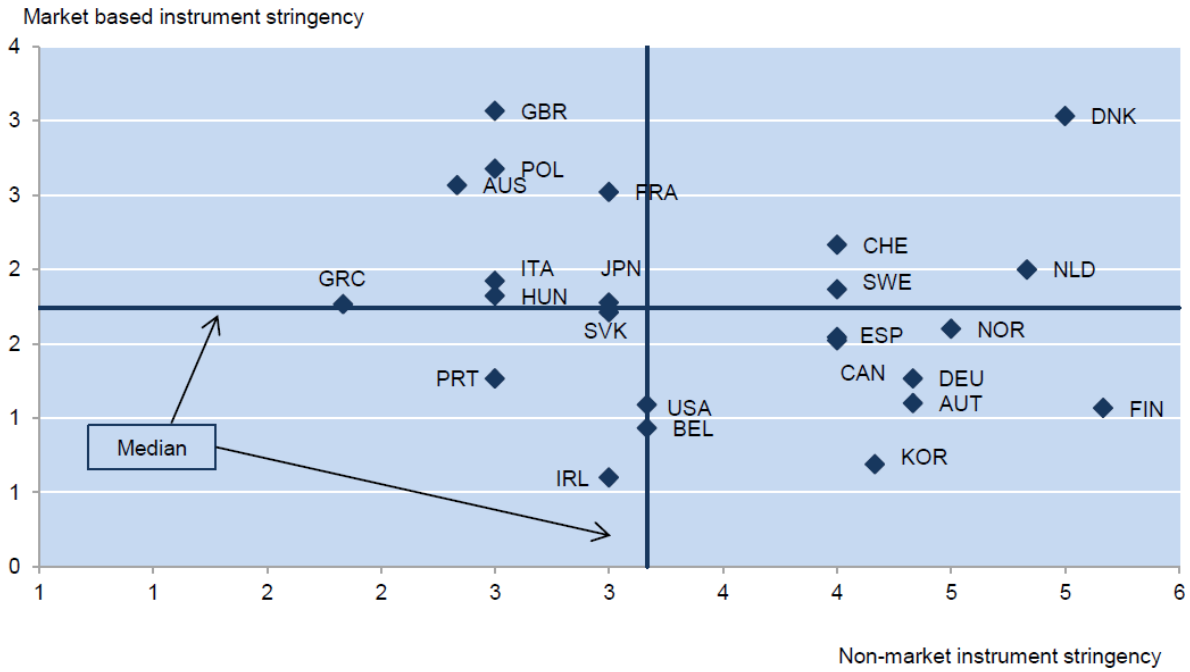

Figure 9 - Relative importance of different approaches to environmental policies - Energy sector indicator[50]

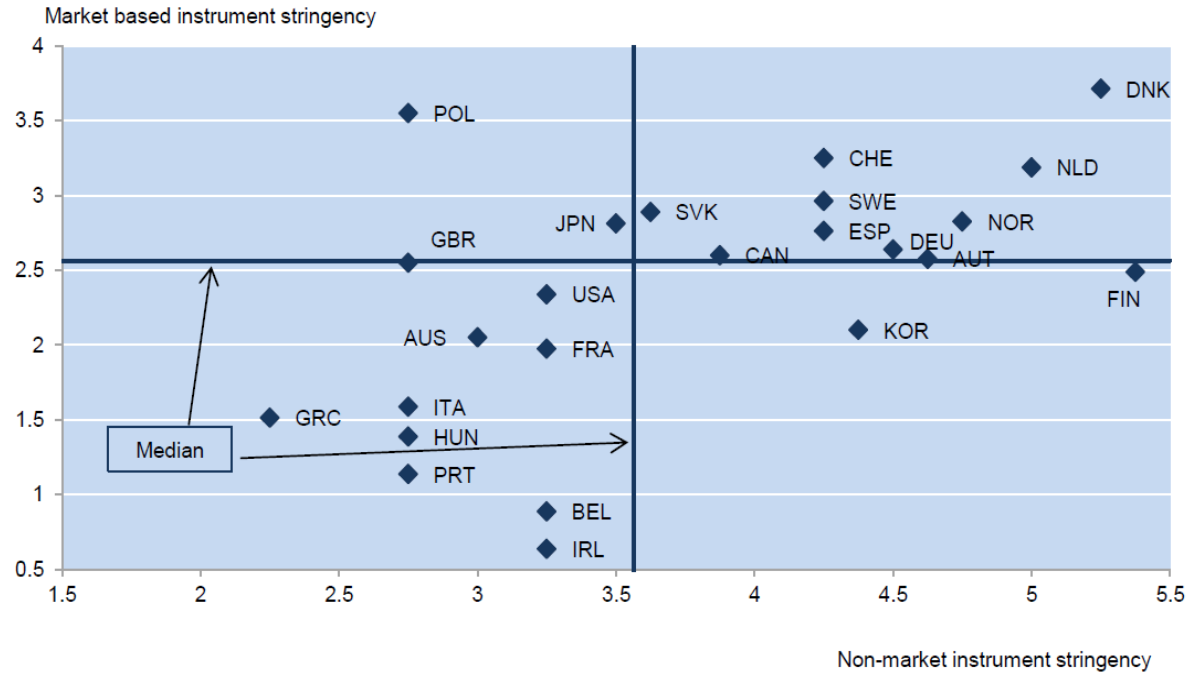

Figure 10 - Relative importance of different approaches to environmental policies - Economy-wide indicator[50]

Regarding the evolution overtime of the EPS indicator at overall level, since the 1990s there is a trend towards an indicator always more tightening. This trend is visible for both categories of instruments but it is especially strong for market-based instruments.

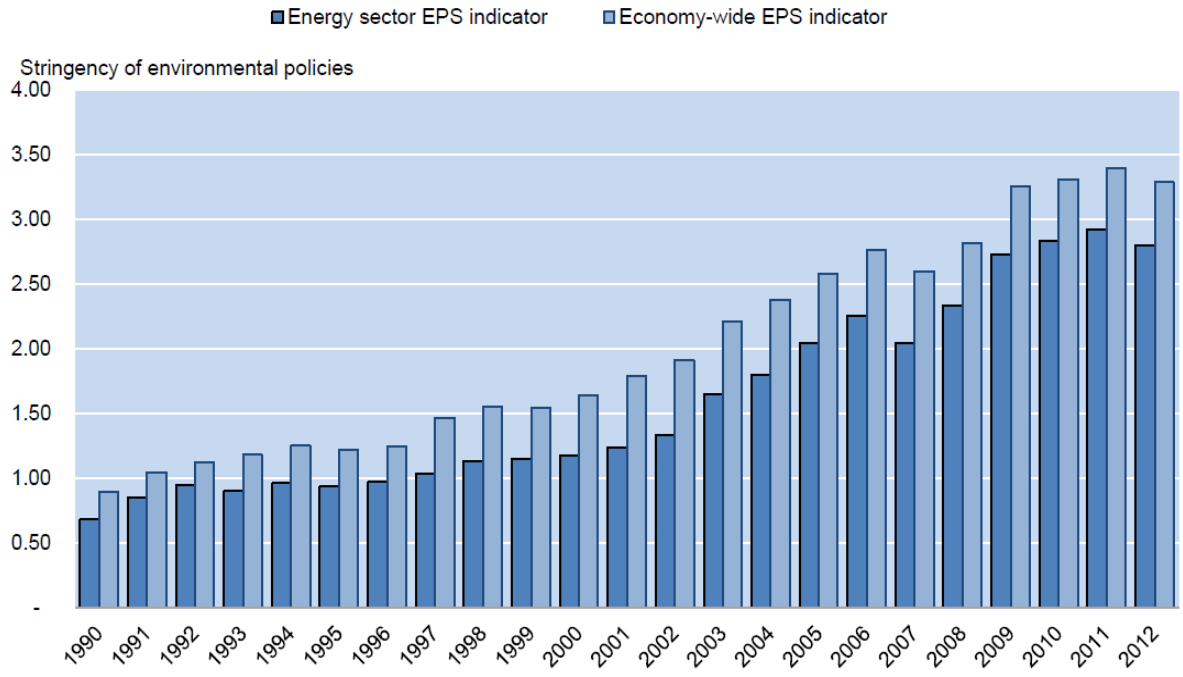

Figure 11 - Average environmental policy stringency over time[50]

The number of instruments (among those included in the analysis) leveraged to mitigate the environmental externalities of the energy sector shows an increase during the past two decades driven mainly by a broader adoption of market-based instruments:

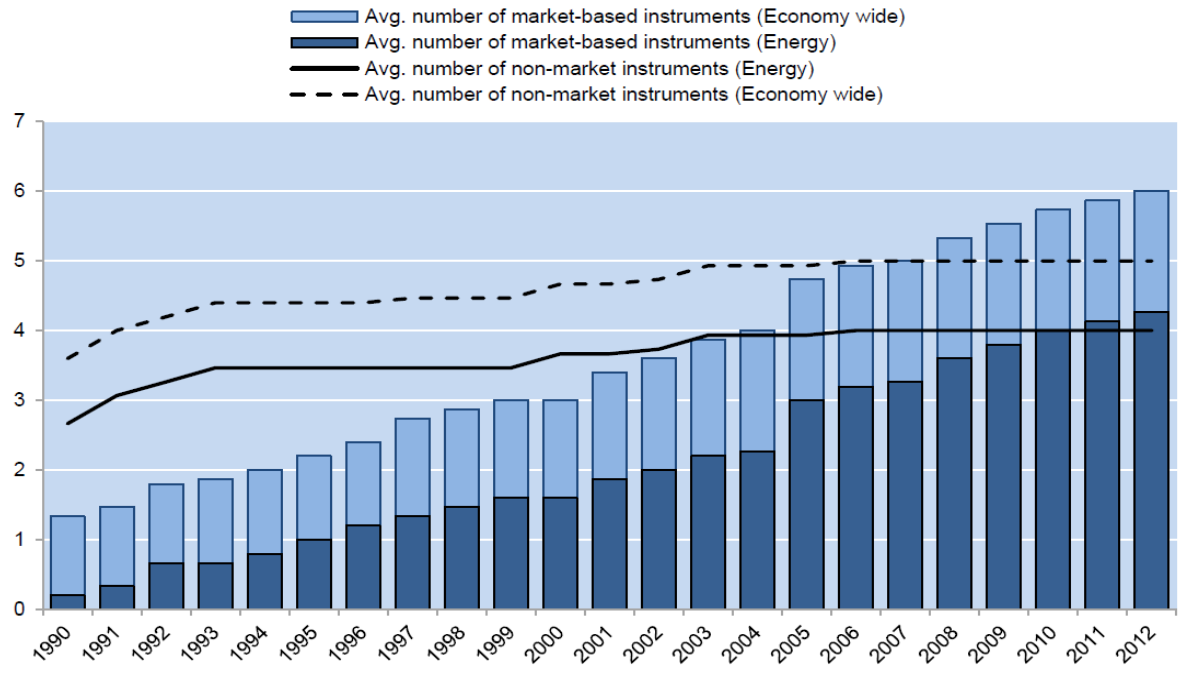

Figure 12 - Average number of instruments over time[50]

Lately (2021) the EPS index has been revised and improved. In particular, an additional sub-index has been added, with the aim of grouping technology support policies. It is further divided into upstream and downstream technology support measures: the former ones (like public R&D expenditure) encourage and finance innovation in clean technologies, including those that may not yet be commercially viable; the latter policies (such as renewable energy support policies) incentivize the adoption of specific technologies. This new sub-index has been created since subsidies for R&D and feed-in tariffs operate differently from market and non-market based policies, where the former ones are defined as instruments based on price mechanisms to increase the costs of environmental pollution, and the others as command-and-control policies to enforce environmental standards. Moreover, the renewed policy interest for clean innovation requires metrics to track progress on innovation policies.

On the other hand, the EPS21 index excludes two policy instruments previously taken into account, i.e. Deposit & Refund Schemes and energy efficiency certificates, because of limited data availability and concerns about the data quality.

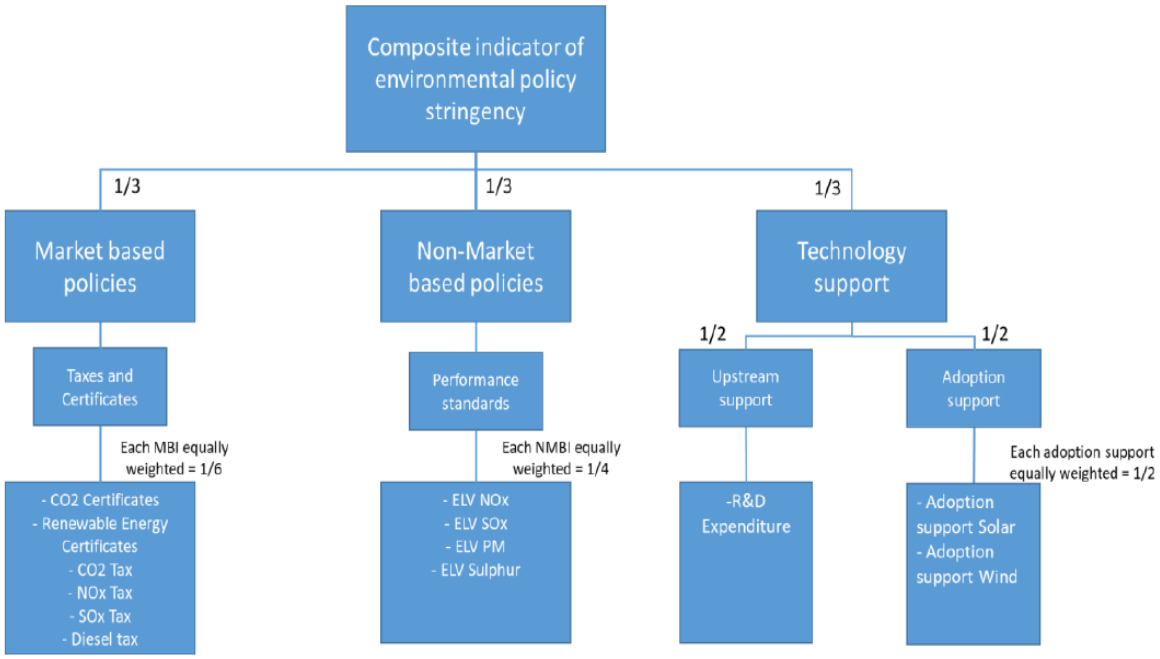

Figure 13 - The 2021 Environmental Policy Stringency Index[49]

Thanks to this updated indicator it has been possible to update previous overall results and to find out new ones, as reported in the following table:

Decades	Average annual growth rate
1990 – 2000	6.8%
2000 – 2010	8.0%
2010 – 2020	1.1%

Figure 14 - Average annual growth rate of Environmental Policy Stringency[49]

While, at specific-country level:

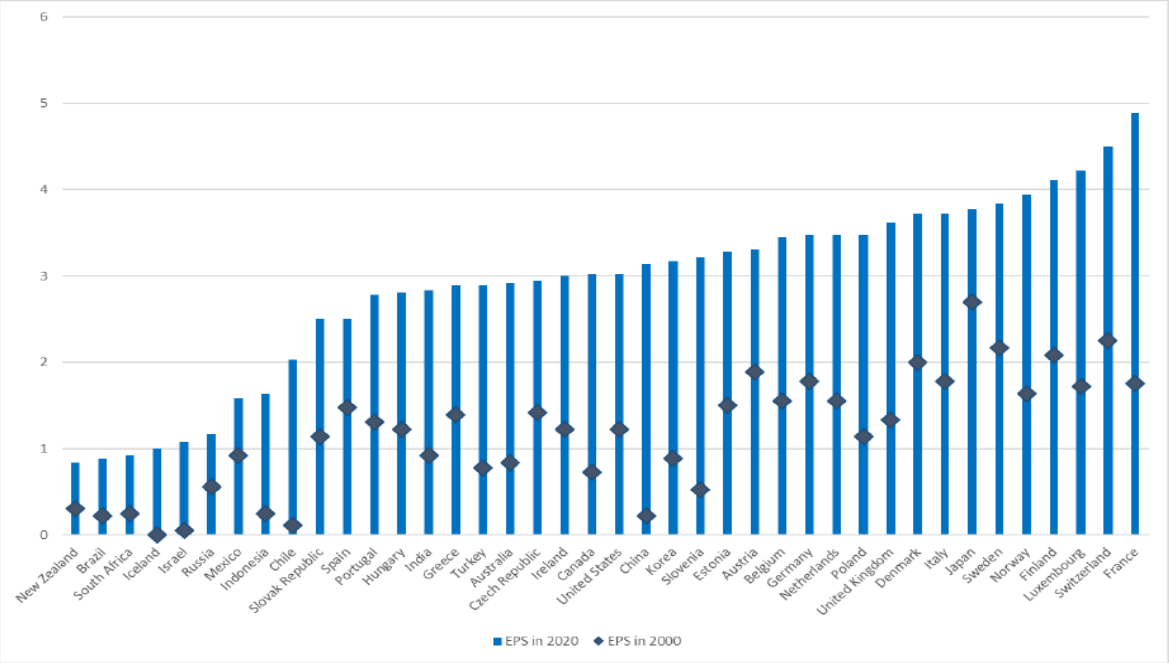

Figure 15 - Environmental Policy Stringency in 2020 and 2000[49]

Overall, measurements show that the stringency of environmental policies has on average increased substantially over the past three decades across OECD countries. The stringency of non-market based policy instruments has increased the most in absolute terms, followed by technology support policies and then by market based policies.

