EVALUATING THE POLLUTION HAVEN HYPOTHESIS FOR THE CHEMICAL INDUSTRY: AN EMPIRICAL STUDY

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Summary

This master thesis evaluates the pollution haven hypothesis for the chemical sector across the globe by studying FDI flows specified for the chemical sector. The pollution haven hypothesis states that industry will favor countries with the least stringent (cost inducing) environmental regulations over countries with relatively stringent environmental regulations when all other factors are considered to be equal. In other words, firms take into account the costs associated with environmental regulations when they decide to move operations abroad. This phenomenon has had the attention of scholars since the 70's, when environmentalism was on the rise. Since then, numerous scholars have attempted to evaluate the hypothesis by either empirical studies or modeling techniques.

The results of these studies are not unequivocal: there has been at least as much evidence provided in favor of the hypothesis as it is provided against it. I suspect this is because of the approach that most scholars have taken in previous research. These unequivocal results could be attributed to three key points.

First, not specifying the instruments in the analysis at stake, and trying to evaluate the pollution haven hypothesis as an (manufacturing) industry wide phenomenon. The manufacturing industry as a collective term embodies multiple industries, and each of those industries is characterized by a certain degree of pollution intensity in the production process, and therefore subjected to differing severities of the pollution haven hypothesis. If the pollution haven hypothesis is true, then the country specific cost structure of a firm as a function of (among others) environmental policy is dependent on the industry's pollution characteristics. Therefore, the pollution haven effect would be stronger and more apparent in sectors with a relatively higher pollution intensity. By not singling out one particular industry, the noise within the data obscures the studies ability to find unambiguous results.

Secondly, not correcting for other factors that play a role in the determination of a target country to relocate to. These factors could be market forces, supply chain issues, and the quality of governance, among others.

Lastly, the use of data of exports as a proxy for the location of industry are subjected to tariffs and duties and do not take into account the country's consumption of the product that the industry produces.

Because of these gaps in former literature on the subject as mentioned above, the main research question of this thesis is:

What is the effect of environmental stringency on the choice of production location across countries for the chemical industry?

In order to provide clarity on the methodological issue of what the dependent variable (to proxy the industry's location) should be in PHH research, the first sub question is:

What is the effect of environmental stringency on the chemical industry's strategic behavior when utilizing an exports based model?

Because this can show the difference between the two formerly used instruments to operationalize the industry's location, a conclusion can be made on both approaches. In order to provide a more extensive conceptual model, and provide clarity on the origin of a country's environmental policy goals, the second sub question is:

What is the effect of Multilateral Environmental Agreements on a country's domestic environmental policy?

Because of these three issues mentioned above, the methodology of this research is as follows: FDI flows specified for the chemical sector will be studied across countries, while correcting with constructs for market forces, other costs for a firm during the production process, the stringency of environmental regulations, infrastructural factors, and governance factors. This research focusses on the chemical industry because it appears the industry with the most "promising" characteristics to attain evidence in favor of the pollution haven hypothesis (in terms of mobility and pollution intensity). The chemical sector is one of the most polluting industrial sectors, while at the same time it is footloose enough to move to more favorable locations. The variables that the construct contain are taken from common open source data platforms such as the UNCTAD and the World Bank. The general idea behind using FDI variance across countries to proxy for production location is based on the required capital that is needed to either expand or maintain operations in a country, or to finance completely new operations. In this way, a capital flow is created, which can be traced and therefore shows the location of the chemical sector across countries.

By using a regression analysis on these five constructs, it is shown that the environmental stringency construct plays a barely significant role in the determination of FDI. Across different FDI samples, the result is even less robust. An interesting finding is that while the environmental stringency construct played a negative role in the FDI based model, it played a positive role in the exports based model. Because of this ambiguity, the implications of such findings should be

established with caution: the likelihood of the existence of a pollution haven effect is limited, and even if it is, it is likely not very strong.

Finding this result with an extensive model, specified for the chemical sector leaves us with the conclusion that if there is such pollution haven effect, it is likely not very strong, and if this is the case for the chemical sector, which is highly pollution intensive, it is likely that the effect is even weaker if not unapparent in other manufacturing sectors. Moreover, the effect of some of the biggest international environmental agreements are investigated in their effect on domestic environmental policy. It turns out that not all of them affect domestic environmental policy as much as others. Therefore the recommendation is made for policy makers to not focus too much on the possible economic side effects of imposing stricter environmental regulations.

The results of this study must not be interpreted in the sense that no degree of environmental policy stringency can affect the profitability of the chemical sector, and therefore should be increased indefinitely: the results obtained here are mostly from 2016 levels. If policy makers wish to increase their environmental performance, that should be achieved through international cooperation and diplomacy, and more MEA's (multilateral environmental agreements) which dictate environmental goals. In that way, no single country can have a large comparative advantage towards polluting industry's profitability. For future scholars the recommendation is made to focus on the positive side effects that environmental regulations can bring about, such as the Porter hypothesis.

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Chapter 1: introduction

Prelude

Ever since around the 1950's, globalization has boosted global trade by astronomical magnitudes. With more and more trade occurring between countries, this has enabled businesses to carefully select their production location regarding the costs of production in that particular country. The prosperity of the Western world, especially seen in contrast with the relative lagged indicators of prosperity in the developing countries as well as the third world, has led to a rather skeptical narrative which claims the developed world to purposefully exploit the developing countries. While the most commonly known way in which they would do so has to do with labor, like the so called 'sweatshops' in south-east Asia, mostly in the production of relatively cheap textile products.

However, since the rise of environmentalism in the western world in the 1970's, this narrative was extended somewhat, and widened its view in the sense that the exploitation of developing countries occurs also through the relative institutional advantages that these countries bring about: they would maintain far less strict environmental regulations on their industry. This stream of thought gave birth to the pollution haven hypothesis.

The pollution haven hypothesis

The pollution haven hypothesis states that firms willingly and knowingly move their operations to countries with less strict environmental regulations. The notion of a 'haven' here, refers to a country with less stringent environmental regulations, and therefore a less costly production process can be set up by polluting firms, enabling higher operational profits. This implies that the concentration of polluting industry is a function of the stringency of a country's environmental policy. The underlying thought there is that environmental regulations incur costs on pollution intensive firms, and in order to assure cost cuts in their operations, these firms move strategically (geographically) to negate them. Of course, this is very dependent on the type of industry that is subjected to these environmental regulations, but one can imagine that very strict environmental regulations on for example maximum daily volumes of carbon dioxide (in combination with the effectively implementation and enforcement of such legislation) can hurt an industry which emits greater volumes than is permitted under such legislation. Therefore, the pollution haven hypothesis would suggest, the company would move away from this country or countries with similar legislations, and would rather establish factories in countries where such legislation are not in place. One could expect that the differences in cost structure across countries as a function of environmental legislation to be the greatest in the most polluting industries; a relatively small

difference in environmental regulations between the home country and the host country can make a multi-billion dollar difference when the industry is sufficiently large and pollution intensive.

Former studies: mixed approaches

The methodology of former studies is as mixed as their attained results. A literature review (as presented in chapter 2 as well) shows that there is no connection between their research approach, and their results regarding the possibility of the presence of a pollution haven effect. One of the biggest differences in the research approach of former empirical studies, is the choice of the dependent variable, and the factors for which they seek to control. Because the pollution haven hypothesis states that firms strategically move to countries with less stringent environmental regulations, one ought to show the differences in industry concentration as a function of some measure of the stringency of said environmental regulations. In former studies, the location of industry is operationalized by either flows of foreign direct investment (FDI flows) or by studying flows of bilateral trade (exports for example).

The general idea of using FDI as a proxy for the production location of the chemical industry (which is in turn the result from strategic behavior by the industry depending on their possible operational profits per country) is that an inflow of capital is required to either expand (by changing production conditions or caused by economic growth and therefore increased demand) or for the sake of maintenance and continuing operations. This is under the assumption that, all other things equal, sectoral (chemical sector) FDI is proportional to the installed capacity of that sector, and the spread of installed capacity across countries is the result of strategic behavior based on imposed cost structure concerning the production, which should be logically reasonable.

The general idea of using bilateral trade flows or an exports based model in the research of the PHH, is that when one particular country is much more favorable to produce their products in because their overall production costs are lower (which are, among other factors, a function of the stringency of environmental policy), they will also export more of their product. In this way, the variance in exports reflect the country's comparative advantage.

Three problems

When studying the work of former scholars, three problems are identified regarding their research approach:

First, some scholars seek to evaluate the pollution haven hypothesis as being an industry wide phenomenon. However, the pollution intensity, geographical mobility and other characteristics vary across industries: some industries are much more pollution intensive than others, while some industries are extremely labor intensive, and some industries require a highly developed

infrastructure. The former studies' mixed results could be accredited to noise in the data by trying to evaluate the pollution haven hypothesis as an industry wide phenomenon.

Secondly, the factors for which former scholars correct, varies greatly. Because former results are so mixed, it is likely that costs associated with the stringency of environmental policy are not the biggest cost category. By not correcting for other influences on a firms' cost structure in a country, a firms motivations in their strategic behavior cannot be fully explained.

Lastly, the use of data of exports as a proxy for the location of industry are subjected to tariffs and duties and do not take into account the country's consumption of the product that the industry produces.

Industry focus

In order to cope with the issues that former studies had, possibly leading to their mixed results, this thesis will focus solely on the pollution haven hypothesis in the chemical industry. Because this is one of the most polluting industries, this industry will likely show the most evident reaction to differences in the stringency of environmental regulations, which is reflected in their strategic behavior of moving towards cheaper production locations.

Because former research attempts to identify the pollution haven effect across industries, this research will focus on one of the most polluting sectors in contemporary industry: the chemical sector. This is in consideration of the notions of former scholars who argued that noise in the data originating from the multiple industries that they tried to identify the effect in could cause the unequivocal results across the different scholars, as well as the notions of Ederington, Levinson and Minier (2005), who argued that the mobility of an industry is crucial in the pollution haven hypothesis: an industry cannot move systematically towards countries with less stringent environmental regulations when the industry's location is too much 'set in stone': for example, some industries such as the petrochemical industry and the lumber industry heavily favor the abundancy of adequate natural resources in the vicinity. They note that previous failed attempts by scholars to identify the pollution haven hypothesis can accredited to industry differences, especially when considering their pollution intensity. Focusing on one industry in particular, and the chemical industry tends to meet the above set requirements, gives research the ability to not only remove some of the noise in the data, but also develop an approach which is tailor-made to one particular industry's characteristics. Therefore, the main research question is to become:

MQ: What is the effect of environmental stringency on the variance of FDI flows across countries for the chemical industry?

Resolving methodological issues: FDI vs trade flows

In order to provide clarity on the methodological issue that is identified in some of the work of former scholars, namely the utilization of trade flows as a proxy for the location of industry, this research will investigate the implications of using a different dependent variable. In order to check this, an attempt will be made to make the pollution haven effect visible through the formerly used instruments, like exports. This will create a contrast with the method that I am proposing, and can give possibly more direction for future academic endeavors on this subject. Therefore, the first sub question will become:

SQ1: What is the effect of environmental stringency on a country's chemical exports?

MEA's influence on domestic environmental policy

To check the origin of the stringency of environmental policy and provide an addition to the conceptual model, one must assess to which extend the state's national (target country's) environmental policy is a function of the ratified multilateral environmental agreements. In this way, it will be clear for policy makers to which extent they can maneuver the direction of their environmental policy, assuming it is bounded by international treaties. Moreover, for strategy coordinators in chemical firms it will be easier to assess the imposed costs of moving operations abroad. Therefore, the second sub question will become:

SQ2: What is the effect of Multilateral Environmental Agreements on a country's domestic environmental policy?

This research

Because the factors for which former scholars sought to control differ greatly, this research will utilize an extensive panel of control factors that each in their own way have their respective influence on the attraction or repulsion of the chemical industry. These factors are reflected in five constructs, which in turn encompass multiple variables to provide a more complete picture of the different aspects of such constructs. These constructs are: market potential, infrastructure, environmental stringency, factor costs (other operating costs which are country specific), and governance factors.

In order to show the influence of the strictness of environmental regulations (environmental stringency) as well as the other four constructs in the variance of FDI flows, a regression model is preferred in this situation. This will leave us with the result of a linear equation that explains the variance of FDI as a sum of the constructs times their weight factors in the equation (standardized beta coefficients). By doing so, not only the influence of the strictness of environmental policy will be displayed (the pollution haven hypothesis) but the influence of the other four constructs as

well: a higher beta coefficient means a stronger influence in the explanation of variance in FDI flows across countries.

In order to provide a more robust result from this analysis, this research will employ five models to examine the pollution haven hypothesis. Moreover, by using these five models, an assessment can be made on some of the methodological issues that former research had. These models can both give an indication of the likelihood of existence of a pollution haven effect, as well as provide answers to some of the methodological issues in former studies as identified before.

Research implications

Although this approach gains in terms of internal validity, an industry specific approach does leave some questions regarding the external validity of the study: are the results that are obtained in this study also valid for all other industries. I would argue that the external validity is not extremely high, but that the (deterring) effect (of stringent environmental regulations on the attraction of industry) for all other industries can only be weaker than it is the case for the chemical sector because the chemical industry is so pollution intensive, it seems logical that it would be effected the most.

But besides the possibility of this negative side effect, the main reason to object more stringent environmental regulations comes from an economic perspective: the possibility that firms would leave the country in search for a pollution haven decreases the government's income in the form of taxes, decreases its economic output, and hurts the job market. Governments have the idea that they have to balance the strictness (or stringency) of their environmental policy with their country's economic performance, under the assumption that polluting industry could move away if more costs in the production process are imposed. The same goes for decreasing their environmental standards, which could attract industry, and would provide governments with more profits to tax and a more favorable labor market with a higher demand. This underlying assumption, regardless of its scientific evidence, urges governments to strike a balance between environmental versus economic performance. In that sense, scientific evidence on the pollution haven hypothesis on a country level can provide governments some sense of security in their decisions regarding setting their environmental standards while considering the economic impact of that decision. Therefore, this research seeks to answer that question by considering the chemical industry as a boundary condition for government's environmental policy: considering the pollution intensity of this sector, if environmental regulations could be set to maximize environmental performance while keeping the economy undisturbed, most other industrial sectors with a lower pollution intensity would be unaffected.

Governments as well as the current scientific literature base can benefit from this research. Because former research hasn't provided an unequivocal answer to the question whether the pollution haven hypothesis is real, as well as strong enough to actually make a difference in the variance of choice of production location. By assessing the influence of environmental regulations on the chemical industry's production location in particular, one could make assumptions for the effect (if there is one) in other sectors: if the cost differences across countries imposed by environmental regulations gets higher as the pollution intensity of the industry increases, it would be far easier to bring light to this effect in the case of the most pollution intensive industry. This would create the biggest absolute cost difference across countries with different levels of environmental stringency, which would give firms the biggest incentive to move their operations to the country with the least stringent environmental regulations to minimize their cost, thereby making the pollution haven hypothesis clearly visible. This could help scholars with their quest of assessing the magnitude of this effect for other sectors as well: by setting the conditions for obtaining the pollution haven hypothesis to the most favorable (most easily obtained by maximizing the sector's pollution intensity), one could make assumptions for the presence of the effect in other sectors.

Thesis structure

This thesis will have the following structure: Chapter two will describe the progress that has been made by former scholars, and builds on their results to provide a theoretical background of the relevant factors in this research. This will provide an explanation of the variables and their constructs on their effect on the chemical industry's profitability in a country, which is expected to directly influence its desired production location. The established theoretical framework will provide an indication of the expected behavior of the constructs (some have positive influence on profitability, while others are expected to have a negative influence). This theoretical framework explains the interrelations between constructs in the conceptual model. Chapter three will describe the methodology of this research and will discuss the motivations for doing so. This includes the collection of data from open-source databanks, the way this is combined to create the dataset, and the steps taken with IBM's SPSS software to analyze said data. Chapter four will describe the results that are obtained from the analysis in IBM's SPSS software. This includes an assessment of the respective influence of the multilateral environmental agreements that are considered in this research on country's domestic environmental policy, as well as an assessment of the internal consistency of the constructs that are used in the regression analysis. Finally, the results from the regression analysis in the five models mentioned before will be presented and shortly discussed. Chapter five will provide a conclusion on this research, followed by a discussion, as well as a policy-and research recommendation.

Chapter 2: literature review and theoretical background

2.1: Former scholars / earlier academic research

Because the investment decision of firms to move their operations to different countries is based on the notion of perfect information regarding the cost structures that firms could obtain in different countries when conducting cost-benefit assessments. This is treated as such in the literature surrounding the pollution haven hypothesis. Perfect information is one of the main assumptions in the neoclassical notions in which the pollution haven is grounded: firms always behave as a profit optimizing entity, even if that means that they would need to relocate to a different country. This is how all former scholars have approached the pollution haven hypothesis: by assuming profit maximization and perfect information, the behavior of a firm is the direct result of the possibility that production elsewhere in the world is cheaper. In this case, the production costs are a function of the stringency of environmental regulations. That is, in the case that pollution is penalized by legislation sufficiently to create a cost difference between different countries. The results of the former scholars associated within this stream of thought are as mixed as their methodologies. Some scholars use solely a theoretical modeling approach, while others use a variety of empirical approaches or a combination of the two to investigate the pollution haven hypothesis.

Not surprisingly, most theoretical models support the notion of pollution havens in countries with less stringent environmental regulations. Most scholars that develop theoretical models use the common North-South analogy, in which the North is a country with relatively more stringent environmental policy, while the South is a country with relatively less stringent environmental policy. Among which are Silva and XieZhu (2009), Cole (2004), Bommer (1999), Bilbao-Ubillos and Camino-Beldarrain (2008), Zeng and Zhao (2009), Cole and Fredriksson (2009), Brunnermeier and Levinson (2004), Barry and Walsh (2008), Pennings and Sleuwaegen (2000) and Malm (2012).

Within this theoretical stream of literature, a distinction can be made in the goal of the research. Some scholars like Silva et al (2009), Cole (2004, Bommer (1999) develop either theoretical models or utilize game theory to assess the likelihood of the pollution haven hypothesis. From earlier solely theoretical work, two important lessons can be learned.

The first is the inescapable influence of neoclassical notions of firms behaving like a profit maximizing entity and the search for the highest operational profits. For example, Bilbao's (2008) work highlights the influences of wage differentials as a motivational factor for firms to relocate. This is confirmed by Barry and Walsh (2008) and Malm (2012). They note that both developed countries and developing countries have something to fear in each other's factor endowments:

poor countries fear the rich country's abundance in capital and technological advancement, while rich countries fear the competitors who are able to harness the cheap labor (and perhaps reduced environmental taxes) of the developing countries. Moreover, they state that most trade takes place between developed nations (often confirmed by empirical scholars), thereby highlighting the importance of controlling for economies of scale or the target countries' internal market size. Pennings and Sleuwaegen (2000) note that low skilled labor intensive industries are most prone to the possibility of relocation abroad, thereby indicating that the local provision of skilled labor must be taken into account for when conducting empirical research.

The second is the presence of the reversed effect of the pollution haven hypothesis: the influence of polluting firms on the environmental policy. This effect deteriorates however, once a countries' economy either grows, or its governance stabilizes, thereby making it less likely to be influenced by industrial actors.

