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# 厦门大学

## 硕士学位论文

### 中国的外商直接投资及污染

### Foreign Investment and Pollution in China

### Andreas Thull

指导教师姓名: **Ass. Prof. Xiaojia Bao**专业名称: **Applied Finance**论文提交日期: **2016年9月**论文答辩日期: **2016年11月**学位授予日期: **2016年 月**

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## 摘要

环境污染是21世纪中国正在面临的最具挑战性的问题之一。与此同时，这个国家正在吸引大量的来自世界各地的外商直接投资。本文的目的是为了分析这些投资在水污染方面对中国的影响。结果表明，外国直接投资有助于减弱水污染的整体强度。这篇文章是通过专注于研究国内投资水平流动的情况，而不是国际投资水平流动情况，来促进现有文献对外商直接投资的影响。

其次，本文认为，外国技术的溢出效应是可以被观察到的，并能帮助国内企业降低污水的排放量。最后，本文利用友好城市作为一个工具变量，来帮助解决内生性问题。

本文的研究成果可以被视为对中国环境监管机构的贡献，特别是针对那些需要了解在哪些领域或的外商直接投资将会如何影响污染问题，其中包括如何降低国内企业自身的整体污染水平。

**关键词：**外商直接投资；污染光晕'假说；污染避难所'假说；技术溢出效应

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## **Abstract**

Environmental pollution is one of the most challenging problems China is facing in the 21st century. At the same time the country is attracting record numbers of foreign direct investment from all over the world. The purpose of this thesis is to analyze the impact of these investment flows on waste water in China. The results show that foreign direct investment helps to reduce the overall water and air pollution intensity. The paper contributes to the existing body of literature on foreign direct investment by focusing on intra-national level investment flows, as opposed to international investment flows. Secondly, the paper argues, that spillover effects of foreign technology can be observed, which help domestic companies lowering their emission levels as well. Finally, the paper makes use of sister cities as an instrumental variable, helping to address the problem of endogeneity. The results of this thesis can be seen as a contribution to Chinese environmental regulators who need to understand in what areas foreign direct investment is going to, how it affects pollution, and to what extent it benefits domestic companies to reduce their overall pollution level.

**Key Words:** Foreign Direct Investment; Pollution Halo Hypothesis; Pollution Haven Hypothesis; Technology Spillover

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## **Chapter I: Introduction**

### **1.1 Motivation and research question**

Pollution is one of the biggest problems that China is facing in the 21<sup>st</sup> century. In 2013 seven out of the ten most polluted cities in the world were located in China (China Daily, 2015). Pollution has reached such a hazardous level that the Chinese Prime Minister Li Keqiang “declared a war on pollution” in 2014 (Reuters, 2014).

Waste water is a particular concern to many Chinese, due to the importance of clean water sources for drinking water. In 2012 the amount of waste water amounted to 68.5 billion tones. This number is comparable to the annual flow of the yellow river. The most important reason for these high levels of waste water is the industrial sector in China (Hu & Tan, 2014). Similarly, it is estimated that over 80% of the national total air pollution in China was caused by the industrial sector in 2004 (Zhang & Fu, 2008). A crucial factor for the industrialization in the country was foreign direct investment which mainly went to the industrial sector. In 2011 foreign invested enterprises in China accounted for as much as 25.9% of industrial output and 45.9% of exports (Morrison, 2015). However when it comes to assessing the impact of FDI on pollution, opinions vary broadly: Some researchers believe that environmental standards are deliberately being reduced as a way to attract even more FDI, due to lower compliance costs. On the other hand other researchers point out, that FDI, in particular investment coming from large Multinational Enterprises (MNE), often comes hand in hand with more advanced technologies, helping to reduce the level of pollution.

This paper analyses the relationship between FDI and pollution in Chinese provinces. It makes three contributions to FDI and pollution literature: First, this paper has not been conducted on a national scale, but on a regional scale. This helps to not only get more detailed results, but also taking into account the different development levels of all

provinces and regions in China. Secondly, this paper makes use of sister cities as a means to reduce the level of endogeneity in the research. Thirdly, this paper tries to analyze in more depth how FDI affects pollution, mainly by various spillover effects on domestic companies. The resulting research questions are:

- (1) Has FDI an effect on water and air pollution in China?
- (2) How is FDI affecting the pollution level of domestic enterprises in China?

The results are intended to help policy makers better understand the effects of foreign investment flows into China. It is important to understand, whether FDI worsens pollution, meaning higher environmental standards are needed, or whether FDI can actually help domestic companies reduce pollution, and thus a more open policy towards FDI (i.e. more tax incentives) should be adopted.