However, in the past ten years, the level of technology support policies has weakened, raising concerns that incentives to innovate in clean technologies may be declining. Actually, this declining trend may be partially due to a shift towards more efficient technology support policies (including the move from feed-in tariffs to renewable auctions) but it is clear that the need for innovation and investment in green technologies requires further increase in technology support policies.[49]

2.2. ENVIRONMENTAL REGULATIONS AND POLLUTION

- **Environmental stringency and CO2**

CO2 emission is considered as the driving force of global warming and climate change. Global energy-related CO2 emissions have increased from 20,521 million tonnes of CO2 in 1990 to around 32,840 million tonnes in 2017 (International Energy Agency, IEA 2020)[64].

A piece of research carried out by Yemane Wolde-Rufael & Eyob Mulat-Weldemeskel[65] investigates the effectiveness of environmental taxes and environmental policy in reducing CO2 emissions for a sample of 7 emerging economies: Czech Republic, Greece, Hungary, Korea, Poland, South Africa, and Turkey, for the period 1994–2015.

This study points out that, between 1990 and 2017, the total CO2 emissions (kt) of the countries considered increased by more than 55%. In South Korea the total CO2 emissions (kt) more than doubled between 1990 and 2017, making Korea the eighth largest emitter of CO2 emissions in the world[66]. In South Africa, a highly fossil fuel–dependent economy, total CO2 emissions increased by around 73% for the same period. In contrast, in the Czech Republic, Greece, Hungary, and Poland, total CO2 emissions declined.

Wolde-Rufael & Mulat-Weldemeskel gathered data from the consumption-based carbon emissions developed by Peters et al.[67], which were estimated based on the domestic use of fossil fuels plus the embodied emissions from imports less exports: indeed, since international trade plays an important role in these emerging economies, CO2 emissions adjusted for international trade may be relatively more important than territorial-based CO2 emissions. On the other side, to measure the stringency of environmental policies, they used the environmental policy stringency index developed by OECD[68].

The study results indicate an inverted U–shaped relationship between environmental stringency and CO2 emissions, which means that environmental policy does not lead to reductions in CO2 emissions immediately, but it takes some time to become effective. They also show a negative relationship between CO2 emissions and total environmental taxes, while CO2 emissions are negatively linked to energy tax. In few words, this seems to suggest that environmental policy stringency and environmental taxes can be two effective policy instruments in fighting negative environmental externalities. Moreover, the finding of a negative relations between CO2 emissions and environmental tax, on the one hand, and a positive relationship between CO2 emissions and fossil energy, on the other, suggests that the most effective way of mitigating CO2 emissions is to reduce fossil fuel consumption by promoting renewable energy.

The article ends by suggesting that environmental measures should encourage, on one side, firms to seek ecofriendly technologies in order to replace fossil fuels with renewable energy and, on the other side, citizens to consume more eco-friendly goods and services.

- **Environmental stringency and renewable energy**

Talking about the relationship between environmental stringency and renewable energy, the effects of environmental regulations on energy consumption can be explained through two major hypotheses:

a. Cost of compliance hypothesis

It states that enforcing environmental regulations raise a firm compliance costs (like the operating pollution control equipment). The increasing in compliance costs turns into a decrease in energy consumption and in manufacturing output, which, in turn, leads to a decrease in company profit. A possible consequence of the reduction of enterprise profit corresponds to a lower opportunity for technological innovation (lower R&D expenses). Therefore, the point is that the application of environmental regulation discourages the consumption of renewable energy.

b. Porter hypothesis

According to the Porter hypothesis, the implementation of an appropriate stringency degree of environmental regulation stimulates a company to increase its R&D activity, helping achieve advanced and environmentally friendly technologies so as to comply with the regulation. This innovation leads also to an offset of the compliance cost. As consequence, the implementation of environmental regulations encourages the consumption of renewable energy [69], [70].

Empirical studies analyze the consequences of environmental regulation on renewable energy consumption in two perspectives:

- **Formal environmental regulations**

This kind of regulations includes permits, emission taxes and penalties implemented by the government towards businesses to achieve sustainable development. Very few works on the impact of environmental regulation on renewable energy consumption exist. One example is from Zhao et al. [71], which assesses that stricter regulation raises renewable energy consumption, while a negative association between the two is reported by Bashir et al. [72].

- **Informal environmental regulations**

Informal regulations generally do not act on a firm directly but contribute to raise the cost of production. Pargal and Wheeler [73] state that the inadequate implementation of formal environmental regulations by the government, in some cases, may trigger social groups to directly request companies to control pollution through complaints, petition letters, demonstrations, or boycotts of the products of polluting firms. And, since enterprises are usually concerned about their social reputation, they may care about those complaints and commit to reduce pollution. For example, Peng and Ji's study [74] shows that informal regulation, proxied by the information disclosure policy, positively affects green innovation in China. [75]

2.3. REGULATIONS SPILLOVERS ON ECONOMY AND SOCIETY

a. Effects on production growth

A study from Silvia Albrizio et al.[76] investigates on the impact that changes in stringency of environmental policies generate on productivity growth in OECD countries, by exploiting the EPS index previously introduced. It bases on a model of multi-factor productivity growth, since this one depends on the firm ability to adopt innovative and efficient technologies available in the market (technological catch-up) and on its capability to innovate (technological pass-through), and where the effect of countries environmental policies varies with pollution intensity of the industry and technological advancement. This analysis provides insights at aggregate, industry and firm level.

Results show that, at country level, one year ahead of the policy change, a negative effect on productivity growth appears. Nonetheless, this negative "announcement effect" is offset within three years after the implementation of the new policy. At the industry level, instead, a tightening of environmental regulation is strictly related to a short-term increase in productivity growth, at least for the most technologically advanced country-industry pairs. It has been also found out that this effect diminishes with the distance to the global technology frontier and vanishes completely for the least productive country-industry couples. At the firm level, only the most technological advanced firms benefit from a positive spillover on productivity growth after a tightening of environmental regulations. In particular, only one firm out of ten is able to

obtain some productivity gains, while about one-third of the firms (the least productive ones), face a negative effect on productivity growth. Indeed, highly productive firms, which are quite often the largest firms in the industry, may be best suited to profit very quickly from changing conditions, especially through seizing new market opportunities, fast deployment of new technologies or reaping previously overseen efficiency gains, but potentially also through outsourcing and relocating parts of production abroad. The most productive firms can usually rely on the most advanced technologies and, moreover, are likely to have more resources to invest into R&D or knowledge-based capital, which allows to anticipate the environmental policy tightening. On the opposite, less advanced firms, which are also likely to be smaller ones, may need higher investment to comply with the new regulations (for instance by adopting cleaner technologies or exchanging equipment), hence suffering from a temporary fall in productivity growth.

Greenstone et al.'s study[77] is the largest using plant-level data, with 1.2 million plant observations from the 1972–1993 Annual Survey of Manufacturers. Outcomes indicate that total factor productivity (TFP) declines by 4.8 percent for polluting plants in strictly environmental regulated counties. However, the impacts vary across pollutants and industries and can sometimes be even positive (strict regulations on carbon monoxide concentrations lead to statistically significant increases in productivity). Furthermore, almost all of the effect occurs in the first year in which the environmental policy is strengthened, suggesting that capital investments in pollution abatement may have only a short-term impact on productivity. Actually, this consideration is shared by a significant part of the literature (see for instance also [78]), i.e. negative effects of environmental stringency on firms productivity growth is limited in the short-run, vanishing in few years.

b. Effects on employment

It is generally known that tighter regulations make production costs increase, which leads to lower the quantity demanded by consumers; this, in turn, implies less derived demand for labor, which ends up in job cuts.

Actually, it must be taken into account that, in environmentally regulated sectors, workers are split in two different categories: "production employment" (which include assembly, marketing, and accounting) and "environmental employment" (workers

dedicated to environmental management). Environmental regulation may affect these two labor types in different ways.

Along with the imposition of regulation, another important aspect is the one related to their enforcement, which includes various forms of government intervention, like monitoring inspections, informal enforcement (for instance warnings), and formal enforcement (such as monetary penalties). The difference between regulation imposition and enforcement lies in the contrast between initial efforts to comply with regulatory constraints and ongoing compliance efforts. The former ones generally identify with long-run adjustments, implying the allocation of both environmental and production capital; the latters, instead, are strictly linked to short-run adjustments.

The recent research from Zach Raff and Dietrich Earnhart[79] focuses on the effects of environmental regulation, specifically its enforcement, on the two different worker groups named above, i.e. production employment and environmental employment, as well as on overall employment. It does it by examining the effect of Clean Water Act (CWA) enforcement on overall, production, and environmental employment at regulated facilities within the US chemical manufacturing sector and taking advantage from the use of a unique survey.

Empirical results from this study reveal that government interventions mostly negatively affect facility-level employment, regardless of the form. However, a stricter environmental enforcement usually forces facilities to substitute environmental workers with reduced production workers, hence facilities prefer to reduce production levels rather than hire more environmental workers. Nonetheless, state inspections induce facilities to hire more of them. These results prove the policy relevance, since environmental protection agencies clearly seek to induce compliance, yet governments generally wish to avoid negative employment impacts.

Hafstead and Williams[80] show that at the macroeconomic level, in the long run, environmental regulations might simply induce a substitution between polluting and non-polluting activities. Instead, at the microeconomic level and in the short-run, the effects found of environmental regulations on employment in energy- and pollution-intensive sectors are small but statistically significant.

Some papers (like [81]) find no evidence that environmental regulations reduces employment, while others do. This is the case of Kahn's one[82], which finds that the growth rate in manufacturing employment over the 1982–1988 period is 9 percent lower

in US counties with more stringent air pollution regulations. The magnitude of this effect differs across sectors, and it is particularly pronounced in chemicals, primary metals, industrial machinery, and instruments sectors.

c. **Effects on (environmental) innovation**

Lately, a number of empirical studies have been performed in order to find a link between environmental regulations and innovation. Overall, they have shown that more strict environmental policy is usually associated with an increase in the number of patent applications and that market-based environmental stringency measures (policy instruments based on price mechanisms to increase the costs of environmental pollution) can stimulate innovation, while the non-market-based ones (command-and-control policies to enforce environmental standards) have a negative impact on innovation.
However, in general they tend to consider small samples of countries and time series, due to missing data.

To overcome this issue, the Mahmoud Hassan and Damien Rousselière's work[83] investigates on the impact of the stringency of environmental regulations on a specific type of innovation, the environmental one. It exploits the environmental policy stringency index (EPS) and a large sample made of 27 OECD countries from year 1990 to 2015.
The analysis finds a significant positive effect of the natural logarithm of EPS on the natural logarithm of the number of patents related to environmental technology. This points out that an increase in environmental stringency leads to accelerate the environmental innovation. Furthermore, non-market based instruments are found to be more stimulating to environmental innovation rather than market ones. According to these findings, two beneficial policy implications can be drawn: first, a stricter environmental policy could not only improve the environment quality but also raising the economic growth by stimulating environmental innovation; second, the effectiveness of command-and-control-based regulation implies that OECD governments can play a significant role in eco-innovation by enacting stronger standards of emission limits and increasing public R&D expenditure on renewable energy and environmentally related technology. A large part of the literature agrees with Rousselière's findings[84].

3. FDI AND ENVIRONMENT

In the last part of the previous chapter, a series of ways and channels through which environmental rules can affect several economic and social aspects has been analyzed. Actually, there is another important spillover due to environmental stringency and which represents the main focus of this thesis: the effect generated on capital investment, in particular on foreign direct one (FDI).

In this section the relationship between the two main topics introduced so far, namely the FDI flows and the environmental regulations, will be investigated. Through several authors' papers and theories, a deep analysis will be carried out in order to understand the links between the two and the reasons behind them, as well as the possible issues and biasness which can lead to misleading empirical findings.

After that, in the last part of the chapter, a number of FDI effects on the environment will be reported and discussed, in order to better understand how important their impact is on the world that surrounds us.

3.1. FDI AND ENVIRONMENTAL REGULATIONS RELATIONSHIP

Over the last century, a huge number of studies and papers have been focused their attention on the causality link between environmental rules and FDI presence all around the world, but their outcomes are often in disagreement and do not converge toward a general evidence or rule. In the next pages the main theoretical hypotheses about this topic will be reported as well as the ways in which a lot of researchers have tried to address this issue following different paths and reasonings, bringing to diverging results. The aim of this section is to gather and examine these different ideas and conclusions, looking for possible explanations to the great amount of ambiguity surrounding the FDI-regulations relationship theme, in an attempt of shedding light on such a debated and confusing topic.

3.1.1. Are FDI flows attracted by laxer regulations…

- **The POH hypothesis**

A number of papers introduces and supports the theoretical hypothesis of the so-called "Pollution Outsourcing Hypothesis (POH)", according to which an increase in the stringency

of environmental regulations encourages firms to either relocate abroad (FDI) or to outsource in foreign countries (International Outsourcing) the dirtier parts of their production process only.

For instance, through a theoretical model of international environmental outsourcing, Cole et al.[85] have examined the role of firm size, transport costs, and environmental regulations in an hypothetical situation in which heterogeneous firms can either pay an abatement cost (and continue to produce in the home market) or face a fixed and variable cost in order to offshore their most polluting activity. The main finding is that with the increase in stringency (everything else equal), offshoring becomes a more attractive solution.

In paragraph 4.3.1 a specific study on this topic[86] deepens the comparison between FDI and IO in a more detailed way.