Within the section of empirical research, another distinction can be made, considering the scholars' methodology. Some scholars like Eskeland and Harrison (2003), Al-Mulali and Tang (2013), Cole, Elliot and Fredriksson (2006), He (2006), Wagner and Timmins (2009), Cole and Elliot (2005), Cole and Fredriksson (2009) try to bring light to the pollution haven hypothesis by studying foreign direct investment (FDI) patterns across countries, while other scholars like Levinson and Taylor (2008), Akbostanci and Türüt-Asik (2007), Jaffe, Peterson and Portney (1995), Ederington, Levinson and Minier (2005), Martinez-Zarzoso, Vidovic and Voicu (2016), Dietzenbacher and Mukhopadhyay (2007), Kearsley and Riddel (2010), Van Beers and Van Den Bergh (1997) and Cave and Blomquist (2008) focus on trade flows or imports and exports. Their methodologies are as different as their results. For example, Dietzenbacher and Mukhopadhyay (2007), Al-mulali & Tang (2013) find evidence against the pollution haven hypothesis, while Cave and Blomquist (2008), Cole & Elliott (2005), Zugravu and Ben Kheder (2008), Martinez-Zarzoso, Vidovic and Voicu (2016), Wagner and Timmins (2009), Akbostanci and Türüt-Asik (2007) find evidence in favor of the pollution haven hypothesis.

Despite the striking difference in research methodology, there appears to be no favorable approach concerning their ability in attaining evidence in favor (or not) of the pollution haven hypothesis. Considering this, a case can be made for both approaches, while both obviously have their advantages and their drawbacks. Some scholars are not mentioned above, because their methodology was so different than others that categorizing would not make sense. Among which are Millimet and List (2004), who used data on new plant openings across counties in the State of New York. Zugravu and Ben Kheder (2008) investigated 21379 investment decisions by French multinational firms. Finally, Wen (2004), investigates the geographical spread of industry across China. Moreover, most studies used different samples and sizes. Based on this, one can conclude

that scholars haven't agreed (yet) on one specific methodology. Therefore, comparing them with each other would not yield a useful result. For a quick overview of the different scholars discussed above, see appendix III.

Besides the difference in using constructs and developing a panel of control factors composed of individual variables, there appears to be a difference in the weight factors that are given to the variables when constructs are utilized. For example, GlobalEdge (Market potential index, 2017) calculates the market potential of a country with a 25% weight factor on the size of the market, a 15% weight factor of market intensity, and so forth. They note that the chosen weight factors in the determination of their construct is based on "that particular factor's contribution to the market potential". However, by using weight factor values of ¼, 1/8, and 10% it shows that these weight factors are determined somewhat arbitrary. Cavusgil (1997) takes a different approach, and weights the factors that encompass a construct of the potential of a market in a somewhat different manner. For example, his measure for market potential consists for 20% out of population, and 15% is determined by GDP and consumption. Still, the relative contributions of the factors remain somewhat arbitrary. Because of this irregularity in methodology of former scholars, this research will provide a method not only to cope with this problem, but also to visualize the impact of such decisions. Those will be discussed in the methodology chapter (chapter 3, paragraph 7: the five regression models).

2.2: Control factors and the development of the causal model

Even though comparing the studies individually wouldn't yield useful results around the validity of the pollution haven hypothesis, former studies do point us in the right direction when considering the factors for which one ought to control, and possible issues that can obscure the pollution haven hypothesis. For example, Millimet and List (2004) show that problems with finding evidence in favor of the PHH can be accredited to internal heterogeneity of regions' policy, for example across provinces within a country.

Moreover, they show the importance of correcting for factors indicating the attractiveness of a developed region as a possible location to move operations to. Such factors could be high wages, high literacy rates, high GDP and an advanced infrastructure. Zugravu and Ben Kheder (2008) refer to this phenomenon as 'market potential', but include governance factors like corruptibility, political stability and governance regulatory quality, and create a complex measure for environmental stringency which includes the ratification of multilateral environmental agreements, as well as ISO 14001 certifications per billion dollar GDP. Lots of former scholars control for market potential related factors in their analysis, such as measures of industrialization, GDP, land area, and population. Among them are Al-Mulali & Tang (2013), Martínez-Zarzoso,

Vidovic & Voicu (2016), Van Beers & van den Bergh (1997), and Bilbao-Ubillos & Camino-Beldarrain (2008).

The importance of including governance related factors in the regression, has also been confirmed by Cole, Elliot and Frederiksson (2006) and Cole and Fredriksson (2009), who proved the reverse Pollution Haven Effect (so the influence of FDI on the environmental stringency) to be a function of the country's corruptibility index as well as the number of legislative organs. Moreover, the desire to control for governance factors has been translated by other scholars in their choice for their sample size. For example, Van Beers and Van Den Bergh (1997) explicitly refrain from sampling beyond OECD countries, considering their relatively homogenous political stability. Moreover, they note that the complexity of the environmental stringency vector in their analysis is of great influence on their results. They note that the more complex the variable, the lesser the result. This is confirmed by Jaffe, Peterson and Portney (1995), who experienced difficulties in measuring environmental stringency. Martinez-Zarzoso, Vidovic and Voicu (2016) use environmental taxes as a proxy for the countries' environmental stringency.

At last, most studies that reported questionable or disproving findings regarding the Pollution Haven Effect, used either a small sample size (like Eskeland and Harrison (2003), or sector wide data (like Al-Mulali and Tang (2013)). Based on the analysis of scholars like Wagner and Timmins (2009) that did use sector specific trade flows or FDI flows, it is clear that the Pollution Haven Effect appears stronger in geographical mobile and polluting sectors than others. Therefore, it appears imperative to keep the sample size as large as possible and to adjust the instruments to the industry sector that is under investigation.

Although there exist large difference in the approach taken by previous scholars, there are similarities as well. Because the pollution haven hypothesis finds it origins in the field of economic geography (i.e. the study of spatial concentrations of industry across the world), that particular stream of literature would be a good base to start from in the decision of which variables the model should control for (that is, besides the stringency of a country's environmental regulations of course). According to the stream of thought 'investment theory', a country's attractiveness for investors can be measured by identifying three concepts: markets, resources, and efficiency.

These concepts return in a great portion of the literature that surrounds the pollution haven hypothesis. For example, Martinez-Zarzoso et al. (2017) use the GDP of both the importing country as well as the exporting country in their gravity model (trade flows). Wagner and Timmins (2007) build on such approach, but incorporate factors such as literacy rates to account for the availability of human capital, corporate tax rates to account for after tax returns on investment, and the total length of the paved road network to proxy the country's infrastructure.

Moreover, when all those are equal, factors such as policy and social stability and other governance factors can be decisive for a country to be favored in terms of investment over another (Yang, Wang, Chen and Yuan, 2011). Zugravu and Ben Kheder (2008) incorporate most of these ideas in their global economy model, and combine most of the relating variables into constructs. For example, their environmental stringency construct contains ISO14001 certificates per $ GDP, international NGO's per capita, energy efficiency, and the ratification of some MEA's (multilateral environmental agreements). All these variables are combined to form this environmental stringency construct.

The effect of MEA's is questionable, because they do not specify exactly which ones they use, therefore I will discuss those later. In more or less the same manner, Kellenberg (2009) uses constructs not only for environmental stringency in his analysis, but for infrastructure, market potential, and a crime index to capture these aspects as well in his analysis. Wagner and Timmins include an index called 'law and order' to proxy for the effectiveness and quality of the governments' bodies. Considering the aspects that are covered above, they appear to have very similar characteristics.

In other words, each in their own way tries to account for at least one of the four factors that this research will employ: market potential, infrastructure, (human) capital and other production costs, and governance factors. These four are clearly the common denominators that each empirical research paper on the pollution haven hypothesis tries to control for. When these, or one of these, are combined with a measure of environmental policy stringency, the pollution haven effect could be made visible. There doesn't appear to be a relation to which one of these constructs (or the variables in them even) are taken into account in the past scholars analysis, and the conclusion that they drew on the possibility of such pollution haven effect is there or not. Therefore, it is hard, if not impossible to tell which one of the research approaches taken by the former scholars is 'the right one'. Because each construct can be composed in many different ways, it is essential for this research to dive into the characteristics of the chemical sector in order to identify the possibility of how this construct could impact the chemical industry's location.

Concerning the influence of the MEA's (multilateral environmental agreements), a preliminary literature review on this particular subject points out that country's use MEA's to coordinate a common level of environmental stringency. In other words, they generally do not ratify because they wish to level the playing field (having more stringent environmental policies in place than other countries, and fearing that might hurt their country's competitiveness), but because they wish to create a level playing field, with all countries having the same standards, thereby creating a mutual burden on the international oriented industry. A common criticism on those MEA's is that they rarely provide or mandate actual policy instruments or ways of implementation. Rather,

they set out broadly formulated objectives by which the ratifying countries must abide by at a certain date in the future. In turn, this leaves the ratifying countries with some freedom on their approach of reaching this said goal. This would imply that the MEA's act as a precursor to the country's domestic environmental policy, rather than acting as some kind of a parallel force as Zugravu and Ben Kheder suggest.

Therefore, this research will treat the MEA's as having a positive influence on domestic environmental policy stringency as shown in figure 1. This would make the causal model as the combined literature would suggest as shown in figure 1. The predicted influences are shown as well, as explained by the paragraphs hereafter.

To summarize the predicted effects above: favorable characteristics for the attraction of foreign capital in the chemical sector are expected to be a high market potential, a well-developed infrastructure, and high quality governance. It is expected that if countries have higher values on these constructs, it will attract firms in the chemical industry, which will be shown by a higher flow of FDI. Repelling characteristics to the chemical industry are expected to be factor cost and environmental stringency, which is the general idea behind the pollution haven hypothesis: tighter environmental regulations impose additional costs on the chemical industry, which in turn will be less profitable, and therefore will be less motivated to move operations to that country. The stringency of environmental regulations is (besides the country's own environmental goals) subjected to the implications of the environmental goals established by MEA's. These effects combined produce the causal model as shown below.

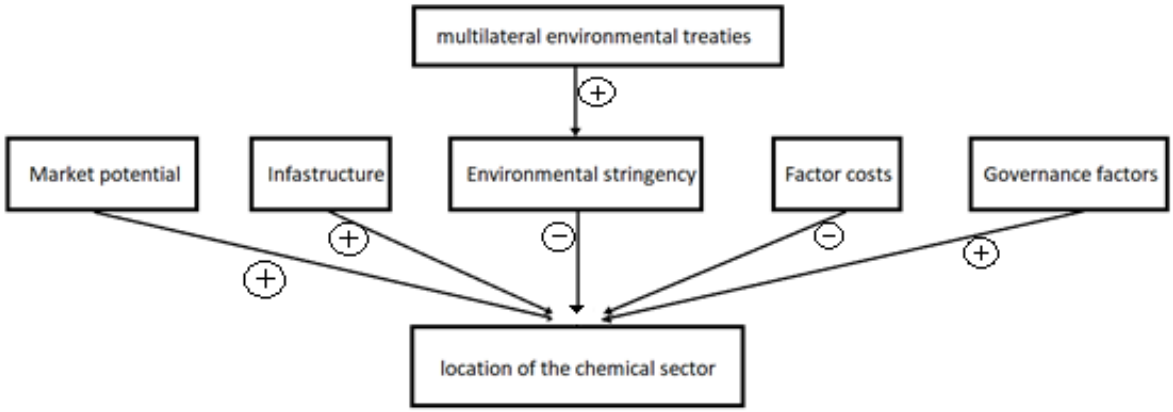

Figure 1, the causal model with the expected signs

The assumptions in this model are the following:

- The firm behaves as a profit maximizing entity

- Firms have perfect information of the cost structures in different countries (in reality, this is probably only the case for large multinationals who can afford to conduct such research)

The next six paragraphs will describe the influence of the constructs on the chemical sector in particular, and how domestic environmental policy is established by international coordination.

2.3: Environmental stringency: theoretical background

The stringency of environmental policy is the most important construct of all in this research, since it seeks to reflect on the additional costs that imposed on polluting firms in their production process. How this exactly happens isn't clarified by former academic research, so therefore it is also important to research how exactly this happens. In this way, a well-developed measure can be constructed that effectively captures those additional costs for polluting firms, in whatever form they occur. Although later on it will be discussed in which ways these costs can affect the profitability of a polluting firm, these costs are regardless a comparative disadvantage all other things equal. Because a firm has the obligation to its shareholders to maximize their profitability of their operations, a firm would prefer the country with less imposed costs in the production process, rather than a country that imposes extremely high costs. For those reasons, the construct of environmental stringency is incorporated in this research, and the construct is expected to have a negative influence on FDI flows.

In former studies that investigated the pollution haven hypothesis, there have been proposed a number of different ways to capture the stringency of countries' environmental policy. Some are a little more ingenious than others: for example, Cole et al. (2006), van Beers and van den Bergh (1997), and Cole and Fredriksson (2009) use the inverse of 'market share of leaded gasoline' or the inverse of 'maximum concentration of lead in gasoline' from a well utilized dataset, ranging from 1992 to 1996. The general idea behind such measures is that lead content in gasoline raises the octane rating, thereby making engines more fuel efficient per kilometer, but also emit lead fumes, which are a very strong local air pollutant, causing a number of health issues in the very same location as they are emitted. For this reason, countries who wish to increase their environmental performance seek to ban these types of fuels. Therefore, the market share and maximum lead content are good proxies for the environmental performance that a country wishes to achieve, and therefore for the stringency of environmental policy. Zugravu and Ben Kheder (2008) focus on the firms attemps to become more environmentally sustainable. They use a proxy of 'ISO 14001 certifications/billion US$ GDP' to proxy for industry's attempts to increase their environmental performance. They note that the participation in the ISO 14001 programs are completely voluntary, they still reflect the 'state of mind' of a country regarding environmental issues, and this is reflected in the company's policy. Some scholars use PACE survey data (Pollution Abatement and Control Expenditures) to proxy for the stringency of environmental

regulations. Among them are Akbostanci et al (2007), Taylor (2004), Ederington, Levinson, and Minier (2005), and Ederington and Minier (2003). Similarly, Wagner and Timmins use an 'Executive Opinion Survey' (World Economic Forum 2003) which reports managers and executives' impressions on the extend that environmental regulations influence cost imposed on their businesses. Although this would give a direct measure from the firm's side of the story, its self-reporting bias is evident.

By exploring the different ways in which governments can set their environmental performance that it imposes additional costs on industry, a literature exploration is required. In order to do so, the value chain for chemical products will be dissected to identify potential 'hot spots' for stringent regulation to gain foothold and affect the profitability of the sector. Governments possess a large number of instruments to control the industry located in their country. For example, they can regulate import and export tariffs, employee safety standards, and environmental negatives associated with the chemical production process, such as pollution (water borne as well as air borne) quantities, concentrations, or frequencies, chemical (or hazardous) wastes, the production or the use of certain harmful chemicals and technologies utilized in the processes. This complexity creates a multidimensional problem for researchers.

The OECD (How Stringent are environmental policies, n.d.) has created an environmental stringency indicator which combines elements which are present in every country's legislative body. It combines supporting elements (such as R&D subsidies, support for energy efficiency, and the promotion of renewable energy) as well as penalizing elements (such as the costs of emissions or emission limits, environmental taxes, and quantified levels of certain substances in emissions). However, such measure would be inappropriate in this research, because it rather reflects the country's environmental awareness, rather than actual policy stringency. For example, considering all other things to be constant, it wouldn't really matter for a chemical firm who's looking for a new production location to settle in country A, in which the government highly promotes renewable energy research, rather than in country B, which has still a high share of conventional thermal plants (such as coal or lignite plants) in their energy mix and the government leaves the research concerning renewable energy sources up to the market.

The authors note that the approach of creating an index for environmental stringency – a common approach in pollution haven hypothesis literature creates a proper and generalizable result for the stringency, but fails in actually indicating what kind of costs the companies face when dealing with these environmental regulations. The main question when using these indexes is the extent to which they can be extrapolated into policy that specifically alters the competitiveness of industry. For example, some pollution haven hypothesis scholars use measures such as maximum lead content in gasoline or market share of unleaded gasoline (Cole and Elliott, 2005) or the

number environmental NGO's per capita (Zugravu and Ben Kheder, 2008). Of course these two measures don't affect the competitiveness of the chemical industry directly, but if we would consider them to be proxies of the countries' overall environmental policy stringency, or the environmental awareness inside respective governments, we could expect their legislation on the chemical industry to follow a similar path. So this means that even when we assume it is the case that the stringency of environmental policy that affects the competitiveness of the chemical industry directly, the created index doesn't tell us exactly how much the operational profits of said industry suffers under increased stringency.

Brunel and Levinson (2016) also note that some measures of environmental stringency can give a false image of the actual policy stringency when not used correctly. For example, when using measures such as environmental tax income one must be cautious when dealing with multiple countries with each their own sectoral composition. For example, a country with an extremely high share of agriculture or service industry will naturally display a very low environmental tax income, while a country with an extremely high fraction of industry will of course display a relatively high environmental tax income. Here the proposed indicator of environmental stringency clearly hasn't fulfilled its duty to indicate the actual policy stringency. A possible solution for such phenomenon would be to correct the environmental tax income for the size of the respective economies (by GDP for example) times the fraction of industry in that economy (manufacturing share for example). This would create a more level playing field, even though it is obviously far from perfect as an environmental policy stringency indicator, for different economies with each their own composition of economic activities.

As the CEFIC (Facts and figures 2016, n.d.) indicates, the regulation of the chemical industry is affecting its competiveness by driving up the costs in production. In agrochemicals (meaning pesticides and fertilizers) and specialty chemicals the costs of regulation are about half of the GOS, which is shown in the next figure (meaning Gross Operating Surplus, which is similar to operational profits, but do not take into account the depreciation of capital (Glossary: Gross operating surplus (GOS), n.d.).

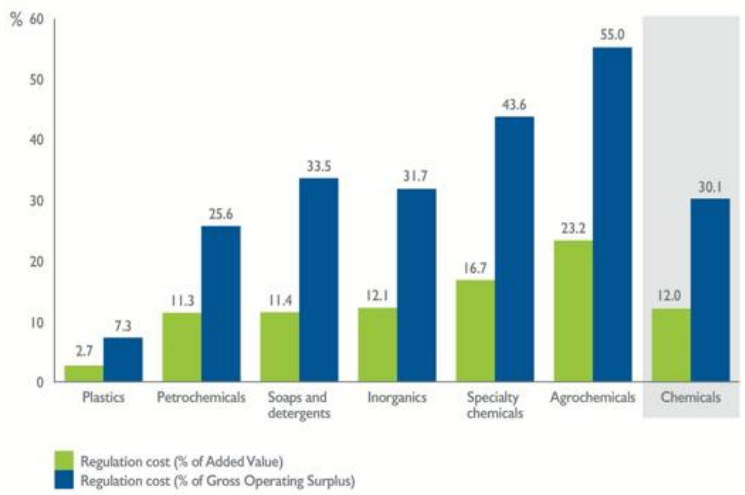

Figure 2: the costs of regulation in the chemical industry in 2016, green is the costs of regulation of added value %, and blue is the costs of regulation as a % of GOS

These administrative costs are broken down further in figure 3 below, also provided by CEFIC (Facts and figures 2016, n.d.).