## **1.2 Background**

### **1.2.1 Theories on FDI and Pollution**

The literature on the relationship between pollution and FDI generally follows two different schools of thoughts. The first one is the so called pollution haven hypothesis, which states that FDI is attracted by countries with weak environmental standards, due to cheaper compliance costs. The FDI - host countries in turn will lower their environmental standards and engage in a regulatory “race to the bottom” in order to attract even more FDI. This in turn will worsen the overall level of pollution within a country (Dong & Zhao 2009).

So far the research on the PHH however, came to many different results, as to whether there is enough evidence for the PHH. Some studies found at least partial evidence for the PHH, whereas others found only little to no evidence (Millimet, 2011).

Due to the lack of consensus on the PHH the pollution halo hypothesis has been created as an attempt to come up with a different explanation. It follows a different school of thought, but to this day there hasn't been as much research about this as on the PHH (Zugravu-Soilita, 2015).

The theory takes the opposite view of the PHH and assumes FDI has a negative relationship with pollution in the host country. This is due to the assumption that FDI mainly originates from foreign companies (and in particular large multinationals) which have more sophisticated and cleaner technologies than local companies. In addition, the presence of these foreign companies might have other effects on domestic competitors (“spillover”). These effects might help local producers to eventually produce cleaner as well (i.e. share of Know-How) (Albornoz et al., 2009).

### **1.2.2 Technological and productivity spillover**

A spillover occurs once FDI interacts with domestic companies (i.e. share of

technology). This interaction in turn helps both sides to learn from one another and to improve technology and practices in a more environmentally sound way. A broadly recognized definition of a spillover effect has been provided by Grossman and Helpman (1992). Firstly, it means that companies can gain information that has been created by others without having to pay for that information in a market transaction. Secondly, the creators (or the current owners) of the information have no (legal) possibility of recourse, in case that another company utilizes the information of this very company. Technological spillover refers to the transfer of technologies, whereas productivity spillover refers to any spillover effect increasing the productivity of domestic companies. Both concepts are somewhat interlinked.

At the heart of the theory of the spillover effect is the idea that foreign companies only undertake an investment into another (host) country when they possess a special “ownership advantage” over a potential domestic competitor (Caves, 1974) (Kindleberger, 1984). One of the very first studies mentioning “technological spillover” has been made as early as 1976 by Hymer. He stated that FDI is more than just a mere transfer of money, in that it comes as a “package” of capital, management and new technologies (Hymer, 1976). In addition to that, Hall (1996) found that companies engaging in R&D actually receive only about half of the profits of this new technology. This furthers the idea that local companies profit as well from technologies arriving hand in hand with FDI in a host country. This effect is further increased by the fact that newly established foreign owned firms in a host country increase the competition on the market (Fan, 2002).

Technological transfer can take place in various forms. Zarsky and Gallagher (2008) summarized the three most important ways: First, setting high (environmental) standards for suppliers of foreign financed companies. This may go hand in hand with training or a transfer of certain technologies. Secondly, the so called “Demonstration Effect” states that some companies may want to copy foreign companies or they respond to an increased competition. Thirdly, technologies can be transferred by

cooperations, for example, joint ventures for example. As a matter of fact, technology transfer doesn't necessarily mean that local companies merely coping existing foreign technologies. Popp (2006) found evidence that foreign inventions often serve as "blueprint" for domestic technologies. That is to say those technologies might be modified for local conditions.

Technological spillover of just one single company can have massive effects on suppliers and other local companies as well. The Chinese subsidy of US-Funded GE Healthcare for example has around 200 suppliers in China. Within a fairly short period of time companies quickly adapted new standards and production methods, leading to a quicker development of the suppliers themselves. A general survey also found that by 2000 90% of MNE subsidiaries have adopted core technologies in production, and about 60% had a component localization ratio of more than 50% (Zhu, 2010).

Another channel of the spillovers comes from R&D activities that MNE's are increasingly conducting in their subsidiaries as well, in order to better account for local demands. In late 2008 more than 1200 R&D centers were set up by MNE's, which contributed to positive technology diffusion to the Chinese Economy (Du et al., 2008).

Finally the professional training of MNE's staff can lead to both technological and productivity spillover as well, since every year MNE's recruits thousands of Chinese graduates, and provides trainings and seminars. These employees may very well work for other Chinese enterprises in the future, thereby using their training and knowledge to improve domestic companies as well (Zhu, 2010).

