# 博士学位請求論文要旨

# The impact of environmental policy on the waste management industry

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## 1 Research aim and motivation

Over the past few decades, waste generation rates around the world have been growing rapidly. Problems related to waste management are pressing and very important. However, it is usually environmentalists, not scholars, who address them.

Admittedly, the topic is difficult, but the author decided to take up the challenge and make a contribution to the understanding of location patterns in the waste management industry and trade patterns in waste products. The research focuses especially on evaluating the relevance of the pollution haven hypothesis (PHH) and the Porter hypothesis (PH) to the waste management industry.[1]

Research addressing this issue is quite limited, and it either concentrates on testing the PHH, with respect to the aggregated waste flows (Baggs, 2009; Kellenberg, 2012), or investigates the problem of recycling (van Beukering, 2001; Kojima and Michida, 2011). To the author's knowledge only one study attempts to test the Porter hypothesis (PH)

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[1]The PHH predicts that when barriers to trade are reduced, the pollution-intensive industry will relocate to those countries where environmental regulations are less stringent. The PH postulates that properly designed environmental policy leads to innovations which may, in turn, enhance firms' international competitiveness.

with respect to the waste management industry. Cecere and Corrocher (2016) found that there is a relationship between stringent environmental policy and the number of innovations in the waste management sector. There is, as yet, no research assuming both the PHH and the PH be true, but for different treatment options.

This research aims to fill the gap in the existing literature by integrating the main treatment options, as well as both the PHH and the PH, into one study, and further by investigating the factors crucial for the development of either, or both, the disposal and the recovery industry. Unfortunately, due to data availability, this study is limited to the EU countries and Norway.

The approach taken is threefold: firstly, in Chapter 2 the location patterns of the waste management industry are examined, allowing for the consideration of both hazardous and non-hazardous waste. Chapter 3 investigates the factors that affect trade flows in hazardous waste at the country level. Lastly Chapter 4 conducts an in-depth analysis of trade patterns in hazardous waste at the facility level.

This research is worthwhile not only for academic reasons, but also because of possible implications for real world policies. Many countries are struggling to improve their waste management systems in an effort to increase efficiency and make them more environmentally-friendly. Understanding the relative importance of factors that create a comparative advantage in either disposal or recovery services is an essential step in building a better system.

## 2   Thesis outline

The dissertation is comprised of five chapters. Chapter 1 is an introduction to the study, providing the background, rationale, and objectives. Chapters 2, 3, and 4 employ empirical models to test the PHH and the PH. They examine location patterns of the waste management industry and trade patterns in waste products. Chapter 5 provides the general conclusions.

Chapter 1 explains the importance of the study and its aim. It also discusses the basic facts and findings concerning international and European trade in waste in order to provide background information for the subsequent empirical analyses in chapters 2-4.

Since the empirical chapters are based on the data collected from the Eurostat and the E-PRTR, these databases are presented along with their limitations. The part concerning the databases is followed by the description of four measures of environmental policy stringency, which is the critical variable in testing the PH and the PHH, and thus appears in all empirical chapters. Chapter 1 also explains the theory of comparative advantage and the Heckscher-Ohlin (HO) model, which constitute the theoretical framework adopted in this dissertation.

Chapter 2 investigates the influence environmental policy stringency has, together with other factors, such as land and capital endowments, on the location patterns of the European waste management industry. The pollution haven hypothesis and the Porter hypothesis are tested simultaneously through the employment of a model that includes interactions between country characteristics and waste treatment option intensities.

Analysis of 27 countries and 3 treatment options reveals that stringent regulations increase a country's share in the recovery sector, supporting the PH. Despite the opposite effect being observed in the final disposal sector, the evidence is not strong enough to confirm the PHH in its original form. The general negative relationship between the pollution intensity and the regulatory stringency, however, indicates the presence of a pollution haven effect.

Chapter 3 tests the PHH by examining country-level data. Two different approaches are presented and contrasted. First, the standard log-linearized gravity model is applied and its results are subsequently compared with the results from the Poisson pseudo-maximum-likelihood estimator. The major advantage of the latter estimator is that it takes into account zero trade flows, allowing for the utilization of all information included in the dataset. Despite suggesting the presence of a pollution haven effect the evidence is ambiguous. In addition the limitations of the country-level data do not allow for reliable analysis of the patterns in waste trade dependent on the treatment option for which it is destined. Accordingly, the conclusion to be drawn is that it is simply not feasible to assess the validity of the PH with respect to the waste management industry by investigating trade in hazardous waste at the country level. Analysis of disaggregated data is indispensable.

