

**Trade in Waste Among Developed Countries:  
Evidence and Origins**

by

**Andrew B. Bernard and Pamela H. Chang**

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Andrew B. Bernard  
Department of Economics  
M.I.T.  
Cambridge, MA 02139

Pamela H. Chang  
Department of Economics  
Wellesley College  
Wellesley, MA 02181

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## **Abstract**

In this paper, we examine the determinants of the international trade in waste between developed countries. Data from the 1980s suggest that while the trade in waste between developed and less developed countries has garnered the most attention, the preponderance of waste flows have been among the developed countries. We examine both economic and institutional factors governing incentives to export and import waste. In particular, we find that countries with high cost of disposal tend to export but that low urban-rural population ratios, industry share in GDP, and population densities are also relevant for explaining the amount of waste that crosses national borders.



# 1 Introduction

Recently there has been increasing attention paid by the press and by policy-makers to the trade in solid and hazardous wastes across national boundaries. The debate over the trade in waste has focussed largely on the pros and cons of situating waste disposal sites in less developed countries. In particular, the arguments have centered on the potential gains from economic 'efficiency' in the form of lower costs, and the undesirability of situating disposal sites in countries that do not have proper facilities to handle the waste in an environmentally sound manner.

The available data has suggested that the trade in waste has been growing at a rapid rate. As developed countries begin to implement higher environmental standards and as costs for waste disposal rise, there has been fear that the generators of hazardous waste are increasingly tempted to avoid the cost rises and dump the waste in less developed countries. In particular, there has been concern that, given the high debt burdens faced by these less developed countries, the importation of hazardous waste provides a source of short-run revenue that poorer countries will find difficult to refuse. The concerns are heightened if the waste disposal facilities are inadequate, resulting in long term environmental damage.

Two highly publicized recent incidents increased public attention on the North-South trade in hazardous waste. The ship, *Khian Sea*, spent two years in the late 1980's searching for a country to unload its cargo of toxic incinerator ash before it allegedly dumped its cargo in the Indian Ocean. In December 1991, the *Economist* published the text of an internal memo by Lawrence Summers, then chief economist at the World Bank, over the desirability of situating dirty industries in less developed countries.

However, contrary to the popular belief that most of the trade is from developed countries to less developed countries, an OECD report in 1985 noted that over 80 percent of the trade in hazardous trade was between

developed countries.<sup>1</sup> While other reports tend to attribute a larger share of the waste movements to the North-South trade,<sup>2</sup> it is difficult to refute the OECD claim that a substantial amount of waste is moving from one developed country to another.

In this paper, we compile the existing data and suggest possible motivating factors for the waste trade among developed countries. We investigate the different environmental policies and institutions governing waste disposal in a number of developed countries and analyze whether these national disparities help to explain the exports and imports of waste. As a first step in assisting governments in both developed and less developed countries as they begin to address the issue of waste trading in their national environmental policies, we provide an analysis of the economic factors involved in the decision by the private agents to export and the decision by government to allow imports. We caution that the data on waste trade exports and imports are scant at best. There is no international authority charged with the responsibility of monitoring this trade, and until recently the domestic authorities in most of the countries appear to have neglected the tracking of this aspect of waste disposal, although national regulations do exist.

We focus on the movement of both solid waste and non-nuclear hazardous waste. This is essential since every country has a different definition of hazardous waste thus complicating cross-national comparisons and making an analysis of data on solely hazardous waste even more tenuous. In addition, recent high profile news stories on stranded shipments of so-called 'trash' have illuminated the problem that the long-run toxic properties of many substances are unknown and policy-makers tend to lump both non-hazardous and hazardous solid waste together when considering what actions to take.

In examining the determinants of the international trade in waste, we

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<sup>1</sup> *Transfrontier Movements of Hazardous Waste* Paris: OECD, 1985

<sup>2</sup> "International Trade in Hazardous Waste Increases in 1988, University Professors Say" *International Environmental Reporter* Feb 1989

focus on the economic incentives for exporters and importers. Producers of waste consider cost differentials of domestic versus foreign disposal. If domestic facilities are inadequate to handle waste, then exports are necessary. Where landfills and incineration plants are both available, landfills are substantially less expensive than incineration in the short run as a method of disposal. We will consider whether incineration and landfill costs help explain the direction of trade. In a tightly packed continent such as Europe, it is possible that the distance between a waste generator and a foreign disposal facility is less than the distance between the point of generation and a domestic disposal facility. We will therefore consider whether transportation costs and the placement of national boundaries explain the movement of waste. Furthermore, if there are economies of scale in disposal, the existence of a facility that is better served by several countries may explain the volume of exports that we observe. We will also expect that discrepancies in potential liabilities will substantially affect the decision to dispose of waste domestically.

