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A Baumol–Oates approach to solid waste taxation

Received: July 13, 2001 / Accepted: October 2, 2001

Abstract

A national Baumol–Oates tax on waste in Denmark helped achieve a reduction of 26% in net solid waste from 1987 to 1998. The tax, which is levied per ton of waste, was particularly effective as regards the heavier waste streams such as construction waste and garden waste. When it comes to industrial and commercial waste, there are indications that the waste tax is not sufficiently significant to induce changes in behavior, and that except for very waste-intensive enterprises, companies do not seem to be very price sensitive. For household waste, the impact of the tax can be improved where tariffs for garbage collection are weight based, rather than per unit. However, the waste sector is an area in which the price signals are modified and filtered by institutionalized practices in municipal administration, and in which true-cost pricing is not easy to achieve. Hence, the rational choice assumption of environmental economics needs to be supplemented by an institutional dimension to interpret responses to environmental taxes correctly.

Key words Economic instrument · Environmental policy · Waste management · Landfill tax · Incineration · Evaluation

The introduction and design of the waste tax

The Danish waste tax was introduced on January 1, 1987, after a decision by the Danish Parliament. It applies to both household waste and industrial waste. The waste tax is a weight-based tax that is levied on all solid waste delivered

to or processed at landfills and incinerators. It is a classic emission tax, and the revenue is not recycled but goes to the treasury. The rates of this tax are shown in Fig. 1; the tax increased from DKr 40/ton in 1987 to DKr 375/ton in 2000, with reduced rates for incineration. No attempt has been made to undertake a formal evaluation of the externalities associated with waste treatment. The tax is merely an instrument to affect behavior. As such, it should be seen as a tax that follows the principles of the classic standard-pricing approach (cf. Baumol and Oates¹).

Incineration is widespread in Denmark, and 82% of residual household waste is incinerated. The term “residual waste” denotes the amount of waste after reuse and recycling, i.e., the amount intended exclusively for landfills or incinerators. Of the total residual waste, 59% is incinerated.² The background for the tax was an acute lack of landfill sites, especially in the greater Copenhagen metropolitan area, and problems with dioxin emissions from incineration. The tax was also meant to support the Action Plan for Waste and Recycling. The target of this plan was a recycling rate of 54% to be achieved by 1996. According to the then Minister of the Environment, Lone Dybkjær (Social Liberals), the waste tax was meant to be a “locomotive” for the action plan.³

Waste that is reused or recycled is not liable to the tax, as the purpose of the tax is to promote such activities. For the same reason there is a general reimbursement mechanism, so that the tax is refunded for waste that is removed from registered waste sites. This is mainly relevant for construction and building materials, which can be reused, but also allows the operators of landfills to have other recycling activities within their domain.

The tax cannot be said to be targeted at preventing or minimizing waste. However, at the national level there are other more preventive economic mechanisms.

- Beer and soft drink packaging: producers must establish a deposit and refund system. This system has been in place since the nineteenth century.
- The deposit–refund system is supported by taxes on packaging containers for all drink products. This sup-

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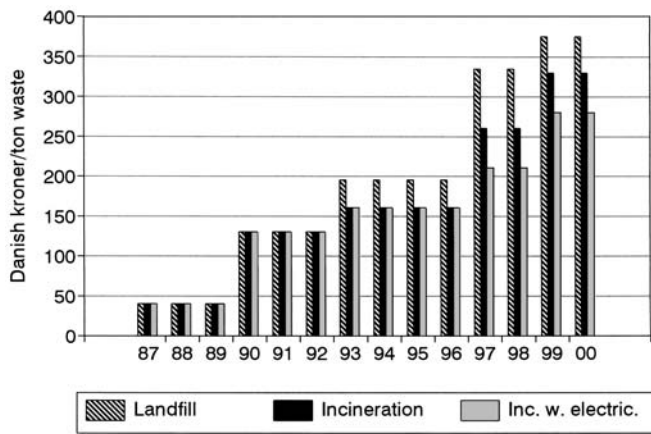


Fig. 1. The Danish waste tax. Tax rates from 1987 to 2000 (DKr 100 = ¥1425)

ports reuse and penalizes throwaway containers (introduced before the waste tax).

- A tax on disposable tableware (introduced before the waste tax).
- Rechargeable batteries: until 1995, there was an agreement with the producers to collect these, but due to lack of compliance a separate tax has been introduced.
- A raw material tax to limit the use of sand and gravel, and support the reuse of building materials for construction. This tax was introduced in connection with the waste tax.