- **The PHH hypothesis**

The "Pollution Haven Hypothesis (PHH)" is the most known and debated theory depicting the direction of the linkage between foreign investment and environmental stringency. It states that firms belonging to heavy-polluting industries, in order to avoid the cost imposed by environmental regulations, tend to relocate their production from developed countries with stringent environmental policies to developing countries where similar policies do not exist or are laxer. This situation may be triggered, for instance, by a reduction of trade costs or barriers. At global level, the logical consequences of both PHH and POH consistent behaviors are the same in environmental terms: the desired effect of stringent policies applied in some countries vanish since the concentration of pollution is simply moved to other countries, which take the name of "pollution havens" and the overall environmental situation does not improve.

Levinson's concerning about PHH led him to identify two different challenges that empirical tests on PHH must overcome [87]:

1. to find an appropriate measure of regulatory stringency (see chapter 2);
2. to use appropriate econometric techniques so as to capture unobserved differences between specific countries characteristics and FDI flows (unobserved heterogeneity) and, at the same time, allow for the possibility that FDI flows and regulations influence each other (simultaneity).

The literature regarding HPP can be split into two generations. In a chronological view, the first studies to be carried out used to exploit aggregate data for their analysis (such as cross-sectional data at the country level) and made no attempt to control for unobserved heterogeneity and simultaneity, since all variables were measured simultaneously; these pieces of research

generally failed to provide convincing support for the PHH. Instead, more recent studies have quite often used panel data and taken advantage from more advanced econometric approaches; this have allowed to address unobserved heterogeneity and simultaneity and, in some cases, to find some evidence in favour of PHH.

Consistently with the Pollution Haven Hypothesis, in the last decades of XX century several authors used to argue that FDI tends to flow from countries with stringent regulations to those with less stringent ones.

In 1987, Pearson[88] provided the first paper in which environmental issues were taken into account as part of the decision to invest abroad. It is focused on the assumption that developing countries initially have few high-polluting sectors and, consequently, do not place a high demand on the provision of environmental services. This usually translates into a low price for those services. The result is that developing countries should have a comparative advantage in the production of dirty (pollution-intensive) goods. In the same years Baumol & Oates[89] worked on a partial-equilibrium two-country model with two sectors that differ in terms of their pollution intensity. They found out that the analyzed developed country has higher regulations and hence a comparative disadvantage in the production of dirty goods with respect to the developing country.

A number of studies has tried to assess the existence of the relationship between regulatory stringency and FDI flows at a country or regional level. Some of them focus on US-inbound FDI and the extent to which it is influenced by state-level (or other) measures of regulations (such as Keller & Levinson[90], see chapter 4). Like the United States, China is so large and with subregional regulatory differences to allow for the possibility that pollution haven evidence could be detected by observing inbound FDI (Di[91]).

Then also other studies have looked for cross-country evidence of the PHH, like the one by Naughton[92], which examines the impact of both home and host country environmental regulations on FDI flows based on a panel of 28 OECD countries and which measures the stringency of environmental rules by looking for the emission intensity of five different pollutants. The outcomes show how host country regulations tend to discourage FDI, while home country ones are linked to FDI through a quadratic relationship: home regulation costs initially increase FDI flows but, after a certain point, make them decrease.

Thanks to the larger availability of firm- and industry-level data on pollution control costs, lately there has been an important increase in the number of tests about the FDI-regulations relationship, taking advantage from such disaggregated data. Indeed, from all over the world

researchers have been looked for the presence of the underlined relationship at a firm or industry level, such as, for instance, Javorcik & Wei[93], Raspiller & Riedinger[94], Manderson & Kneller[95]. The first study[93] investigates on investment flows into Eastern Europe and the former Soviet Union, finding no evidence that dirty-industries FDI is attracted to countries with weaker environmental regulations. Similar conclusions are achieved by Raspiller & Riedinger[94], whose focus is on France. Finally, about United Kingdom, according to the last paper[95], UK firms which find it costly to comply with environmental regulation are no more likely to opt for foreign investment than firms facing lower environmental compliance costs. On the opposite, other industry-level analysis, based on Mexico[96], Germany[97], and South Korea[98] data, show evidence of pollution haven–consistent behavior for the most pollution-intensive industries in their samples.

An interesting research testing PHH from Margarita Kalamova and Nick Johnstone[99] supports a particular hypothesis for which the relationship between stringency and FDI is non-linear, with the effects of increased relative environmental policy stringency in the host country decreasing after a certain threshold. It makes use of a measure for environmental stringency based on managers' perceptions in a given country and takes into account a sample of 27 OECD countries and 99 host countries over the period 2001-2007, while the bilateral FDI flow taken from the International Direct Investment Statistics Yearbook of the OECD is used as a dependent variable. For what concerns the variable related to environmental policy considered as regressor, the stringency index of the World Economic Forum is used as measure of environmental regulation regime. The main results emerging from the analysis are that relatively lax stringency in host countries has a statistically significant positive effect on inward FDI flows in both developed and developing countries (although usually in the range of 2.7-5.5%, that is small relatively to other factors) and that this effect tends to exhibit an inverse U-shape, decreasing below a certain level of environmental stringency (i.e. when the environmental stringency of a host country becomes too lax, this country loses its attractiveness towards foreign investment). The article hypothesizes that this non-linear relationship may be due especially to a combination of two distinct factors:

- Since more stringent environmental regulations impose new production cost on firms, above a certain threshold level of stringency the attractiveness of the country for foreign investors reduces. Indeed, firms tend to relocate to countries where the abatement cost is lower (it is called the "relative abatement cost problem").

- Below this threshold level, there may be a "signaling" role played by environmental policy, with excessively lax policy indicating a more uncertain (and thus less attractive) environment for foreign investment. This argument is related to the so called "hold-up problem": in fact, if it is true that investors can freely choose where to locate their FDI, it is also true that the host government can choose how much to demand from the investment returns (or may even choose to appropriate the investment completely); if foreign investors manage to anticipate this behaviour, they could invest too little or not invest at all. So, considering the environmental policy regime as a variable with signaling value, then a very lax environmental stringency could discourage relocation of production to that host country. The hold-up effect runs counter to the relative abatement cost one.

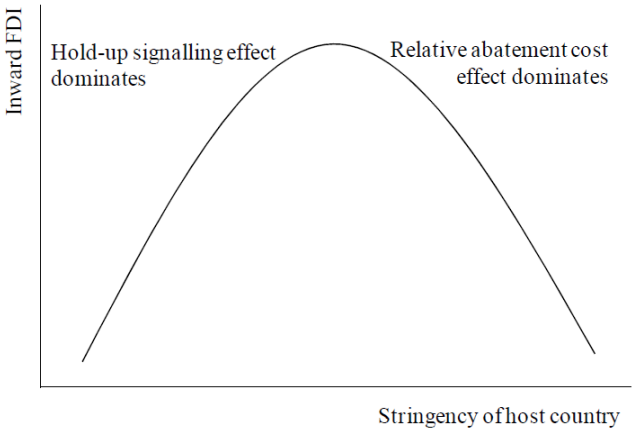

Figure 16 - Relationship between environmental stringency of the host country and inward FDI[99]

This reasoning leads the paper authors to the formulation of the following hypothesis statement**:** **"**A decrease in environmental stringency in the host country will have a positive impact on the amount of FDI that is attracted by this host country. This effect, however, will reverse to negative, once stringency becomes too lax, which implies a certain threshold level."

Overall, results from all these kinds of studies have been quite controversial, since in some cases they suggest that environmental stringency-FDI flow relationship exist and that, the looser the former, the larger the latter (and vice-versa), while many other outcomes do not seem to state the same (several times no relationship is found).

3.1.2. … or by more stringent ones?

As stated above, no general evidence about PHH existence has been found. Indeed, the outcomes from the huge amount of studies carried out throughout years were quite controversial and in disagreement, hence they failed in identifying an evident rule or behavior for which FDI flows are influenced by environmental regulatory differences in a specific manner. This spurred the development of several alternative theoretical models in an attempt to explain why FDI may not necessarily be attracted by environmentally low-regulated regions and, on the contrary, they may be attracted by high-regulated ones.

Sanna-Randaccio and Sestini[100] provide one possible explanation for the lack of evidence that FDI is attracted by countries with low environmental stringency: the key point is that, if the home country has a large market size, then a firm relocates abroad, in case of regulation gap between the origin and the host country, only if this one is large enough to offset any increase in transport costs due to export the product back to the origin country.

Another theoretical contribution which tries to explain the lack of PHH-consistent evidence and even suggests the existence of a completely opposite behavior is provided by Dijkstra et al.[101]. Making use of a Cournot duopoly three-stage model, where the duopoly structure in the host country is exogenous, it emerges that an increase in the stringency of environmental regulations increases the production costs for all firms, including domestic ones. A key assumption is related to the principle that, if a foreign firm owns more efficient technology and pollutes less per unit of output, then an increase in environmental regulations in the host country gives to that firm a cost advantage, as it faces lower pollution abatement cost per unit of output than domestic competitors. Therefore, the foreign firm has ironically an incentive in lobbying for stricter environmental regulations, so that competition in that country decreases.

An alternative approach to Dijkstra et al. paper is represented by the R. J. R. Elliott and Y. Zhou one[102]. This model takes into account a firm A which is looking for entering a foreign market through FDI or exporting. That foreign country is regulated by more stringent environmental regulations than the firm A home country. Moreover, it contains a domestic firm B that is considering entry or not into the local market. The assumption is that firm A is assumed to have first-mover advantage and the argument is that it may choose to invest in that high environmental regulation country as a way of deterring domestic entry in that market (and, of course, increasing its profit). Although one would expect the opposite, the study demonstrates that, within a certain range of parameter values for the fixed plant and firm set-up costs, the tariff rate and a marginally higher environment permit fee, the expected theoretical argument is

verified, and also that firm A is likely to choose FDI as preferred mode of entry with respect to exporting (it may also choose to invest in that country with strict regulations and export to the home country with laxer ones). Moreover, the paper shows that when the production process of the domestic firms is sufficiently dirty, more stringent environmental regulations could also improve the total social welfare if foreign (more advanced and cleaner) companies replace domestic producers.

The situation in which stringent environmental regulations attract foreign FDI takes the name of "green haven effect" and it is actually supported by a relative high number of recent studies, including the ones that follow. Rivera and Oh[103] find out that European MNCs tend to enter markets in countries with more stringent environmental regulations (and that this attitude is greater in relatively cleaner industries). Thanks to French firm-level data from 1996 to 2002, Kheder and Zugravu[104] provide empirical evidence that more stringent environmental regulations result in higher FDI inflows in most of the Commonwealth of Independent States and developing countries. Analyzing data on FDI flows from US firms to Chinese provinces, Bu and Wagner[105] discover that those companies with advanced environmental technology have a tendency to invest more in regions characterized by higher stringency, while those technological weaker are less likely to invest in such regions. Poelhekke and Van Der Ploeg[106] focus on Dutch FDI data and find that firms emphasizing reputations for sustainable management and corporate social responsibility (CSR) may invest in countries with stricter environmental regulations.

Last, Yeseul Kim & Dong-Eun Rhee's study[107] employs panel data of 120 developing countries from 2000 to 2014 to estimate the effects of environmental regulations on FDI in these countries, exploiting the environmental performance index (EPI) as the indicator to represent a country degree of environmental regulation stringency. Its empirical results are contrary to the pollution haven effect, namely, stringent environmental regulations significantly attract FDI. Furthermore, no evidence that stringent environmental regulations increase outbound FDI in developing countries are found. Consequently, the results consistently show that, in developing countries, stringent environmental regulations increase net FDI flows. A possible cause is that host country environmental regulations could enhance domestic productivity, which, in turn, attracts foreign multinational firms. In addition, it has become harder for multinational firms to take advantage of lax environmental regulations in developing countries as such an approach could harm their international reputation, a situation which could negatively affect their marketing operations and, consequently, their shareholders' interests.

3.1.3. Possible ambiguity causes

To sum up, there is an evident ambiguity and disagreement among the theoretical hypotheses and all the empirical evidence found out by the different researchers throughout years. As seen, although earlier theoretical contributions provided a simple framework to predict that capital should flow from environmentally high-regulated to low-regulated countries, a lack of significant empirical evidence led more recent researchers to provide new theories according to which firms may prefer to relocate to (or to remain in) countries or regions with relatively stricter environmental regulations as optimal strategy. Indeed, in several cases and especially in developed countries, the disadvantage of higher environmental costs is more than offset by pull factors such as agglomeration economies, raw material supplies, skilled labor, availability of capital, infrastructure, and so on[108].

Possible explanations to the distances in findings of different papers may be found in the following causes.

a. **Model structure**

   As a unique clear method to deal with the linkage between FDI and environmental stringency has not been identified yet, theoretical and statistical models are built differently by researchers, starting from the initial assumptions to the construction of the mathematical relationship and the variables/factors considered. Unsurprisingly, different initial models could take to diverging results.

b. **Unobserved heterogeneity**

   This issue is related to the fact that, in several cases, statistical models do not include other relevant variables which can significantly affect the relationship under analysis. Sometimes this could end up in misunderstanding the real impact of regulations on FDI, which may be partially confused with the overlapping effect of the others unobserved factors.

   This problem is particularly evident when cross-sectional data is used, while panel data enables to control the possibly correlated, time-invariant heterogeneity without the need of observing it.

c. **FDI nature**

   Different types of FDI (see chapter 1) may respond differently to environmental regulation and the fact that many of the previous mentioned studies do not care about the different nature of capital investment may be considered as a possible reason for

misunderstanding and misleading empirical results, contributing to the general ambiguity.

However, a little part of literature takes this issue into account and demonstrates its weight in affecting empirical findings. For example, Kukenova & Monteiro[109] argue that export-platform FDI is particularly sensitive to environmental stringency, as the most polluting stages of production are more likely to be located in a host country which has relatively lax environmental regulations; Rezza[110] finds that horizontal FDI is not affected by the environmental stringency of host countries while vertical one is likely to be deterred from locating in more environmentally regulated countries; Tang[111] affirms that host country environmental stringency has a negative impact on both export-oriented and local-market-oriented types of FDI, with an higher intensity for the former.

Lastly, a study from Sylwia Bialek & Alfons J. Weichenrieder[112] develops the hypothesis that environmental stringency predominantly discourages Greenfield FDI investment rather than mergers and acquisitions (M&A) ones. There may be two reasons why Greenfield projects react more strongly to environmental regulation than M&As: first, environmental requirements may be stricter for Greenfield than for M&A investment because of vintage differentiation rules (VDR) (see Chapter 2), since grandfathering rules might give a strong competitive advantage to those regions where preexisting plants are located; second, in the case of M&A, the acquisition price should be a function of the regulation faced by the company: as the purchaser of an existing plant is only willing to pay the discounted value of future profits, a company whose profits prospects are reduced due to tight environmental regulation will have a lower evaluation and acquisition price than a company subject to lax regulation (in a few words, part of the regulation is capitalized in the purchase price). Instead, talking about Greenfield FDI, the investment costs depend on the cost of inputs (construction materials, wages, etc.) which are less likely to be related to environmental stringency. The study testes its hypothesis using the information on the German outbound FDI in 2005-2011, remembering that Germany is one of the largest economies overall, with 10% of total world exports and a share of 5–8% in the world FDI in the years considered (UNCTAD data). The outcome of the research demonstrates that the likelihood of a country to be chosen as host of a German FDI depends on its environmental stringency, the industry of the project, and the mode of entry as well: empirical results show how a

stricter regulation reduces new Greenfield projects in polluting industries, while has a much smaller impact on the number of M&As. In particular, Greenfield FDI is approximately four times more elastic than M&A ones in their reaction to a tightening of environmental stringency. Therefore, the sharper the environmental regulations, the larger the prevalence of M&A investment over Greenfield ones. This finding has an important implication for host countries: indeed, as discovered by Harms and Méon[113], an higher GDP growth rate is usually associated with Greenfields rather than with merger and acquisitions flows.

d. Measurement of environmental stringency

Thanks to data stored in national and official economic databases, it is quite feasible to get to know the amount of FDI inflows or outflows into/from a specific country (or group of countries). On the opposite, finding needed data about the level of environmental stringency is not that easy. As illustrated in chapter 2, there are several possible ways to try to measure environmental regulations, but each one faces specific obstacles, which could lead to misleading measurements, generating, in turn, biasness when examining the relationship between regulations and investment.