Since waste is regulated to some extent in all developed countries, both the extent and the severity of environmental regulations are potential determinants of the decision to export. If, in fact, these regulatory discrepancies are a primary factor in the waste trade, then we must answer the question of why countries so seemingly similar impose such varying regulations. Such discrepancies may be determined by several factors, including differences in industry mix, the degree of urbanization, income distribution, and historical incidents involving environmental damage.

The remainder of the paper is divided into 7 sections. In Section 2, we present the evidence on the waste trade that is available to date. We present a simple model of the decision to export waste in Section 3. Section 4 is a summary of the regulations in various countries, while section 5 analyses the different motivating factors for exporting and importing waste. In section 6, we consider why governments choose to impose either lax or strict regulations.

We conclude and discuss further research in Section 7.

## 2 Evidence

Most of the data presented in this section comes from OECD publications, with some information provided by Greenpeace.<sup>3</sup> Data on exports of waste appear to be more readily available than data on imports. As shown in Table 1, almost all of the OECD countries in the late 1980's participated in the waste trade. The table also shows that the comparability of the numbers across countries is poor as numbers rarely exist for different countries in the same year. Recognizing this problem, we still consider an examination of the data to be revealing.

OECD figures suggest that Germany is the greatest exporter of waste in tonnage. In 1988, 5.7 percent of its waste was exported. More recent statistics show that percentage to have more than tripled. West Germany generated 14.21 million tons of hazardous waste in 1988, over 7 times the waste generated by the United Kingdom and over 10 times the amount produced by Denmark. The increase in waste generation over the late 1980s in many major developed countries has occurred at the same time that these countries have seen a decrease in their landfill capacity. West Germany saw a decrease in its landfill capacity of 24 percent from 1985 to 1989. In the United States, the US General Accounting Office reported that over 2,700 landfills closed in the early 1980s while the amount of hazardous waste generated increased from 9 million tons in 1970 to 268 million tons in 1986. One of the other major exporters in Europe is Austria, which authorized over 43

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<sup>3</sup>There are numerous discrepancies between the OECD and Greenpeace figures. For example, the OECD claims that Denmark exported only 9,000 tons of waste in 1988. However, Greenpeace reports Belgium claims that it imported 200,000 tons from Denmark in 1989. At the same time, the OECD asserted that in 1988, Denmark only produced 112,000 tons of waste. Could such a dramatic increase in waste production and export occur in one year?

percent of its generated waste to be exported in 1987. The largest shares from Austria were sent to the former East Germany, the United Kingdom and West Germany. Even among OECD countries that do not export heavily, there are some like Belgium which use their geographical location to act as a hub for waste traffic. In particular, the southern French speaking region of Wallonia in Belgium diverts waste from Central Europe to northern France and the United Kingdom.

Data on imports were available for only 5 countries, Canada, France, West Germany, the United States and the United Kingdom.<sup>4</sup> Both OECD and Greenpeace seem to agree that France is the biggest importer of waste in the EC and suggest that it is the major dumping ground for waste not accepted in other European countries. However, Michel Mousel of the Director of the Pollution Prevention Department of the Ministry of Environment in France claimed that “globally, the waste of foreign origin only represents 5 percent of the volume treated in France, and in no way justifies the sensational headlines calling France ‘the wastebin of Europe.’”<sup>5</sup> The United Kingdom is also considered a major importer. An article in the *Economic Review* in 1991 suggested that of all British imports, 10 percent came from the United States, 36 percent came from the Netherlands, 22 percent came from Belgium and 12 percent from Switzerland, suggesting that less than 20 percent may be coming from less developed countries.<sup>6</sup> In fact, according to U.K. authorities, the United Kingdom imports waste from 26 different countries. Furthermore, Greenpeace figures reveal that waste imports in the United Kingdom rose from 5 thousand tons in 1983 to 180 thousand tons

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<sup>4</sup>Whether imports are nonexistent or unreported for the remaining countries cannot be evaluated with the OECD numbers.