See Danish Environmental Protection Agency publications⁴ for details on these environmental taxes.

Theory and practice of price signals in the waste sector

The difficulty in employing a price mechanism in the waste sector is that the prices of transactions in this sector only bluntly reflect actual costs. There is a tightly knit set of regulations which govern and rule the management of the various waste streams, and the operators in the waste sector are tightly regulated.

The waste sector consists of a complex network of actors who are in relatively well-defined positions in relation to each other, and whose transactions are institutionalized through the waste sector regulation. Therefore, waste management is not a free market with free competition and full transparency, but rather a market dominated by regional and local monopolies, and subject to a complex planning system.

The municipality is formally responsible for waste collection, either through direct collections or through instructions to the waste producers, and the main dividing line in the legislation is between “collected waste” and “instructed waste.”

Pricing of collected waste

The collection of waste must take place according to a nonprofit-making cost-coverage principle, according to which the municipal authority can charge citizens for refuse disposal on the basis of its actual cost. The national regulations do not specify in any detail exactly how the municipality should charge its users, as this is left to local discretionary decisions. Usually a general fee is charged which covers all types of waste facilities, both for disposal and recycling. The fee is normally fixed in relation to the volume of the waste bin, and there are limited opportunities for choosing the size of the waste bin or the frequency with which it is collected. The incentive of the waste tax, which is charged on a *weight* basis, is therefore watered down by municipal user fees that are charged on a *per volume* basis. Hence, for most households, increased recycling activity will not be reflected in a lower refuse collection fee.

The designers of the waste tax were well aware of this problem, and the argument behind the tax was not to influence the individual households, but rather “to make it more profitable for the refuse collection authorities in the municipalities to establish recycling and sorting systems.” In the legislative text, it was thus argued that “For every ton of waste delivered to recycling, the refuse collection authority will be able to save the corresponding tax.”⁵ The implicit assumption was that it would be possible to make the local and regional waste utilities optimize their behavior, disregarding their monopoly and the possibility of simply passing the tax on to the consumers.

Pricing of instructed waste

For instructed waste, the municipalities normally instruct the waste producers as to which waste site they should take their waste to. According to the Environmental Protection Agency, the waste producers are free to take their waste products to any recycling site they prefer, although they are obliged to use the landfills and incinerators assigned by the municipality.⁶

However, few waste producers take their own waste to the waste sites. They normally contract with transporters who are specialized in this service. There is often a tendering procedure by which the cheapest transporter is identified. The waste tax is then integrated into the bill of the waste transporter. The tax may not always be visible to the waste producer, even though it may make up nearly half of the bill for getting rid of the waste. However, some transporters present the tax bill from the waste site to prove that the waste has been disposed of legally.

The designers of the waste tax argued that “A tax on depositing and incineration of commercial waste will directly affect the individual company, which can save the tax and reduce its refuse disposal costs by sending its waste for recycling or by changing the production processes to produce less waste.”⁷ The price incentive from the waste tax for instructed waste is more likely to have a direct effect on the decisions of the waste producers than is the case with collected waste.

The possibilities for improving recycling depends on the facilities available in the municipality. For some waste streams, the municipalities are obliged by national regulations to provide a recycling opportunity. Other waste streams are unregulated at the national level, meaning that the local municipalities are free to decide whether they should offer recycling opportunities. These streams include organic waste from households, garden waste, bulky refuse, building materials, plastics, scrap, and metals.

Municipalities should be able to meet the target of the Action Plan for Waste and Recycling of a 54% recycling ratio, and therefore in principle recycle as much as possible. However, especially where the municipalities run their own incinerators, they may have an interest in not improving recycling to a level that would create an overcapacity in incineration. Fewer than 15% of the municipalities were able to meet the target of the plan.⁸

The environmental parameter: assessing outcome

The overall development: a reduction in waste

On basis of the data compiled by the Tax and Customs authorities on the proceeds of the tax, we have computed

consistent time-series for the waste quantities delivered to registered sites in the period 1987–1998⁹ (Fig. 2). Some data problems were encountered because the Tax and Customs authorities only keep their accounts for 5 years. However, the lost data were identified in dossiers of the Environmental Protection Agency. Generally, data are available for in-weighed and out-weighed waste at each registered site. For 1987, data for out-weighed waste are available only at the aggregate level. The pre-1990 registered sites are municipal landfills and incinerators. The post-1990 registered sites are private landfills and disposal facilities. While the first group is very stable, the latter is marked by many new registrations and several changes.