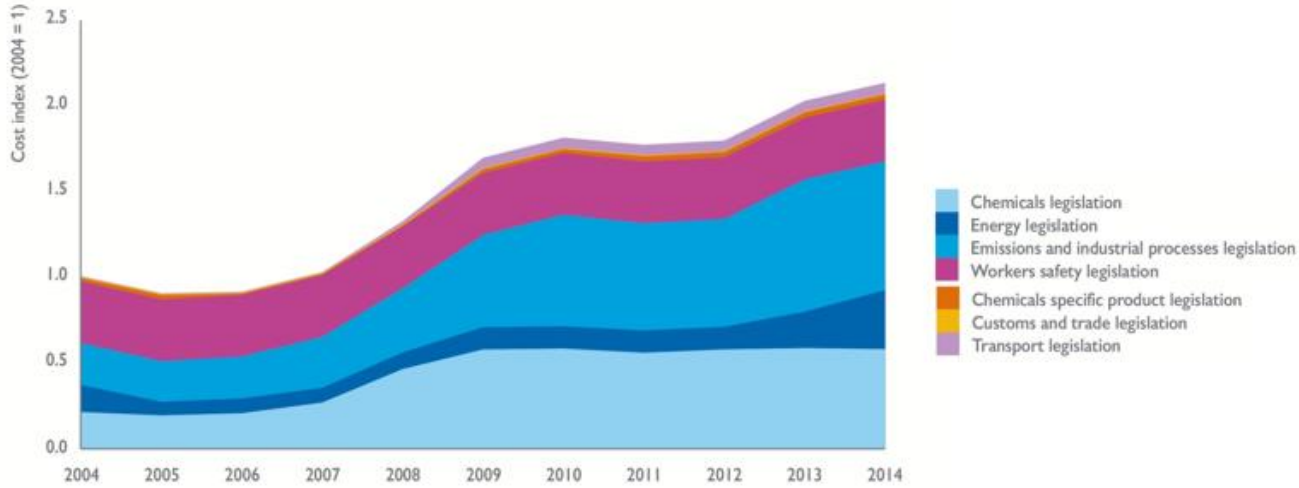

Figure 3: regulatory costs of the EU chemical sector broken down

What this clearly shows is that the groups 'workers safety legislation' (purple), emissions and industrial processes legislation (blue), and chemicals legislation (light blue) form the majority of the costs imposed on the industry. The 'chemicals legislation' package encompasses all sorts of legislation associated with the product and reactants produced and used in the production process such as labeling, monitoring of hazards, and risk management (Maroulis, De Kettenis,

Bougas, Ravet, Reid and Rzepecka, April 2016). In this way, no dangerous products can be brought into the European chemicals market. The European legislation that compasses all these issues is called REACH: Registration, Evaluation, Authorization and Restriction of Chemicals (Reach, n.d.). The impact of REACH and other directives can be seen in the figure as well, as in 2007 the regulatory costs of chemicals legislation increased drastically. The steep growth of the regulatory costs burden in total is mostly caused by the groups 'emissions and industrial processes legislation' (blue) and 'chemicals legislation' (light blue). Even though the regulatory costs are expected to decrease after 2017/2018, it still forms a large burden for the industry (Lasserre, n.d.). It is also stated that a centralized approach would be more suitable for legislative filing. However, it seems likely that such approach would only benefit large multinationals, while the small and middle sized companies cannot generate such 'administration of scale' advantages.

Furthermore, what this figure shows as well is that regulations concerning imports, exports and other transport do not constitute a large fraction of the total costs of regulation. This would mean for our analysis of the value chain that we only need to consider the midsection, meaning the production process, which is constrained by emission caps and costs. The chemicals legislation package which was discussed above doesn't really fit in here, not neither anywhere else in the value chain because it is not really part of the production process. For that reason, it is not part of the environmental stringency that this construct seeks to embody.

Emissions and industrial processes legislation

Last but not least, the emissions and industrial processes legislation. As can be seen in figure 10 above, it is the biggest group in terms of imposed costs on the industry based on legislative action. According to Greenstone, List, and Syverson (2012), US based manufacturing plants suffered a 2.6% decrease in TFP (Total Factor Productivity, a measure for differences in productivity with a set input for labor and capital) by the introduction of stringent legislation for 4 pollutants: carbon monoxide, ozone, Sulphur dioxide, and TSP (suspended particles). This is clearly a confirmation of neoclassical notions of decreased competitiveness after cost imposition: it means that factories produced 2.6% less products when labor and capital inputs are considered to be constant. For the organic chemicals sector the effect was even stronger: they find a decrease in TFP of 17%. Even though this seems to confirm a decrease in competitiveness in the short term, the article doesn't elaborate on the behavior of the firms after this.

According to Michael Porter, they would innovate (weak version), or even increase their competitiveness by innovating (strong version), as stated by Ambec, Cohen, Eglie and Lanoie (2013) in their review paper of the Porter hypothesis. However, the Pollution Haven Hypthesis clearly states that over a longer period of time, these companies would move away to the

aforementioned ‘pollution havens’. This is not confirmed by this paper, for it only witnesses the impact of stringent air quality regulations on a short term basis. Maybe the pollution haven hypothesis needs a ‘weak version’ as well, somewhat in the form of just reduced competitiveness for the firm. Usually in the PHH literature, perfect competition is assumed for the sake of argument, but that doesn’t have to be the case, and almost never holds true in reality, which is mostly defined as an oligopoly. If a chemical company is located in a very isolated (geographically) area, and being the only supplier in that region, that company would be able to pass the imposed costs of the stringent environmental regulations on to its customers without having to go out of business or having to relocate per say.

According to Maroulis et al, the European Union’s main instrument to combat global warming and reducing the emissions of greenhouse gasses is the ETS (Emission Trading Scheme), which is basically speaking a secondary market for the rights (emission allowances) to emit said greenhouse gasses. With the European Union’s administration controlling the amount of issued emission allowances each year, they can control the actual price of emitting greenhouse gasses while giving the market enough freedom to cope with these increasing costs of pollution, by for example employing more sustainable energy generation techniques. In other words: by increasing the costs of for example CO2 emissions, the administration tends to make conventional (thermal) power generation less cost effective than for example cleaner methods such as wind or solar generation.

This works more or less the same way in the chemical sector: the administration determines what is to be considered a ‘good’ or ‘proper’ way of production, and uses this as a benchmark in the determination of the amounts of emissions rights that have to be issued annually. By using the ‘best’ (meaning, utilizing the most sustainable production techniques) 10% of the market as a benchmark, they make the less sustainable production techniques less cost effective, which forces them to adapt or go out of business in the long run. Even though the chemical sector emits more types of greenhouse gasses than for example the energy (generation) sector, the EU ETS copes with that by using the scientifically determined global warming potential of these substances. However, only two types of emissions are included at the time: emissions of nitrous oxide (N2O) and perfluorocarbons (PFC’s). In other words, the EU ETS trades emission allowances, with one allowance giving companies the ability to emit one ton of CO2, or its equivalent in nitrous oxide or perfluorocarbons (The EU emissions trading system (EU ETS), n.d.).

Directives for the maximum quantities or concentrations of other pollutants are directed by centralized European organs, but it is up to the countries themselves to work out how exactly this would translate in policy. This is at least the case for Sulphur dioxide, nitrogen oxide, volatile organic compounds and ammonia.

Formally speaking, the costs under this legislative package can be spread out under four different categories:

- Monetary obligations, such as the costs for CO2 allowances in the ETS
- Administrative burden, for the maintaining and development of the monitoring system
- Substantive obligations, such as investments to make the industrial process more efficient. A higher efficiency would most likely mean that less ETS allowances have to be purchased. Moreover, they are forced to implement the so called 'best practices'.
- Indirect costs, such as costs which can be passed on from earlier in the value chain. For example, if a chemical factory uses intermediate products as its input, and those are produced elsewhere, they have been subjected to the costs of the ETS beforehand. The same would go for electricity that the factory uses.

Off course, this is only the EU, not the rest of the world. It's probably not safe to say that the rest of the world enjoys these kind of policies. However, finding comparable data in these fields is tough.

ISO 14001 certificates

The ISO 14001 standard is a certification for the proper environmental management systems. Creating these systems and applying for the certification will probably be accompanied with high costs; therefore it is a good indicator for environmental awareness. However, one must be cautious with increasing the complexity of the environmental stringency index. As noted by Van Beers and van den Bergh (1997), an increasing complex environmental stringency variable can be detrimental for the research results. Zugravu and Ben Kheder (2008) use it as well in their model, and proves itself accordingly to be useful.

Environmental taxes

Martinez-Sarzoso, Vidovic and Voicu (2016) noted the usefulness of utilizing a country's environmental taxation as a proxy for environmental stringency. Despite that they used it as a proxy alone; in my research it will form an important link in setting up a proper measure for environmental stringency. Even if a country would be so underdeveloped that pollution abatement cost are that low that it would become economically feasible for a multinational company to move operations to that country, it would raise the secondary issue of getting the proper labor force in place. If the country is too underdeveloped and no proper labor force is available to start operations in the first place, the operation of moving abroad has to be canceled, for it would cost too much to move a sufficient labor force abroad.

2.4: Market potential: theoretical background

When former researchers utilized the concept of market potential, they generally refer to the presence of other businesses, which is deemed an attracting factor for industry. In this way, firms assure themselves of a large internal market to sell their products to, as well as provide their business with the opportunities to reap economies of scale, and create synergies with similar businesses. Because of these considerations, the expectation is that a country with a higher score on the market potential construct will result in more chemical firms, and thus a higher FDI flow. Therefore, the market potential construct is expected to have a positive influence on FDI flows.

Taking into account factors for market potential when researching the pollution haven hypothesis is a common approach to the methodology. For example, Barry and Walsh (2012) and Malm (2012) noted that the factor endowments of developing countries and developed countries are in direct competition with each other: developed countries generally speaking have a large internal market and modern infrastructure which would promote the access to large market, while on the other hand the developing countries are generally speaking favorable when looking at factors such as labor costs. This implies that the construct of market potential mainly focuses on the demand for the chemical industry's products.

Head & Mayer (2000) developed an econometric model to explain the choice of location of Japanese industry in the European Union in the 1980 – 1985 period. Their model incorporated demand side factors as well as supply side factors, such as the local competition. For the demand side, they build (among others) on Harris' (1954) work, and find the market potential term to be a significant and positive factor in the choice of location. Another interesting remark about their research is that wage differentials between countries plays a notably smaller role. A possible explanation for this phenomena is that their inquiry only looked at choice of location within the EU, where generally speaking wages are not so different as compared to wage differentials worldwide.

Harris's (1954) work inspired other PHH scholars as well. For example, Zugravu and Ben Kheder (2008) estimate the market potential of one country by taking its GDP and surrounding countries GDP divided by the distance to the first country. This approach was originally developed by C. D. Harris in 1954, and has been since then the standard approach to such issues. This method would give a proper estimate of the area's market size, but doesn't account for cross border trading barriers that could be in place. As noted by Head & Mayer (2000), Harris' method does show the market potential of various regions, but trade obstructions can cause the measure to give a more rose-tinted picture of the size of the market than that it actually is. This is confirmed by Martinez-Galarraga (2014) who describes the industrial move to the American border in Mexican industry after trade liberalizations. Moreover, it doesn't account for regional differences. For example,

when considering the proximity of the US and Russia, one would have to be cautious by simply taking the distance between the most western point of Alaska, and the most eastern point of Siberia, which are both two regions of high GDP countries who are relatively close to each other but the distance between the economically developed regions such as New York and Moscow, or Silicon Valley and Moscow are very far apart.

Head and Mayer (2010) evaluate the market potential for most countries in the world over the 1960 – 2003 period. They show that high market potential results in high income per capita. They show that for the Netherland and Belgium for example, both countries with a high market potential because of their surrounding countries, they have a high income per capita. On the other hand, countries such as the US and Japan, who's strong internal market drives the high income per capita. The effects on income are supported by the findings of Hanson (2001), who researched agglomeration patterns in industrial sectors. Hanson shows that wages increase due to the increased share of higher-educated workers in the local labor force, as well as a higher industry growth rate in more industrial diverse settings. The latter could indicate spillover effects between industries, or decreased transport costs, thereby generating agglomeration benefits.

The approach that will be used for this part of the pollution haven hypothesis investigation shows some similarities with New Economic Geography (NEG); a new stream of literature that studies markets spatially. The main idea behind this theory is that when trade-costs and agglomeration patterns are taken into consideration for the choice of location for industry, the settling behavior will display strong agglomeration patterns and industry tends to move to each other, as well as to large markets, as described by Ottaviano & Pinelli (2006). This is achieved by a greater industrial variety, and therefore a lower local price index, which in combination with higher wages (which firms are willing to pay because of the agglomerated regional internal market) pulls more works to the region, according to Martinez-Galarraga (2014).

2.5: Infrastructure: theoretical background

In literature surrounding the pollution haven hypothesis, it is common that scholars seek to control for accommodating factors for industry. For the chemical industry and especially its products characteristics (which can be hazardous in some cases), a well development infrastructure is of vital concern. When discussing infrastructural requirements of the sector, it is important to note that the concept of infrastructure not only refers to logistical infrastructure, but to IT infrastructure as well. Cellphone and internet access are prerequisite of any type of developed industry. For those reasons, the construct of infrastructure is incorporated in this research, and is expected to have a positive influence on FDI flows.

Taking into account some measure of the infrastructure of a country is a common phenomenon in PHH literature. Possible examples of infrastructural requirements are access to a (industrial sized) port, adequate railroads, distribution centers, pipelines, water-transport networks and perhaps even other chemical production sites in the neighborhood to reap some kind of economies of scale (Vugrin, Warren, and Ehlen, 2011). Investors clearly have a preference for a well-developed infrastructure, according to Wheeler and Moody (1992).

Some measures for the development of a country's infrastructure are clearer than others, although their influence remains positive on attracting industry. For example, Cole et al. (2006), Cole and Fredriksson (2009), Kelleberg (2009), and Wagner and Timmins (2007) all use some measure for the infrastructure of a country, but their approach in this varies a lot. For example, Cole et al. (2006) and Cole and Fredriksson's (2009) study only takes into account the IT infrastructure of a country, by using variables such as 'television sets per 1000 people' and 'telephone mainlines per 1000 people'.

On the other hand, Wagner and Timmins use a measure of 'total length of the paved road network' to account for the physical infrastructure in a country. Those approaches seem very different, because they both appear to grasp different aspects of infrastructure. Because of that reason, I try to account for both of those, and account for transport by waterway as well. This seems to resemble the approach taken by Kellenberg (2009) who uses the infrastructure index taken from the global competitiveness report. However, by taking an index from such report, one tends to loose certain insights in how this index works and more specifically, how the variables within work. For that reason, the infrastructure construct that will be utilized in this study seeks to account for transport by train, transport via water, and a measure of the IT infrastructural development.

As one could imagine, even if it would be in all other aspects be cheaper to produce chemical products in the middle of the dessert, managers and / or strategists would prefer the mainland over this, simply because the costs would not outweigh the benefits. The assessment of the infrastructural requirements in the chemical sector is vital in the PHH research, because the other constructs in the model do not necessarily account for the availability of adequate infrastructure.

Infrastructural requirements: an European example

To illustrate the importance of infrastructure in the chemical sector, one does not need to look far. In 2015, the EU's chemical exports were 147 billion Euro's, compared to its home sales and intra EU trade, which were 372 billion Euro's combined. Its chemical imports were in that same year about 90 billion Euro's. This shows in a very roughly manner the importance of extra continental trade for the European Union. Even though its internal market is quite large, its reliance on trade

with other parts of the world is obvious. The port of Rotterdam is crucial in this, by not only providing the proper connectivity with the rest of the world, but also by hosting many chemical companies (Port infrastructure best in the world, September 5, 2014). Moreover, a vast infrastructure connects the port with the hinterland of the Netherlands, and even Germany's Ruhr district, a large industrialized region in the west of Germany by the Betuwe route, which is a specialized rail freight network (Why the Netherlands – Extensive infrastructure, 2013).

According to a report from the EPCA (European Petrochemical Association) in collaboration with the CEFIC (European chemical industry council) (Supply Chain Excellence in the European Chemical Industry, October 2004), the European chemicals market is going to get stressed under the upcoming developing regions of the world, who seek to compete in the global market. They predict that the traditional view on the developed countries' competitiveness; the high end market and knowledge intensive market is not going to cut it in the distant future, and suggest that the European chemical industry can save additional costs by developing their supply chain.

Currently, most transport in the chemical sector is conducted over the roads, but the report suggests the utilization of railways and transport over water to be viable options in the close future: currently the European Union is developing a proper railroad network for freight transport, and by relieving regulations for chemical transport over water, intra EU integration can be developed even further.

The importance of the Port of Rotterdam is highlighted by a report by the VNCI ('Vereniging van Nederlandse Chemische Industrie' – the Dutch chemical industry association) and Deloitte (2010) as well, which seeks to identify key changes in the industrial landscape in the Dutch chemical industry by 2030 to 2050. The cluster of industrialized regions bounded by the Rotterdam, the Ruhr area in Germany, and the port of Antwerp, creates a viable entrance and exit for Europe's manufacturing industry (in the report, this is referred to as ARRRA region: Antwerp, Rotterdam, Rhine, Ruhr Area). By highlighting the importance of the ARRRA region as a gateway for Europe's industry and being vital to its connection with overseas markets such as the US, China, India, Brazil, and the Middle East, it implies that the availability of port infrastructure is vital to a prosperous chemical industry. Moreover, it implies that when a region doesn't have natural resource endowment to petrochemical feedstocks like crude oil or natural gas, it needs a port to import those natural resources in a cost effective manner.

2.6: Factor costs: theoretical background

In this research, we use a definition of factor cost which is inspired by Zugravu and Ben Kheder's (2008) definition slightly, in the sense that this construct reflects a firm's variable cost (depending on the amount of product that they produce, or the turnover they generate). This is achieved by accounting for the inverse of the availability of qualified labor (assuming wages rise as qualified labor becomes scarcer), as well as the tax rate on commercial profits. By combining these two variables an image is created that reflects additional costs for the firm in question. Because a country which has a higher value of factor cost as a construct features all other things equal higher costs, and evidently suffers in this particular aspect of its comparative advantage, it is expected that this forms a deterring factor for the chemical industry. For those reasons, the construct of factor cost is incorporated in this research, and construct is expected to have a negative influence on FDI flows.

Accounting for labor market characteristics in a country as well as taxation regimes are rare in the literature surrounding the pollution haven hypothesis. Although it is uncommon, I feel the need to highlight the differences it can make. For example, in 2013, workers in the chemical industry in Ukraine made 3.57 €/h, while in the US they made 20.86 €/h (Boulamanti and Moya, 2017). In the same sense, in Brunei firms would only have to pay 8.7% taxes on commercial profits, while in Tunisia they pay 60.2%. As shown here, these differences can be huge, and accounting them seems appropriate.

Labor

Zugravu and Ben Kheder formulate the factor costs as the prices of both labor and capital. The authors find that the data on the costs of labor (of all industry) is lacking, and for the countries that do provide the data on labor costs, they find these costs to be highly correlated with governance factors. Therefore they use the logarithmic-linearized lagged value (to avoid any possible endogeneity with the dependent variable) of the K/L (capital labor) ratio to account for factor costs and the countries endowment in production factors. With K being the capital stock and L being the total labor force. They find in their models the K/L ratio to have a negative influence on industry's location, which appears to be logical because one could expect firms to favor labor abundant countries (low cost labor) over high cost labor countries.

Even though it is clear that the capital labor ratio is a potent alternative for the situation when no data on the cost of labor and the cost of capital is lacking, it does have its limitations. For example, when operationalizing the costs of factors of production by using the capital labor ratio, it makes a set of assumptions following the school of thought of neo-classical economics as shown by Girardi (2017). For example, the distribution of capital across industries follows a risk-adjusted spread. This would imply that firms do have the perfect information that is necessary to weigh the

pro's and con's like this research intends to do, meaning taking into account all the elements like the potential of a market, the governance factors that enable its financial well-being and so on. Moreover, it assumes a perfectly competitive (market based) world with perfect mobility, which is probably not the case for the chemical industry. Cole, Elliott and Okubo (2010) define industry's mobility to be strongly dependent on transport costs as well as plant fixed costs and agglomeration patterns, in which at least the last two factors play a significant role in the chemical industry. They show that the chemical industry in Japan is one of the least mobile industries.

One specific problem relating to the cost of capital, is that using the K/L ratio assumes homogenous prices of capital, and especially used when investigating the pollution haven hypothesis as an industry wide phenomenon would do more bad than good for the assumption of homogenous prices of capital. Even when researching solely the chemical industry, the case for homogenous prices of capital is meager at best, considering the different modes of production and the enormous diversity of the sub industries that encompass the chemical industry. But still, it would seem more reasonable to assume for only one industry than as a phenomenon that occurs across industries. However, Zugravu and Ben Kheder still find a solid result regarding K/L ratio's in French firms' investment decisions: statistically significant and over -0.3 in their models. They ascribe this purely to the search for cheap labor, which is found when labor is an extremely abundant factor of production, and therefore the K/L ratio is low.