In the empirical contributions to the literature, the main types of measures adopted are: actual measures of pollution emissions (such as SO2 emissions or energy use, or alternatively, pollution abatement costs), measures of environmental legislation (see [114] as example), and indexes of environmental regulation (taking advantage of existing ones, or constructing new ones from scratch, sometimes through the use of surveys). One of the main issues that could affect these computational methodologies is endogeneity (see next point).

e. The endogeneity of environmental regulations

In the context of FDI and the environment, the endogeneity problem can identify with the correlation of environmental stringency with other unobserved determinants of the FDI decision (omitted variables). This means that, by affecting in a direct way the regulations variable, also the econometric relation with FDI is, indirectly, influenced.

Furthermore, another possibility may be that FDI itself affects environmental stringency (mutual causality), according to the so called “simultaneity” issue. Indeed, firms presence and capital flows may be able to influence the development and implementation of environmental policy in the home or host country. For instance, an increase in FDI may have, as consequence, the insurgence of new industrial lobby

groups pressuring local bureaucrats to change environmental regulations. Similarly, if a country or region observes a fall in FDI inflows it may decide to lax environmental stringency to help reverse this trend. Simultaneity effect could lead to a significant biasness in the final result.

In order to address these concerns, studies have tended to use panel data for country-, industry-, or firm-level measures of regulatory stringency, so that the use of instrumental variables (IV) method could be put in place. This involves the substitution of environmental stringency variable with some other (observable) variable, namely the instrumental variable, closely correlated with regulations but uncorrelated with the other possible determinants of FDI (the other unobserved parameters) or with FDI in a direct manner but only through its effect on environmental regulations. However, it is not so easy to find valid and appropriate instruments (this topic is further deepened in [115]). Another possible approach to deal with endogeneity is to find a natural experiment under which firms or countries are exposed to some particular environmental policies determined by an external force (hence in this case the environmental regulation variable would be exogenously determined). Unfortunately, as explained in chapter 2, such natural experiments are relatively scarce.

Among the few contributions to this literature, including Poelhekke & Ploeg[106] and Millimet & Roy[115], two emblematic studies are taken as examples.

The first one is from Fredriksson et al.[116] and represents the first study to address the issue of environmental regulations endogeneity in their association with FDI. It is based on a theoretical model developed endogenizing environmental policy so that government corruption can influence capital flows only through its effects on environmental policy and on the amount of public goods. The idea behind is that workers and environmental lobby groups may offer prospective bribes to corrupt bureaucrats, in return for favorable environmental policies. Moreover, each corrupt bureaucrat may also steal a share of tax revenues related to public expenditures. Hence, the influence of corruption on FDI can pass through two distinct channels: the impact on the supply of public goods and the effect on environmental stringency.

Exploiting US state-level panel data from 4 industrial sectors - aggregate manufacturing, chemicals, metals, and food and kindred products - from 1977 to 1987, and using as measures of corruption (non-military) government employment and the share of legal services, it emerges that corruption effectively influences the supply of relevant public

goods as well as the stringency of environmental regulations, and that, in turn, they both can play a significant role in determining the location of US FDI inflows. Furthermore, it is shown that measured effects of environmental stringency on FDI are quite sensitive to the exogeneity assumption, as different estimates in many industrial sectors are found when environmental regulations are treated as endogenous, i.e. treating environmental regulations as exogenous can bias the estimates of the impact of environmental policy on FDI.

The other example is related to Cole et al.'s research[117] and to the issue of simultaneity, in an attempt to understand whether FDI itself can impact on environmental regulations, hence treating environmental policy as an endogenous variable. The authors effectively conclude that, when the degree of corruptibility is sufficiently high, FDI leads to less stringent environmental policy, contributing to the creation of a pollution haven[108].

Another part of the literature strictly related to the endogeneity topic is made up by a series of theoretical and empirical studies testing agglomeration externalities and spatial spillovers. Agglomeration externalities are supposed to be an important determinant for FDI location decision. Moreover, there is evidence that environmental regulations can be spatially correlated and tend to be similar between countries with close trade relations[118].

As representative example, Wagner & Timmins' work[97] is reported. It makes use of data on German outbound FDI and inward FDI stock to capture agglomeration effects. It controls for endogenous time-varying determinants of FDI using the generalized method of moments estimator (GMM) to correct for endogeneity bias. Findings strongly support the Pollution Haven Hypothesis in the most pollution-intensive industries. Wagner & Timmins argue that ignoring the externalities associated with FDI agglomeration can bias estimate results.

f. POH

One last possible reason for which sometimes the lack of significant evidence of a PHH-consistent effect is found is related to the Pollution Outsourcing Hypothesis, introduced at the beginning of the chapter. Indeed, if firms choose to outsource/offshore only the dirtiest part(s) of their production abroad, the firm-level emission intensities tend to lower, ending up in affecting observable data and, consequently, partially masking the pollution haven effect.

Michel's contribution[119] can be a good example to explain the extent of this dynamic: while investigating the role of offshoring on the reduction in air emissions in Belgian manufacturing sector, it finds that offshoring has contributed to 17% of the reduction in greenhouse gas emissions between 1995 and 2007.

3.2. FDI SPILLOVERS ON ENVIRONMENT

In environmental terms, inward FDI impacts on host countries can be either positive or negative. On the one hand, if MNCs relocate to countries or regions with less stringent regulations this could increase the levels of local pollution (such as air and water ones) and damage the health of the local environment and population. On the other hand, FDI from more technologically advanced countries may bring along new greener technologies and cleaner methods of production which can either disrupt less efficient local firms or be absorbed by those ones, resulting, in both cases, in an improvement of local environment conditions. Instead, regarding the case of outsourcing of only dirty parts of production processes, it may be less likely to result in the use of cleaner technologies and positive environmental spillovers, although sometimes outsourcers may lobby their arms-length partners for improving their environmental performance to green their supply chain.

That part of literature which investigates the environmental implications of FDI itself, is mainly focused on looking for the answers to the following three questions.

1. **Are foreign firms in developing countries cleaner than domestically owned firms?**

Theoretically there are several reasons why foreign-owned firms may be less pollution intensive than domestically owned firms within a developing country:

a. firms from OECD typically know and make use of newer and more energy-efficient technologies with respect to domestic companies and which, on average, generate fewer emissions per unit of output;
b. foreign-owned firms are typically larger than domestic ones, which means that they are likely to have better access to the resources needed to undertake a greater degree of R&D and staff training. They are also more likely to adopt environmental management practices and accreditation schemes such as ISO 14001;
c. foreign firms whose production systems are compliant with stringent OECD environmental regulations must meet the same environmental constraints also when

they establish in a developing country, otherwise they cannot export their products back to OECD markets.

Actually, according to the outcomes of several contributions on this topic, the evidence that foreign firms are effectively greener than domestic organizations is rather mixed. In fact, while earlier studies like the ones by Hartman et al.[120], the already mentioned Pargal and Wheeler[73] and Dasgupta et al.[121] indicate no statistical significant impact on manufacturing plants emissions by foreign ownership, Eskeland & Harrison[122] (see chapter 4) and Cole et al.[123] agree in affirming that foreign firms use cleaner source of energy. In addition, Cole et al. come across an interesting discovery: taking into account the characteristics of the CEO of each plant and, specifically, whether the CEO is foreign trained, it turns out that plants with a foreign-trained CEO seem to have lower levels of energy intensity, in a statistically significant way. The effect of foreign training is particularly evident among foreign-owned plants, suggesting that not only the access to new technology (which, as said, is likely to be greater for foreign-owned plants) is necessary to reduce energy intensity but also the ability and know-how to use this technology.

Furthermore, it must be specified that, despite the fact that most of studies implicitly or explicitly assume that the FDI in question originates from high-regulated OECD economies, a recent trend for FDI identifies, instead, with the significant growth in flows from developing countries (usually toward other developing regions, an example of which could be the rapid expansion of Chinese FDI in Africa); in this case it is questioned whether firms from such developing economies effectively hold and make use of more stringent environmental practices than domestic plants in the host country.

2. Do domestically owned firms become greener in presence of foreign firms?

In the first chapter of this paper a series of channels through which foreign firms presence may influence local ones have been analyzed. Actually, there is another one that has not been mentioned yet. In fact, it is also possible that foreign companies presence may influence the environmental performances of domestic firms. The possibility of this happening in a positive manner takes the name of "Pollution Halo Effect".

The main causes for environmental spillovers occurrence are the following ones:

a. foreign companies might deliberately choose to spread environmental knowledge and technologies to domestic ones. For instance, this could happen because a foreign firm may choose to purchase intermediate goods only from suppliers who adopt specific environmental management practices, or may decide to sell its goods only to local

companies that are compliant with a given set of environmental rules or practices (maybe in case shareholders want to avoid negative reputational effects from being associated with firms perceived to be acting in an environmentally irresponsible way);

b. domestic organizations may imitate the good practice of foreign ones if it is in their interests to do so. Firms can absorb environmental knowledge and experience, directly or indirectly, through forward links with suppliers, backward links with customers, or horizontal links with competitors;
c. moreover, there may be a faster way for them to benefit from knowledge transfer, that is hiring workers directly from foreign advanced firms.

Albornoz et al.[124] have provided an important test on the existence of environmental spillovers. Using Argentinean firm-level data capturing a wide range of environmental management practices, they have managed to measure forward, backward, and horizontal linkages along with a firm-specific measure of how closely a firm is connected to the other ones that it supplies, buys from, and directly competes with. The key finding is that those firms that supply a sector with a large foreign presence and who have formal and informal links with their customers are more likely to adopt environmental management practices.
However, other studies do not agree with the same conclusion.

3. **In general, does the presence of FDI result in environmental improvements within the host country?**

- **FDI and pollution**

Zugravu-Soilita[125] study examines the impact of FDI from France, Germany, Sweden, and the United Kingdom on national emissions of a range of pollutants. The outcome shows that the environmental impact of FDI depends on the host country environmental regulations, capital endowments, technology gap between foreign and domestic firms, and domestic labor productivity. More specifically, FDI seems to be associated with a reduction in pollution in countries with relatively low capital-labor ratios and relatively stringent regulations. On the opposite, it is related to an increase in pollution in relatively capital-abundant countries with lax regulations. These results are consistent with the PHH, in the sense that capital-intensive (and tehrefore pollution-intensive) foreign investment flows toward capital-abundant countries with less stringent regulations, while cleaner labor-intensive FDI is attracted by labor-intensive, high-regulated economies. However, capital-intensive countries tend to have more stringent policies, whereas labor-intensive regions tend to have relatively lax regulations.

Kim & Adilov[126] have focused their attention on a country-level study in which they have found out that FDI has the effect of reducing per capita CO2 emissions in developing countries, which can be interpreted as evidence that foreign direct investments into developing regions brings advanced and cleaner technologies. On the contrary, Shahbaz et al.[127] finding shows that FDI inflows produce the opposite effect, that is an increase in CO2 emissions in developing countries, although this result appears to be sensitive to the econometric assumptions and to the choice of countries and time periods taken into account. A Chinese study by Lan et al.[128] argues that FDI environmental spillovers depend on the technological capabilities of the specific region, measured by human capital. It indicates that inward FDI reduces pollution emissions in provinces with high levels of human capital but tend to increase them when human capital is low.[108]

- **FDI and energy consumption**

The topic about the contrast Pollution Haven Hypothesis - Pollution Halo Hypothesis is strictly related to the relationship between FDI and energy consumption. Indeed, according to the former theory, one of the most relevant reasons why foreign investment aggravate pollution is that they bring along non-renewable energy consumption in the host countries, while the other hypothesis supports the point that they help transfer green and renewable energy technologies into foreign countries.

The FDI - energy consumption association can be explained through three different mechanisms[129], [130]:

a. **The scale effect**

   According to the scale effect, FDI flows make energy consumption in host countries increase since these generally raise the level of production of those countries. As firms aim at minimizing their production cost by looking for cheaper resources, a higher production level is likely to boost up non-renewable energy consumption. In other words, the scale effect is concerned with FDI discouraging renewable energy consumption in host countries [131]–[133].

b. **The technique effect**

   The technique effect deals with the technology transfer host countries benefit from attracting FDI inflows. In this case, energy is efficiently used and FDI lowers energy intensity in the production procedures. Several empirical works state that FDI reduces energy intensity in various case studies, including Turkey [134] and

China [135] at the country level, and more than 60 other developing countries [136]. Overall, the technique effect tend to improve the environmental quality [137].

c. **The composition effect**

For this last mechanism, the effect of FDI on energy consumption is undetermined and depends on the economic sector the FDI flow is related to. In general, while an increase in the share of FDI in secondary sectors may raise non-renewable energy consumption, the FDI growth in the tertiary sector may lower it.

Literature investigates the relation between FDI and renewable energy consumption mainly in two perspectives:

- **Linear effect of FDI on renewable energy consumption**

  A number of works suggest a positive relation between FDI and renewable energy consumption (for instance Doytch and Narayan [138]), while others show a negative association between them (like Paramati et al. [139]) and other ones find the insignificant effect of FDI on renewable energy consumption (such as Lee [140]).

- **Nonlinear effect of FDI on renewable energy consumption**

  An example is represented by Shahbaz et al.'s paper [141]: adopting the cross-sectional autoregressive distributional lag model and using data of 39 countries from 2000 to 2019, it detects a U-shaped association between FDI and renewable energy consumption. In fact, while the scale effect is dominant in the early stage, the technique effect tends to play a significant role in the later one, due to technological transformation.

- **A particular study considering moderating variable**

  The number of papers exploring the relationship among FDI, renewable energy consumption and certain external variables is very scarce. One of the most important studies in this context is from Yan Tan and Utai Uprasen [75] and which considers environmental regulation as a moderating variable and, at the same time, a threshold variable to capture the nonlinear association between FDI and renewable energy consumption. It takes advantage from data belonging to the dataset of the BRICS countries from 1990 to 2015 and indicates that FDI flows tend to reduce renewable energy consumption when the degree of regulatory stringency is lower than a certain level, while it induces renewable energy consumption once the stringency is higher than this threshold. Hence, this research provides three main conclusions: first, the

relation between FDI and renewable consumption is nonlinear; second, the effects of FDI on renewable energy change from negative to positive when the environmental regulatory stringency overcomes a specific threshold level; third and very important, control variables (such as GDP per capita, trade openness, financial development, and urbanization), influence renewable energy consumption as well. These results may help explain the contradictory findings of the other studies on the effect of FDI on renewable energy, in an attempt of harmonizing the prediction of the Pollution Haven and Pollution Halo Hypotheses. [75]

4. SOME EVIDENCE FROM ALL AROUND THE WORLD

In the previous section, the main theme of this work has been introduced and discussed, that is how much FDI flows are affected by environmental stringency (and vice-versa). In order to better understand it and have a clearer and more detailed view about it, some of the most significant examples on this topic and its nuances will be analyzed. In particular, three of the greatest economic powers today, related to different realities, will be taken into account: on the one side China, representative of developing countries; on the other side United States of America, belonging to developed ones, as well as most of European Union. The final short part will be specifically dedicated to Italy.