Figure 2a shows the gross delivered waste for municipal and private sites. For the municipal waste sites there was a decline of about 17% from 1987 to 1993, but from 1993 to 1998 the amount increased again by about 3%. Figure 2b shows the out-weighed waste, i.e., the waste for which a refund was obtained. These figures include waste that was reloaded. For municipal sites there was a substantial increase in the out-weighing of waste (62%) throughout the whole period. Some of this waste was slag and cinders from incinerators. While 13% of the gross delivered waste was outweighed again in 1987, the figure was 25% in 1998.

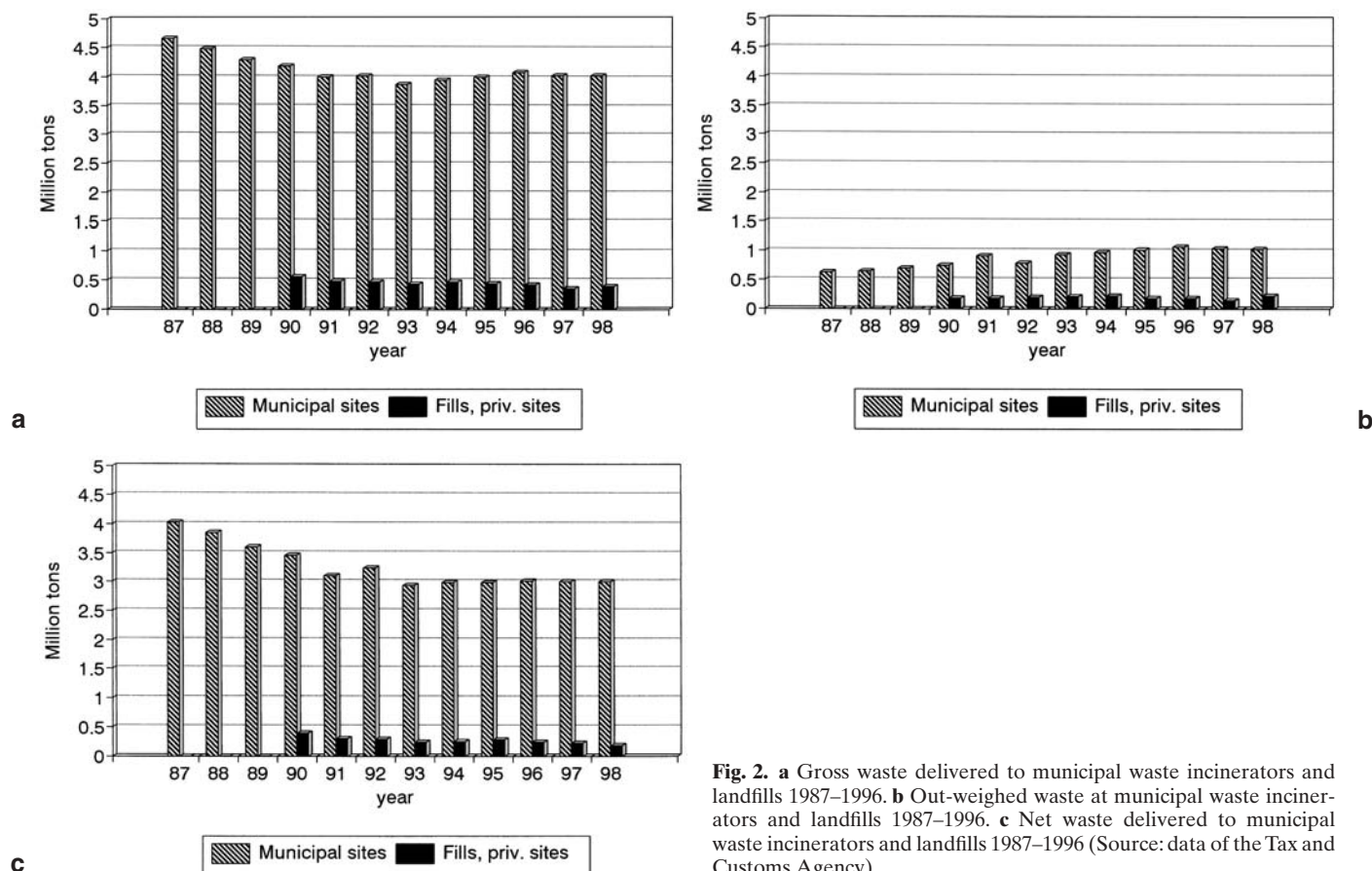


Fig. 2. **a** Gross waste delivered to municipal waste incinerators and landfills 1987–1996. **b** Out-weighed waste at municipal waste incinerators and landfills 1987–1996. **c** Net waste delivered to municipal waste incinerators and landfills 1987–1996 (Source: data of the Tax and Customs Agency)

Figure 2c is the most interesting because it shows the net delivered waste (i.e., gross delivered waste minus out-weighed waste). The net in-weighed waste is the most useful indicator because the figures for gross in-weighed waste are blurred by slag and cinders, which have been weighed twice, first as solid waste and later as ashes. It can be seen from Fig. 2c that from 1987 to 1993 a considerable decline (−26%) in waste took place at the municipal sites, from a total of about 4 million tons in 1987 to 3 million tons in 1993. Since 1993 the amount of waste has been stable, despite a high growth rate for consumption, production, and building activities.

Identifying the reductions

Waste has been reduced, but what types of waste? From 1987 to 1993 we can assess the development on basis of *RENDAN*¹⁰ data on gross delivered waste. In this period, the main decline was in building waste (−64%) and household waste (−16%), whereas waste from private enterprises increased (+8%). Mixed waste decreased (−22%).

From 1994 to 1998 we can assess the development on the basis of *ISAG*¹¹ data. In this period, the overall amount of waste was stable, despite a high rate of growth in production and consumption. Household waste (−7%) and building waste (−25%) declined further, while waste from private enterprises increased (+12%), and mixed waste also increased (+19%).

It is indicative of the role of the tax that some of the most marked reductions have taken place in waste streams that have not been subject to regulations or decrees at the national level, i.e., building waste and composting of garden waste. These are also among the heavier waste types, which would be expected to be the most sensitive to a weight-based tax. Despite the strong emphasis on recycling of paper and glass, and the visibility of containers in the streets, the “command-and-control” effort on this point has contributed less significantly to the reduction of waste.