The chemical industry is developing rapidly. The cost effectiveness of the chemical industry has increased over the past decades by means of new maintenance practices and streamlined production lines, using IT (Operating costs in the chemical industry (January, 1998). However, its labor intensiveness is decreasing over time, according to the report by the CEFIC (CEFIC report, Facts and Figures, 2011). In total, the chemical sector accounts for 5.4% of the total manufacturing industry's employment in 2007. However, employment is decreasing in the chemical sector. In 2000, the employment in the European chemical's sector was about 1,440,000 and that decreased to about 1,157,000 in the next 10 years, averaging at about -2.2 % per year, as shown in figure 4.

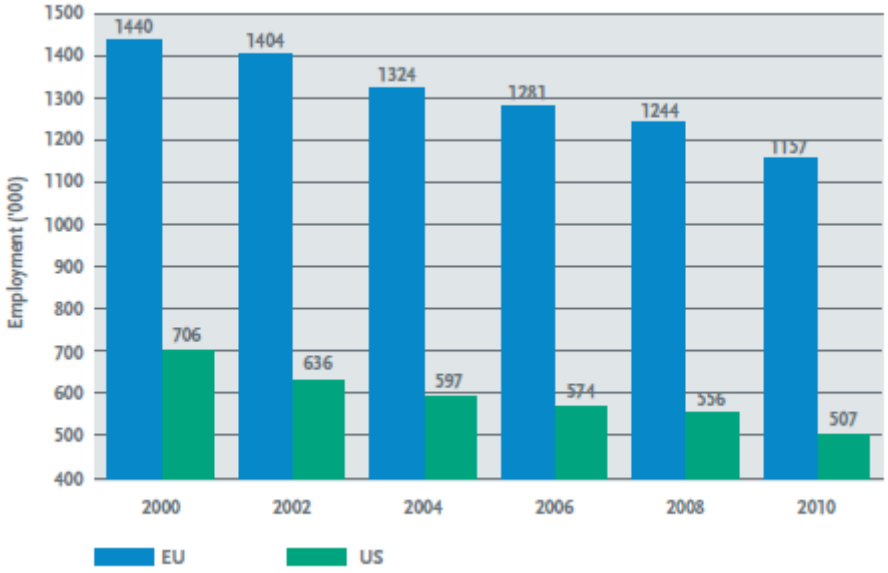

Figure 4 employment in the chemical sector EU vs USA

The sharpest decrease in EU chemical employment was between 2008 and 2010, but that could be accredited to the impact of the financial crisis 2008. Although employment is decreasing slightly, the EU's chemical sector is still the highest paying sector in all of Europe's manufacturing businesses. They are higher qualified, trained, and paid better than their American counterparts. The growth of labor cost are increasing as well. This indicates that the total labor force has shrunk, but the quality of it has risen. However, this could be very location dependent. Pinkerton, Schmidt, Xamplas and Kolbe (2014) state "The salary for a chemical plant operator varies by location, and the estimator should look up the average value for the area."

Repetto (1995) concludes that little evidence has been found to support the notion of industry leaving industrialized countries in search for lower production costs (labor and environmental regulations). Many people feel that industry cannot take anymore burdens concerning environmental stringency increased costs. This holds true especially in pollution intensive industries such as the chemical industry (petrochemical industry), paper and pulp industry, and the metals industry. The US has lost market share in these sectors, and firms have moved their business abroad. This effect has been mediated by the establishment of NAFTA, which gave firms an easy way to relocate their business, but not harm their trading options. Therefore, OECD countries tried to smoothen this effect by establishing MEA's in order to negate a possible 'race to the bottom'. Unions fear the increasing governmental focus on environmental issues, because they think this would result in firms using capital to invest in pollution control equipment, rather than maintaining (or expanding) the current workforce. This seems to be a reasonable claim, considering the steady decrease in both the European and the American workforce in the chemical

industry. Repetto reasons that only the sectors that extract natural resources from the environment will suffer in terms of job losses, but that would be compensated by job creation in high tech and environment aware sectors. Similarly, jobs lost due to the introduction of environmental stringency would create jobs in sectors that supply firms with pollution control equipment, both of which appear to be a little overly optimistic. Later in the article, the author claims domestic industry's competitiveness (jobs) not to be a valid economic objective, which clearly shows the authors' bias in this matter, all of which makes it less of a research paper rather than a plea. The author does make an appropriate notion of introducing best practices for industry though. He considers it to be justified when a firm makes a leap in market share on expense of another when he former can make higher operational profits under pressures of environmental regulations when the latter cannot. This introduction of best practices is a common phenomenon in the European Union where the exchange of knowledge and technology to facilitate the useful exchange of abatement practices.

Corporate taxes

Davis & Hashimoto (2015) investigate the effects of corporate tax on the location of industries. Their reasoning follows the same neo-classical approach like the pollution haven hypothesis: if you assume perfect capital mobility, industry will locate to the place where the costs of production are the lowest, and if you take the corporate tax rate into consideration here, you will likely see industry to relocate to the places where this is the lowest, and therefore where the profits are the highest. Moreover, they reason that the higher concentrations of industry will generate knowledge spillover effects in time, which can aid their competitiveness. The authors find that this holds true, but acknowledge that earlier research' results are divided on this issue.

2.7: Governance factors: theoretical background

The construct governance factors attempts to capture both the quality of the governments' policy, as well as the control of corruption and the stability of a country. The quality of governments' policy gives an indication of the extent to which governments can realize their goals by successfully implementing policy that can be both maintained and enforced. The World Bank provides an estimate as well as a rank on the three variables that this construct will contain: political stability, control of corruption, and regulatory quality. Earlier work conducted by Zugravu and Ben Kheder (2008) as well as Wagner and Timmins (2009) points out that incorporating governance factors as control variables in the research of the pollution haven hypothesis is necessary, because it gives a reflection of security of investments in a particular country. Therefore it is expected that this construct will positively contribute to attracting the chemical industry.

Zugravu and Ben Kheder (2008) note the importance of taking governmental factors into account when researching the pollution haven hypothesis. Even though that this effect is not exclusive to the chemical industry, it is still a force to be reckoned with. Especially in the case of developing countries, bad governance can create unnecessary high costs for (foreign) industry, and may scare off potential investors. They use the corruption index, political stability index, and the regulatory quality index established by the World Bank. The same three indicators will be used as well in this research to proxy for government related factors. Zugravu and Ben Kheder (2008) find that a higher corruption index seems to deter foreign (French in this case) investment, while higher political stability as well as regulatory quality seems to attract foreign investment. Most of their findings are statistically significant as well in their models.

Wagner and Timmins (2009) control for government related factors as well. They model these as a 'law and order' construct, which they include their analysis. They do so by using an indicator of the strength and impartiality of the legal system (law), and 'order' should capture how this is enforced in practice. With this, they create a six point scale in which one would mean a high risk country, and 6 being a low risk country. Even though they don't refer to the paper by Zugravu and Ben Kheder (2008), their work still shows some similarities, without actually referring to concepts such as 'corruptibility' and 'regulatory quality'. They find a positive association between their 'law and order' construct and FDI (German in this case).

Corruption and foreign direct investment

Corruption has shown to be major deterring factor in the flows of foreign direct investment. While developing countries could be hosting some of the highest shares of manufacturing in the world, government factors such as corruption could prevent that. As shown by Dumludag (September 21, 2012), corruption can be hinder FDI in a significant way. If governments misuse their power, and let nepotism and / or their own personal (or private) benefits prevail, the economic environment could suffer drastically. The part of the dataset used in this research for the measure of corruption is coming from the World Bank. Their corruption index compasses both the small scale corruption, as well as the large scale corruption. Examples of small scale corruption could be for example, irregular payments to local government officials (bribes) or irregularities in taxes. Examples of large scale corruption could be payments in judicial decisions, rigged elections, or the misuse of public funds. Either way, this would deter foreign businesses significantly. This happens through the process of investor (foreign capital in this case) discouragement: once it becomes known that the economic rewards are not based on the merit of the company that is operating in the corrupt country, but rather on factors such as nepotism or extreme forms of nationalism.

This particularly holds true for the developing world: in 1998, the total foreign direct investment flow was about 150 billion US dollar, and jumped to a staggering 500 billion US dollar in 2010.

Despite the enormous figures, the distribution of foreign capital is far from even: it seems to hold that the countries with the highest rates of corruption face the lowest inflow of capital. Habib and Zurawicki (2002) researched the impact of corruption on the attraction of foreign direct investment. They note that the effect of corruption is extremely relative: developing nations with high levels of corruption such as Brazil and China attract huge level of FDI, and between developed nations, a huge difference can be found between Italy and Belgium, while both have similar levels of corruption. The authors find that the perception of corruption is strongly dependent on the difference in corruption between the host country and the home country.

Regulatory quality and foreign direct investment

Regulatory quality is defined by the World Bank as "the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development" (Regulatory Quality indicator, n.d.). The index established by the World Bank encompasses many elements, but for this research some are more important than others. The market oriented subjects appear to be most vital for this research. For example, regulatory quality measures entrance barriers to markets, which may be vital for the spread of the chemical industry. Moreover, the variable encompasses the regulation of markets, such as anti-trust regulations and other unfair competition practices, and perhaps most importantly: the ease of setting up subsidiaries by a foreign company. The score on regulatory quality are also affected by the country's degree of 'protectionism'. This variable seems to capture near perfectly the business climate which could determine the country's attractiveness for foreign businesses.

Even though it is not captured explicitly by the regulatory quality index, the idea is not very farfetched to assume that proper governance of markets brings with it a certain degree of awareness of how to stimulate them with adjacent institutions. For example, as shown by Freeman (2004), the proper linkage between "education systems, scientific institutions, research and development, and production and markets" have shown to bring about a considerable advantage in terms of the country's economic performance (trade in this case) as well as productivity.

Gani (2007) finds promising results of the effect that regulatory quality on businesses can have by studying multiple governance factors' impact on FDI flows in countries in Asia and Latin America. To be precisely: the rule of law, governmental effectiveness, regulatory quality, control of corruption, political stability, and voice and accountability are tested on their effects on FDI. He controls for economic growth, market growth, degree of openness and unit costs. He finds positive

and statistically significant effects for all studied governance factors, expect for 'voice and accountability', which isn't statistically significant, but still positive.

Political stability and foreign direct investment

The World Bank's political stability index is not just about the stability of the government itself, but also about the extent to which they can maintain order on the street as well (Political stability indicator, n.d.). For example, a country's score on the political stability index is affected by violent demonstrations or riots, armed conflicts with other countries, internal conflicts or tensions based on ethnicity, religion, or regional conflicts.

It appears to be evident that the political stability of a country increases investor uncertainty more or less in the same way as corruption does: if the corruption in a government doesn't allow a firm to make profits in a country purely based on their strategy and merit, that same uncertainty plays a role when the government is unstable. This would mean that affirm which decides to operate abroad is subjected a chance of losing business for a reason which is outside their span of control. This would surely create severe uncertainty for the investors, which in turn would object to moving the firm's operations to that location.

Although this effect would appear to be fairly reasonable when approached theoretically, in practice the effect of political stability hasn't shown to play a significant role in investor decisions as much as corruption and regulatory quality. For example, Jadhav and Katti (2012) find political stability to even have a negative influence on FDI in BRICS countries in the 2000-2010 period, and Wang and Swain (1997) showed that political instability to affect FDI inflows of multinational companies and their subsidiaries negatively as well. In contrast, Ghani (2007) finds political stability to have a positive influence on FDI in countries in Asia and Latin America. And Saida, Ochi and Ghadri (2013) find political stability to have a positive influence on FDI in 20 developing and developed countries in the 1998-2011 period as well. One possible explanation for these mixed results could be that the factors of governance studied display a strong correlation with each other, and testing them simultaneously could cause the more obvious effects such as corruption to explain to much in the variance in the regressions, and thereby causing less obvious effects such as political stability to play a less significant role. Although Zugravu and Ben Kheder (2008) find the governance factor political stability to play a positive and significant role in most of their models when researching the pollution haven hypothesis, one should be cautious by inserting too much explanatory variables in the model that explain more or less the same thing.

2.8: Multilateral Environmental Agreements: theoretical background

Although some former scholars use the ratification of Multilateral Environmental Agreements (MEA's) as part of their indicator of the stringency of environmental policy, this research will regard those agreements as a predecessor to the establishment of more stringent environmental policy. A preliminary literature review on this particular subject points out that country's use MEA's to coordinate a common level of environmental stringency. In other words, they generally do not ratify because they wish to level the playing field (having more stringent environmental policies in place than other countries, and fearing that might hurt their country's competitiveness), but because they wish to create a level playing field, with all countries having the same standards, thereby creating a mutual burden on the international oriented industry.

A common criticism on those MEA's is that they rarely provide or mandate actual policy instruments or ways of implementation. Rather, they set out broadly formulated objectives by which the ratifying countries must abide by at a certain date in the future. In turn, this leaves the ratifying countries with some freedom on their approach of reaching this said goal. This would imply that the MEA's act as a precursor to the country's domestic environmental policy, rather than acting as some kind of a parallel force as Zugravu and Ben Kheder suggest: they use 'factor costs' as a construct to indicate some of the variable cost that a firm could face when moving to a certain coutnry, which includes an index for environmental stringency, which in turn is composed of, among others, the ratification of MEA's. In that way, they more or less assume that the ratification of MEA's in itself induce costs on firms, which is not the case. The same goes for Smarzynska and Wei (2004), who also use the number of MEA's ratified (among others) as an indicator of countries' environmental regulatory stringency. To look into this relationship between international goals and domestic policy, this research will investigate the impact of a constellation of MEA's on the ratifying country's environmental policy stringency.

International treaties embody a completely different aspect of policy formation compared to normal, domestic policy. Domestic policy is formed because of the lacking accountability of domestic firms, social groups and institutes. It thereby fixes to a certain degree a failure of the market. However, when accountability structures do not incorporate whole countries, international treaties are necessary to create the said structures. This fixes to a certain degree governmental failure, when they lack international accountability. By setting international standards for environmental policy for example, a 'race to the bottom' is prevented, and policy coordination is maintained by setting up Multilateral Environmental Agreements (MEA's), according to Congleton (2001). These aforementioned MEA's generate a smoothening effect on countries' environmental policy, creating a more homogenous level of stringency across the

countries that have ratified them, which should benefit all countries associated by reaping the benefits of synergies and a level playing field (Scott, 2011).

However, most of these MEA's focus on the goals to be achieved by the ratifying countries, but do not impose regulation on how to do this, and is still up to the individual states to decide. This means that domestic environmental policy is set to meet the targets or principles established by the MEA's, but since they do not specify how exactly this should be done, there is still some maneuverability for the individual countries which leaves the possibility of an arbitrage opportunity for firms to gain from a differential in environmental stringency across countries (Congleton, 2001). A common criticism of MEA's is that the general doctrines that they set out are too vague to actually enforce certain legislation in the countries affiliated (Seyfang, 2003).

Besides the countries individual policies, another important source of influence on firm's behavior in the chemical sector are the industry associations (Hoffman, 1999). By setting the norm for firms' processing behavior, they try to control the sector's reputation as a whole. Among these industry associations' green initiatives are the Responsible Care Program (2015), the Strategic Approach to International Chemicals Management, and the ICC's (international chamber of commerce) Business Charter for Sustainable Development. In contrast to MEA's which set out goals for countries to be achieved, these industry associations set out normative practices and facilitate the sharing of knowledge regarding process sustainability, while leaving actual performance goals out of the equation. Because of this, the affiliations with industry associations will be treated as being an MEA, which it is in the crudest form: it is multilateral, they are concerned with environmental performance, in which the affiliated parties agree to a certain standard.

As mentioned before, the constellation of MEA's that will be looked into here is not complete in the sense that not MEA's impact on the chemical sector is evaluated. Rather, by conducting a preliminary literature review, it is found that there is a certain relationship between de different MEA's which resembles a hierarchal structure. By following this to the top, we can identify the MEA's that have the biggest impact on industry, and therefore are worthwhile investigating for their respective influence on domestic environmental policy (Scott, 2011). These are: The Stockholm action plan for the human environment (1972), The Helsinki Protocol on the reduction of sulfur emissions (1985), The Nitrogen Oxide Protocol (1988), Volatile Organic Compounds Protocol (1991), Oslo Protocol on Further Reduction of Sulphur Emissions (1994), The Aarhus Protocol on Heavy Metals (1998), Aarhus Protocol on Persistent Organic Pollutants (1998), The Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (1999), Minamata Convention on Mercury (2013), Stockholm Convention on Persistent Organic Pollutants (2001), Vienna convention on protection of the Ozone layer (1985), The Montreal

Protocol (1987), The Basel convention on the control of transboundary movements of hazardous wastes and their disposal (1989), Kyoto protocol to the convention on climate change (1997), The Earth Summit in Johannesburg (2002), the Bamako convention (1998). As a private sector initive, the Responsible care group is investigated as well. A short description of these MEA's can be found in appendix IV.

2.9: Hypotheses overview

To conclude on the hypotheses that are established based on the theoretical framework that was developed in this chapter, an overview will be provided. Regarding the main research question, and in line with the pollution haven hypothesis (as well as the earlier work of Cole, Elliott, and Fredriksson (2006), Wagner and Timmins (2009), and Cole and Elliott (2005), the first hypothesis of this research is as follows:

Hypothesis 1: Countries with higher scores on environmental stringency will deter FDI flows

As hypothesized before, an exports based model would work less good than a FDI flows based model, but if the pollution haven hypothesis is valid, then this result should have to problem to robust across different operationalization's of the choice of production location, including exports (Akbostanci, Tunc & Turut-Asik (2007), Martínez-Zarzoso, Vidovic & Voicu (2016)), although the model would produce a lesser fit to the data. Therefore, the second hypothesis is as follows:

Hypothesis 2: Countries with higher scores on environmental stringency will show reduced exports of chemical products

As shown in the conceptual model as well, the influence of the selected multilateral environmental agreements (MEA's) are positive, in the sense that only MEA's are taken into consideration that are expected to have a (presumably) positive significant effect on domestic environmental policy (Congleton, 2001). However, the severity of the impact of these selected MEA's varies based on the contents of that specific agreement. Overall, all of them are hypothesized to have a positive influence on environmental stringency:

Hypothesis 3: A country's ratification of MEA's will increase its environmental stringency

Chapter 3: research approach

This chapter will describe the methodological approach that will be taken in order to shed light on the pollution haven hypothesis, and the methodological issues as identified earlier. The pollution haven hypothesis assumes that industry moves away from countries with too strict environmental regulations which raise their production costs.

This can will be tested by using a regression model which uses FDI flows as the dependent variable, and the five constructs (market potential, infrastructure, environmental stringency, factor cost, and governance factors) will act as the independent variables. If the construct of environmental stringency is observed to exert a significant negative influence on FDI flows, this would indicate evidence in favor of the pollution haven hypothesis. If the environmental stringency construct is either or both insignificant and/or positive in the regression analysis, that would indicate evidence against the pollution haven hypothesis.

Some of the methodological issues that former studies indicated will be dealt with by also including a regression analysis with exports as the dependent variable, thereby creating a contrast with the FDI based method. Moreover, the retained components from a principal component analysis will be utilized as new independent variables to visualize the impact of different weight factors inside the constructs.

The methodological approach will be discussed in the following paragraphs, starting with the operationalization and data collection methods, followed by a description of the data assemblage process, and more on how the data is used to create a dataset suitable for SPSS. Next, the results from the principal component analysis are discussed, and finally the five models by which the data is analyzed will be presented.