<sup>5</sup>*The International Trade in Waste: A Greenpeace Inventory* 1990

<sup>6</sup>Greenpeace’s list of waste exporting countries show that some developed Asian countries are also exporting to the U.K, specifically Hong Kong and Singapore. Other less developed countries found exporting include the Philippines and Panama.

in 1987.<sup>7</sup> Figures provided by both organizations verify that movements of waste among the EC countries are prevalent and substantial.

### 3 A Simple Model of Waste Trade

We consider a model in which the decision by generators of waste to export is a result of the minimization of their disposal costs. Firms in the home country, denoted by the subscript  $h$ , have a choice of disposing their waste at home or of sending it to a site in one of a number of different foreign countries. We assume that there are  $F$  foreign countries indexed by  $f = 1, \dots, F$ . Firms in the home country will calculate the difference between the cost of disposal at home,  $D_h$ , and the cost of disposing the waste abroad,  $D_f$ , for each of the foreign countries. The minimum cost will determine the location of disposal.

$$\min(D_h, D_f)$$

We divide the cost of disposing in any location,  $D_i$ , into 3 terms: the actual cost of disposal at the site,  $C_f$ , the transportation cost of moving the waste,  $T_i$ , either from the home country to the foreign dumpsite or within the home country, and the expected potential liability,  $L_i$ .

$$D_i = C_i + T_i + L_i \quad i = h, f$$

$C_i(s_i, p_i, R_i)$  is the cost of disposal at site  $i$ , and depends on  $R_i$ , the regulations in the country,  $p_i$ , the availability of a facility, and  $s_i$ , the size of the facility.  $R_i$  ranges from 0 to  $\infty$ , where  $\infty$  is a complete ban on the disposing

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<sup>7</sup>*The International Trade in Waste: A Greenpeace Inventory 1990*

of such waste. Costs of disposal is increasing in regulations.

$$\frac{\partial C_i}{\partial R_i} > 0, \quad R_i = [0, \infty)$$

$$C_i(\infty, \cdot, \cdot) = \infty$$

$$C_i(\cdot, 1, \cdot) = \infty$$

$p_f$  determines whether a facility exists in the foreign country. If  $p_f$  is zero, it means that no facility exists. If one does exist,  $p_f$  is 1. The cost of disposal when a plant does not exist is infinity.  $s_f$  is the size of the plant. We assume that such disposal sites exhibit increasing returns to scale. As the size of a facility rises, the average cost of disposal falls. The transportation cost  $T_f$  is a function of two variables, the distance between the generator and the foreign disposal site,  $d_f$ , and the mode of transportation,  $m$ .

$$T_f = d_f m$$

The final term is the expected liability should leakage occur once the waste has been deposited. This is the discounted penalty cost multiplied by the probability of damage occurring.

We make a few observations. First, the cost functions  $C$  for the home and foreign countries do not have to be the same. Countries may have very different disposal facilities. When discussing technologies for waste disposal, the most obvious examples are landfills and incinerators. Secondly, there is no reason to assume that the distance between the generator and the foreign disposal site  $d_f$  is greater than the distance between the generator and the home disposal site  $d_h$ . Thirdly, the expected liability is the discounted sum of the potential liability of every period into the indefinite future.

We now examine information on regulations, availability and cost of differing types of disposal, transportation costs, and potential liability in the OECD.

## 4 Regulations on Waste Trade between Developed Countries

While there has been a major focus on the potentially harmful impact of the hazardous waste trade on less developed countries, there is still dispute over whether the same concern should be accorded to the waste trade between developed countries. If countries have the same disposal capabilities and can guarantee sound environmental management and safe transportation of the waste, then in theory waste can be treated as a normal traded good. Research has suggested that with the appropriate monitoring procedures and proper disposal facilities in the importing country, the waste trade can be an efficient means to hazardous waste disposal.<sup>8</sup> Proponents of this viewpoint look to the bilateral agreement between the United States and Canada. Over 90 percent of the exports of waste from the United States end up in Canada, primarily in an incinerator in Ontario and a landfill near Montreal and are believed to be disposed of as soundly as they would have been in the United States. The procedure for Prior Informed Consent which requires that the exporter obtain the approval of the government of the importing country prior to any export of hazardous waste, and the high level of environmental supervision on Canada's part contribute to this economically efficient and environmentally sound outcome. However, the United States has a similar bilateral agreement with Mexico that has been less effective. The lack of monitoring and enforcement across the border have led to "sham recycling" and "illegal shipments" into Mexico. Hilz and Ehrenfeld (1991) conclude that while bilateral agreements work well between similarly developed countries, they can be problematic between a highly industrialized country and a less developed one. We will discuss the efficiency of the waste trade among developed countries in a latter section.