Chapter 4 continues and deepens the analysis started in Chapter 3. It offers a fresh look at the pollution haven hypothesis by investigating facility-level data on trade in hazardous waste. Similarly to previous chapters, it distinguishes between waste destined for final disposal and waste destined for recovery. Chapter 4 is divided into two parts: the first examines the factors affecting waste generators' decisions on whether to export waste or manage it domestically; the second investigates the factors that determine the exporting facilities' decision on where to ship waste.

The empirical analysis in the first part is based on the binomial logit model. The results show that the stringency of environmental regulations of an origin country makes facilities, located in that country, more likely to ship their waste abroad; suggesting the presence of a pollution haven effect. However, this cannot be confirmed without subsequent analysis focused on the the characteristics of the destination country.

The second part of Chapter 4 combines very disaggregated data with the highly flexible mixed logit model together with a reliable measure of environmental policy stringency. Including all these elements in one analysis allows for the uncovering of the dramatic differences in the reactions of individual waste generators to the environmental policy stringency of the destination country. Although there is no evidence confirming the PHH in its strongest form, a significant pollution haven effect has been revealed. While most facilities are deterred by the environmental policy stringency of the destination country, there are also waste generators attracted by strict regulations. Nonetheless, facility-level data provided by the E-PRTR is not detailed enough to enable precise analysis of waste streams that do not follow the pattern consistent with the presence of a pollution haven effect.

Chapter 5 summarizes the results and discusses the contribution of the present study to existing literature. It also contains recommendations for further research and indicates policy implications.

# 3 Conclusions

The results obtained in the present study are generally consistent with existing research in that they confirm a pollution haven effect in the waste management industry. The

approach here, however, allowed for enriching previous conclusions in two ways. First, by investigating not only trade patterns but also location patterns it was possible to include both hazardous and non-hazardous waste in the analysis. This resulted in the discovery that predictions consistent with the PH rather than the PHH might be of more importance if the whole waste management industry is considered. Second, the analysis of very disaggregated data allowed for showing the PH might be relevant with respect to some waste shipments, even in the case of hazardous waste. These two findings have substantial implications both for future research and for practice.

First, it is essential future research does not assume the whole waste management industry is polluting. Even when working with data comprising of only hazardous waste, it is worthwhile to look for ways of separating waste into various categories, for example, based on recoverability.

Second, the results of this study suggest that testing the PH with respect to the waste management industry is both feasible and desirable.

Third, as Chapter 2 shows, it is possible to successfully integrate these hypotheses into one study. Here the analysis was focused on the waste management industry, but the approach presented can be equally applied to other industries. The PHH and the PH may be true with respect to different product groups, just as they are relevant to different treatment options.

Fourth, it seems that stringent environmental policies promote innovations in the waste management industry, and thus stimulate the development of the recycling sector, which is based on technology to a much greater extent than is the disposal sector. However, a government needs to conduct a detailed cost-benefit analysis, taking into account the whole economy, prior to the introduction of stricter regulations.

Finally, the results of this study also have implications regarding the restrictions of trade in waste products. The presence of a pollution haven effect suggests that restricting trade in waste destined for disposal may well be justified in some cases. The European Community's waste legislation is based on the assumption that if there were no restrictions, large volumes of waste would end up in the landfills of countries with relatively lax environmental standards (mostly transition countries) instead of being recycled or

managed in some other, more environmentally-friendly, way. However, if anything, EU policies seem to be too strict. In the case of hazardous waste, not only waste destined for disposal but also that destined for recycling is subject to very costly and lengthy bureaucratic procedures. This often makes international shipments too expensive for facilities and waste is eventually landfilled in the country of origin or, worse, is exported illegally. The first option might be especially relevant to low-income countries having access to cheap disposal services. It is probably not a common occurrence that a facility from a low-income country, whose waste can be efficiently recovered with advanced technology, profits from recovering waste in a high-income country, despite bureaucratic costs. It must be more common that a facility from a high-income country recovers waste in a low-income country because of the difference in prices. This is presumably why chapters 3 and 4 confirm a pollution haven effect with respect to the recovery of hazardous waste. Trade in waste intended for disposal is very rare because of EU legislation. Possibly many of the reported shipments refer to waste which requires advanced technology for its disposal. Waste generators who look for the cheapest way to dispose of waste are likely engaging in illegal trade, therefore, not only domestic regulations, but also international agreements should be designed in such a way as to take account of possible illegal activities.