3.1: Data collection & operationalization

As mentioned above when presenting the research approach, this study uses a regression model to visualize the respective influences of the constructs. Moreover, it assumes the domestic environmental policy to be (to some extent) the result of Multilateral Environmental Agreements (MEA's). In order to do so, the constructs that are presented in the conceptual model on page 21 need to be translated into variables that, when combined, give a good representation of that particular construct. Most of this is achieved by studying the approach of former scholars: when they mention they seek to control for some of these constructs or a similar factor which could also apply to the chemical sector, this variable is taken into consideration for this research. After an evaluation of this factor on its applicability to the chemical sector, it is taken into account during

the building of the dataset and the analysis. The operationalization of the constructs is described in the next five paragraphs. The date of the variables differ, at a maximum of 2 years, assuming no large differences have occurred in that period.

Market potential: operationalization

In this construct, the country's GDP, its population, and its land area will be included, which is in line with the standard formulation of the gravity model of bilateral trade used in the research of the pollution haven hypothesis. The GDP variable (taken from the World Bank) will account for the other industries that a firm can serve while settling in a host country. This is in line with pretty much all empirical work on the pollution haven hypothesis. The population will be added as well, which will provide a measure of the size of the host country's internal market (as for the consumption of the product), which is in line with the research conducted by Cole and Fredriksson (2009) for example. The land area variable is added as well to account for the available space a country offers for possible industry. In countries such as the Netherlands or Luxembourg, the available space for (chemical) industry is severely limited, which makes it less likely to be a proper location for building factories. To conclude on the construct of market potential: it displays not only a measure of an internal market that it can serve, but also allows for symbioses between industries: for example, its good business for a polymer factory to be located near a toy factory.

Infrastructure: operationalization

The chemical industry requires a robust infrastructure in order to operate properly, as shown in 'Chapter 2: literature review and theoretical framework'. The chemical industry has branched out to even remote regions, but in order to do so, it must be connected by logistical channels to trade hubs. Although by doing so, the industry can serve local markets, and reap benefits from profitable local factor endowments (such as less stringent environmental regulations perhaps). Assuming transport by truck over paved roads would be possible, and canceling out the transport via air transport, which is not common in the chemical industry, this leaves the requirements for transport by either cargo ship or cargo train. Moreover, the chemical industry (but really any industry even) requires basic infrastructure for IT purposes, such as broadband connections and mobile phone services. Therefore the infrastructure construct must contain at least a measure of railway connectivity, cargo ship connectivity, internet connectivity, and mobile phone connectivity. The World Bank databank provides data on these subjects, as shown in appendix I: data sources. To proxy for the railway connectivity of a country, the variable 'Rail lines, total kilometers' is added. To proxy for the cargo ship connectivity, two variables are added: an index for the 'quality of the port infrastructure', as well as an index for 'liner shipping connectivity'. To proxy for the IT development of a country, two variables are added: 'fixed broadband subscriptions per 100 people', as well as 'individuals using the internet as a percentage of the

population'. The need to control for infrastructure is acknowledged by former scholars in the research of the pollution haven hypothesis. For example, Cole, Elliott, and Fredriksson (2006) use variables such as 'television sets per 1000 people' and 'telephone mainlines per 1000 people' to control for basic infrastructure requirements. The same goes for Cole and Fredriksson (2009). Kellenberg (2009) uses an index of infrastructure, derived from the Global Competitiveness Report. Wagner and Timmins (2007) do not assume appropriate paved road networks, and add a variable 'total length of the paved road network' to account for this.

Environmental stringency: operationalization

As shown in 'Chapter 2: literature review and theoretical framework', the chemical sector can be subjected to multiple forms of penalization by environmental regulations. Fortunately, most of the governmental impositions on the industry are reflected by the revenue that those impositions bring about. For example, when a chemical firm has exceeded its pollution limit, and it needs to pay some sort of financial penalty over this pollution, this is reflected in the countries environmental related tax revenue. The OECD provides such data for countries as 'environmental related tax revenue per capita'.

However, by using the environmental tax revenue for a country doesn't account for the environmental performance of a country, but it shows the government's intent to get to a certain height of environmental performance. For this issue, an index of environmental performance is added which seeks to capture the eventual outcome of stringent environmental policy: for that reason the variable 'Yale EPI' is added. Yale's environmental performance index captures multiple aspects of country's performance as the results of their environmental performance. It this sense, aspects such as health impacts, biodiversity, fisheries and animal habitats are taken into account. However, this is the environmental performance of a country, but that doesn't necessarily means it has stringent regulations that could affect industry. For example, Iceland is number two on their list, but has almost zero chemical industry. So the two variables above seek to capture the government aspect of this issue.

The 'ISO 14001 certificates per country' variable seek to capture the industry's attempts to reduce their environmental impact. This is line with the research conducted by Zugravu and Ben Kheder (2008), who used 'ISO 14001 certifications/billion US$ GDP' to proxy for industry's attempts to increase their environmental performance. They note that the participation in the ISO 14001 programs are completely voluntary, they still reflect the 'state of mind' of a country regarding environmental issues, and this is reflected in the company's policy.

Many other scholars (Cole and Fredriksson 2009, Cole, Elliott and Fredriksson 2006, among others) use a proxy of the inverse of 'market share of leaded gasoline' or the inverse of 'maximum

concentration of lead in gasoline', but this data is rather old, the dataset which describes this (as shown in appendix I: data sources) collected this data in the years 1992 – 1996, which may have been too long ago to still give an appropriate estimate of the stringency of environmental regulations in 2016, and therefore will be left out in the regression. It is unfortunate that modern data on these variables (maximum lead content in gas and the market share of leaded gasoline) is not available, for these are a great proxy for the stringency of a country's environmental policy: lead in gas can create very severe local air pollution when the gasoline is combusted. Because of this, the removal of lead in gas is typically one of the first action points for a country who wishes to increase its environmental performance. In the past, it was added to gasoline to increase the octane rating (a measure of the energy potency of the fuel), so if the government would prohibit this, the fuel efficiency of engines would go down and more fuel would be needed, and therefore would incur more fuel cost for consumers for the same travel distance.

Factor cost: operationalization

When considering the aspects that are discussed in 'Chapter 2: literature review and theoretical framework', one would preferably require some measure of chemical engineering students as a share of the workforce. However, such data is to my knowledge not available. Instead, the quality of the labor force will be represented by the 'primary school completion rate of the relevant age group'. If this can proxy the importance of education in a country, then from there it can represent the fraction of the students that enter higher education. I think it is safe to assume that the fraction of the students that go into chemical engineering as a percentage of the total group that enter higher education is not country dependent. If this would be more or less constant, the 'primary school completion rate' can proxy the availability of qualified labor. Finally, an inverse must be taken from this measure, because the construct factor costs represent additional costs that a firm must bear when settling in a particular host country, and having less qualified personal in the country's total workforce must mean higher wages, and therefore by extension also higher costs for the firm. The tax rate is easier: the World Bank provides such data on as percentage of the commercial profits, and therefore would account properly for the strategic behavior of firms to perhaps shunt these taxes. Therefore, the variable 'total tax rate on commercial profits' will be incorporated as well in the construct Factor Costs.

Governance factors: operationalization

The three factors: regulatory quality, corruption, and political stability embody the construct of governance factors. The World Bank provides its data on these subjects in two forms: one in an 'absolute index estimation', ranging from -2.5 to 2.5, and one on a relative rank. Considering governance factors in research of the pollution haven hypothesis is common. For example, Cole and Fredriksson (2009) incorporate measures such as the 'number of checks and balances within

governments'. Cole, Elliott, and Fredriksson (2006) incorporate a measure of corruption taken from the International Country Risk Guide. The review paper by Taylor 2004 acknowledges the influence of governance factors. Zugravu and Ben Kheder (2008) incorporate the factors 'political stability', 'regulatory quality', and the 'control of corruption' developed by Kaufmann, Kraay, and Mastruzzi (2005). Those three will embody the Governance factors construct in this research as well, but taken from the data provided by the World Bank. A note about the 'corruption' variable: it is a measure of 'control of corruption', not the level of corruption.

3.2: Building the dataset

Now the required variables are identified, the variables are looked up by utilizing open source data banks. Most of the former scholars depended solely on open source data, which is an approach that this research will take as well. The exact sources of the data are presented in appendix I: data sources. Most of the data banks have the option to extract the variable (at country level) into an excel file. The same goes for the export value of a country to provide an answer to the first research question. These spreadsheets are then combined into one. The operationalization of the MEA's is done a little different than the other constructs / variables. Most of the conventions and protocols have a separate document to indicate the status of their ratification. When ratified, the countries are obligated to translate the protocol or convention's goals into domestic policy. This is not the case for a country or a representative's signature. The status of their ratification is shown in the dataset with a "0" or a "1" value. A "0" here means the country hasn't ratified, while a "1" indicates the ratification of the MEA. The end result of this step is a large spreadsheet which gives an indication of the value of the variable for every country.

3.3: Data handling

As explained above, as a preliminary step, all data from all variables (see appendix I for their sources) is combined in an excel spreadsheet, which will form the input for IBM's SPSS for analysis. Next, all missing values in a variable's column are filled in with the average of that variable. Next, the FDI dataset kindly provided by Astrit Sulstarova, Chief Investment Trends and Data Section at the UNCTAD statistics bureau is incorporated here with the fourth sampling method of the six shown below. The dataset is then reduced to match the size of the FDI data (50 countries) which is sampled as described below in the next paragraph. Next the dataset is imported into SPSS. All variables are collectively normalized by creating z-values. This must be done because almost all variables are continuous, but have different units. For example, GDP is expressed in billion dollars, but land area is expressed in square kilometers. By creating Z-scores,

the variables of a country can be bundled or compared with each other because they now represent their relative place in the distribution of the data for that variable. Outliers are kept in: because linearity is assumed as well as confirmed by former studies, it is essential for the model to account for a very high level of foreign direct investment by a same order of magnitude of score on market potential for example. Next, the z-values are combined by using an average in the 'compute variable' function into their respective constructs.

3.4: FDI variable sampling

The data provided by the UNCTAD specifies the FDI flow for the chemical industry as a whole for 54 countries, as well as the mere manufacture of chemical products for 50 countries for as many years as the data was available to the UNCTAD over the period 1993-2016. So this means that each country's data contains two series: the chemical industry's FDI as a whole, and FDI specific for the manufacture of chemical products. I have chosen to use the latter, which is the FDI flow specified for the 'manufacture of chemical products', because the goal of this research was to adapt the research approach to the chemical sector.

The chemical industry as a whole encompasses multiple fields, such as the pharmaceutical sector and the manufacture of pesticides, which could be bound to a certain location geographically: in countries with lots of agriculture for example in the case of the manufacture of pesticides, or to countries with less regulations on the trial and development of pharmaceuticals. Because this research does not account for such factors, the series of a country's FDI for the chemical industry as a whole is not suitable, and therefore the mere manufacture of chemical products will be considered in this chapter.

The data on FDI flows specified for the 'manufacture of chemical products' are available for 50 countries in the dataset provided by the UNCTAD. Moreover, the FDI flows are not only specified for each country, but also for multiple years. However, because of lacking data availability, the dataset does not contain a FDI value for every country for all years the data set contains (1993-2016). Because of this, the FDI value that eventually will be used in the analysis later on, will be taken by calculating an average of as much years as possible (that the dataset contains). By doing so, year specific effects will be mitigated (such as the financial crisis in 2008). Moreover, in this way, the notion of the importance of FDI accumulation by Wagner and Timmins (2007) is taken into account. Although such accumulation is best resembled by taking the sum of FDI values across time for a country, because of the lacking data on specific years, this would give countries who can report more data an unfair 'advantage', in the sense that countries who report less data over time give the impression that there is less FDI inflow, although that may not be the case.

The sample contains mostly developed countries. Because the data provided by the UNCTAD relies solely on the countries' willingness and ability to report such data, this is not entirely unexpected. One could hypothesize that a country's ability to monitor its industries and report on this is a function of its level of development. Very few developing countries (defined by the United Nations Development Program) have submitted data on FDI inflows, which limits this database considerably.

3.5: Exports data

The data on the exports of chemical products are derived from the OECD's databank. This dataset encompasses the exports of chemical products for 202 countries, which is a far larger dataset than the FDI dataset, which only contained entries for 50 countries. With 202 entries in the dataset for this dependent variable, this means that the entire data set is reduced way less than the FDI based dataset. This leaves more entries 'in between, meaning between the FDI countries entries, which would give a more precise image in the explanation of production location of the chemical industry by the variance of the five constructs.

3.6: Principal component analysis

A principal component analysis is conducted on the constructs in order to reduce the dimensions of the data. By reducing the dimensions of the data, the true essence of the constructs can be captured in a new variable, which in turn can be used in the regression analysis. The results obtained from SPSS are shown below for the constructs. A principal components analysis of the standardized variables (which give the same results as the normal values) is conducted to reduce the dimensions by using the factor analysis in SPSS with an orthogonal rotation technique (Varimax). To start, all constructs are tested with a KMO and Bartlett's test in SPSS. All Bartlett's tests shows that inter-variable correlation taken as a single group is significantly different than zero. This means that it can be useful to extract a single factor from constructs. The results of the factor analysis from SPSS are shown in the table on the below. The fourth column indicates the rotated sum of squared loadings only in the case of the infrastructure construct, because in that case more than one component was extracted.

Construct	Variable	components extracted	extraction sums of squared loadings		Component 1 loadings	Component 2 loadings
			Cumulative % component 1	Cumulative % component 2		
Market potential	GDP	1	64.094	-	0.463	-
	Population				0.394	-
	Land area				0.463	-
Infrastructure	Fixed broadband subscriptions	2	44.332	65.958	0.942	-0.052
	Individuals using the internet				0.900	-0.226
	Liner shipping connectivity index				0.461	0.690
	Mobile cellular subscriptions				0.352	-0.611
	Quality of port infrastructure				0.791	0.305
	Rail lines				0.008	0.549
Environmental stringency	Environmental tax revenue	1	50.692	-	0.790	-
	EPI Yale				0.827	-
	ISO14001 certificates				0.461	-
Factor cost	Tax rate on commercial profits	1	63.547	-	0.797	-
	Inverse primary school completion				-0.797	-
Governance factors	Political stability	1	85.423	-	0.886	-
	Regulatory quality				0.935	-
	Corruption				0.950	-

Table 1: principal component analysis results from SPSS

What this table shows is that for the market potential, environmental stringency, factor cost and governance factors –constructs, only one component is extracted, meaning that these constructs have a common characteristic that the variables inside the construct load onto. The infrastructure construct is a little different though. The table shows that the construct of infrastructure is ideally broken up into two components, which in their own way measure some aspects about infrastructure. The components that are extracted by SPSS are saved as a new variable, which can be utilized in another regression model, as explained in the next chapter.

3.7: The 5 regression models

As explained before, this research not only seeks to provide an answer to the probability of a pollution haven effect, but also to some of the methodological issues that previous research faced; no earlier research provided a systematic approach to assess the validity of their research approach. For example, no comparative studies have been executed to the methodological issue of the dependent variable to proxy industry's location: both FDI flows and bilateral trade models have been used, without assessing the pros and cons of such approach. Moreover, the weight distribution of the variables inside some of the constructs that have been used before as control variables is not uniform, as shown in subchapter 2.1. Furthermore, the research approach by former scholars concerning the way that environmental stringency is measured differed greatly. For those reasons, this research considers five models to resolve these methodological issues, which are explained below.

Model 1

The first model is considered to be the 'normal' model, and utilizes flows of foreign direct investment across countries as the dependent variable, which is explained by the variance of the five constructs. This will give some sort of baseline result, and can provide an indication of the validity of the pollution haven hypothesis based on the influence of the environmental stringency construct.

Model 2

The second model: 'MEA based model' uses flows of foreign direct investment as the dependent variable, but a different construct for environmental stringency, namely a combination of the three earlier used variables (environmental tax, ISO certificates, and EPI Yale) and a summed score on the ratification of MEA's: ratification produces a 1 value, while no ratification produces a 0 value in the dataset. By combining these factors, the methodology of Zugravu and Ben Kheder and Smarzynska and Wei (2004) is replicated to some extent by using the ratification of MEA's as a proxy for the stringency of environmental policy. However, as the literature in chapter 2: Multilateral Environmental Agreements points out, the connection between MEA's and domestic environmental policy is clearly a chronological one: country's set their domestic policy to comply with the norms that MEA's dictate. Therefore, by comparing the results in the regression of the environmental stringency construct as well as the overall model fit an assessment can be made on the utility of including the score of MEA's in the environmental stringency construct.

Model 3

The third model: 'Components based model', utilizes flows of foreign direct investment as the dependent variable, but instead of the five constructs, it uses the retained components from the

principal component analysis to counter the weight factor's problem as discussed in chapter 2, paragraph 1. Because in earlier literature, the weight factors of the variables inside the constructs varied, this approach seeks to bypass that by using the retained components of the explanatory constructs, thereby eliminating the problem of how heavy each of the variables inside a construct should weigh. Because a qualitative (or theoretical) motivation on what the weight factors inside a construct should be can always be subjected to debate and doubt, including a statistical approach here would be a good point to start from in order to compensate to this issue.

Model 4

The fourth model: 'Exports based model', uses the same 'normal' five construct as the independent variables in the regression analysis, but as the dependent variable it uses export flows of chemical products to proxy for the location of industry. This is done because former research did not provide a systematic approach to the problem of how to proxy the location of industry. By showing the differences between this model and the first model (normal), a conclusion can be drawn on the methodological issue that former research wasn't able to solve before regarding the utility on using different dependent variables.

Model 5

The fifth model takes the results from the Cronbach's Alpha test into consideration. According to Cronbach's Alpha: Simple Definition, Use and Interpretation (2017), only constructs with an alpha score of higher than 0.7 can be retained. This means that the constructs that are used as the independent variables have to have some degree of internal consistency in order to be retained according to the test. When the tests were conducted on the constructs, it turned out that only the construct governance factors was internally consistent enough to be retained. Therefore, only governance factors is retained as a construct, and the other constructs are dissected, with only one variable to proxy for the construct.

Chapter 4: results

In this chapter, the results from the analysis in IBM's SPSS are displayed and discussed. It will have the following structure: first, a short description of the five models are presented. These five models are constructed in order to provide a proper answer to the research questions of this thesis: they will not only provide an indication of the likelihood of the presence of a pollution haven effect in the chemical industry, but will also shed light on the methodological issues that former studies haven't resolved. For example, the question whether the location of industry is reflected best in FDI flows or trade flows, the question of what elements the environmental stringency construct should contain, and the question of what weight factors to give to variables inside the constructs that act as control variables. After the description of the models, the results are displayed and discussed.

4.1: Influence of MEA's on environmental stringency

Not all MEA's correlate with the measure of environmental stringency. The table below shows differences between the prediction based on their contents and goals, and the correlation results with the environmental stringency construct.

MEA	Expected	Correlation	Significant
Responsible care	Low	0.096	No
Bamako	Moderate	0.005	No
Kyoto	Substantial	0.379	Yes
Basel	Low	0.07	No
2001 POP's	Weak at best	0.019	No
2013 Minamata	Moderately high	0.021	No
1999 Gothenburg	Severe	0.252	Yes
1998 POP's	Minimal	0.328	Yes
1998 Heavy metals	Modest	0.245	Yes
1994 Oslo	Severe	0.334	Yes
1991 VOC's	Extensive	0.393	Yes
1988 NOx	Considerable	0.305	Yes
1985 Helsinki	Considerable	0.213	Yes
1972 Stockholm	Modest	0.063	No

Table 2: differences between the effect of MEA's on environmental stringency, and the expected impact

The most surprising results from this analysis is the influence of The Aarhus Protocol on Persistent Organic Pollutants of 1998 and The Aarhus Protocol on Heavy Metals (1998), which turned out to have a bigger influence of environmental policy stringency than expected. What we can conclude from this is that for the case of the POP protocol, is that 'environmental focus' plays a larger role than expected. In particular, the influence of the POP banning protocol was expected to be minimal because it only banned the use and sales of those particular substances. However, this should be seen as 'governmental goodwill' regarding the environment. Moreover, regarding the heavy metals protocol, environmental performance is strongly linked to the ambient air quality, which can be heavily affected by the combustion of metal-contaminated fuels.