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<sup>8</sup>Hilz and Ehrenfeld, "Transboundary Movements of Hazardous Wastes" *International Environmental Affairs*.1991

While we will not directly analyze all the various policy options, it is worth mentioning that a number of different solutions have been proposed to deal with the international trade in hazardous waste. They include a policy of free trade, a global ban, regional agreements, global agreements and bilateral agreements. Debates over the superiority of any one option have centered on the issues of implementability, equity, efficiency and sustainability. However, to analyze the movements of the waste trade among the developed countries, it may be useful to understand the regulatory framework under which this trade is occurring. Among the developed countries, there have been 4 major frameworks, the EC Directives, the OECD Directives, the UN Basel Convention, and for the US, the bilateral agreement with Canada.

The EC directives and the OECD guidelines are very similar. They do not prohibit exports by member countries to non-member states but they do establish reporting and consenting requirements in those instances. The exporter must show the existence of a waste disposal contract with a facility in the non-member state capable of handling the waste properly. Among the weaknesses in both frameworks is the ambiguity over the definition of 'sound environmental management' and the lack of liability in cases of accidents and negligence. After joining the United Nations Environmental Programme, the OECD ceased its efforts, and currently the governing regulations on the trade in hazardous waste are provided by the UN.

The UN first addressed the issue of waste exports in 1972, in Principle 21 of the Stockholm Declaration, requiring nations to conduct extraterritorial waste disposal safely. In 1978, they set down the Cairo Guidelines and Principles which were aimed at assisting countries in developing sound policies for hazardous waste management. It was not until 1989 with the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal that strict regulations concerning waste exports were set out. Monitoring procedures were adopted through a requirement for notification and prior informed consent, a manifest system and the submission

of a yearly report. In particular, the Basel Convention prohibits exports to the Antarctic region, to states not parties to the Convention, to states which have national regulations prohibiting waste imports, and to states which are unlikely to dispose of the waste soundly in the opinion of the exporting country. There are provisions to allow trade if the country which is exporting does not have the necessary technical capacity or suitable disposal facilities.

However, even with these guidelines set down by the UN and approved by the 116 nations present,<sup>9</sup> there are still major disparities in national regulations among the developed countries. Such disparities in regulations may help to explain the tremendous movements of waste among them. Below, we summarize some of the environmental rules applicable in the OECD countries. We can identify four parties involved in hazardous waste management: the generators of hazardous wastes, the carriers, the disposers and the national governments. We deal with the issue of governments in a latter section.

#### **4.1 Generators of hazardous wastes**

While there are no obligations for generators of hazardous wastes under international law, all the major developed countries do appear to have their own set of national regulations for generators. In particular, Germany and Austria appear to have some of the most stringent regulations. Both countries require generators to obtain permission in order to dispose of the waste themselves, to provide information to authorities, to keep a register containing various bits of information, to complete a trip ticket, and to transfer their waste to a given site. At the same time, only 4 of the OECD countries attempt to place obligations on the generators not to produce certain types of wastes. They are Finland, France, Switzerland and the Netherlands. This is significant since the Basel Convention set as its goal "to make it (waste disposal) so costly and difficult that industry will find it more profitable to cut

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<sup>9</sup>Only 33 nations signed it at the time.

down on waste production and ... recycle what waste they produce.”<sup>10</sup> With so many closures of landfills anticipated, estimated at about 50,000 in the EC, even with no increase in waste generation, disposal will still be a problem. A vital component of any long term waste disposal solution must be an decrease in the amount of waste generated. The obligation to recover or recycle certain types of wastes is laid down by Finland, Norway, the Netherlands, Japan, France, Switzerland and Italy. Nearly all countries with hazardous waste legislation require producers to obtain special permission to dispose of the waste themselves, the exceptions being Canada and Switzerland.

## **4.2 Carriers**

Carriers of hazardous wastes are in general obligated to obtain special authorization, to provide consignment notes identifying the waste being transported, and to notify the authorities in cases of accidents. The countries with the strictest regulations on carriers appear to be Germany, Austria, the United States and Canada. A large number of countries do not require carriers to take out special insurance policies. The countries that do require carriers to take out insurance or provide financial sureties are Germany, Austria, Switzerland, Belgium, Canada, the United States and Sweden.