Disentangling the role of the waste tax – an ex post analysis

As is noted in the evaluation guide from the Organization for Economic Cooperation and Development,¹² “A frequent difficulty in assessing the effects of an economic instrument in environmental policy is that economic instruments are in practice rarely used in isolation, but are combined in a ‘package’ of policy measures. Often, the effects of new economic instruments are reinforced by regulatory measures, or other measures, taken at the same time.”

In our research we have relied on “backward mapping” of the impact of the waste tax. We cannot a priori say exactly what reasons or motives the waste producers may have had for reducing their waste (or not) when many policy instruments are in play, as is the case in the waste sector, but we can survey them. Because this was basically a sociologically

oriented case study method, we then combined our quantitative data with more qualitative interview data.

The designers of the waste tax regarded manufacturing companies and the municipal refuse collection authorities as the most important target groups for the incentive accruing from the tax, and in the course of the evaluation study two substudies were carried out. A number of manufacturing companies in different industrial sectors were interviewed in depth about their waste management practice, and a postal survey was carried out among all municipal waste management units in Denmark.

The response from enterprises

It is somewhat counterintuitive that waste has increased in the private enterprises, since these were supposed to be more sensitive to the waste tax. However, knowledge about the costs and benefits of various waste disposal options is limited in many companies. Typically, the physical responsibility for waste management is separated from the accounting unit, and the two units are not in contact with each other. Despite two or more requests to the companies, information about waste management costs were difficult to obtain because the companies did not have an overview themselves, and the figures were scattered in the accounting books.

There were interesting differences among the various types of firms. Generally speaking, the breweries, the iron and steel industries, and the railway companies were the most professional, and had the most comprehensive knowledge about their waste products and recycling costs. The newspaper printers were in a middle group who were positive toward recycling and who followed the guidelines, but who knew little about the costs and benefits. The supermarkets, the teleservice companies, and the universities were generally rather negligent about their waste management. The latter group, however, did not have smaller amounts of residual waste than the first group.