In the charts below, both FDI inflows and outflows are shown for the named areas:

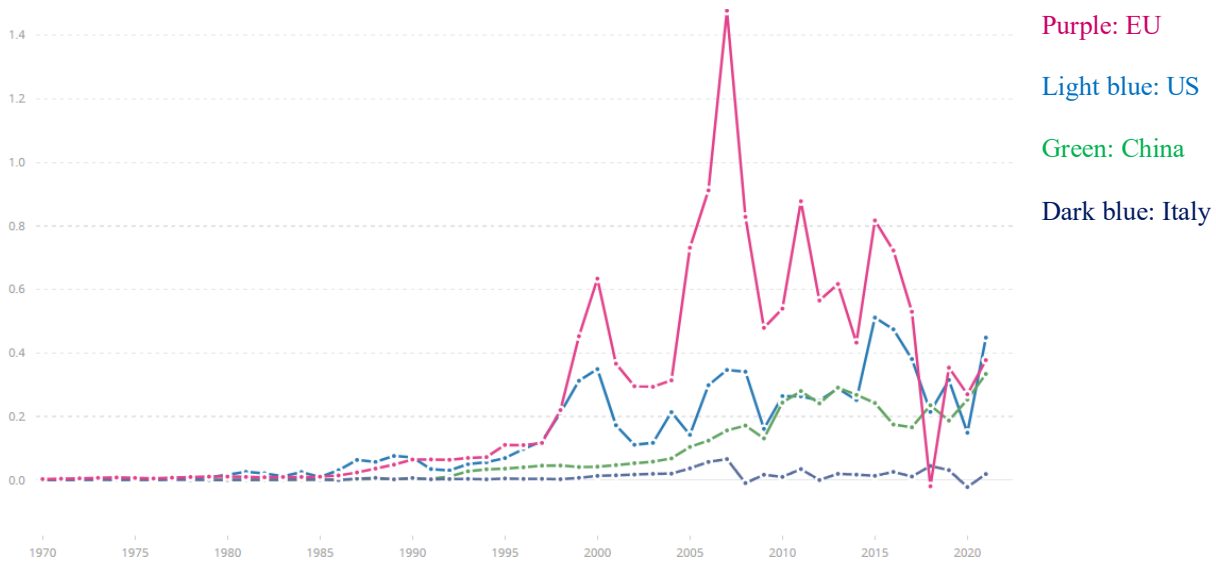

Figure 17 - Foreign direct investment, net inflows (BoP, current US$)[142]

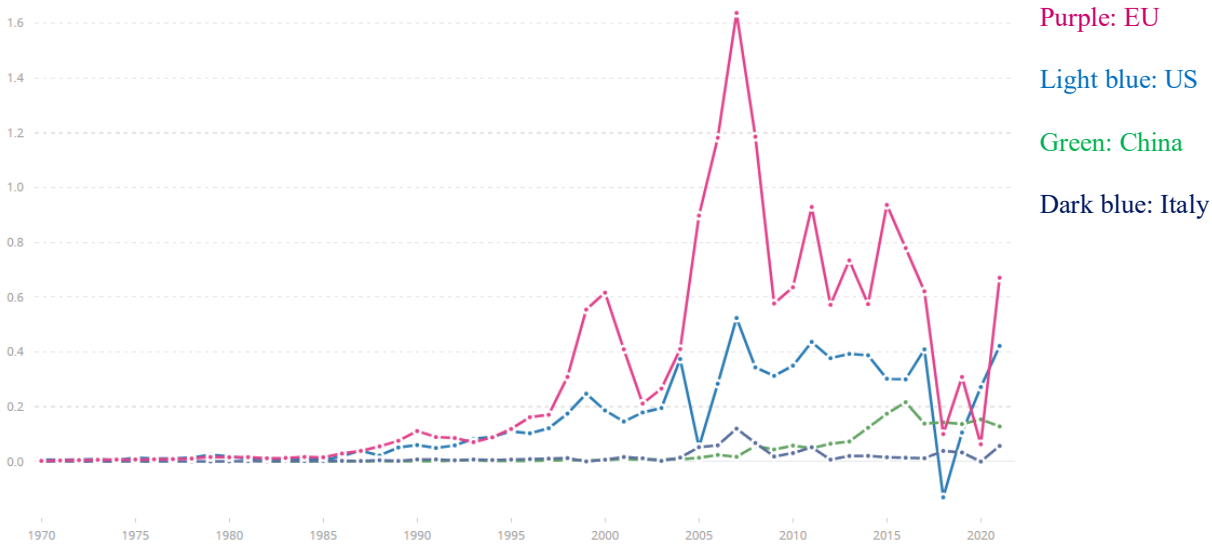

Figure 18 - Foreign direct investment, net ouflows (BoP, current US$)[143]

4.1. CHINA

As already discussed in the previous chapters, FDI has become an important thrust for the economic development of many developing countries. However, there is a delicate balance between foreign investment, economic development and environment. In the following pages, one of the biggest and most important developing country nowadays, namely China, will be analyzed.

On the one hand, China is the second largest FDI recipient country in the world and foreign investment flows in the country represent an always greater and more important way of financing, rising from 430 million dollars (0.21% of GDP) in 1982 to more than 144 billion dollars (12% of GDP) in 2017[144]. In the specific, in the last two decades, FDI in China has grown at an annual rate of about 22%[145]. On the other hand, China fast recent economic growth has been accompanied by severe environmental degeneration. In fact, the PM2.5 concentration in Beijing during 2013 significantly exceeded the health standard suggested by the World Health Organization (WHO)[146], [147], and an economic loss of 246.26 billion Yuan (approximately 1.1% of the national GDP) in 2007 was recorded[148]. Moreover, the serious air pollution in China has been producing significant public health impacts[149], [150]. For instance, the Global Burden of Disease (GBD) study undertaken by Institute for Health Metrics and Evaluation and WHO linked over 3.2 million premature deaths to PM pollution in 2010, and roughly one-third (1.23 million) of the world estimated PM pollution-related

premature deaths happened in China[151]. Given this situation and the fact that China has a relatively lax environmental policy, concerns have raised among academics about whether China is seen as a "Pollution Haven" by multinational companies[152].
Therefore, China is currently one of the most interesting and "under observation" countries with regards to the relationship between FDI and environment and a huge amount of recent empirical material fills the literature on this topic. In the following pages, the main contributions will be reported and discussed.

In 2012, Yi Lu et al.[153] decide to examine whether there is a pollution haven effect in presence of a change in environmental regulations, exploiting the implementation of the Two Control Zones (TCZ) policy in China. More specifically, in order to conduct a difference-in-differences (DID) analysis, they focus on two possible variations: time (before and after the policy change) and cross-sectional (two groups identified: the treatment group, including cities subject to the new environmental policy, and the control group, with cities not touched by it).
With the growing concern over the air pollution problem, in 1998 Chinese governments decided to put into effect a new policy, namely the Two Control Zones (TCZ) policy, so as to prevent the air quality of heavily-polluted areas from deteriorating further. The TCZ included SO2 pollution control zones and acid rain control zones. The National Environmental Protection Bureau (NEPB) designated cities as TCZ, based on several criteria. In particular, a city was designated as a SO2 pollution control zone if it exceeded a certain standard value (a threshold) of SO2 concentration, while it was designated as an acid rain control zone for too high PH values of precipitation. Among a total of 380 cities, 175 were designated as TCZ. In general, SO2 pollution control zones were located in northern China, probably because of the heating system, whereas acid rain control zones were more likely to be in southern China where the weather is more wet. Once a city was designated as TCZ, tougher regulatory policies were implemented in that area. These new environmental regulations generated significant improvement in air pollution control: by 2008, the SO2 emission in TCZ cities became similar to those in non-TCZ cities.
Considering the amount of FDI for 280 cities over the period which goes from 1992 till 2009, the researchers find that cities designated as TCZ attract around 41% less FDI than non-TCZ ones, concluding that areas with tougher environmental regulations attract less foreign direct investment.

Despite the findings from Yi Lu et al., more recent studies show results less generalized and more flexible. The first one to be presented is Yanyun Li et al.'s work[154], which takes advantage from China eleventh Five-Year Plan to further investigate on the topic.

The Five-Year Plan for national economic and social development of the People's Republic of China is an important initiative setting goals and direction for the future development of the economy by the central government. The environmental reduction policy was first introduced during the tenth Five-Year Plan, but it did not effectively work in reducing sulfur dioxide emissions nationwide and this was mainly due to the limited policy location. Instead, the eleventh Five-Year plan, which ran from 2006 to 2010, established a sulfur dioxide emissions reduction target for the entire country by 10% by 2010 (which means about 22.944 million tons) and, more importantly, it distributed this target to all the different provinces, sharing different burdens. So that, to achieve their own pollution reduction targets, provinces with higher targets had to exert greater effort. Thanks to the eleventh Five-Year plan, a decrease was recorded in total SO2 emission by roughly 14% from 2005 to 2010 and most provinces achieved or even exceeded their targets.

In their study, Yanyun Li et al. split and attribute the provincial target to each city in it, through the proportion of city sulfur dioxide emissions to provinces in 2005, obtaining a detailed list of cities environmental stringent regulations. In particular, for data about province-level target, they refer to the "Total Emission Control Plan of Major pollutants in China during the Eleventh Five-Year Plan". The distribution of the provincial pollution reduction targets varies from 0 to more than 25% with mean and standard deviation respectively of 9.65% and 6.81%, and, according to the researchers' computation, the distribution of the urban pollution reduction targets for 282 cities ranges from 0 to more than 5.01%, with mean value of 1.25% and standard deviation of 0.92%. The emission density for 34 industries varies from 0 to closely to 60% with a mean and standard deviation of 2.50% and 9.23%, respectively. To measure foreign direct investment flows they use FDI data obtained by Chinese enterprises with sales above RMB5 million (which is equivalent to around $770,000), taken from the Annual Survey of Industrial Firms (ASIF) in China during period 2001–2009. Therefore, they use firm-level data to measure FDI activities.

The core of the study consists in a comparison between the changes of firms FDI in industries with different pollution intensities in the different cities before and after the eleventh Five-Year Plan period. Results show that firms belonging to more pollution-intensive industries located in areas with higher pollution reduction targets experienced a reduction in foreign invested capital. The reasons for this reduction of firm-level inward FDI are expressed in terms of

entering and exiting of foreign invested enterprises: low and intermediary productivity firms show strong negative response in attracting inward FDI after the stringent environmental regulations take place, and in most cases FDI capitals are induced to exit from these firms. As consequence, since low productivity foreign invested firms are forced to leave the market, industries average productivities increase.

Therefore, from the analysis, two main findings emerge: first, the stringent environmental regulations could cause the increased probability of incumbent inward FDI to exit and decreased probability of non-incumbent FDI to entry. Second, the stringent environmental regulation could mainly induce the declining of inward FDI flows for low productivity firms. Indeed, the stricter environmental policy force firms to adopt the new clean technologies, which can increase the overall productivity by dropping low productivity firms. As evidence, the study detects that, for FDI invested firms, the average log of productivity is 5.17 before the eleventh Five-Year Plan, whereas it increases to 6.06 after it.

Wang et al.[145] try to understand the efficiency of FDI attractiveness for 31 provinces of China in the period from 2015 to 2017, under the relative environmental regulations, considering pollution abatement and control expenditures as proxy for environmental regulation measurement. They find out that the mean overall efficiency in the eastern regions is significantly higher than the one in the non-eastern regions, regardless of environmental policy applied. In general, both foreign company number and FDI amount in the eastern region are greater. Furthermore, the average of overall efficiency in the eastern regions increases faster than that in the non-eastern regions when considering environmental regulation. These findings lead the authors to suggest that the non-eastern regions should take appropriate environmental regulatory measures to improve energy saving and environmental protection expenditure efficiency and that, especially in those areas, government should try to improve FDI efficiency.

Another important paper which succeeds in pointing out the substantial difference between eastern and non-eastern zones of China is the one made by Hu et al.[155]. Through the standardized entropy method, it measures the environmental stringency (ERS) intensities of 283 Chinese cities at prefecture level between 2003 and 2016, and makes use of the fixed-effects model to analyze the influence of the ERS on the location selection of FDI in these Chinese cities. In the specific, regulation intensity is measured based on five different indices, among which the most important ones are the removal rate of industrial sulfur dioxide, the removal rate of industrial fume, and the comprehensive utilization rate of industrial solid waste. Thanks to this approach, the ERS level of each city can be accurately demonstrated.

Results from the work indicate that on nationwide, central, and western regions the influence of stringency variable is significantly negative, which means that environmental regulations are indeed an important consideration of foreign investors when choosing location, and that stricter ERS hinders the FDI inflows, according to the Pollution Haven Hypothesis. On eastern region samples, instead, stricter policies seems to promote FDI flows, in contrast with the Pollution Haven Hypothesis. Taking advantage of virtue of superior location, efficient infrastructure, and good business environment, the eastern region has become the first choice for foreign investment. This finding may suggest that, for foreign-funded enterprises, good business environment, low labor cost, and huge market size are more attractive than a lax environmental regime. According to the article, the different Chinese regions should implement different ERS policies and utilize region-specific ERS instruments, modifying them in a timely manner to suit the local conditions. Moreover, the western region should invest more on infrastructure construction and on more recent and innovative technologies to reduce the cost of foreign direct investment.

Yang et al.'s study[156] confirms the same findings. Through a spatial Durbin applied on a panel data of 30 provinces in China from year 2003 to 2014 it aims not only at analyzing the impact of environmental regulations on FDI in China, but also at exploring their spatial correlation and the spatial spillovers generated by the two in the country. Indeed, it turns out that a spatial correlation between regional environmental regulation and FDI exists: at national level, environmental stringency tends to inhibit FDI inflows in the local region and the surrounding areas, although this inhibition is not significant. Overall, evidence of Pollution Haven Hypothesis results to be insufficient in China, even if the degree and the direction of influence of environmental regulations on FDI clearly depends on the different regions. In fact, in the eastern region this influence appears to be positive, while in the central and western regions environmental regulation poses a hindrance to the introduction of FDI. Another important insight is about the importance of economic openness as factor which can directly affect FDI inflows, as well as labor cost and human capital level, with these latter ones also influencing foreign investment location selection within the country. In addition, the level of regional economic development and R&D investment seem to have a significant indirect impact on the choice of FDI location.