## **4.3 Disposers**

Obligations of disposers of hazardous waste under general international law apply only to certain lakes and international watercourses, and fall within the scope of the ADR (European Agreement concerning the International Carriage of Dangerous Goods). Under EC Directives, European disposers are obligated to be specifically authorized, to separate toxic and hazardous waste from other substances, to keep a register or supply information to the

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<sup>10</sup>“Emerging Controls on Transfers of Hazardous Waste to Developing Countries,” *Law and Policy in International Business* Vol 21, 1989

authorities, and to record and identify waste for each disposal site. The tightest regulations are imposed by Germany, Austria, Canada, the United States. The least regulated appears to be Switzerland and Denmark. Again, there are still many developed countries that do not require disposers to take out insurance policies, although almost all of them place the obligation on disposers to record the location of each deposit.

## **5 Motivating Factors for Waste Exports**

In this section, we focus on the economic factors involved in the decision by private agents to export and the decision by governments to allow imports. Many governments in less developed countries have explicitly banned hazardous waste imports, although imports have subsequently been documented. Numerous examples of this can be found in studies of countries in Africa. The lack of financial resources and regulatory infrastructure may make the decisions by these governments to ban imports non-enforceable. We assume that among the developed countries, government regulations are enforced, and any imports are legally accepted imports, although we recognize the possible existence of illegal dumps. Since regulation is inextricably tied to the issue of hazardous waste disposal, we will consider how differing regulatory environments and access to different technologies across countries determine the flow of waste.

### **5.1 Environmental laws**

Intuitively, one would expect the countries with the strictest environmental laws to be the most likely to export. As countries impose stricter regulations on the disposal of hazardous waste, there is an added incentive to export the waste abroad, either illegally dumping it in less developed countries, or exporting it to countries where the disposal costs are lower. Stricter regula-

tions may be in the form of banning disposal of certain types of chemicals and waste, or in the form of requiring better treatment prior to disposal and thus higher costs. There is clear evidence that Germany is a major exporter of waste, and that France is one of the major importers of waste. Germany exports dredging sludge which may not be spread on German soils because of its high toxicity. According to the latest figures, France, which has some of the weakest regulations, exports 1.5 percent of its waste produced and imports 6 times as much as it exports. In 1988/1989, France imported 10 times the amount of hazardous wastes imported by Germany. Austria, which has strict regulations on generators, carriers and disposers, exported 43.5 percent of its waste generated in 1987. Denmark, which appears to have relatively weak regulations on disposers, exports only about 8 percent of its waste. At the same time, however, Finland and Switzerland, which appear to have no stricter obligations than Denmark, do export a much higher percentage of their wastes, 24 percent and 27 percent respectively.

The United Kingdom's environmental regulations have been described as "lax", "haphazard", "ramshackle", and "antediluvian".<sup>11</sup> While there are no records of any toxic waste being exported from the United Kingdom, imports grew ten-fold from 1984 to 1991. Although on paper it appears as though the obligations placed on carriers, generators and disposers by the British government are similar to many of their European counterparts, the United Kingdom leaves responsibility for its waste disposal in the hands of 200 Waste Disposal Authorities (WDAs). These WDAs often perform two conflicting functions, operating the waste disposal facilities as well as overseeing regulations. As a result, in the past, the 200 WDAs together with the local authorities have applied widely differing standards across the country, and have been accused of lax regulatory oversight, and thus lowering costs and enabling them to price their waste disposal services below that of

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<sup>11</sup>Redston and Thomas, "The Economics of Toxic Waste," *The Economic Review* Vol 8, no. 5 May 1991

their rivals in other countries. The WDAs are soon to be replaced by new Waste Regulation Authorities. However, the revamping of environmental standards in the United Kingdom, including those for waste disposal have been shelved to some extent as a result of the recent recession.

On the other side of the Atlantic, the United States and Canada both have strict environmental standards and yet the United States exports less than 1 percent of its waste and Canada exports less than 4 percent of its trash. The existence of the bilateral agreement between the 2 countries ensures the existence of a safe export destination with lower cost. The distance to an alternative disposal country may explain the lack of waste exports.

It appears that for a number of the developed countries, the disparate environmental standards do explain the direction of the waste trade, the prime examples being Germany, France and the United Kingdom. Countries with strict environmental standards tend to export a higher percentage of their waste than the countries which have lax regulations. However, for countries, such as Finland and Switzerland, it is difficult to attribute their high percentage of exports to strict environmental laws since they do not have unusually tight standards.