In a recent survey, the compulsory “green accounts” of ten enterprises (with about 30 production sites) were analyzed to assess the change in the generation of waste following the 1997 increase in the waste tax. Except in one case, it was found that the waste tax did not exceed 1% of turnover, or 1% of net profits. In the case of a cement factory, the waste tax amounted to 6–8% of turnover and 4–5% of net profits.¹³ The same survey found considerable variations in the degree of recycling among different sectors. For traditional smokestack industries such as iron and steel, breweries, and shipyards, the recycling rates were as high as 90%, whereas for more innovative enterprises such as the medical industry and the plastics industry recycling rates tended to be fairly low, usually below 35% and in one case only 5%.

The response of the refuse collection authorities

The municipalities have been active in offering recycling facilities to their citizens. The most important reason has

been the political desire to improve recycling, but the cost component has also played a role. For the heavy waste factions, the waste tax is seen as significant for the cost-effectiveness of the system. When we link this information to the evidence of the waste statistics, it is not difficult to disentangle the effect of the waste tax from the other policy instruments that were listed. The greatest reductions have taken place thanks to the increased recycling of garden waste and building waste, and these waste factions are not subject to national decrees on recycling.

The role of the tax

We can establish simple baselines for the business-as-usual development in waste on the basis of the indices from Statistics Denmark for production, consumption, and building activities. These baselines indicate that declines in waste have taken place against significant growth rates in all three sectors. This situation is most significant in the building sector, where the 63% decrease in waste should be seen against an increase in activity of 20%. Command-and-control measures can only explain a minor part of the waste reduction, i.e., about 16% (paper and glass recycling in households). For the remaining part, there are no other policy instruments that can explain the development apart from the tax, which we calculate accounts for about 80% of the waste reduction.

The impact of weight-based waste fees

We can speculate whether recycling facilities would be better utilized if the municipalities charged their waste fees on a weight basis rather than at a flat rate with only a few levels for different volumes. There are some municipalities in Denmark which have introduced weight-based waste charges. The experiences of some of these have been analyzed and compared with the recycling ratio in other municipalities without weight-based waste charges.¹⁴ The figures are drawn from ISAG, the Environmental Protection Agency's waste statistics.

In Tinglev and Bogense, two smaller rural communities, a system with weight-based fees has been introduced. In the case of Tinglev, each household pays a small flat rate plus a weight-based rate.¹⁵ The refuse collection vehicle has a scale that registers the amount of waste in the waste bin. There is an electronic identity tag at the top of the waste bin which is read by a scanner, and the identity and the weight is recorded on a diskette. At the end of each year, the waste bill is made up in installments and collected with the property tax.

Figure 3 shows the amount of "residual waste" (i.e., waste after recycling) per capita in ten Danish municipalities before and after the introduction of new waste management systems with recycling facilities. The two municipalities with the most significant reductions in waste were Tinglev and Bogense. Here, residual waste has been reduced to about 100 kg/capita, whereas waste has remained at 200–

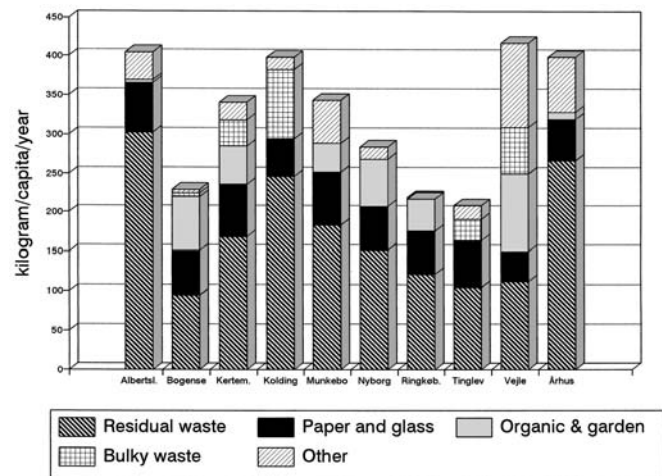


Fig. 3. The amount of residual waste in ten municipalities before (late 1980s) and after (1993) the introduction of the new waste systems. Weight-based fees were introduced in Bogense and Tinglev (Source: data of the State Building Research Institute)

250 kg/capita in places such as Århus, Kolding, and Albertslund. When the waste reductions in Tinglev and Bogense are compared with the recycling statistics, it can be seen that the waste has not disappeared into the countryside or otherwise been disposed of illegally but is being recycled. Only the city of Vejle is able to show a waste reduction level similar to that of Tinglev and Bogense. Vejle has a very comprehensive recycling system, where most of the waste factions are collected at the doorstep. The Vejle system is seen as the leading Danish system. However, this system is very expensive. Despite a Dkr 50 million subsidy from the Environmental Protection Agency, the per-household waste fees in Vejle are more than twice as high as those in Tinglev and Bogense.