Expanding on the work of Zugravu and Ben Kheder (2008) who used 'some' MEA's as a part of their environmental stringency construct, this research maps the difference on the FDI flows by incorporating the MEA's in the environmental stringency construct as well. Specifically, the MEA's that turned out have a significant correlation with the construct in the first place: The Kyoto protocol (1997), The Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (1999), Aarhus Protocol on Persistent Organic Pollutants (1998), The Aarhus Protocol on Heavy Metals (1998), Oslo Protocol on Further Reduction of Sulphur Emissions (1994), The Protocol concerning the Control of Emissions of Volatile Organic Compounds (1991), The Nitrogen Oxide Protocol (1988), and the Helsinki Protocol on the reduction of sulfur emissions (1985). These are incorporated in the MEA based model, as a part of the environmental stringency construct.

4.2: Dissected model: Cronbach's Alpha test interpretation

As indicated by the results from the Cronbach alpha tests, the data isn't overly internally consistent. If we maintain the general standard of a minimum of 0.7 to maintain the construct, only the governance factors construct would suffice, as shown in the table below, displaying the constructs Cronbach's alpha test results.

Construct	Cronbach's Alpha test result
Market potential	0.622
Infrastructure	0.670
Environmental stringency	0.492
Factor cost	-0.745
Governance factors	0.914

Table 4: Cronbach's alpha tests on the constructs

According to Cronbach's Alpha: Simple Definition, Use and Interpretation (2017), a score higher than 0.7 would be acceptable in order to retain the construct. This would mean that only the alpha score of governance factors, which was 0.914, can be considered sufficient to retain the construct as a whole. In the same way, market potential is questionable, just as infrastructure. Environmental stringency and factor cost are poor, and therefore those four will not be retained as a whole in the 'dissected model'.

If we would follow the standard as shown in the table above, we can only retain the governance factors construct, because it has an alpha score higher than 0.7. The rest of the constructs have to be dissected, and cannot be used as a whole because of their low Cronbach alpha test score. This score was the lowest for the factor cost construct, which had an alpha score of -0.745, because of its coding (Ritter, 2010): because primary school completion and tax rate on commercial profits are generally speaking aspects of more developed countries, they together produce an alpha score of 0.427. However, since the factor cost construct is meant to express additional costs for the chemical firms, the inverse is taken of the primary school completion: when the availability of skilled labor is scarce, the wages will be higher.

Because of the results of the Cronbach's alpha tests, the constructs will be proxied in this model by only one variable. The variable chosen here is the one with the highest component loadings as shown in the principal component analysis in the previous chapter. In this sense, the certainty is increased of providing the correct proxy to the construct. These are GDP for market potential, fixed broadband subscriptions for infrastructure, the EPI for environmental stringency, the tax rate on commercial profits for factor cost, and as mentioned before, governance factors is retained as a whole.

4.3: Five regression models: overview

As explained before in chapter 3, paragraph 7: 'the five regression models', this research considers five different regression models, as shown in the list below. As discussed before, the FDI series across countries specified for the manufacture of chemical products, sampled by taking an average of as many years as possible is the dependent variable in this research. This variable is explained by the factors market potential (MRKTPOT), infrastructure (INFRA), governance factors (GOV), factor costs (FCTCST), and environmental stringency (ENVSTR). The conditions in order to do so are met: the variance in the dependent variable is explained by a linear sum of the construct multiplied by a (beta) coefficient). The linearity in the summation of the construct is reflected in the theoretical basis in which they are created. Moreover, any influence of such constructs other

than linearity is not apparent from past literature. Five models are created to deal with methodological issues:

1. The 'normal' model: uses FDI flows as the dependent variable and the five constructs as the independent variables
2. The 'MEA based model' uses FDI flows as the dependent variable as well, as well as the five other constructs as the independent variables, but in this case, the environmental stringency construct contains not only the formerly used environmental taxes, ISO certificates, and Yale's EPI, but a summed score of the ratified MEA's as well: because ratification is noted as a 1 value in the dataset (and not ratifying is noted as 0), a sum taken be taken to proxy a country's international efforts in environmentalism. Combining these four (normalized) variables creates a new MEA-incorporating environmental stringency construct
3. The 'PCA based model' uses FDI flows as the dependent variable, but uses the retained components from the principal component analysis as the independent variables. In this way, the issue of what the weight factors should be of the variables inside the constructs is resolved.
4. The 'export based model' uses exports as the dependent variable, and uses the 'normal' five constructs as the independent variables. With this comparison, a conclusion can be drawn on the importance of the choice of the dependent variable in the methodology of the pollution haven hypothesis.
5. The 'dissected model' uses FDI flows as the dependent variable, and uses only the governance factors as a retained construct. The other constructs are dissected and are reflected in only one variable of that particular construct because of their Cronbach's alpha score of lower than 0.7.

4.4: Regression analysis results

The models are entered into the regression analysis by using IBM's SPSS software. The results of the models and the influences of the construct expressed in their standardized beta coefficients in order to easily compare the constructs, and because the constructs were already normalized in order to deal with the different units inside the constructs, such as billion dollar GDP, and square kilometers land area. The results of the regression analyses are shown in the table below.

model	normal	MEA	PCA	export	dissected
R2	0.548	0.539	0.539	0.720	0.697
N	50	50	50	202	50
marketpot	0.513**	0.538**	0.580**	0.466**	0.831**
infra	0.412*	0.413*	0.255	0.252**	0.031
(infra2)			0.131		
envstr	-0.331*	-0.252	-0.195	0.233**	-0.002
fctcst	0.076	-0.124	-0.074	0.100	-0.041
gov	0.149	0.076	0.151	0.069	0.005
* means P<0.05, ** means P<0.01					

Table 3: regression results of the first four models

What the table above shows is that of all the different models, the 'exports' based model fitted the data the best: with an R squared value of 0.720, it produced a far better fit than the FDI based models. This is primarily caused by the far greater sample size in the exports based model (202 countries) versus only 50 in the FDI based models: when the exports dataset is reduced to the same 50 countries in the FDI based models, it produces only a slightly better fit: a R square value of 0.589. Only market potential and infrastructure play a significant role in that case.

As the table shows that across all models, market potential turned to be positive and significant factor. Infrastructure was significant and positive in all models except for the PCA based model, in which the retained components from the principal component analysis was retained to function as a proxy for the constructs' essence, and the dissected model, in which infrastructure was proxied by fixed broadband subscriptions alone. The environmental stringency construct had a negative influence in the FDI based models, but a positive influence in the exports based model.

Only in the exports based model and in the 'normal' model, it turned up statistically significant. This evidence is both in favor and against the pollution haven hypothesis.

Although the model fit as measured by its R squared value was higher for the export based model than in the FDI based models, this doesn't necessarily mean that the pollution haven hypothesis can be completely refuted for the chemical industry, but rather should be interpreted in a sense that the possibility of such effect is likely not very high, or the effect is not strong enough to produce robust results.

As for the factor cost and governance factors constructs, they did not turn up significant in any of the models, suggesting they play no role in the explanation in the variance of industry across countries.

If we compare the results on the environmental stringency construct, we can see that including the MEA's into the construct doesn't do the construct a lot of good: it shows a statistical insignificant effect, while the overall model fit (measured by R squared) only slightly increases. This is in line with the literature review on the subject, as presented in chapter 2: MEA's play a dictating role on domestic environmental policy, and are not a parallel force of domestic policy. This would suggest that in future research, MEA's should be considered to be an external driving force to domestic policy.

In order to check the normality of the residuals, the residuals of the normal model are saved as a new variable in SPSS when conducting the regression. Next, they are analyzed for their normality with the Kolmogorov-Smirnov test and the Shapiro-Wilk test. The test indicates a significance of 0.001 in the KS's P-value, and a P value of 0.000 for the Shapiro-Wilk Test, which would indicate that the residuals are not normally distributed.

Chapter 5: Conclusion and discussion

5.1: Conclusion

This chapter will present the conclusions that are drawn on the outcome of the analysis conducted with IBM's SPSS software. As mentioned before, the pollution haven hypothesis, as well as two methodological issues that former research indicated, are tested by using five different regression models.

The first model is considered the normal one, and uses FDI flows as the dependent variable, and the variance of the five constructs as the independent variables. The second model incorporates MEA's in the construct for environmental stringency. The third model uses the retained components of the principal component analysis as the intendent variables instead of the five constructs, thereby eliminating the issue of what the weight factors of the variables inside the constructs should be. The fourth model uses exports of chemical products as the dependent variable, and the five constructs as the independent variables, thereby creating a contrast between the two operationalizations of the location of chemical industry. The fifth model uses the variance of FDI flows as the dependent variable, and all the separate variables as the independent variables.

The results indicate that while the models were workable according to their ANOVA analysis and R squared values, the influence of the contested factor: environmental stringency was varying across sets: the construct turned up statistically significant in the exports based operationalization of the location of the chemical industry, but varying significance in the FDI based models.

Moreover, the overall model fits measured by the R squared values of the models wasn't particularly higher when FDI models were employed rather than exports based models. On the contrary, the exports based model produced a higher model fit, as measured by the R squared values. From these findings we have to reject the a-priori assumption that FDI work better than export based models in the research of the pollution haven hypothesis. However, when the exports based dataset was reduced to the same 50 countries as in the FDI dataset,

Moreover, from this we also have to conclude that the influence of environmental stringency is varying, so that would mean that if the stringency of environmental regulations of a country plays a role in the production location decision of chemical firms, it is probably not a fairly big one. Therefore, the answer to the main research question -

MQ: What is the effect of environmental stringency on the choice of production location across countries for the chemical industry?

- would be, a varying, and therefore an insignificant effect. This is taken from the varying sign and statistical influence of the ENVSTR construct.

Moreover, regarding the first sub question:

SQ1: What is the effect of environmental stringency on the chemical industry's strategic behavior when utilizing the formerly used instrument to proxy for production location (trade flows)?

The effect of environmental stringency even turns up statistically significant and positive. From this point, we can safely conclude that FDI doesn't work better in the explanation of the pollution haven hypothesis, and that environmental policy stringency doesn't play a noteworthy role in the settling behavior of the chemical industry. Concerning the second sub question:

SQ2: What is the effect of the ratification of international treaties concerning the environment on the target country's environmental policy stringency?

We can state that some of the MEA's (multilateral environmental agreements) are positively and significantly correlated with the construct of environmental policy stringency. Those MEA's are the following: The Kyoto protocol (1997), The Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (1999), Aarhus Protocol on Persistent Organic Pollutants (1998), The Aarhus Protocol on Heavy Metals (1998), Oslo Protocol on Further Reduction of Sulphur Emissions (1994), The Protocol concerning the Control of Emissions of Volatile Organic Compounds (1991), The Nitrogen Oxide Protocol (1988), and the Helsinki Protocol on the reduction of sulfur emissions (1985). It is good for governments to know that the ratification of MEA's doesn't necessarily hurt their businesses international competitiveness. In this way, larger steps can be taken to preserve the environment.

Concerning the control variables, we can safely conclude that a country's market potential plays the largest role in the attraction of foreign capital. Its result is robust across the five different models.

Concerning the construct of governance factors, we can conclude that, given the insignificant results of the construct governance factors, although positive in all models, doesn't play a noteworthy role in the attraction of foreign capital, as well as the location of industry when operationalized by utilizing trade flows.

Concerning the role of infrastructure, we cannot safely conclude its influence in investment decisions. Although the construct turned up positive in all analysis, it was not statistically significant all of them: in the results of the dissected model (individual variables) as well as the regression with the extracted components, its influence was not statistically significant. This

means that its role is questionable regarding its influence on the production location of the chemical industry, although it's plausible.

Regarding the influences of the factor cost construct, we can conclude that it doesn't play a noteworthy role in the production location of the chemical industry. This is based on its mixed signs and insignificance in all models.

Given this evidence, we can conclude that chemical industry is not likely to be affected heavily by stringent environmental policy. The pollution haven hypothesis, which claims a significant effect of environmental regulations in the settling behavior of polluting industry, even it is there, is not strong enough to produce robust results across the FDI samples, as well as the exports based model.

5.2: Discussion

Validity

Because of the industry focus in this research, the external validity of this research is not very high: it is meant to be optimized to match the chemical industry's characteristics. However, because the chemical industry is one of the most polluting industries, as well as relatively footloose, the pollution haven hypothesis should be easier to detect in this industry than in others. In this sense, the results of this research found solely for the chemical industry can function as a boundary condition for other industries: because the pollution haven hypothesis assumes costs imposed by stringent environmental regulations, the differences in comparative advantage between countries (which can induce an industry flight risk if costs are raised too much) will be the greatest in the most polluting sectors. This implies that the results obtained in this research can function as a worst case scenario, in the sense that other industries will only be effected less by the difference between levels of environmental stringency across countries.

Signs and significance

Although most of the results have the expected sign in the regression analysis, their significance varies a lot across datasets. As noted by Van Beers & Van Den Bergh (1997), the more variables that a construct contains, the less the significance. This would entail that more experimentation with different compositions of the construct could improve this research. It is suspected that the statistical insignificance of the governance factors construct across the five models has to do with the sample of the flows of FDI: a low score on governance factors would entail as well that the country in question is also not able to monitor and report on their industrial activities. Therefore, it is suspected that this doesn't affect the study's validity. The relatively more apparent constructs like market potential and infrastructure explain a great proportion of the variance in FDI, which is expected following earlier research and the theory in chapter two. The insignifance of the factor cost construct is a little different though. The analysis showed that when the two variables (inverse primary school completion rate and tax rate on commercial profits) were taken into the regression analysis separately, they did not turn up significant either. This could indicate that the relative contribution of labor costs and taxes on commercial profits is very small, or that the companies found a way around these issues, by for example hiring expats from other countries and therefore not needing the local workforce, or finding a way to make sure that the commercial profits aren't taxed in that country, by for example setting up licensing constructions of technologies with its holding. Perhaps the factor cost construct could be improved by including a measure of fuel costs, which were deemed relatively high for a subsector of the chemical industry

by Boulamanti and moya (2017). However, if they are produced in that country in question, a country's GDP should incorporate such factor: the gained wealth would contribute to the country's economy.

Normality of residuals

As mentioned at the end of the results chapter, the residuals are not normally distributed for the normal model. Although this cannot be confirmed, it is expected that this could be caused by three things. One possibility is that the linear regression equation that explains the variance of FDI by a sum of the constructs with their respective weight factors, is in fact not linear. Opening a random econometrics book on a random page shows the possibility that economic functions are rarely a simple linear equation, but rather a parametric function, or one with a power function or a logarithm to express the relation between variables. Another possibility is that the regression equation is missing one variable or construct, which could fill in the residuals in a way that it produces residuals which are normally distributed. Another possibility is that the assumption of perfect information is not correct. If the firms that operate within the chemical sector do not have perfect information about cost structures across countries (which are dependent on the country's market potential, infrastructure, environmental regulations, factor costs, and governance factors), they will not move their operations accordingly, which produces not normally distributed residuals in the regression, as well as a lower model fit.

Dependent variable

Considering the differences between FDI and exports as the dependent variable: not as expected, the results of using FDI were less precise, in terms of overall model fit. Chemicals were suspected to be subjected to more import and export regulations (probably even more than all other manufacturing products, because of their unique and sometimes dangerous properties), which could obscure the image of were exactly the industry is located. However, considering the better model fit of the exports based model, this is rejected. This would imply that for further research of the PHH in the chemical sector, it might be a better idea to proxy strategic behavior with exports rather than FDI flows. However, it could be the case that exports are "overstated" when considering an economy with many state owned enterprises: this would reduce flows of FDI, but that economy could still export a lot of its produced products. However, unusually this is only applicable to the most productive firms: because exports are subjected to lower sunk costs, but higher variable costs (due to the costs associated with transportation), one would need to produce at much lower costs at home in order to be competitive overseas, according to Melitz (2003).

MEA's

The results did show that some of the MEA's are a very good predictor of environmental stringency. Two MEA's were very different from the expected values: The Aarhus Protocol on Persistent Organic Pollutants of 1998 and The Aarhus Protocol on Heavy Metals (1998), which turned out to have a bigger influence of environmental policy stringency than expected. Checking for the ratification of the other MEA's can save managers or strategy coordinators in the chemical sector a lot of time and effort in order to find out which country to move operations to (all other things constant). Moreover, the identification of the role of MEA's will be useful for future scholars who either wish to pursue the pollution haven hypothesis, or similar subjects. However, it could be the case that because of the multilateral increase of environmental stringency caused by the ratification of MEA's, it would be ever more difficult to detect a systemic difference in strategic behavior of polluting sectors. If that would be the case, that would be bad news for PHH-enthusiasts, but good news for environmentalists.

Data availability

The experiment could be improved when somewhere in the future more data on FDI flows becomes available. The data set provided by the UNCTAD was far from complete, and consisted mostly out of developed countries. Perhaps more robust results on the subject could be obtained by examining more complete data. For example, the FDI based models only contained 50 entries of mostly developed countries while the exports based model contained 202 entries, and produced way more accurate results in terms of R squared values of the model fit.

Governance factors

Regarding the influence of governance factors which turned up insignificant in all models, it could be the case that this has to do with the sample of the dependent variable: when much data points for country's are missing, it could be the case that a factor such as 'regulatory quality' not only effects investment decisions by firms into the host country, but also the ability (and willingness) of the host country to report on- and monitor investments decisions and industrial activities.

Internal heterogeneity?

Because in this research the unit of analysis was the flow of capital on country level, as well as the market potential of a country, the infrastructure etc., we can never be certain if the data is in some way distorted at country level. For example, Millimet and List find evidence that would suggest that polluting industry moves away from stringent environmental regulations within a state, and move across counties. This means that the possibility of internal heterogeneity of the factor endowments within countries (per province for example) must be taken into account when interpreting the results. This research has not corrected for the degree of federalism, or even

confederalism (the ability of the most local forms of government such as counties or states to have more legislative authority than the central government). Therefore, there is always the possibility that polluting industry seeks to avoid stringent environmental regulations by moving to a different area within the home country's borders.

Findings in contrast with earlier work

The results of this study regarding the likelihood of the pollution haven hypothesis, go against the conclusions of the work of Cave and Blomquist (2008), Cole & Elliott (2005), Zugravu and Ben Kheder (2008), Martinez-Zarzoso, Vidovic and Voicu (2016), Wagner and Timmins (2009), Akbostanci and Türüt-Asik (2007), who find decisive evidence in favor of the pollution haven hypothesis.

Concerning the work of Cave and Blomquist (2008), who found evidence in EU inbound energy-intensive trade, but not for toxic intensive trade, could be based on industry differences. Although not all chemicals are considered to be toxic, it is much safer to say that most toxic intensive products are chemicals. In this way, their sector specific findings could be interpreted as being in line with the findings of this study.

Concerning the work of Cole & Elliott (2005), who found evidence in favor of the pollution haven hypothesis by studying outward FDI flows from the US to Mexico and Brazil, could be the result of the narrow scope of their research. Although the US doesn't appear in the top 10 of most stringent environmental regulations, it is still very much a developed country with relative unfavorable aspects of comparative advantage, such as high wages. High wages and low levels of environmental stringency are, according to the scholars, not something that is likely to occur in the same country. They control for almost any other factor that this research seeks to control for as well, but neglects the influence of governance factors, and use the PAOC data (pollution abatement and operating costs), which is self-reported to the US bureau of the census, as a measure of environmental stringency. This data is measured by one average of the 1989 -1994 period. So it could be the case that, because of the still developing network of MEA's to raise environmental stringency multilaterally, the countries such as Mexico and Brazil were much more favorable back then, and therefore a pollution haven effect could be detected. Another explanation could be that pollution havens only occur on a much smaller scale, such as in the case of the US and Mexico.