## **5.2 Disposal Facilities Availability-Landfills and Incineration Plants**

The Basel Convention permits trade in waste when the exporting country is unable to dispose of the hazardous waste in a sound environmental manner. This may be due to lack of suitable landfills or incinerators. Consider the case of Ireland which has no national waste incinerators. The country disposes over 70 percent of its waste overseas. While there are plans to build an incinerator, Ireland produces only 5,000 of the 8,000 tons that would be necessary for the incinerator to be economically feasible. The economic viability of the plant would entail the importation of 3,000 tons of hazardous

waste from abroad. There has been continuing opposition from the public to the concept of importing waste, and as long as Ireland prohibits the import of waste, the incinerator is economically infeasible. On the other hand, the British government has tended to encourage trade in waste in the past, asserting that it has a first class technology for dealing with waste. Its argument of comparative advantage in environmental technology however does not seem to be supported by the overwhelming popularity of landfill as a method of disposal and does not suggest a high technology industry. Economically speaking, as we shall see in the next section, the UK does have a comparative advantage in costs.

France has dumping grounds and incinerators for wastes not tolerated in West Germany and Switzerland. However, it is not clear whether France's facilities are any better than its neighbors for dealing with these particular types of waste. It is worth noting that Switzerland had considered the construction of an incinerator but faced public opposition, as did Greece. This may help to explain why Switzerland exports 27 percent of its waste generated, even though its environmental standards are not particularly stringent. Finland has one incineration plant for hazardous waste, does not appear to have very strict regulations but continues to export 28 percent of its waste abroad. The Finnish Ministry of the Environment asserted that the incineration plants handles almost all of the country's waste. However, Greenpeace has received reports that the waste generated in Finland is greater than the capacity of the incinerator and that PCBs are being sent to the UK.<sup>12</sup>

While the existence of suitable sites for landfills is often a matter of natural geological formations within the country, the construction of an incineration plant is an endogenous variable. Governments choose whether to build an incineration plant, recognizing that the lack of one may spur exports of waste. As a result, we recognize that the issue of the availability of

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<sup>12</sup>*The International Trade in Waste: A Greenpeace Inventory*1990

incineration plants is highly linked to government regulations.

### 5.3 Disposal Costs-Incineration and Landfill

Some countries do not have any appropriate disposal facilities and therefore must export their wastes abroad; however, among the countries that do have domestic waste disposal capabilities, we consider whether relative costs play a role in the direction of trade. Recent findings on incineration costs in some of the developed countries find that Germany has the highest per ton incineration cost, while the Netherlands and Denmark follow closely at about \$115 per ton.<sup>13</sup> Norway, and France all have higher incineration costs than the United States and the United Kingdom, as one can see from Table 2. It is tempting to link the incineration cost to the severity of environmental regulations in these countries. It is certainly true that higher standards lead to higher disposal costs, as authorities require that better, newer and more expensive technology be installed to operate a waste disposal facility. However, it is worth noting that Denmark has relatively lax regulations as well as the third highest incineration cost, and that France has looser regulations than the United States but higher costs.

In Europe, availability and therefore cost of landfill space also varies substantially. Britain has good impermeable rubbish dumps in the Midlands and South East England, although some of these pits tend to be far from the cities which generate the waste. In particular, there is a network of incinerators, treatment plants, and old quarries. The stable rock foundation and impermeable clay soil facilitate safe disposal. Landfill costs in the United Kingdom are consequently one third that of West Germany. The Netherlands on the other hand not only has high incineration cost but also finds it hard to dig holes since much of the country is lying at or below sea level.

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<sup>13</sup>“All that Remains: A Survey of Waste and the Environment,” *The Economist*, May 29, 1993

It exports 12.5 percent of its waste, and has landfill cost of \$44 per ton, almost twice the cost of the United Kingdom. Among the countries for which landfill costs are available, West Germany has the highest cost per ton, \$60, with high costs for Denmark and Sweden, both at \$54 per ton respectively. The UK and France have the lowest costs, \$24 per ton in the UK and \$20 per ton in France. This major disparity in landfill costs suggest why many generators all over Europe would prefer to export to England and France, even though they must incur transportation costs.