Not only the intensity of environmental stringency is affecting FDI, but also the different policy tools used to enforce it. This is what emerges from the Xiao Yu and Yong Li's empirical work[157]. For this study, two indicators are chosen in order to measure the quality level of

FDI inflow: unit scale of FDI (FDIS) and unit benefit of FDI (FDIB). FDIS index is expressed by the ratio of the actual use of FDI in each region over the number of foreign-funded enterprises registered in it, at the end of the year. Higher actual use of FDI for every foreign-funded enterprise (that is higher value of FDIS) means a higher quality level of FDI inflow. FDIB index, instead, is expressed by the average main business revenue of industrial enterprises in which foreign countries invested. The higher the FDIB, the higher the profit rate of foreign capital, and a higher profit rate is more likely to attract higher-quality foreign capital inflow.
Exploiting a panel data from 30 provincial administrative regions in China during 2009-2018, the analysis leads to several key points:

- A strict environmental regulation policy does not hinder the inflow of FDI, but it can, instead, improve its quality. This is what suggested by the observation of an overall rising trend in the mean values of indicators of FDIS and FDIB in all 30 provinces in China, from 2009 to 2018, with the implementation of more stringent environmental regulations. However, there are significant differences in FDI quality among the different regions: in the eastern area, FDIS value is slightly larger than that in central and western ones, although the gap is gradually narrowing; in the central region, FDIB is significantly higher than in the eastern and western regions, with the gap gradually widening;
- Significant differences in the effects of different environmental regulation policy tools on the quality of FDI are found. In particular, the administrative supervision policy and social participation policy can improve FDI quality in a more substantial way with respect to the other factors. This means that high-quality FDI tends to flow into regions with no corruption, efficient political operations, and a democratic and orderly social environment. On the other hand, the effect of the monitoring policy and screening on the quality of FDI is not significant, indicating a lack of powerful local legal support for environmentally matters, and this could end up in weakening the effectiveness of the other environmental regulation policies;
- The different regions, with their own characteristics and peculiarities, prefer to adopt different strategies in order to attract foreign investment. Specifically, the eastern region seeks to guide foreign-funded firms in realizing technical innovation, promoting to “maintain scale and improve benefits” for them by introducing market-oriented and socialized policies. The central and western regions are instead more focused on government-led environmental regulations, looking for optimizing the

business environment and assisting foreign-funded companies in "improving benefits and expanding scale";

- By the way, the environmental reforms exert a limited effect on FDI quality, since FDI inflows are affected by many other factors such as resource endowment, public infrastructure, economic market potential, industrial agglomeration, contract execution rate, political stability and legal system of the market[158].

A particular research from Jiangfeng Hu et al[144] investigates, through three different panel models, on how labor-based FDI and capital-based FDI can result in green technology spillover under different levels of environmental regulation intensity; measurement of green total factor productivity (GTFP) is performed exploiting the Global Malmquist–Luenberger (GML) index on a panel of 36 industry sectors in China from 2003 to 2015, and chemical oxygen demand, ammonia nitrogen and SO2 and smoke (powder) dust emissions are considered as unexpected output. Based on the static linear model, it emerges that environmental regulations have significant and positive relationship with the green technology spillover of capital-based FDI, while no significant relationship is found for labor-based FDI. According to the static threshold model, instead, green technology spillovers from FDI show double thresholds in terms of environmental regulation intensity: when the intensity is lower than the first threshold, only capital-based FDI results in green technology spillover; when the environmental regulation intensity is between the first threshold and the second higher one, the green technology spillover effects of both types of FDI are negative; finally, when the environmental regulation intensity exceeds the second threshold, the green technology spillover effects of both kinds of FDI become positive (although only the coefficient of capital-based FDI is really significant). The last approach used is the dynamic panel model (for robustness check of empirical results), whose results put in evidence the need of a level of environmental regulation intensity higher than the third threshold in order to induce the two types of FDI to generate green technology spillover. In conclusion, whether FDI can generate the green technology spillover effect and its direction can depend on the host country environmental regulation intensity and, in general, the stricter the regulation, the more important the severity of the spillover effect.

Another study from most of the same authors[152] examines the spillover effects always of labor-based FDI and capital-based FDI on green technology progress rate (measured by the GTFP also in this case) on four different sets of manufacturing industry classifications, i.e. high/low discharge regulation and high/low emission standard regulation. Results indicate that FDI spillovers on the manufacturing green technology progress can actually assume either a

positive direction or a negative one, based on their own structure and on the strength of environmental stringency. In particular, in the low discharge regulation and low emission standard regulation industry, labor-based FDI shows a significant negative spillover effect, while capital-based FDI a significant positive one. Instead, in the high-intensity environmental regulation industry, the negative influence of labor-based FDI is completely offset, and capital-based FDI keeps bringing along positive spillovers. However, if it is true that in the low-intensity environmental regulation industry the labor-based FDI results in a negative effect, this latter can be reduced by strengthening environmental stringency. Another interesting finding is that the direction and magnitude of FDI green technological spillover effect is affected not only by the strength of environmental regulations but also by the tools used to put them in place. Indeed, in the low-intensity environmental regulation industry, the effect of discharge regulation aiming at gaining green technological spillover effect from FDI is relatively good, while, in the high-intensity environmental regulation industry, the tool of emission standard regulation is more useful than the discharge regulation one.

Therefore, to briefly sum up the interesting outcomes about China, the first insight to take into account deals with the fact that, despite the continuous growth of FDI inflows within the country, these are distributed very unevenly among the different areas: most of China FDI concentrates in the eastern region (especially in the Yangtze River Delta and the Pearl River Delta). Some studies suggest that around 90% of the difference in economic development between the eastern, central, and western regions arises from the regional difference in foreign capital [155], which means that FDI contributes greatly to the imbalanced development between regions of the country.

In the eastern area FDI flows are attracted by more stringent regulations, while in the rest of the country a stricter environmental policy tends to hinder FDI attractiveness. However, it must be considered that foreign investment inflows are affected only partially by environmental stringency, as there are a lot of other factors to consider, like resource endowment, public infrastructure, economic market potential, industrial agglomeration and so on. Indeed, the eastern region has become the first choice for FDI especially thanks to superior location, complete infrastructure, and good business environment.

In order to improve regional economy, some local governments compete to relax environmental regulations to attract foreign investors. Besides the fact that this strategy is hardly sustainable, those government should realize that, for foreign-funded companies, a good business environment, low labor costs, and a huge market size are more attractive than a lax

environmental policy. Moreover, stricter regulation could force firms to pursue technological innovation, which could improve their own competitiveness and make them earn extra profit, which in turn could offset the additional cost induced by environmental policies. For these reasons, local governments should design a reasonable stringency level, rather than just keep increasing its intensity, so that both enterprises and the entire society could benefit from innovation and cleaner FDI spillovers. In addition, depending on the specific region, different environmental policies should be implemented and specific instruments should be put in place. Going more into details, the natural environment in the western region is already harsh and relocating polluting industries in there could mean to break the environmental balance further. That is why the regulations level should be designed in line with local conditions, and the local pillar industries should be supported with favorable policies. In order to narrow the economic gap with eastern and central regions, the western region needs to construct better infrastructure, introduce newer and cleaner technologies, and step up innovation [155].
Furthermore, dealing with the issue of a general weak enforcement component, it could turn out to be useful to deepen the reform of the environmental supervision structure, tightening the law enforcement of environmental rules. As a possible solution, the government could establish a comprehensive environmental management department with clear powers and responsibilities, and decentralize environmental protection responsibilities. Finally, the Chinese government should benchmark international trade laws and regulations, and promote the liberalization of international investment to attract more easily multinational enterprises with high-quality capital and cleaner advanced technologies [157].

One last interesting paper, signed by Yan Dong et al.[159], explores the impact of environmental regulation on outward foreign direct investment in China, rather than on inflow ones. The National Bureau of Statistics of China reported that China contributed for $136.9 billion to global FDI in 2019, that is approximatively the 10% of worldwide quantity. Chinese outward FDI stock in 2019 reached $2.2 trillion, with a share in global FDI stock of 6%[160]. Based on the fDi Markets database, the researchers build a city-year level greenfield FDI dataset for China. Study results suggest that environmental regulations significantly encourage outward FDI flows. Specifically, highly polluting industries are the most likely to be motivated to invest abroad. Furthermore, another finding is that these ER-induced FDI outflows are mostly directed toward countries with weaker environmental regulation (according to the PHH), and that they prefer host countries with a smaller geographic and cultural distance to China. This attitude is

consistent with the “law of distance”, which argues that distance hinders international business activities (see [161]).

4.2. UNITED STATES

Although contributions to literature regarding FDI-regulations association in the US are less recent and lower in number compared to the ones on China, it is worthy to have a look at them, since United States of America is considered one of the global greatest powers in economic field and one of the most active countries contributing to FDI flows exchange.

In the last 20 years, the amount of foreign direct investment in the United States has more than doubled. In 2000, inward FDI was 1.26 trillion US dollars and in 2021 it shifted to 4.98 trillion US dollars [162]. In particular, the countries which sent the most of FDI to United States in 2017 were Japan, United Kingdom and Canada. In 2019, about 8.7 million jobs offered in the US rose as consequence of foreign direct investment [163].
The other side of the coin is not so bright: United States is the world second-largest emitter of carbon dioxide (preceded only by China) and, in 2021 only, about 67 million tons of pollution were emitted into the atmosphere in the country, mainly coming from the transportation and electric power sectors. According to a survey conducted by the US Environmental Protection Agency (EPA), due to agricultural pollution, approximately half of the country rivers and more than one-third of its lakes are polluted and unfit for swimming, fishing, and drinking. A congressionally mandated report released in late 2021 described the US as the leading country for plastic waste generation: it produces more plastic waste than any other nation, equivalent to about 42 million metric tons every year, which amounts to 287 pounds (130 kilogram) per person. In total, the country produces almost twice as much as China, and more than all the countries in the EU combined together[164].

Actually, this thesis already delt with one of the most interesting papers on the topic of FDI-environmental policy relation in US, that is the Fredriksson et al.’s one[116] (see chapter 3), while other works were mentioned and will be deepened through this section.

Following a chronological order, one of the first documents considering environmental regulation as a possible variable affecting FDI inflows in US country is the contribution from List and Co[165]. It tries to estimate the effects of state environmental regulations on foreign MNCs new plant location decisions from 1986 to 1993 using state-level data and different measures of regulatory stringency. Data on FDI are taken from the International Trade

Administration (ITA) annual publication "Foreign Direct Investment in the United States", and only new plants investment are considered. The authors find evidence that, overall, more stringent pollution regulations deter new firm entry in a significant way, since regulatory elasticities are in the 2-5% range for several states.

One of the most important and debated studies on how US FDI flows are affected by environmental policy is signed by Keller and Levinson [90]. It blames previous works on the same topic to suffer from at least one of the three following issues:

1. difficulties in quantifying international (among countries) differences in environmental regulations and assess how much they affect international trade with respect to other factors, such as factor costs, market access, transportation costs and exchange rate risks, which may vary substantially among different countries;
2. due to their nature of cross-section analysis, it is very complex to take account of unobservable characteristics in the different states that may be correlated with both regulatory compliance costs and investment, and these unobserved factors could result in an omitted variable bias in the analysis of the effect of strict regulations on foreign investment.
3. they use cost-based measures of environmental standard stringency, which fails to control for the different states industrial composition; for instance, if lax regulations attracted polluting industries, pollution abatement spending could turn out to be negatively correlated with the stringency of state regulations.

The paper proposes specific solutions in order to avoid these three problems:

1. in order to overcome the difficulties of comparing different countries, it chooses to examine foreign direct investment into various US states as a function of manufacturers pollution abatement costs in those states. Data on environmental costs in US states are more comparable than those for different countries as well as data for the other characteristics mentioned above, since they vary less than across different countries. This translates into a more precise and accurate measure of regulatory stringency and a better control for the other characteristics which may attract or deter foreign investment;
2. the problem related to the omitted variable bias is addressed by examining investment and environmental regulatory costs over an 18-year period, from 1977 to 1994, which allows to control for unobserved time-invariant state characteristics in the estimations. It is used a continuous and time-varying measure of the pollution abatement costs in

each state, based on data taken from the Pollution Abatement Costs and Expenditures (PACE) survey, conducted by the US Census Bureau;

3. the third issue is faced by allowing for differences in industrial compositions among the different states, measuring state pollution abatement costs from the PACE data, adjusted using each state industrial composition.

Two types of FDI data are considered in the analysis: data on the value of gross property, plant, and equipment belonging to foreign-owned manufacturers and on manufacturing employees working for foreign-owned firms, from the series Foreign Direct Investment in the United States of the Bureau of Economic Analysis (BEA); data about planned new foreign-owned factory openings taken from the series Foreign Direct Investment in the United States, collected by the International Trade Administration (ITA). ITA and BEA data together provide a comprehensive picture of FDI in US states.

In conclusion, results show robust evidence that abatement costs cause moderate deterrent effects on foreign investment. This effect is visible in particular on capital and employees at foreign-owned manufacturers in pollution-intensive industries, and generally on the number of planned new foreign-owned manufacturing facilities.

Some years later, Henderson and Millimet[166] assess the robustness of Keller and Levinson findings by exploiting a more recent nonparametric methods (in contrast with the parametric one used by the previous study). They manage to reveal that, while some of the parametric results are robust, some others are not, meaning that modeling assumptions matter in a crucial way; moreover, the impact of greater relative abatement costs is not uniform across states, but follows specific patterns; finally, overall negative effects of abatement costs on FDI inflows are of smaller magnitude than the ones detected by Keller and Levinson.

The empirical contributions explored so far are focused on inward FDI flows. However, being US one of the most significant examples of developed country, it is not only subject to welcome foreign investment capitals, but it also plays an important role as exporter of capital flows towards foreign destinations. For example, in 2020, the United States invested over 890 billon US dollars in the United Kingdom and another 843.95 billion US dollars in the Netherlands [163] and, in 2021, FDI from the United States to other countries amounted to 6.49 trillion US dollars[162]. This is the reason why a great number of papers about United States are concentrated on investigating the volume of FDI outflows and their relationship with environmental rules.

Temporally speaking, Xing and Kolstad[62] are among the first ones in analyzing the influence of environmental regulations of foreign host countries on US FDI outflows. They examine foreign direct investment of six different US industries, two of which - chemicals and primary metals - belong to those industries with high pollution control costs, while the remaining ones - electrical and non-electrical machinery, transportation equipment, and food products - to those with lower pollution control costs (as pollutant, aggregate national sulfur emissions is considered).

The statistical evidence suggests the existence of a significant negative linear relationship between FDI flows from US chemical and metal industries and the environmental stringency of foreign host countries. On the contrary, no similar effect is found for the other less polluted sectors (electrical and non-electrical machinery, transportation equipment and food products). However, to correctly interpret these findings, it must be taken into account that the environmental variable is only one of the determinants of FDI flow exchanges and there is no evidence that this alone can determine the direction of FDI flow for polluting industries. Anyway, Xing and Kolstad concludes that it is more likely that capital investment associated with polluting industries flows to countries with lax environmental regulations rather than to countries with stricter ones.

In the same years, another important study is carried out by Eskeland and Harrison[122]. It is mainly focused on three different matters:

1. analyzing the pattern of foreign investment in four developing countries, namely Mexico, Venezuela, Morocco and Cote d'Ivoire, and their relationship with environmental policy of FDI home industrialized countries. However, in order to control and keep track for other country-specific factors which could affect foreign investment attractiveness, measures of trade policies, industrial concentration, domestic regulatory environment, factor endowments, and wages are created. Although weak evidence according to which foreign investors are concentrated in sectors with high levels of air pollution is found, there is no clue that FDI in these developing countries is related to an increase of abatement costs in developed ones;
2. examining the pattern of outbound US investment between 1982 and 1993, so as to understand if they can be explained by variations in pollution abatement costs across the sectors US economy. Apparently, some evidence that US outflows are linked to industries with high costs of pollution abatement emerges, but results are not robust to the inclusion of other variables in the analysis, to the point that they can be completely

reversed, meaning that outbound foreign investment is higher in sectors with lower abatement costs;

3. comparing the pollution behavior of multinational firms in developing countries with local firms operating in the same sector considering their emissions, which are approximated with energy consumption and composition of fuel (to understand how dirty it is). Outcomes show that foreign plants are significantly more energy efficient than domestic ones and that they use cleaner types of energy compared to them.