### **1.2.3 Environmental regulations and compliance**

Studies on spillovers affecting the environment have their roots in research on productivity spillovers which is mainly concerned with the competitiveness of

companies (Albornoz et al., 2009). Thus studies often measure for example the relationship between FDI and productivity of local companies (Thuyen, 2014). This is due to the fact that companies are profit driven and therefore want to produce at the cheapest level possible. However as private companies have little to no incentive to reduce pollution a market failure will occur (Fischer, 2008). That is to say those companies don't engage in the "efficient" level of R&D activities that would make anyone better-off without making someone else worse-off (Ledyard, 2008). The problem occurs firstly, due to the fact that emissions are not priced by the market, therefore private companies have no incentive to reduce their level of pollution ("Environmental externalities"). Secondly, emissions are a global externality. That is to say that it doesn't matter where pollution occurs, since the effects of it ultimately affect anyone on the planet (Dechezleprêtre et al., 2015). Thirdly, companies themselves hardly benefit from environmental research; therefore the benefits are often not covered by the costs for a company (Popp, 2011). In some cases however, investment in climate friendly technology can pay off, that is, if the money saved by using less energy offsets, the initial investment, Fisher et al. (2008) provided evidence for that. In fact he found, that a higher productivity might be linked with a lower marginal pollution, meaning the next good produces, needs less energy than the previous one.

In order to reduce the effects of market failure, policy makers can implement regulations to force companies into reducing their overall level of emission (Fischer, 2008). Due to often more stringed regulations in developed countries, most of the multi-nationals have to stick to these standards and therefore often have better technologies than companies from developing countries (Lanjouw and Mody, 1996). In addition, the host country can implement regulations themselves. As an example, China passed legislation for passenger vehicles in 2004, which were even stricter than the US-standards at the time (Bradsher, 2004). Another example of environmental regulations are environmental taxes, a pollution allowances system or fees for heavy pollutants. All of these can contribute to both productivity and technological spillovers,

since companies need to comply with the new legislation (Requate & Unold, 2002) (Wheeler, 2001). An additional example of making FOE's sharing their technological knowledge is through tax incentives. China ruled that the Chevrolet Volt electric vehicle would only be eligible for certain tax subsidies, unless General Motors transfers the technological knowledge to a joint venture with a Chinese partner (Bradsher, 2011). As a matter of fact large multinationals operating abroad seem to maintain their environmental standards which they adhere to in developed countries, when they settle abroad, indicating that FDI often arrives with the most modern technology for lowering pollution in a host country (Dowell, et al., 2000). In some cases large enterprises have even been involved in environmental scandals, like Nestle and Pepsi who constructed new plants without a proper environmental assessment, leading to increased water pollution. This scandal however made foreign companies even more aware of their environmental impact, due to reputation concerns (Liu, 2016).

The fact that since the beginning of the 21<sup>st</sup> century FOE's are responsible for 85% of the overall high tech- exports may be an additional indicator, proving that multinationals have better access to more advanced technologies Liu (2008).

It also seems that large MNE's are willing to invest heavily in pollution reduction. Not only for the sake of complying with environmental laws and regulations, but also to improve their public image as a clean company. As an example Apple pledged to plant 1 million acres of new forest land in China, and its Chinese supplier Foxconn invested around 33.5 million USD on green projects in 2014 (South China Morning Post, 2015). This behavior which is known as "Corporate Social Responsibility" can actually pay-off for the company. As Zeng (2012) showed in a study of FDI in less-developed countries: When FOE's signal to consumers their social and environmental responsibility, it often leads to more support among consumers.

### 1.2.4 Sister Cities

In order to reduce the problem of endogeneity between FDI on the one hand and pollution of the other hand, this paper will make use of an instrumental variable, namely the amount of sister cities (or twin towns) that each province has in each year. A methodological discussion on this instrumental variable can be found in Chapter 3.3. Sister city agreements between Chinese and foreign countries have been signed since the 1970s. The first agreements have been signed with various Japanese cities like Yokohama (1973) and Kyoto (1974). With the opening of the Chinese economy under Deng Xiaoping this process saw a rapid increase in the 1980s after the US signed the first sister city agreement in 1978. Other western countries followed shortly. Today hundreds of agreements have been signed. The city of Beijing alone has more than 50 agreements with other cities from all around the world. The city of Shanghai has more than 60 sister city agreements (Foreign Affairs Office of Shanghai, 2016).