#### **5.4 Disposal Costs-Transportation costs, national boundaries, economies of scale**

We now examine the issue of whether exports are explained by the proximity of disposal facilities. Countries in Europe are closely situated and given the numerous borders for any given country, it is quite likely that a generator in a country such as Germany would find the cost of a foreign disposal site such as one in France, together with the transportation cost less than the domestic disposal cost. Even where the foreign and local disposal costs are equal, it may be the case that the transportation cost to the French site is less than the transportation cost to another locale in Germany. The fact that European countries engage widely in the waste trade may then be linked to the geographic locations of these countries.

Furthermore, it is possible that economies of scale also influence the disposal choice. An example is Ireland where the economic viability of an incinerator depends on the importation of 3,000 tons of waste from abroad. In this case, if there are 2 countries similar to Ireland, each with 4,000 tons of waste to dispose of and economically needing 8,000 tons to operate an incinerator efficiently, it may be better for one country to build the incinerator and for the other to merely export its waste to the former.

## 5.5 Potential liability

In addition to differences in domestic environmental standards on the content of waste and the location of disposal, the extent of liability in the event of leakage or damage from the deposited waste varies considerably across countries. Potential liability can be based either on cost of cleanup, or on the profit a firm gains from disposing of the waste cheaply but poorly. Liability data is scant. In the US, liability is often based on the social costs of inadequate management of waste, or on the cleanup costs, as in the EPA's Superfund. However, in Norway, Sweden and Finland, the penalty fee is often associated with the profit surplus gained by the violation.

## 6 Governments

So far, it appears that in some cases where the government prohibits the disposal of certain types of hazardous waste domestically, generators of hazardous waste tend to export abroad. This is true of West Germany and Austria. There is almost no information on how much of the waste is being illegally dumped within the countries. Similarly, countries that do not have the appropriate facilities to deal with hazardous waste properly, such as Ireland and Switzerland, find that they also have no alternative but to export. In cases where there are disposal facilities within the country but where the cost of disposal overseas, inclusive of transportation cost, is less, generators will act as profit maximizers and ship the waste abroad.

Neglected in this discussion is the issue of why seemingly similar countries choose to impose such disparate environmental standards. There have been many who have argued that environmental concerns are secondary to the more immediate concerns about poverty, literacy, and mortality, and that those who pursue high environmental standards are those who have achieved a threshold standard of living. Those who so argue that campaigning for

the environment is positively correlated with income levels must wonder why France and Germany, much alike in their living standards, have such different environmental standards.

A number of factors could account for these discrepancies. In particular, we consider the following: historical incidents of environmental damage cases, industry and manufacturing as a fraction of GDP, the mix of industries within manufacturing, the urban population as a percentage of total population, and the skewness of the domestic income distribution.

We note that in 1990, 70 percent of GDP in Germany comes from industry and manufacturing while in Austria, 64 percent of GDP is in industry. Both countries have strict domestic environmental regulations. This relationship may be due to the fact that the total amount of pollution is higher when a country has a higher percentage of its GDP being attributed to industry and therefore environmental issues draw more attention or may be because the probability of environmental damage rises with the higher percentage of GDP in industry.

There does not appear to be any relationship between the percent of industry that is chemical-related or heavy machinery-related and the stringency of regulations. Nor does there appear to be a link between the skewness of income distribution and the environmental standards in waste disposal. Our statistic on income distribution is the fraction of the income in the hands of the top 10 percent of the population divided by the bottom 40 percent. If this fraction is large, then income distribution is exceedingly skewed. Due to the fact that the number of environmental damage incidents predominantly occur in transit or in the less developed countries where disposal facilities are inadequate, historical incidents at home appear to be rare in the developed countries in Europe.

At the same time, it is worth noting the United Kingdom is the only country with an urban population that is over 90 percent of its total population. This may help to explain its lax regulations. With most of its

population located in urban cities, there may be more sparsely populated areas suitable for landfills. Countries with a low percent of urban population such as Austria, Finland and Ireland all tend to export rather than import. Perhaps the geographical dispersion of their population makes it difficult to find appropriate sites for disposal.

## 7 Conclusion

In this paper, we consider the size and sources of the international trade in solid and hazardous waste. We assemble existing data on the trade in waste among OECD countries and discuss potential determinants of the trade. Contrary to prevailing wisdom, not all the international movements in waste are from developed to less developed countries; there is a sizable trade among developed countries. We use these flows to develop an understanding of the determinants of waste trade.