Perspectives and conclusions

A 26% reduction in taxed waste at the municipal waste sites occurred from 1987 to 1998. This development was the result of a comprehensive waste policy with many different instruments in use, including a waste tax. The reductions took place mainly from 1987 to 1993, and since then the amount of waste has not declined further. This trend is believed to be connected to the positive economic developments since 1993, but also to higher marginal recycling costs in the remaining waste factions.

There was a command-and-control effort toward glass and paper recycling, but these two waste streams account for only a small share of the total waste reduction. The "unregulated" waste streams, such as building and construction waste and garden waste, account for the remaining (and greater) part of the reductions. The survey among municipalities showed that the facilities for reuse and recycling of these waste streams were offered for both political and economic reasons. In the case of building and construction waste in particular, the waste tax was seen as important for the profitability of recycling.

Where was the waste put that was not brought to landfills and incinerators? From the statistics of the recycling facilities, it seems reasonable to assume that it was used for other purposes. In the building sector in particular, new equipment has been introduced for the reuse of tiles, concrete, and asphalt. Garden waste is being composted at municipal sites. Despite rumours in the press, on the basis of a few known incidents, that waste is being disposed of illegally, an environmental surveillance of the counties has not detected general problems with illegal disposal.

The waste statistics did not allow us to draw many conclusions about the developments among private enterprises, but it is evident that waste has not been reduced significantly among these firms. We do not know what the baseline scenario would have been, and it might be that waste quantities would have increased in the absence of the waste policy and the waste taxation. However, from in-depth interviews in a few sample companies, it seemed that some of them were not really aware of the waste tax, or of the possible savings from a more active waste policy. Other companies, in particular breweries and some iron and steel manufacturers, had more precise estimates, but did not wish to reveal them.

An environmental economist might not be surprised that the waste tax led to substantial reductions in most of the heavy-waste factions such as building and construction waste and garden waste. The waste tax was not expected to lead to waste reductions across the board, but only where the marginal treatment costs of recycling were lower than the waste tax rate. As the waste tax has been increased, not only building waste but also garden waste began to be recycled. However, because of the institutional set-up in the waste sector, the incentives from the waste tax did not always reach the waste producers. It was primarily a signal to the municipal refuse collection authorities, who in return relied on more altruistic recycling behavior among their customers and users. The refuse collection authorities seem to have been more responsive to the waste tax than many manufacturing companies. This is something of a paradox according to conventional economic theory, which would predict a pass-on behavior from regional utilities to customers, and greater responses from firms.

To find an explanation for this paradox is itself an interesting research question, which deserves considerable attention. We propose the hypothesis that the refuse collection authorities were more sensitive to the waste tax because it fell within their primary business domain. The attention of managers is a limited resource. Among manufacturing companies, the most active response was found among breweries and iron and steel plants with a long tradition of selling their waste products, whereas supermarkets and teleservices were negligent. For most companies, and in particular the latter group, waste management is outside their primary business domain, and is seen as an insignificant issue in their business attention hierarchy. In institutional terms, this can be explained by the path-dependency of company behavior. There are informal institutionalized practices about "how to make money" which lead companies to focus their attention on the issues that traditionally

are likely to yield benefits.¹⁶ We regard this as a controversial institutional hypothesis to be tested against the behavior of economic man ("rational fool") which is assumed by environmental economics. This assumption would be a simple explanation of the negligence of some firms with high transaction costs. However, the in-depth interviews often pointed to circumstances which could not support the assumption of rational behavior by firms.

As a final comment on the effects of the waste tax, the experiences of the municipalities of Tinglev and Bogense, with weight-based waste fees, seem to indicate that the potential of the present waste tax, which is the highest in Europe, has not yet been fully exploited. At present, the institutional set-up of the waste sector, e.g., the autonomy of the municipalities to set flat-rate fees, filters the incentive from the waste tax. If the private waste producers were more systematically exposed to the price incentives accruing from the tax by paying their fees on a per-weight basis, a further reduction in waste by increased recycling seems to be within reach.

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