Concerning the work of Zugravu and Ben Kheder (2008), who found evidence of the pollution haven hypothesis in the variance of new plant openings by French firms, this could be the result of the host country they considered. If France could be considered by any measure as extremely

strict in environmental regulations, then finding evidence in favor of the PHH would be relatively easier than finding it based on a worldwide FDI inflow, or exports outflow.

Concerning the work of Martinez-Zarzoso, Vidovic and Voicu (2016), the evidence that they find in favor of the pollution haven hypothesis, could be similar to the results found by Cole and Elliott (2005). While Cole and Elliott focus on FDI flows between the US and Mexico and Brazil, the work of Martinez-Zarzoso, Vidovic and Voicu focusses on the trade flows within the European Union. The difference in environmental stringency here can be found between the original 15 EU countries, and the newly added east-European countries (CEEC's). It could be the distance that plays a role in the pollution haven hypothesis to occur in the first place.

Concerning the work of Wagner and Timmins (2009), who find evidence of the pollution haven hypothesis by studying sector specific outward FDI flows from Germany, that could by caused by the extreme high ranking of environmental stringency of Germany in the work of Cole and Elliott (2005). They report that the top 10 countries with the highest ranking of environmental stringency are: at the first place (most stringent environmental regulations): Switzerland, Germany, Sweden, Finland, Norway, the UK, Canada, Ireland, Austria, and at the 10th place Denmark. This ranking is based on the work of Eliste and Fredriksson's (2001) index of the stringency of environmental regulations. The second place in environmental stringency in Germany could be the main factor that produced their study's outcome.

Concerning the work of Akbostanci and Türüt-Asik (2007), who studied trade flows with Turkey in the 1994 – 1997 period, and find evidence in favor of the pollution haven hypothesis, this could be the result of the time period they researched. As mentioned before, with the ever increasing (multilateral) environmental regulations worldwide as the result of the MEA's and other forms of international coercion, larger differences in environmental stringency could disappear over time.

5.3: Recommendations for further research

By showing that coefficients of the environmental stringency construct is not significant across all models, and even significant and positive for the exports based model, is has shown that for the chemical industry, the pollution haven hypothesis must be refuted. By showing this for one of the most polluting sectors, as well as one of the most footloose (geographically mobile) ones, it is very likely that the effect of environmental policy stringency on a firms profitability and international competitiveness plays an even smaller role in less polluting sectors. In other words, given that in this sector the effect is very small, it is probably weaker or even non-existent in other sectors which are less pollution intensive.

Moreover, given this result, if scholars wish to continue the pursuit of the pollution haven hypothesis, they would probably get more accurate results by using trade flows as the dependent variable rather than FDI flows, as measured by the R-squared values of the model fits. Moreover, since the constructs such as market potential and infrastructure have shown to have a very strong effect on the firms' decisions to move to a certain country, it has shown to be essential to be incorporated into models as control factors. Because of the strong influence of both the market forces and adequate infrastructure, it might be worthwhile to focus more on the influence of the Environmental Kuznets Curve (EKC), which assumes that the level of a country's state of development positively influences its need for better environmental performance (Cole, 2004, Kearsley and Riddel, 2010). In this case, the level of development of a country can be (among other things) reflected by studying its market potential and infrastructure. One hurdle in researching this is the availability of data: the lower a country's level of development, the lower its ability to report and monitor its industrial activity. Moreover, multicollinearity statistics pointed out that governance factors, market potential, and infrastructure are not heavily related, which would indicate that the EKC is not very apparent in this industry.

This rather weak evidence regarding the pollution haven hypothesis doesn't directly mean that the complete opposite would be true: the so called Porter hypothesis, because it assumes innovation under financial penalizing of pollution. Firms could also be less inclined to innovate, and just settle for lower profit margins in the short term. The Porter hypothesis states that industry tends to innovate their processes more to meet stricter environmental criteria. However, in the model that has been established in this study, one probably wouldn't find evidence in favor of the Porter hypothesis simply by finding a positive and statistically significant effect of the environmental stringency construct: it wouldn't be the case that firms active in the chemical sector would willingly move to countries with a relatively higher score on the environmental stringency index in order to innovate their processes. Rather, one could see it as a higher propensity to remain operating in that country, and innovate their production processes accordingly.

With the increasingly higher standard of environmental awareness in that country, associated with higher production costs before innovating, the firm would be less hesitant to take on more ambitious environmental sustainability oriented innovation programs. However, if that would be the case, such considerations are shown more easily in the research setup as an in-depth case study for example. Another possibility would be to use PACE survey data if available (Pollution Abatement and Control Expenditures) to check exactly how much the firms suffer financially under more strict environmental regulations. If one could connect this to for example

environmental sustainability patent output, or another proxy for innovative endeavors by firms, one could check for the Porter hypothesis.

The theoretical framework regarding the concept of environmental stringency is expanded by showing the influence of MEA's in the establishment of domestic environmental policy. Moreover, by showing that exports work better as the dependent variable than FDI flows. This can provide a suggestion and be of help for future scholars in similar subjects.

So to conclude on this particular issue, I would recommend scholars to focus their efforts on the positive effects of environmental regulations on industry, because the evidence that the negative effects are strong enough to make industry move away are not strong enough seemingly. With the role of raising environmental standards unilaterally through the influence of MEA's, it is suspected that attaining evidence in favor of the PHH will only get more difficult in the future.

5.4: Policy recommendations

Although this research focusses solely on the chemical sector and therefore is limited in its external validity, I remain convinced that an industry specific study would be good benchmark in order to provide governments with proper policy recommendations regarding the tradeoff between environmental policy and economic (competitiveness) considerations. As mentioned before in the discussion, if the chemical industry is hardly affected by the pollution haven effect, than other industries which are less pollution intensive, will be affected even less, and will be less of an industry flight risk under more stringent environmental regulations. This is under the assumption that if policy is established regarding pollution control while maintaining an eye for economic effects such employment, tax revenues and economic output with the chemical industry as a boundary condition, the possibility of firms in other manufacturing sectors leaving the home country in search for less stringent environmental regulations would be far less likely. However, using the chemical industry as a boundary condition for environmental policy, considering the chemical industry's pollution intensity, will hurt the industry relatively more than other industries of course.

On the other hand, this study used a 'snapshot' of the chemical industry in 2016. Therefore, the conclusions of this research shouldn't encourage policy makers to pursue making environmental policy evermore strict; rather it is just that at this level (2016 data), they are not causing industry to move away at a significant rate as shown in the analysis. In the long run, technologies ought to grow in their environmental performance, which enables the country's environmental policies to grow with them. This means that governments should double down on best practice initiatives by the sector: if all can use the same 'green' technologies, they should, and this should be promoted

by governments in the form of subsidies if necessary. With best practices exchanged in the industrial community, and a more level playing field regarding different levels of environmental stringency across countries, countries will decrease the industry flight risk. However, if governments seek to grow their environmental policy, this should occur simultaneously with the industry. This means that more contact between the two parties and close monitoring will be helpful to the correct implementation of such long term plans.

If increasing environmental performance is required in order to reach certain environmental performance goals, then the most suitable approach would be to lobby internationally for more multilateral environmental agreements. By incorporating more and more countries into these MEA's, no single country can give industry the benefit (economically speaking) of becoming a pollution haven. This can only be achieved by international cooperation, and expanding on the work of the already established MEA's. This could be achieved by developing closer links between trade organizations such the WTO, and the MEA producing institutions such as the UNDP (UN Development Program).

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Appendix I: data sources

Construct	Variable	Source	Link
Market potential	Population 2015	The World Bank	https://data.worldbank.org/indicator/SP.POP.TOTL
Market potential	Land area 2015	The World Bank	http://data.worldbank.org/indicator/AG.LND.TOTL.K2?view=chart
Market potential	GDP 2015	The World Bank	http://data.worldbank.org/indicator/NY.GDP.MKTP.CD
Infrastructure	Fixed broadband subscriptions per 100 people 2015	The World Bank	https://data.worldbank.org/indicator/IT.NET.BBND.P2
Infrastructure	Individuals using the internet (% of the population) 2015	The World Bank	https://data.worldbank.org/indicator/IT.NET.USER.ZS
Infrastructure	Liner shipping connectivity index 2016	The World Bank	https://data.worldbank.org/indicator/IS.SHP.GCNW.XQ
Infrastructure	Mobile cellular subscriptions per 100 people 2015	The World Bank	https://data.worldbank.org/indicator/IT.CEL.SETS.P2
Infrastructure	Quality of port infrastructure 2016	The World Bank	https://data.worldbank.org/indicator/IQ.WEF.PORT.XQ
Infrastructure	Rail lines total km's 2015	The World Bank	https://data.worldbank.org/indicator/IS.RRS.TOTL.KM
Environmental stringency index	ISO14001 certificates per country (most recent)	ISO	http://isotc.iso.org/livelink/livelink?func=ll&objId=18808210&objAction=Open&nexturl=%2Flivelink%2Flivelink%3Ffunc%3Dll%26objId%3

			D18808772%26obj Action%3Dbrowse%26 viewType%3D1
Environmental stringency index	Market share (%) of leaded gasoline 1992-1996	The New Zealand digital library	http://www.nzdl.org/gsdlmod?e= d-00000-00---off-0envl--00-0---- 0-10-0---0---0direct-10---4------- 0-1l--11-en-50---20-about---00 -0-1-00-0--4----0-0-11-10-0ut fZz-8-00&a=d&c=envl&cl=CL1.7&d =HASH015033a1eb95f875e7 16a2ca.6.4.6#HASH015033 a1eb95f875e716a2ca.6.4.6
Environmental stringency index	Maximum concentration of lead in gasoline (g/L) 1992 - 1996		
Environmental stringency index	Environmentally related tax revenues as a share of the country's GDP 2014	OECD	http://www.oecd.org/env/tools-evaluation/environmentaltaxation.htm
Environmental stringency index	Environmentally related tax revenues per capita 2014		
Environmental stringency index	EPI Yale 2016	Yale	http://epi.yale.edu/sites/ default/files/2016_epi_ framework_indicator_ scores_friendly.xls
Factor costs	Primary school completion rate (% of the relevant age group) 2015	The World Bank	https://data.worldbank.org/ indicator/SE.PRM.CMPT.ZS
Factor costs	Total tax rate of commercial profits 2015	The World Bank	https://data.worldbank.org /indicator/IC.TAX.TOTL.CP.ZS

Governance factors	Corruption 2015	The World Bank	http://info.worldbank.org/ governance/wgi/#home
Governance factors	Political stability 2015		
Governance factors	Regulatory quality 2015		
FDI (chemical sector)	FDI	UNCTAD email	By Astrit Sulstarova
Exports (chemical sector)	Exports	OECD	https://stats.oecd.org/Index.aspx?

Table 6: data sources

Appendix II: Other descriptive statistics on the variables

This paragraph will present other descriptive statistics on the variables, besides the PCA provided in the paragraph above. This paragraph will contain three elements for each of the five constructs which are suspected to influence the investment locations in the chemical industry: a table showing the Pearson's correlations between the variables inside a construct, followed by a description of the variables that are inside the constructs, including the variable's range, standard deviation, etcetera, and finally the results from the Cronbach's alpha test.

Market potential

The correlation table shown below displays the correlations between the variables that the construct of market potential contains, as provided by SPSS.

		Zscore: pop(total) 2015	Zscore: Land area (sq. km)(2015)	Zscore: gdp (current us$)2015
Zscore: population 2015	Pearson Correlation	1	.306*	.303*
	Sig. (2-tailed)		0.031	0.032
	N	50	50	50
Zscore: Land area (sq. km)(2015)	Pearson Correlation	.306*	1	.455**
	Sig. (2-tailed)	0.031		0.001
	N	50	50	50
Zscore: GDP(current us$) 2015	Pearson Correlation	.303*	.455**	1
	Sig. (2-tailed)	0.032	0.001	
	N	50	50	50

Table 7: correlations between variables in the market potential construct

What this correlation table clearly shows is that the variables inside the construct are positively correlated with each other. However, this should not be a problem in the analysis, because each of them captures a very different aspect of market potential.

Descriptive Statistics						
Variable	N	Range	Minimum	Maximum	Mean	SD
pop(total)2015	50	1.3E+09	330823	1.3E+09	6.9E+07	1.9E+08
Land area (sq. km)(2015)	50	1.6E+07	2590	1.6E+07	1120559	2844131
gdp (current us$)2015	50	1.8E+13	1E+10	1.8E+13	9.8E+11	2.6E+12

Table 8: descriptive statisitcs

The constructs' internal consistency is evaluated by using the Cronbach's alpha test on the normalized variables.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.622	0.622	3

Table 9: Cronbach's alpha test

The score of 0.622 gives a value to the internally consistent variance if a composite would be taken from the three variables. The fact that the Cronbach's Alpha score is the same as the standardized value is that the test was conducted on the already standardized variables because they all operated on a different scale; for example, 'GDP' was measured in dollars, while 'land area' was measured in kilometers. If taken from the unstandardized values, the Cronbach's Alpha (normal) score was 6.694 * 10-5. From the score of 62% we should take that the construct is viable in the regression.

Infrastructure

The figure below shows the correlation between the variables that encompass the construct of infrastructure.

		Zscore: Fixed broadband subscriptions (per 100 people) 2015	Zscore: Individuals using the Internet (% of population) 2015	Zscore: Liner shipping connectivity index 2016	Zscore: Mobile cellular subscriptions (per 100 people) 2015	Zscore: Quality of port infrastructure 2016	Zscore: Rail lines (total route-km)
Zscore: Fixed broadband subscriptions (per 100 people) 2015	Pearson Correlation	1	.822**	.346**	.357**	.539**	-.200**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.004
	N	202	202	202	202	202	202
Zscore: Individuals using the Internet (% of population) 2015	Pearson Correlation	.822**	1	.335**	.532**	.566**	-.235**
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.001
	N	202	202	202	202	202	202
Zscore: Liner shipping connectivity index 2016	Pearson Correlation	.346**	.335**	1	.231**	.419**	-.191**
	Sig. (2-tailed)	0.000	0.000		0.001	0.000	0.006
	N	202	202	202	202	202	202
Zscore: Mobile cellular subscriptions (per 100 people) 2015	Pearson Correlation	.357**	.532**	.231**	1	.309**	-.153*
	Sig. (2-tailed)	0.000	0.000	0.001		0.000	0.029
	N	202	202	202	202	202	202
Zscore: Quality of port infrastructure 2016	Pearson Correlation	.539**	.566**	.419**	.309**	1	-0.115
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.102
	N	202	202	202	202	202	202
Zscore: Rail lines (total route-km)	Pearson Correlation	-.200**	-.235**	-.191**	-.153*	-0.115	1
	Sig. (2-tailed)	0.004	0.001	0.006	0.029	0.102	
	N	202	202	202	202	202	202

Table 10: correlation between normalized variables in the infrastructure construct

What this shows is that the variables inside the construct are strongly correlated with each other. Although not everyone, but most of the normalized variables are also positively correlated. What this means for the analysis, is that caution must be taken to make sure that not all the variables measure the same thing. I have tried to take this into account by measuring different aspects of a developed infrastructure in a country: IT infrastructure, port-, and railroad infrastructures. If

infrastructure turns up to have an insignificant effect in the analysis, it might not be bad idea to drop a few variables in order to combat that.

Descriptive Statistics						
	N	Range	Minimum	Maximum	Mean	SD
Fixed broadband subs (per 100 people) 2015	50	40.777	0.9531	41.7301	21.7844	11.5101
Individuals using the Internet (% of population)2015	50	80.2	18	98.2	67.8769	18.4838
Liner shipping connectivity index 2016	50	111.99	3.62	115.61	40.1716	28.8689
Mobile cellular subscriptions (per 100 people)2015	50	93.293	66.9166	160.21	122.471	21.8513
Quality of port infrastructure 2016	50	4.8	2	6.8	4.33131	1.12316
Rail lines (total route-km)	50	227535	683	228218	26914.3	41161.1

Table 11, descriptive statistics of the variables in the infrastructure construct

The constructs internal consistency is evaluated by using the Cronbach's alpha test on the normalized variables.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.670	0.670	6

Table 12: Cronbach's Alpha test

That means that 67% of the variability of the composite score (the construct) of the variables could be considered internally consistent reliable variance. From this we should take that the construct as a whole is workable in the regression.

Environmental stringency

The table below shows the correlation between the variables inside the environmental stringency construct, provided by the SPSS software.

		Zscore Inverse marketshare of leaded gas 1992-1996	Zscore Inverse maximum concentration lead in gas (g/L) 1992-1996	Zscore: Environmentally related tax revenue per inhabitant ($) 2014	Zscore: EPI yale	Zscore: iso14001 certificates
Zscore Inverse marketshare of leaded gas 1992-1996	Pearson Correlation	1	.541**	0.105	.411**	0.184
	Sig. (2-tailed)		0	0.467	0.003	0.201
	N	50	50	50	50	50
Zscore Inverse maximum concentration lead in gas (g/L) 1992-1996	Pearson Correlation	.541**	1	0.184	.283*	0.234
	Sig. (2-tailed)	0		0.2	0.046	0.102
	N	50	50	50	50	50
Zscore: Environmentally related tax revenue per inhabitant ($) 2014	Pearson Correlation	0.105	0.184	1	.437**	0.109
	Sig. (2-tailed)	0.467	0.2		0.002	0.45
	N	50	50	50	50	50
Zscore: EPI yale	Pearson Correlation	.411**	.283*	.437**	1	0.186
	Sig. (2-tailed)	0.003	0.046	0.002		0.197
	N	50	50	50	50	50
Zscore: iso14001 certificates	Pearson Correlation	0.184	0.234	0.109	0.186	1
	Sig. (2-tailed)	0.201	0.102	0.45	0.197	
	N	50	50	50	50	50

Table 13: correlation of variables in the environmental stringency construct

The correlation table shows some interesting things inside the construct. As one could expect, is the market share of leaded gasoline and the maximum concentration of lead in gasoline negatively correlated with environmental tax revenue (per capita, not per $ GDP). This would mean that when environmental standards are lower, the lead content in the atmosphere is higher, and environmental tax revenue is lower, as shown by the significant and negative correlation in B5

and C5. The same reasoning applies to the Yale environmental performance index (EPI), as shown in B6 and C6. Moreover, it's good to see that the EPI correlates positively and significantly with the ISO certificates, which both would indicate a higher level of environmental awareness. If the analysis would require the construct to be further distilled, it could be a good idea to drop the environmental tax revenue per dollar GDP, since it correlates strongly with the environmental tax revenue per capita, but not very strongly and significantly with the other variables.

Descriptive Statistics						
	N	Range	Minimum	Maximum	Mean	SD
Environmentally related tax revenue per inhabitant (US$) 2014	50	1717.52	9.0186	1726.54	606.373	319.003
EPI yale	50	39.26	51.42	90.68	79.4694	8.76326
iso14001 certificates	50	40635	2	40637	3719.24	8842.08

Table 14, descriptive statistics

The construct's internal consistency is evaluated by using the Cronbach's alpha test on the normalized variables.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.492	0.492	3

Table 15: Cronbach's Alpha test

That means that 49% of the variability of the composite score (the construct) of the variables could be considered internally consistent reliable variance. From this we should take that the construct as a whole is workable in the regression.

Factor cost

The table below shows the correlations between the variables that the construct contains.

		Zscore: inverse primary school completion rate 2015	Zscore: Total tax rate of commercial profits 2015
Zscore: inverse primary school completion rate 2015	Pearson Correlation	1	-0.271
	Sig. (2-tailed)		0.057
	N	50	50
Zscore: Total tax rate of commercial profits 2015	Pearson Correlation	-0.271	1
	Sig. (2-tailed)	0.057	
	N	50	50

Table 16: results from SPSS on the factor costs variables

The results from SPSS are a little bit counter intuitive: one would expect that primary school compeltion rate (thereby the access to higher qualified labor) would be higher in a developed country, and that a more developed country could permit higher commercial tax rates, because its developed status and internal market would attract capital sufficiently. Given this result, extra caution must be taken when utilzing the factor costs as a construct as a whole.