While the numbers are sketchy and incomplete, we can draw several conclusions from the data. Within the OECD, unsurprisingly, countries with high costs of disposal, either landfill or incineration, tend to be exporters. Conversely, low cost countries are more likely to import. Other factors associated with export include a lack of incineration facilities, low urban-rural population ratios and a higher share of GDP in manufacturing. The role of domestic environmental regulations in cross-country flows is less clear-cut. Countries with strict regulations tend to export, Germany and Austria, but countries with lax regulations may import or export depending on other factors such as population density.

The results from this first look raise more questions than they answer. Without data on flows over time, more formal statistical analysis of the determinants is difficult. We plan to look at data on flows among the US states to more precisely identify regulatory and cost influences on the trade in waste.

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Table 1: Production and Movement of Hazardous and Special Waste

	Year	Production 1000 Tons	Imports		Exports	
			1000 Tons	Percent	1000 Tons	Percent
Australia	1980	300			0.30	0.10
Austria <sup>1</sup>	1987	400			87.00	43.50
Canada <sup>2</sup>	1980	3290	120.00		101.00	3.10
Denmark	1988	112			9.00	8.00
Finland	1987	230			65.00	28.30
France <sup>3</sup>	1989	3000	250.00		45.00	1.50
Germany	1988	14210	20.20		805.40	5.70
Ireland	1984	20			14.00	70.00
Italy	1989	3640			3.00	0.10
Japan	1985	666			0.04	
Netherlands <sup>4</sup>	1986	1500			188.00	12.50
New Zealand	1982	60			0.20	0.30
Norway	1989	200			8.00	4.00
Spain	1987	1708			0.10	
Sweden <sup>5</sup>	1985	500			30.20	6.00
Switzerland	1989	400			108.00	27.00
Turkey <sup>6</sup>	1989	300				
U.K. <sup>7</sup>	1989	2200	34.20			
U.S. <sup>8</sup>	1987	238327	120.00		127.00	0.10

- 1) Data for export refer to 1983. Production data refer to 1987. Secretariat estimates.
- 2) Hazardous waste produced:wet weight.
- 3) Data on amounts imported and exported refer to 1988.
- 4) Excluding ship cleaning residuals.
- 5) Data on amounts imported and exported refer to 1988.
- 6) Secretariat estimates.
- 7) Fiscal year commencing April 1.
- 8) Data on amounts imported and exported refer to 1988.

Table 2: Country Characteristics

	Exports	Imports	% GDP in Industry	Income Growth <sup>1</sup>	Income Distribution <sup>2</sup>	Incineration Facility
Australia	0.1%	na	46%	3.3%	1.67 (1985)	na
Austria	43.5%	na	64%	2.1%	na	na
Canada	3.1%	3.6%	63% (1988)	3.2%	1.38 (1987)	na
Denmark	8.0%	na	47%	1.7%	1.28 (1981)	yes
Finland	24.0%	na	59%	3.6%	1.18 (1981)	yes
France	1.4%	8.3%	50%	2.1%	1.39 (1979)	yes
Germany	18.0%	0.1%	70%	1.7%	1.20 (1984)	yes
Ireland	70.0%	na	38% (1988)	2.4%	1.24 (1973)	no
Netherlands	13.0%	na	51%	1.7%	1.14 (1983)	yes
Sweden	6.0%	na	59%	2.0%	0.98 (1981)	yes
Switzerland	27.0%	na	na	2.3%	1.76 (1982)	no
U.K.	na	1.5%	69% (1988)	2.3%	1.00 (1979)	yes
U.S.	0.1%	0.01%	55% (1988)	2.8%	1.59 (1985)	yes

  

	Incineration Costs (per ton)	Urban Population % of Total	Regulations <sup>3</sup>	% of Industry in Chemicals, Transport, Machinery	Landfill Costs
Australia	na	85.5	na	28	na
Austria	na	57.4	S	33	na
Canada	na	76.3	S	35	na
Denmark	\$115	86.1	L	33	\$54
Finland	\$40	59.8	L	30	\$14
France	\$60	74.0	L	40	\$20
Germany	\$130	86.2	S	54	\$60
Ireland	na	58.7	L	45	\$38
Netherlands	\$115	88.5	L	38	\$44
Sweden	\$54	83.9	L	42	\$54
Switzerland	na	60.9	L	na	na
U.K.	\$52	92.3	L	44	\$24
U.S.	\$58	74.0	S	43	\$40

1) Annual growth rate, 1979-1989.

2) Ratio of top 10% to bottom 40%.

3) S=strict, L=lax.