Later, Eskeland's work is taken as reference point by Hanna and her research[114]: indeed, it tries to estimate the effect of tougher environmental regulation at home on outbound FDI from US MNCs. The study exploits the exogenous variation in firm-level regulation created by the Clean Air Act Amendments CAAA, a legislation that dramatically strengthened environmental regulation in the United States.

Through it, in 1970 the Environmental Protection Agency (EPA) established separate national ambient air quality standards (a minimum level of quality that all US counties are required to meet) for four specific pollutants: carbon monoxide (CO), ozone (O3), sulfur dioxide (SO2), and particulate matter (PM). In July of each year, states where air pollution concentrations exceeded federal standards for a specific pollutant received a nonattainment designation for that pollutant. The law forced that state to develop a State Implementation Plan (SIP), including specific regulations for every major source of the pollutant for which the county was in nonattainment. Existing plants in the nonattainment region were either subject to controls for assessing the technologies they used and their tools or forced to adapt to cleaner changes in industry production process. The policy was designed with the aim to regulate similarly all states nonattainment, and this eliminates the possibility that differences in other characteristics across counties are potentially correlated with firm production choices, which would bias the estimated environmental regulation effects on FDI. Moreover, this approach allows also to avoid bias associated with industry specific trends and, since the CAAA induced substantial variation in the level of regulation faced by an individual firm across time, this methodology ensures that firm specific factors (firm size, production technologies) do not drive the results, as well.

The paper takes advantage from a firm-level dataset collected by the Bureau of Economic Analysis (BEA) of the US Department of Commerce on the activities of US based multinational firms ranging from year 1966 to 1999, and from annual data about the four pollutants and attainment/nonattainment designations for each US state.

According to the results, the CAAA regulations causes multinational enterprises to increase their foreign assets in polluting industries by 5.3 percent and their foreign output by 9 percent, according to the Pollution Haven Hypothesis, but that, contrary to popular belief, heavily regulated firms do not disproportionately increase production in developing countries.

Another significant contribution comes from Kellenberg[167], whose work manages to find a robust confirmation of HPP by accounting for strategically determined environmental and trade policies. In order to determine these policies, an identification strategy is outlined starting from the idea that countries strategically compete internationally in setting environmental policy, and it is based on other country exogenous characteristics as instruments for own country environmental policy (strategic policy interactions across countries). The analysis considers a time period going from 1999 to 2003 and the outcomes point out robust evidence that environmental and other trade policies - such as tariffs and intellectual property rights - are endogenously determined, and this leads to identify a substantial pollution haven effect for US multinational firms in foreign countries. Indeed, it is found that for the countries in the top 20th percentile in terms of US multinational production growth, approximately 8.6% of that growth can be attributed to the decline of levels of environmental stringency and enforcement. And the impact is even more pronounced for developing and transition economies: in the top 20th percentile of US multinational production growth, the percentage of growth related to the fall of relative environmental stringency and enforcement policies is around 32 points.

Interestingly, another finding counterintuitively show that the most capital-intensive “dirty” industries (such as mining, utilities, chemicals or metals) are not necessarily the most likely to be affected and to react to the tightening of environmental policy, and that pollution havens may be driven more by relatively “footloose” and “cleaner” industries (like electronics, appliances, and components). This can be explained by taking into account the increase in legislation targeting e-waste, the phase out of lead and fire retardants, and the recycling content standards imposed in several countries in the period considered.

Finally, the study uncovers evidence that the enforcement of environmental policies tends to be a more important deterrent to US multinational activity than the level of the regulation itself. In fact, while environmental regulations on the books are quite transparent to the electorate and general public, governments and firms are usually better informed than the public about the actual strictness of enforcement of those policies; this potential informational asymmetry between firms, government, and the general public regarding the actual enforcement may create

incentives for countries to cooperatively adopt relatively stringent environmental laws, but non-cooperatively compete in their level of enforcement.

The last study considered has already been mentioned in the previous chapter[111]. Tang's article is one of the most recent among the most significant ones included in this literature and, as previously stated, it examines the current topic taking into account different types of FDI, distinguishing from the most of previous studies that ignore their heterogeneity.

In particular, it focuses on the difference between local-market-oriented and export-oriented FDI in their responsiveness to an environmental stringency. Export-oriented FDI are associated to export-platform FDI (see chapter 1), which can emerge when MNCs use a host country as an export platform to serve a group of proximate countries with which trade costs are lower. It means that export-platform FDI not only is affected by the host country characteristics, but also by those of neighboring countries. Thus, local-market-oriented FDI logically competes especially with local firms in the host country while export-oriented FDI is in competition with firms outside the host country.

The theoretical model constructed in the paper represents a Cournot and a Bertrand equilibrium where a MNC compete with a local firm located either in a host country or outside it. Making environmental regulation strictness in the host country increase, it is found that the competitiveness of the MNC engaging in export-oriented FDI is more sensitive to the change than the one of the local-market-oriented FDI MNC. The prediction of the model is then empirically tested in the real world.

Data used to measure US outward FDI for the 50 chosen host countries (both developing and developed) are taken from the annual survey conducted by the Bureau of Economic Analysis (BEA) from 1999 and 2003. More specifically, local-market-oriented and export-oriented FDI are approximated by the sales of US multinationals toward different destinations. On the other hand, for the measurement of both the stringency and the enforcement of local environmental regulations, an index from the Global Competitive Report is exploited. In the model set, the endogenous environmental variable is identified through strategic interactions in policy-making among countries, following the strategy previously proposed by Kellenberg[167]. According to Tang, indeed, it is critical to treat environmental regulations as endogenously determined, since a simple OLS estimation could generate bias on the effect of local environmental policies.

At the end, findings indicate a significant deterrent effect of local environmental regulations in host countries on inward FDI, regardless of the type of FDI concerned.

In addition, it emerges that FDI in a host country is not only affected by local environmental regulations but also by environmental laws in proximate countries: a stricter policy in countries that are proximate to a host one would make this latter more desirable for foreign investment. Furthermore, comparing the relative stringency of environmental regulations between a host country and the United States, a significantly stronger effect of environmental policies on both types of FDI is found in those host countries where environmental regulations are stricter than those in the United States. In these countries, export-oriented FDI exhibits a greater sensitivity to local environmental stringency than local market-oriented FDI, consistently with the model prediction.
The author ends hypothesizing that sometimes failures in detecting empirical evidence of PHH might be caused by ignoring the difference among FDI categories, since the pollution heaven effect might be more or less significant for certain of them.

Overall, from the analysis of all these works, it clearly emerges how they are strictly related each other and that a considerable number of them ended up inspiring the later ones. Despite the different approaches used and the mixed results obtained, most of them agree in affirming that, both inward and outward foreign investment flows tend to be negatively affected – among a series of factors and specific country characteristics - by the narrowing of environmental stringency (either in US or in host foreign countries). However, it must be considered that those studies are not very recent (like instead Chinese ones) and neither are data on which they are based. These facts have to be considered, since they do not allow to investigate on FDI behavior and patterns closer in time and, most of all, to exploit the newer and more efficient econometrics tools.

4.3. EUROPEAN UNION

The European Union is the world leading source and destination of FDI flows, given that it has attracted one third of the world FDI inflow. During the period ranging from 2001 to 2014, the FDI per capita was about 2800 USD, that is seven times higher than the amount in the 1991–2000 period. FDI inflows in EU countries increased by 94% (from 282 billion USD to 533 billion USD) in just two years, from 2014 to 2016[168].

Air pollution is the most serious environmental issue in Europe nowadays, immediately followed by droughts, wildfires and biodiversity loss[169]. Since 1970, EU implemented several regulation measures and tools to control environmental degradation among its countries.

Today, the body of EU Environmental Law (entitled as "environmental acquis") includes nearly 500 directives, regulations and decisions[170]. One of the most important instruments is the European Union Emission Trading Scheme (EU-ETS). The EU-ETS is one of the most developed environmental regulatory systems in the world and its purpose is to create a limited amount of tradable carbon allowances within the European Union (putting therefore a price on pollution and incentivizing firms to minimize carbon emissions, which in Europe represent around 81% of the total greenhouse gasses[171]).

In addition, under the European Effort Sharing Regulation, each Member State agreed on limiting the greenhouse gasses (GHG) emissions between 2013 and 2020. After 2020, EU decided to continue this initiative, and, for the period 2021–2030, each Member State has to annually reduce emissions for the sectors not covered by the EU ETS, so as to have 30% less emissions in 2030 with respect to 2005.

Furthermore, in 2019 the European Green Deal was presented, with the aim of turning from coal energy into cleaner sources and renewable energy. EU ambitious goal is to become the first climate-neutral continent in the world by 2050 [172].

Figure 19 – EU Gas emissions (metric tons per capita) and Low-carbon energy share (%) in primary energy consumption – 2018 [172]

Filip De Beule et al.[173] recently put the focus on the relationship between carbon inefficiency, regulatory stringency and 3,685 worldwide foreign direct investment projects from 358 MNEs operating under the third phase (2013–2020) of European Union Emission Trading Scheme.

The question posed by the article is whether MNEs FDI location choices during phase III of the EU-ETS are consistent with a pollution haven effect (shift of the production and pollution to countries outside the EU jurisdiction) causing, as consequence, carbon leakage. Although in the first two phases of EU-ETS no significant evidence of carbon leakage was uncovered, during the third one, the carbon price increase from 6,45 € to 32,57 € per tonne of CO2 makes the noncompliance with the environmental policy much more costly for firms.

According to the authors, the main firm-/industry-specific environmental characteristics/situations that can influence misalignment in the context of the EU-ETS and, as a result, incentivize MNCs to direct their FDI towards pollution havens outside EU are:

a. carbon-inefficient firms face higher costs due either to investment in pollution reduction technologies or to increased compliance costs;
b. although the general overallocation of allowances in the early stages of the EU-ETS helped mitigate the system effectiveness, it was shown that, already in its first two stages, allowance shortfalls negatively impacted firm value, turning carbon allowances into a valuable asset, either from an intangible point of view (reputation) or from a tangible one (asset value of excess allowances). From the increase in stringency of the third phase and the rise of carbon prices, only MNEs with a number of carbon allowances greater than their verified emissions can gain a benefit, while those ones with a shortage of carbon allowances face higher abatement costs: if they are not able to reduce their emissions, they have to purchase additional allowances or face substantial fines;
c. firms from carbon leakage sectors are more sensitive to the EU-ETS regulations, since they are highly exposed to competing products from outside the EU. Carbon leakage is strictly related to industries where international trade is commonplace and hence where firms have high strategic flexibility in their location choice (see the complete list in [174]).

   Non leakage industries, instead, are not expected to be prone to external carbon leakage. However, these firms may consider host countries for their FDI flows within the EU, always based on the specific environmental regulatory stringency. A classic example of a firm operating in non-leakage industries is a power plant: it needs to produce "locally" and so it has low strategic flexibility in locating outside the EU-ETS; indeed, setting up a power plant in Poland to generate electricity for the German market is feasible, but setting up a power plant in China to export electricity to the EU is not.

From the analysis, evidence of a pollution haven effect under the third stage of EU-ETS emerges, and it is especially related to those MNEs operating in carbon leakage sectors. The negative impacts of the shifting of their capitals outside EU are represented by a loss of industrial production for European countries (investment leakage) and by the weakening of the effectiveness of its environmental policy in reaching global climate goals. Hence, these results highlight the dangers of implementing a stringent unilateral climate policy from both an economic and an environmental perspective.

Another interesting research from the same authors[175] investigates, instead, on how cross-country differences in environmental regulatory stringency among member states of the EU-ETS influence the FDI location choice of multinationals. The idea behind is that the benefits of relocating abroad at the intra-regional level are more likely to outweigh the costs involved in managing institutional diversity across countries. In particular, it concentrates on phases I and II of the EU ETS (2005–2012), during which the cross-country regulatory heterogeneity is caused by the discretion at country-level about the implementation of the measures, in accordance to the national allocation plans (NAPs) (in some countries allocated allowances excessively surpass verified emissions, like in Lithuania and Slovakia, to accommodate economic interests, while other countries do not overallocate allowances to their industries, such as in case of UK and Germany). A set of 2745 FDI projects in EU ETS member states related to 357 EU ETS-covered multinationals is assumed as input data.
Also in this study the relation between ER and the FDI location choices is considered based on the same firm and industry characteristics highlighted in the previous work, adding a fourth one to them:

d. carbon intensity, which represents the cost exposure that EU ETS-covered MNEs face, that is the verified emissions of a firm scaled by sales. Carbon-intensive firms (and thus highly polluting) are likely more sensitive to ER.

The outcomes provide evidence for the willingness to exploit arbitrage opportunities at the intra-regional level (invest in less stringent countries within EU region) in the early stages of EU-ETS and under specific boundary conditions, i.e. for those firms which do not operate in carbon leakage sectors and which are more carbon-intensive, carbon-inefficient and underallocated, all else equal. This proves that, even within the EU-ETS system, cross-country environmental stringency differences are significantly taken into account by the dirtiest multinationals with limited strategic flexibility. EU might have inadvertently promoted an intra-

regional pollution heaven effect by both allowing cross-country variation in environmental regulations and by overlying focusing on and compensating for external carbon leakage risk. Even though the NAPs were abolished in Europe in phase III reducing cross-country stringency heterogeneity, the results found in this paper remain significant in a worldwide context.

According to some empirical works, EU successfully attract high-quality and innovative inward FDI, which help transfer and improve green knowledge and fight CO2 emissions [172], [176].

Some others do not agree with these statements, such as in case of Mehmet Mert et al.'s contribution[177]. It examines the relationship among CO2 emissions, GDP, renewable and non-renewable energy, and FDI inflow in 26 European countries, as well as on the role of environmental regulations within the scope of the Pollution Haven Hypothesis and Kuznets curve framework in two EU country macro-groups, namely 1–4th and 5th enlargement countries of EU, since their adaptation periods of environmental legislation may indicate differences; in fact, the 5th enlargement group (which includes Malta, Cyprus, Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Slovenia and Hungary), entered the EU in 2004, adopted the environmental regulations at least two decades after the countries belonging to the 1–4th enlargement.

The Kuznets curve (EKC) hypothesis constitutes the theoretical basis of the relationship between FDI, economic income (GDP) growth, and environmental pollution. More specifically, the EKC is a U-shaped relationship between a selected pollutant (as pollution indicator CO2 emission is used in most of the empirical studies) and GDP per capita. According to this framework, an income increase worsens the pollution level in the early stages of the economic development, but after some level of GDP per capita (the so called "turning point"), the trend reverses and the environment degradation shrinks. Changes in pollution can be distinguished and linked to the scale effect, the composition effect, and the technique effect (as already discussed in chapter 3 of this thesis). Indeed, at the initial stage of development, high level of pollution is generated due to the increase in production and in usage of natural resources (scale effect); the composition effect is instead associated to the change in the production structure from more energy-intensive manufacturing sectors towards more environmentally friendly and less polluted ones. FDI inflows can contribute to generate both the scale and composition effect in the economy, as well as the technique effect, since they can change the production method through transfer and diffusion of newer technology. Therefore, FDI is an important variable to be considered in the EKC relationship.

Mert et al .'s work provides empirical results confirming the validity of both the EKC and PHH hypotheses overall for EU countries (co-integrating the two panels), as non-renewable fossil energy consumption and FDI inflow seem to deteriorate the general pollution level in the region. Indeed, FDI inflow appears to be able to mitigate carbon emissions in 1–4th enlargement countries in short run, but this effect vanishes in the long run. However, results differ when analyzing separately the two country groups: while results confirm the evidence of EKC in 5th enlargement countries, they do not support it in 1–4th enlargement countries. Moreover, while environmental regulations do not play an important role in the validity of PHH, they represent a significant factor in the validity of EKC in EU countries overall. On the other hand, renewable energy consumption lowers the CO2 emissions in general in EU and especially in the 5th enlargement countries.