Descriptive Statistics						
	N	Range	Minimum	Maximum	Mean	SD
NOTprimary school completionrate	50	39.28	0.99	40.27	15.6965	6.55206
Total tax rate (% of commercial profits)2015	50	124.6	13	137.6	45.136	19.1684

Table 17: descriptive statistics

The construct's internal consistency is evaluated by using the Cronbach's alpha test on the normalized variables.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
-0.745	-0.745	2

Table 18: Cronbach's alpha test

This means that the composite score (the construct) of the variables could be considered internally inconsistent, and thereby unreliable as a construct. This would indicate that the construct as a composite is more or less useless, and the variables that it contains should be treated sepeartly, if not dropped completely. This could have been anticipated because of what the variables mean in reality: when tax rates are high, as well as when (almost) no human capital is available (not-primary school completion), a firm would face less operational profits. However, one could expect that a country which is meager endowed in human capital, would rather decrease its profit taxes to attract at least some business from abroad. This incongruence resulted into a low internal consistency as displayed by the Cronbach's Alpha test. Although they clearly do not combine properly, I still believe that the factors such as the availability of human capital as well as the total tax rate on commercial profits play a noteworthy role in the elucidation of variance in FDI across countries, and therefore the variables will be taken seperatly in the analysis.

Governance factors

The table shown below will display the correlations between the variables that the construct of governance factors contains.

		Zscore: stability	Zscore: regulatory quality	Zscore: corruption
Zscore: stability	Pearson Correlation	1	.713**	.755**
	Sig. (2-tailed)		0	0
	N	50	50	50
Zscore: regulatory quality	Pearson Correlation	.713**	1	.873**
	Sig. (2-tailed)	0		0
	N	50	50	50
Zscore: corruption	Pearson Correlation	.755**	.873**	1
	Sig. (2-tailed)	0	0	
	N	50	50	50

Table 19: correlation table of the variables that the governance construct contains

What this table shows, as one could expect, is that the variables inside the construct correlate very, very strongly with each other. Therefore, if the construct would turn up insignifcant in the analysis, it might be a good idea to just use one of them to proxy for the construct, instead of combining the three.

It could be the case that the very small and insignificant influence of the governance variable is because the sample. If extremely corrupt countries don't provide FDI or exports data (very possible), the construct only evaluates countries with good governance variables, which may be correlated with large markets.

Descriptive Statistics						
	N	Range	Minimum	Maximum	Mean	SD
stab, est	50	3.95203	-2.5441	1.40797	0.05483	0.87746
regQ,est	50	3.68617	-1.8577	1.82846	0.50974	0.87506
corr,est	50	3.61179	-1.3283	2.28353	0.33228	0.9818

Table 20, descriptive statistics

The construct's internal consistency is evaluated by using the Cronbach's alpha test on the normalized variables.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.914	0.914	3

Table 21: Cronbach's alpha test

That means that 91% of the variability of the composite score (the construct) of the variables could be considered internally consistent reliable variance. From this we should take that the construct as a whole is workable in the regression.

Appendix III: literature overview

Study	Methodology	Dependent variable	Control factors	Result regarding PHH
Bommer (1999)	Theoretical	political support	innovation	positive
Al-Mulali & Tang (2013)	Empirical	emissions	FDI, energy consumption, output, GDP,	negative
Akbostanci, Tunc & Turut-Asik (2007)	Empirical	exports	pollution intensity, terms of trade, exchange rate, foreign income, Herfindahl index	positive
Cole, Elliott & Fredriksson (2006)	Theoretical & empirical	environmental stringency	FDI, corruption, manufacturing share, GDP	reverse PHH positive
Ederington, Levinson & Minier (2005)	Empirical	imports	environmental stringency, duties, factor intensity	negative
Millimet & List (2004)	Empirical	New plant openings	environmental stringency, manufacturing employment, wages, employment rates, population	negative
He (2006)	Empirical	Emissions	FDI, labor cost, economic growth	negative

Wagner & Timmins (2009)	Empirical	German outward FDI	environmental stringency, GDP, distance, infrastructure, governance factors, exchange rate, corporate income tax, land area, literacy rates	only positive for the chemical industry
Martínez-Zarzoso, Vidovic & Voicu (2016)	Empirical	trade flows	environmental stringency, GDP	
Dietzenbacher & Mukhopadhyay (2007)	Empirical	emissions	imports and exports, pollution intensity	negative
Bilbao-Ubillos & Camino-Beldarrain (2008)	Theoretical	industrial concentration	wages, labor skill level, distance, market potential	n/a
Study	Methodology	Dependent variable	Control factors	Result regarding PHH
Zeng & Zhao (2009)	Theoretical	industry relocation	pollution intensity, environmental stringency, pollution externalities, wages, GDP	negative

Zugravu & Ben Kheder (2008)	Empirical	New plant openings	market potential, total factor productivity, factor intensity, environmental stringency, governance factors	positive
Cole & Elliott (2005)	Empirical	US outward FDI	factor intensity, PAC, market potential, transport costs, wages, labor skill level, trade openness	positive
Cole & Fredriksson (2009)	Theoretical & empirical	environmental policy stringency	FDI, governance factors	reverse PHH positive
Kearsley & Riddel (2010)	Empirical	trade flows	emissions, EKC	negative
Cave & Blomquist (2008)	Empirical	trade flows	pollution intensity, environmental stringency	
Brunnermeier & Levinson (2004)	Review	n/a	Unobserved hetrogenity, endogenous environmental policy	n/a
Barry & Walsh (2008)	Review	n/a	Sectoral relation, skill level workers, labor market	n/a
Pennings & Sleuwaegen (2000)	Theoretical	industrial relocation	labor intensity, market potential, openess, global networks	n/a

Van Beers & van den Bergh (1997)	Empirical	trade flows	GDP, population, distance, EU/EFTA membership, land area, environmental stringency	negative
Malm (2012)	Empirical	industrial relocation	Consumption, energy consumption, emission, labor	only positive for labor
Wen (2004)	Empirical	industry concentration	natural resources, footlooseness	only positive for the control factors

Appendix IV: MEA's overview

MEA's overview

The following paragraphs will describe multiple MEA's in an attempt to provide an overview of their goals and to determine to which extent these MEA's will influence domestic environmental policy and as an extension, the chemical industry. Congleton (2001) provided a substantive overview of all treaties, even though some are not relevant for this research paper, so some of these will be taken out.

The Stockholm action plan for the human environment in 1972

In Stockholm, Sweden, from 5 to 16 June in 1972 the conference was held (Momtaz, 1996). 113 countries took part in the discussions and signed the treaty (Report of the United Nations conference on the human environment, A/CONF.48/14/rev1). The conference resulted in 109 general, and nonbinding recommendations for an environmental policy action plan. Although it didn't yield any strict policy obligations, the countries participating here showed their intentions of keeping industry in check in order to protect the environment. In other words, it didn't yield any 'hard' policies, but did promote awareness and change in countries' attitudes (Seyfang, 2003). Because of this, the impact of this particular MEA on domestic environmental policy is expected to be modest.

The Helsinki Protocol on the reduction of sulfur emissions (1985)

The Helsinki Protocol on the reduction of sulfur emissions (1985) was the first product of the Convention on Long-Range Transboundary Air Pollution (LRTAP) in 1979. It was signed and ratified by 25 countries. The protocol mandated the reduction of sulfur emissions by 30% of their 1980 levels as soon as possible (Protocol on the Reduction of Sulphur Emissions, n.d.). Sulfur emissions are a common feature of the combustion of any fossil fuels, be it for heating, electiricty, or transport. The "hard" target of a 30% reduction of 1980 levels would cause countries to take corresponding domestic policy actions. Therefore, I assume the influence of this protocol on the countries' affiliated environmental policy stringency to be considerable.

The Nitrogen Oxide Protocol (1988)

The Nitrogen Oxide Protocol (1988) was the second protocol produced by the Convention on Long Range Transboundary Air Pollution and was ratified by 25 countries. The main objective of the protocol is to reduce NOx emissions as well as their transboundary fluxes to 1987 levels, and to exchange knowledge on how to do so (Summary of the treaty, NOx protocol, n.d.). The main source

of NOx emissions are again the combustion of fossil fuels. Because of the quantified (be it relative) target, and the numerous sources, the effects of this protocol to be considerable as well.

Volatile Organic Compounds Protocol (1991)

The Protocol concerning the Control of Emissions of Volatile Organic Compounds (1991) was the third product of the Convention on Long Range Transboundary Air Pollutants and was ratified by 16 countries, mostly European. Its main objective was to reduce volatile organic compounds (VOC's), a particular class of air pollutants. This was achieved by providing the associated countries with three options: a 30% reduction by 1999 by using a year from 1984 to 1990 as basis, a reduction to a certain absolute limit, or the stabilization by 1990 if the levels were not exceeded in 1988 (Protocol concerning the Control of Emissions of Volatile Organic Compounds, n.d.). The term VOC encompasses many compounds, but most are alkanes, alkenes or aromatic hydrocarbons like benzene or toluene (Protocol to the 1979 convention on long range transboundary air pollution concerning the control of emissions of volatile organic compounds or their transboundary fluxes, n.d.). Many of these are used either as solvents, or are released when combusting fossil fuels or waste. Because of the quantitative target, as well as the strong sectoral dependence of the sources, the effects of this protocol on the countries' environmental stringency is expected to be extensive.

Oslo Protocol on Further Reduction of Sulphur Emissions (1994)

The Oslo Protocol on further reduction of sulphur emissions was the fourth protocol to the Geneva Convention on Long Range Transboundary Air Pollution in 1979, which was ratified by 29 countries. The protocol builds on the first protocol of the LRTAP convention: the Helsinki protocol on the reduction of sulphur emissions (1985), which main goal was to reduce sulphur emissions by 30% of their 1980 levels (Protocol on Further Reduction of Sulphur Emissions, n.d.). The Oslo Protocol takes this a step further, by forcing the ratifying countries to commit to a strong emission ceiling by slowly increasing the mandated reductions, coming to a peak in 2010 (Protocol to the 1979 convention on long range transboundary air pollution on further reduction of Sulphur emissions, n.d.). At that point, the countries have to have their emission standards in order, and maintain these levels in the future. It is because of this extension of the initial plan, it is expected that the impact of this protocol on the countries' domestic environmental stringency will be severe.

The Aarhus Protocol on Heavy Metals (1998)

The Aarhus Protocol on heavy metals was the fifth protocol to the Geneva Convention on Long Range Transboundary Air Pollution in 1979. It was ratified by 34 countries, which were mostly European but included Canada, the US, and the UK as well (Stats and summary of the Protocol to

the 1979 Convention on Long-Range Transboundary Air Pollution on Heavy Metals, October 3, 2017). Its main goal was to decrease emissions from heavy metals, especially three metals which are deemed to be extremely harmful to human health and the environment: cadmium, lead, and mercury (The 1998 Aarhus Protocol on Heavy Metals, n.d.). If inhaled, heavy metal fumes can cause brain damage, and irritation to the eyes and respiratory system, according to the full text of the full text of the protocol (n.d.). Quantitatively, the countries who ratified the protocol vowed to reduce their emissions to their respective 1990 levels. Considering the narrow scope of this protocol, the impact on domestic environmental policy is expected to be modest.

Aarhus Protocol on Persistent Organic Pollutants (1998)

The Aarhus Protocol on Persistent Organic Pollutants of 1998 was the sixth protocol to the Geneva Convention on Long Range Transboundary Air Pollution in 1979. It was ratified by 33 countries, which were mostly European (Stats of the Protocol on Persistent Organic Pollutants (POPs), May 14, 2012). Its main goal was to eliminate the emissions or usage in general of 16 specific substances: 11 pesticides, 2 industrial chemicals and 3 contaminants (The 1998 Aarhus Protocol on Persistent Organic Pollutants (POPs), n.d.). This would have to be achieved by a total ban on the sales and the usage of these products (annex 1, 24). The list of banned substances was amended in 2009 with 7 new compounds, 5 of them being chemical (by) products and 2 flame repellants. Because the protocol just ensures a ban on these products in particular, the effect of the protocol on the countries' environmental stringency is expected to be minimal.

The Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (1999)

The 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone was the seventh and final protocol to LRTAP convention in Geneva in 1979. By setting emission ceilings for Sulphur, nitrogen oxides, ammonia, and Volatile Organic Compounds (VOC's) (Protocol to the 1979 convention on long range transboundary air pollution to abate acidification, eutrophication and ground level ozone, n.d.), it builds on the Helsinki Protocol on the reduction of Sulphur emissions (1985), the Nitrogen Oxide protocol (1988), and the Volatile Organic Compounds protocol (1991) as described in the previous paragraphs (Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, n.d.). It was ratified by 24 countries, which were mostly European but included the United States as well (Status of the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, May 24th, 2012). Because of the far reach of this protocol, as well as the ambitious, stacking-wise approach of emission reductions, the effect of this protocol on the countries' environmental stringency is expected to be severe.

Minamata Convention on Mercury (2013)

The Minamata Convention on Mercury in 2013 was a global convention with the primary aim to decrease mercury emissions worldwide. It proposed not only a phase-out on the use of mercury in some products, but it covered the whole value chain of mercury as well, like the ban on creating new mercury mines, a phase out of the existing mines, and a decrease in mercury emissions (The Minamata Convention on Mercury, n.d.). Taking into account that the convention doesn't just provide a plan for the reduction of emissions, but targets the whole mercury value chain and provides a plan for financial and technical aid would increase its effectiveness. Therefore, the impact of the Minamata convention on countries' environmental stringency is expected to be moderately high.

Stockholm Convention on Persistent Organic Pollutants (2001)

The Stockholm Convention on Persistent Organic Pollutants in 2001 was a major global MEA for the reduction and ban on certain organic pollutants (Overview of the Stockholm convention, n.d.). The list substances that the convention aims to control is almost entirely the same as the POP's that the Aarhus Protocol already covered, but for only European countries (Convention text of the Stockholm convention, n.d.). The Stockholm convention has been ratified by a staggering 181 countries all over the world (Status of ratification of the Stockholm convention, n.d.). This is of course a great result for a MEA, but for the identification of its relative impact on domestic policy, it is not so good, because there are almost no differences across countries. Therefore, its impact on domestic environmental policy is expected to be weak at best.

Vienna convention on protection of the Ozone layer (1985)

The Vienna convention on protection of the ozone layer (adopted in 1985) was the first convention to be ratified universally. Its main objective was to promote cooperation in monitoring, research and development concerning the effects of humans on the ozone layer (The Vienna Convention for the Protection of the Ozone Layer, n.d., Momtaz, 1996). Because of its universal ratification (Status of ratification of multiple conventions, n.d.) in addition to its non-binding objectives, the Vienna convention itself will not be adopted into the dataset because its relative influence on domestic policy cannot be visualized.

The Montreal Protocol (1987)

The Montreal protocol of 1987 was the product of the Vienna convention which was adopted two years earlier. Its main goal was to reduce the human influences on the ozone layer by mandating strict emission cuts (50%) of 8 chemicals which are deemed to have the most influence on the ozone layer (An introduction to the Montreal Protocol, n.d.). Most of them were

chlorofluorocarbons (CFC's), a chemical commonly used as refrigerants. Because it is just a ban on the sales and use of certain chemicals, this protocol will not be included in the analysis, for it will not show a relatively environmental stringency increase in countries who ratified it because of the considerations mentioned above.

The Basel convention on the control of transboundary movements of hazardous wastes and their disposal (1989)

The Basel convention of 1989 was the result of growing environmental awareness in first world countries (mostly European) after the 1970's. The increase of industrialization of this period came with a heightened environmental focus. First world countries deemed it to be undesirable to have waste disposal in their own countries, and sought to transfer this externality to third world countries, following a NIMBY line of thought (Overview of the Basel convention, n.d.). Instead of formulating a mechanism that would identify substances as hazardous wastes, the convention listed a numerable amount of substances which are to be controlled. Among them, many chemicals, thereby creating a heavy impact on the downstream chemical sector and waste trading sector (Text and Annexes of the Basel convention, n.d.). Considering the fact that almost every country ratified the convention, except for the US, and the US having a similar mechanism in place under the RCRA, the relative effects of ratification on countries environmental stringency is expected to be low.

Kyoto protocol to the convention on climate change (1997)

The Kyoto Protocol was adopted during the third meeting of the UNFCCC in Kyoto, Japan in 1997 (Status of Ratification of the Kyoto Protocol, n.d.). The protocol's main objective was to combat global warming by controlling emissions, and particularly the emissions from developed countries, rather than developing countries (The Kyoto protocol, n.d.). That is specifically, the emissions of carbon dioxide, methane, nitrous oxide, hydrofluorcarbons, and Sulphur hexafluoride (Kyoto Protocol to the United Nations framework convention on climate change, n.d.). The Protocol was a great success, and was ratified by almost every country, except a few. The protocol focusses on particular sectors: the energy sector, the industrial sector (the chemical industry is included here), solvents and other products, the agricultural sector, and the waste sector according to Annex A of the protocol. Because of these particular emissions and sectors, the impact on the countries environmental policy is expected to be substantial.

The Earth Summit 2002, Johannesburg

According to Seyfang 2003, the key product of the Earth Summit 2002 was the declaration on Sustainable Development. However, when seen in contrast with other conventions that took place before it, it was basically a confirmation on commitments that were made in prior conventions,

without adding stringent or crucial elements, because a lack of political willpower. Because no real new commitments were made, as well as the marginal influence in further conventions, this convention will not be part of the analysis.

Bamako convention (1998)

The Bamako convention was Africa's response in 1998 to some failures of the Basel convention (on the movements of hazardous waste). They found that the convention still allowed for the multilateral trade agreements of hazardous waste, even if those respective countries would provide their consent. This resulted in the shipment of hazardous waste to African countries (The Bamako Convention, Environmental Governance, n.d.). The effect of the convention on the ratifying countries'' environmental stringency is expected to be moderate, because it only targets the movements of waste, and doesn't provide the countries with a quantitative goal of waste reduction. However, it does make it easier to analyze the pollution haven hypothesis, because by mandate of the treaty, the waste stays where it's produced, so it will be easier to map the connection between industry location and (local) abatement options.

Responsible care group

One of the key programs of the ICCA is the Responsible Care Group. Its main mission is to promote the safe management of chemicals and their production by engaging with stakeholders in all parts of the chemical value chain (Responsible care stats repot, 2015). The program was initiated in Canada in 1985, which was a crucial time in environmental awareness. This is also shown in the previous chapters: the 1970's and the 1980's were the times that the environmental awareness of chemicals really took off. This shows in the establishment of multiple MEA's and increased environmental stringency. According to its status report (2015), the level of implementation of the program is at various stages in different countries. This would imply that the countries implementation of the program is not only a function of time, but also a function of that countries' economic development, as shown by Cole (2004). Regardless, the program has shown to have made amazing strides over the years. Currently, it is under development or implemented in more than 60 countries, and over 80% of the world's largest chemical firms have signed up for the program. Moreover, the ICCA is spreading to Africa at the moment as well, introducing Ghana, Tanzania and Kenya as well. By the introduction and standardization of performance benchmarks, the responsible care group seeks to get developing countries on par with western sustainability standards. This includes data on the release of Sulphur dioxide, nitrogen oxide, liquid waste discharges, greenhouse gas emissions, energy consumption and efficiency and water consumption. However, their objectives are not quantified. Moreover, the adoption of a firm or a

country's industry association into the responsible care group does not mandate domestic policy, for it is a private sector initiative. However, it could reflect in some extent the environmental awareness of a country, which in turn urges its industry to increase their environmental performance. Because of this indirect link, the impact of the responsible care group is expected to be low.