Quantifying the gains from sister city agreements is very difficult, since agreements are made in a variety of sectors. Normally a sister city agreement provides just a basis for further cooperation and exchange. As Povich (2012) put it “The benefits can be as simple as a cultural exchange or as complicated as getting a contract to design a \$1 billion theme park in China“ (Governing, 2016).

Such cooperation makes it easier to increase the economic and cultural exchange between two cities or regions (Baycan-Levent, 2008). As Fraser (2013) put it: These agreements are “geared towards more investment, trade and export”. When the City of Beijing for example met with representatives of Helsinki, 50 companies joined and showcased their know-how to Chinese companies. Many deals, sales agreements or other kinds of cooperation for the future have been agreed upon at this summit (Helsinki Times, 2016).

With regards to environmental protection, many investment agreements have been signed as well, through the mechanism of sister cities. In 2005 an “environmental

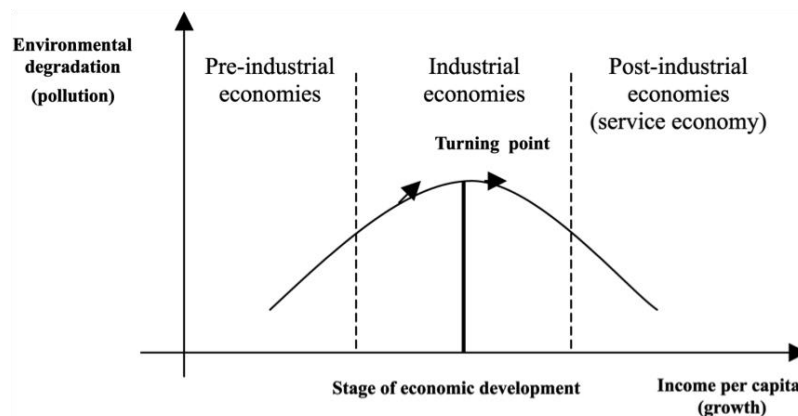
industrial park” was built in Qingdao, with funds coming from the sister region Bavaria in Germany (Helsinki Times, 2016). French sister cities invested in some of their own companies within China focusing on reducing the pollution level, i.e. for soft drink producers (German.China, 2016). Another example is that partner cities helped foreign investors building several wind parks in China (Wiwo, 2011), or the city of Cologne brought companies willing to invest in several recycling facilities to Beijing (Vertretung der Bundesrepublik Deutschland in der Volksrepublik China, 2016). A study from New Zealand on its relationship with Chinese cities found that sister city agreement can be seen as a “door opener”, which helped many companies from New Zealand to invest in China and built plants or representative offices (Maniam, 2011). This paper therefore assumes that most sister city agreements boost FDI coming to China.

Sister cities are being agreed upon for various reasons. Since the municipality government is in charge of making these agreements (“grassroots diplomacy”) the reasons for doing so can vary greatly. For example the city of Beijing focuses primarily on making agreements with other capital cities, such as Tokyo, London, Berlin or Mexico City. Shanghai as a famous harbor city, focuses primarily on cities that also have big harbors such as Hamburg, Rotterdam or Alexandria. The city of Xiamen focuses among others, on other cities that attract large numbers of tourist each and every year, like Netanya, Nice or Myrtle Beach (What’s on Xiamen, 2015). Due to the long term nature of sister cities (lasting for decades) factors often include long term reasons, as opposed to short term reasons.

### **1.2.5 The Environmental Kuznets curve**

The Environmental Kuznets curve describes the relationship between the GDP per capita-level (or income level) of various countries and the level of pollution in the same country. It states that developing countries that are still in a somewhat early state of

industrial development will face an increasing level of pollution for every additional level of GDP per capita. At some point however the country will reach a turning point, at which the level of pollution decreases for each additional gain of GDP per capita. At this latter stage the countries have typically developed into a service economy. The term “curve” originates from the relationship between GDP per capita and pollution, which follows a u-shaped curve as can be seen in figure 1. (Stern, 2003) It is still a matter of debate where China or it’s regions are actually situated on the curve (Song, 2008).



**Figure 1: The Environmental Kuznets curve**

Source: Stern, 2003

## 1.3 Literature Review

### 1.3.1 Pollution Heaven and Halo

Due to Globalization the FDI stocks of countries all around the world have increased enormously. The two contradicting theories, Pollution Halo and Pollution Heaven Hypothesis, have been developed as an attempt to explain this relationship. Both theories assume that more developed countries (service economies) have more



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