The article concludes presenting some suggestions for EU country policies: since renewable energy mitigates the pollution, the first advice is to stimulate, also by promoting green technology transfer, innovative alternative energies production (such as solar, wind, and biomass), and to increase the overall energy efficiency; this may lead to lower energy consumption, which tends to increase environmental pollution. The second hint is to tighten the environmental regulations on FDI inflow: the fact that inward FDI is deteriorating the emission level may mean that dirty foreign industries are investing in EU. In this context, the new framework from European Commission about the screening the FDI inflows throughout the EU zone, which entered into force recently, is assumed to be very helpful.

The first advice is shared also by other empirical studies, like the one from Albulescu et al.[48], which, on the one hand, finds similar results about the relationship between renewable energy and CO2 emissions. On the other hand, instead, it disagrees with the previous article on the nature and effect of EU inward FDI: according to it, foreign investment help reduce the level of pollution (and increase income), validating the EKC but also the Pollution Halo Hypothesis. However, the overall impact of environmental regulations results to be unclear.

Another contribution (Abdouli & Omri[178]) searches for the links between - among the others - FDI inflows, environmental quality, and economic growth in the Mediterranean region for the period 1990–2013. In the panel, 7 European Mediterranean countries are considered: France, Spain, Italy, Greece, Albania, Malta, and Slovenia. For those countries, the presence of bidirectional and positive correlation between FDI inflows and economic growth implies that a higher level of FDI inflows leads to a higher additional economic growth and, on the other side, a higher economic growth sends positive signals to attract further FDI. Bidirectional causality

is found also on the relationship between FDI and CO2 emissions, and it is considered as evidence of the need of a stricter environmental policy and of a spreading of environmentally friendly technologies adoption in order to lower pollution. Furthermore, the paper draws the attention to the linkage between CO2 emissions and economic growth, meaning that the environmental degradation could have a causal impact on economic growth, as a persistent increase in CO2 emissions could end in exerting a negative externality on the economy by affecting human health, and reducing productivity in the long term.

PIIGS countries (Portugal, Ireland, Italy, Greece, and Spain) are examined as well (Lorente et al.[179]), by looking at the relationships between foreign direct investment, renewable energy, urbanization process, and carbon emissions in the period ranging from 1992 to 2019. Findings support the HPP, since, in the long run, inward FDI contributes to the environmental degradation in the PIIGS economies, as well as urbanization, while renewable energy helps inhibit CO2 emissions.

Finally, Christoforidis and Katrakilidis research[180] focuses on Central and Eastern European (CEE) countries, from 1995 to 2014. The list includes EU countries such as Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia, Estonia and Lithuania. For the years under analysis, these countries are considered host economies which attract a high number of FDI inflows. The study finds out a relationship between FDI and environmental degradation depicted by a non-linear function similar to the inverted U-shaped EKC, meaning that in the early stages of CEE countries economic growth, the FDI inflows and the consequent higher production and energy consumption tend to increase CO2 emissions. Therefore, these countries could be initially seen as pollution havens. Then, after a certain FDI threshold point, the FDI impact on the environment becomes positive, lowering local pollutants through the adoption of cleaner technology and innovative practices. Another interesting finding is that in Estonia, Lithuania, Romania, Slovakia and Slovenia, FDI has a positive effect on environmental quality in the short run, while the opposite effect is found in Croatia, the Czech Republic, Hungary and Poland. Last, overall economic growth leads to higher levels of environmental quality, due to the sustainable development process of CEE countries.

Overall, from the papers analyzed in this section, a not very clear picture of FDI effects role on environment and environmental policies emerges, but most of them agree in validating the EKC hypothesis, related to the Kuznets curve and the three stages of development, as explained above.

In the last part of the chapter, a special focus will be placed on the analysis of the topic of interest in Italy.

4.3.1. Italy

Although Italy has a strong potential in attracting investment, the inward flows are very small in number with respect to several other EU countries. From the nineties, Italian regions indeed attract significantly less FDI than their observable potential, and this could find a reason in the inefficiency of the bureaucratic apparatus and of the legal system at country level, which do not allow an efficient enforcement of property rights[181].

Within the country, foreign investment tends to be concentrated in a few and very circumscribed areas, that are those traditionally characterized by a high concentration of firms and where it is possible to observe a major presence of companies quoted on the stock exchange and foreign companies. In the period between 1999 and 2005 almost all the FDI flows were allocated to the North (80%) and, more specifically, to Lombardia (55%) and Piemonte (14%); the most attractive regions in the Centre were Toscana (9.1%) and Lazio (8.1%), while only a very small quota of FDI arrived in the regions of the Italian Mezzogiorno (1%). The reasons why FDI is localized in those areas with a major concentration of medium and big enterprises and innovation services may be mostly found in structural aspects, such as the existence of a dense concentration of enterprises (agglomeration effect) and the possibility of achieving some advantages deriving from the presence of big and leader firms in their operative sector. The existence of such conditions, in fact, allows firms for better strategic agreements aimed at both the implementation of innovation and the conquest of new market quotas. Other difficulties which discourage inward FDI are related to the presence of a poor production structure in the country and especially in the southern area, with clear need of improvements in infrastructures and in the R&D sector[182].

Among the very few works focused on the FDI - environmental stringency relation in Italy, the one that follows represents one of the most important and accurate.

Through a dataset (referred to year 2011) of 684 small and medium manufacturing firms (SMEs) located in Italy, representative of the textiles and garments, home products and furniture, mechanics and machine tools, electronics, rubber and plastics industries, Antonietti et al.[86] provide evidence of how Italian environmental policy is linked to firms offshoring decisions. A distinction is drawn between international outsourcing (IO), when activities are accomplished by external producers, and foreign direct investment, if production is carried out

"in-house" (see chapter 1). FDI is strictly related to the control and retainment of the value generated along the chain, implying the need of coordination by the lead firm, hence tending towards hierarchy. FDI involves a major initial investment (and is therefore less volatile) compared to international outsourcing, which instead represents a more flexible and less expensive way of internationalizing, at least in the short term. And, since SMEs are subject to more stringent budget constraints with respect to MNEs, they are less likely to follow FDI. Furthermore, an additional distinction is made between offshoring destinations in Southern regions (where policy pressure and stakeholders' awareness on environmental issues are generally lower) versus Northern regions (where minimum environmental standards are more likely be met by all industries).

The hypothesis is that the increasing pressure for "greener production" may influence firms governing decisions differently. In particular, it may lead to a shortening of the value chains and/or moving towards hierarchical governing forms that enable greater control on it. Firms may be motivated to keep their production at home (either producing "in-house" or outsourcing to a network of local suppliers) to facilitate the management of processes designed to reduce their environmental impact, which could match with developing new green products or improving control over suppliers environmental features. Along this line, the lower costs that a firm might achieve if it offshored its production activities to countries with laxer environmental regulations could be offset by the greater benefits associated with pursuing a green competitive advantage: firms might export their higher environmental standards to countries with lower environmental requirements in order to compete on those markets thanks to the sustainability of their products.

The firms considered in the sample of this study tend to offshore production more through IO (17%) than through FDI (13%). The most offshoring-intensive industries are manufacturers of garments (14%), non-metallic mineral products (18%), and machinery and equipment (27%). When outsourcing, they also tend to choose Northern (15.2%) rather than Southern countries (8.5%), whereas firms engaging in FDI are equally distributed between countries in the North

and South. In particular, both FDI and IO are mainly exported in the Far East (especially in China), and in the European Union countries.

Note: values on the vertical axis refer to the % of firms out of the total number of FDI/IO firms

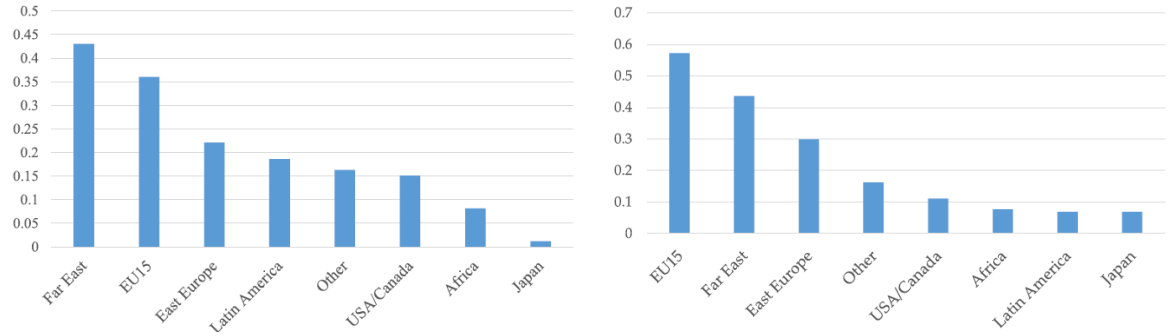

Figure 20 – Distribution of FDI (left) and of IO (right) by area of destination[86]

For the analysis, emission intensity in CO2 and acidifying gases (ACID) are used as proxy for measuring the stringency of environmental regulations, taken this information data from the National Accounting Matrix for Environmental Accounts (NAMEA) provided by the Italian Statistics Institute (ISTAT) for year 2008 (the last available update).

Final results show that the probability of production being offshored through FDI is higher for larger and more experienced firms, especially those located in the North of Italy. Only ICT companies are related to a higher probability of investment in the South. Firms more likely to introduce new environmental products tend to locate in countries with a high environmental awareness and commitment, where the profitability of these innovations is higher; in this case, FDI is considered the best option, in order to maintain control over the production process. About environmental stringency, it seems to affect FDI only when concerning with a reduction in the emissions of acidifying gases (like nitrogen oxides, sulfur oxides and ammonia), which are used especially in industries of low- and medium-low technology (e.g. to manufacture non-metal mineral products, textiles and furniture). Instead, stricter environmental regulations on CO2 emissions are related to a greater propensity to outsource production abroad, in particular towards Southern regions, and also in this case it is more likely to happen for medium- or low-tech industries, and for firms with a low labor quality as well. On the other hand, firms with more complex internationalization strategies, or that are more sensitive to innovation and reputation, do not consider environmental regulations as important drivers for their offshoring strategy.

To sum up, it emerges that, in general, environmental policy stringency does not play a real key role in firms decisions regarding their internationalization, contradicting the PHH theory.

Environmental regulations on CO2 emissions are related only to IO decisions, while firms that have a clear environmental innovation strategy are more likely to organize their value chain around vertical governance structures which allows for greater control, i.e. by maintaining the ownership of activities offshored (through FDI) rather than opting to purchase them from international suppliers (IO).

CONCLUSIONS

Concerning about global environmental situation keeps raising every day. Climate change is a real threat both for our lives and for our social-economic systems. Countries all over the world are getting involved in serious environmental agreements, with the aim of reducing the current pollution emissions, especially trough environmental regulations, leading to a struggle between companies economic interests and public opinion environmental ones.

Foreign direct investment flows, a mean for multi-national corporations to invest abroad and increase their profits, can be categorized into different forms based on the specific reasons behind their existence, and can generate several spillovers (positives or negatives) on local firms and host countries, most of all in terms of technology and innovation, energy efficiency, employment, GDP level and environment. However, domestic firms must meet certain requirements to be able to benefit from good FDI effects and host countries must offer an advantageous political/economic environment in order to attract multi-national enterprises.

Environmental regulations represent an emergency tool to limit environmental degradation and can be measured in several ways; the most used ones are surveys, actual measures of pollution emissions (or alternatively, pollution abatement costs), measures of environmental legislation, and indexes or indicators (like EPS). However, the different methods are subject to a list of issues that could bias the measurement, such as multidimensionality, industrial composition and endogeneity, which includes simultaneity. In the second chapter, the efficiency of environmental policy stringency is questioned, as well as its effects both on economy and society.

This thesis first aim is to investigate on the association between FDI flows and environmental regulations, by examining a high number of empirical studies included in the literature. According to the most known theory, the Pollution Haven Hypothesis, companies would take advantage from FDI to avoid the additional costs associated with the high level environmental stringency in their home country (most of the time a developed one), moving their activities to foreign host (usually developing) countries with laxer environmental policies and lower environmental costs. This process would simply lead to a shift of pollution linked to dirty activities toward lower environmental regulated countries, which would become “pollution havens”, nullifying the attempt to reduce global environmental degradation.

First studies carried out were typically based on aggregate (cross-sectional) levels of data and they usually failed in finding evidence supporting PHH. More recent works, instead, tend to rely on panel data and to show mixed results: on the one hand, some of them point out PHH-consistent evidence; on the other hand, others indicate the opposite result, that is stricter environmental policies are more likely to attract FDI.

What emerges from this thesis analysis is that today it is not possible to give a definite answer to the question: "Do environmental regulations deter (attract) FDI?". Indeed, obtained outcomes are affected from a multitude of factors, starting from the specific conditions of the area examined (and the time period considered) to the direction followed to analyze the relationship, which includes data taken into account to compute FDI and stringency of regulations, the chosen method to link them and all the other parameters considered. In fact, environmental regulation costs are just one of many FDI determinants: availability of raw materials, cheaper cost of labour force or quality of local workers, agglomeration economies, transport costs and quality of infrastructures may also be very significant factors considered by firms in their decision to invest/relocate abroad, despite the additional costs faced from the introduction of more severe environmental rules. Also, another important issue contributing to the findings ambiguity, is the endogeneity of environmental regulations, as these could be affected by other unobserved factors and not exogenously determined, or may be even subject to a mutual influence with FDI itself (simultaneity), generating a bias in their measurement and making it harder to find clear evidence and clear estimations of their influence on foreign investment flows.

In the last chapter, empirical works on three specific geographical areas, namely China, United States and European Union, are deepened. The most significant contributions are probably those related to China, being it one of the greatest economies among developing countries and, at the same time, one of the most negatively affected area by environmental degradation and, consequently, by environmental regulatory policies.

Empirical findings show how the FDI-environmental stringency relationship develops in two different directions within the country: while in the eastern region FDI flows seem to be attracted by more stringent regulations, in the rest of the country a stricter environmental policy tends to hinder FDI attractiveness. However, foreign investment inflows are affected only partially by environmental stringency, as there are a lot of other factors to be considered, like resource endowment, public infrastructure, economic market potential and industrial

agglomeration. Indeed, the eastern region has probably become the first choice for FDI mainly thanks to superior location, complete infrastructure, and good business environment [155].

In general, in its early stage of economic development, a country can aim at attracting different types of FDI through preferential policies including lower environmental regulations, but this economic development choice at the expense of environment health is unsustainable in the long term. Indeed, after the economic development reaches a certain level, the focus should shift on both the economic growth and the environment protection aspects together. This would imply a gradual tightening of environmental regulations and a screening of inward FDI, considering no more its scale but rather its quality: from the green technological spillovers of high-quality FDI, both local enterprises and the entire society can benefit [152]. Furthermore, local governments should design a reasonable stringency level, rather than just keep increasing its intensity, and draw specific policies and instruments based on the characteristic of each region [155].

These policy suggestions, in many cases, may turn out to be useful also for developed countries.

Finally, a possible recommendation for future studies on the topic investigated in this thesis could be to pay more attention to the different elements that are hidden behind analysis assumptions and possible biasness, especially avoiding cross-sectional data, recognizing the correct FDI form, and looking also for other possible factors affecting FDI-environmental stringency association for the specific areas and the specific time periods examined.

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