Introduction of Weight-Based Charges for Domestic Solid Waste Disposal

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DISCLAIMER

The usual disclaimer applies - all errors of fact, interpretation and conclusions are the authors' alone.

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1 Introduction

This study was commissioned by the Environmental Protection Agency under the Environmental RTDI Programme 2000–2006. The purpose of the study was to investigate the effects on householder behaviour of the introduction of pay-by-weight as a method of charging households for waste collection.

The importance of this topic stems primarily from the desire to reduce the amount of waste going to landfill and to reduce the amount generated. It is of interest to the authorities, because of the resource implications, and to society in general to help informed choices to be made. It is well known that, in theory, such charges would reduce the amount of waste collected but whether and how this would apply in an Irish case were questions worth investigating.

This paper proceeds as follows. In Chapter 2, the academic literature on unit-based charges is reviewed to set the context. There have been a number of applications of such charges where the experience has been assessed, in the USA, Europe and elsewhere, though in the majority of cases the charges have been based on volume of waste rather than on weight.

There follows in Chapter 3 a case study of the introduction of weight-based charges in West Cork. The study obtained information on the amounts of household waste left out for collection in the year before and the year after the new charging regime was introduced. This body of data on weight of waste was supplemented by information obtained from a questionnaire administered to a representative sample of about 1200 households in West Cork. Analyses undertaken include the calculation of the levels of waste reduction that ensued and the patterns of reduction according to household characteristics, to see who reduces most and how. Household recycling behaviour was also the subject of investigation as well as composting activities and other efforts to reduce waste.

In keeping with the terms of reference, the study uses analytical techniques similar to those employed by Fullerton and Kinnaman (1996) in their paper on the introduction of unit-based charges in the city of Charlotteville in Virginia, USA. The responsiveness to price is calculated as well as the impact of numbers in the household on weight of waste *per capita*. The parallels and some differences with the Fullerton and Kinnaman study and a later study in the Netherlands are noted.

The possibility that the incentives inherent in a charge-by-weight system will encourage various undesirable activities is also addressed. The burning of household rubbish was investigated through the household questionnaire. While it was not worthwhile asking household respondents about other illegal means of waste disposal, such as fly-tipping, respondents were asked whether they had experienced other people using their bin without their agreement.

Attitudes to the charges are an important aspect of the success or otherwise of the introduction of the new pricing regime and they can indicate how information and facilities can be improved in the future. Respondents were asked about the scheme's fairness, fairness being an issue that can hamper the success of such reforms, and they were asked whether or not they felt that they have enough information on recycling and other waste-reducing methods. Attitudes on the important issue of how to finance waste services were obtained by asking respondents about payment methods, including payment through an increase in income tax.

Chapter 4 follows with a summary of the main findings. A concluding section highlights some of the main considerations, including points emerging from the study that could inform policy.

2 Background

2.1 Review of the Literature

2.1.1 Overview

The economic literature on solid waste services has primarily focused on waste from residential sources, almost to the point of excluding waste from commercial and industrial sources. The literature itself consists mostly of empirical work investigating the demand for residential waste services. This review will concentrate on studies investigating user or unit-based fees (volume and weight), waste diversion, and some miscellaneous studies on the practicalities of unit-based charges for waste disposal services.

2.1.2 Objectives and issues surrounding unit-based fees

The primary objectives of introducing unit-based fees for the solid waste disposal services in the reviewed literature were to reduce the amount of waste going to landfills and to reduce the amount of waste generated. The key characteristic of a successful unit fee is a pricing structure that creates a real economic incentive to reduce waste.

A prerequisite for an effective programme to divert waste away from landfill using a unit-based fee is that households are explicitly exposed to the fee structure, that is, that the marginal cost of additional disposal is not concealed within a flat fee structure facing households. Economic theory is very clear that a shift from flat to variable fees will lead to increased source reduction and materials diversion (Kemper and Quigley, 1976; Wertz, 1976; Jenkins, 1993; Canterbury, 1994; Morris and Holthausen, 1994; Fullerton and Kinnaman, 1996; Van Houtven and Morris, 1999; Linderhof *et al.*, 2001). On payment of a flat fee for waste collection, there is no economic incentive for households to divert waste away from landfill disposal. With unit-based fees for waste disposal, households incur costs for each additional unit disposed. With volume-based fees, such as an annual fee for the weekly collection of a 240-litre bin, the incentive is somewhat 'lumpy' because the additional cost is only payable at increments of 240 litres. With a weight-based fee, the household pays a marginal cost for all waste disposed and therefore faces a continuing incentive to divert waste.

Although economic theory is quite clear that unit-based fees are very effective at diverting waste away from landfill disposal there are several practical difficulties. Thøgersen (1994, pg. 417) has questioned economists' claims that the market-based approach, such as user fees or taxes, is the most efficient instrument for regulating consumer behaviour with regard to the environment. In a similar vein, Fenton and Hanley (1995, pg. 1327) suggest that there is no *a priori* reason to expect that a single category of instrument will be adequate, and that a mix of targets and instruments may be necessary to achieve a successful waste management plan. It will be noted below that where there have been successes in diverting waste away from landfill through unit-based fees, these successes were dependent on parallel programmes and instruments that encouraged recycling and composting. Indeed, Thøgersen (1994, pg. 435) notes that there would be no recycling in the Danish municipalities he examined without monetary incentives.

One argument against using a financial incentive is that it may have a negative impact on the attitude towards the activity it was meant to stimulate (Frey, 1993; Thøgersen, 1994). Thøgersen relies on a psychology literature to suggest that voluntary participation levels in waste diversion activities (e.g. recycling) may decline with the implementation of a monetary incentive aimed to increase participation in the same activities. Whether or not such a theory is practically relevant, one negative impact of unit pricing is illegal dumping, for which there is some empirical evidence. However, illegal dumping arises not because the financial incentive of unit pricing is not effective but because illegal dumping is the chosen preferred waste diversion activity.

The literature identifies five significant issues that may hamper the success of unit pricing of solid waste disposal (Bauer and Miranda, 1996, pg. 3). These are:

1. Undesirable diversion
2. Complexity of public education
3. Service to apartment buildings
4. Added administration costs
5. Impact on disadvantaged residents.

Bauer and Miranda (1996) found that unit pricing does not necessarily lead to higher levels of illegal dumping. In urban areas, the dumping that does occur tends to be dumped in commercial skips, as opposed to littering, which may be a more significant problem in rural areas. The report notes that illegal dumping often involves bulk waste (e.g. furniture and appliances) and that this type of illegal dumping may be avoided by offering citizens an inexpensive way of disposing of such waste.[1] Even if the full cost of disposal of bulk waste is not imposed on households, larger costs associated with littering and clean-up may be avoided. Documented cases of increased illegal dumping in the aftermath of unit pricing are described in Markowitz (1991) and Fullerton and Kinnaman (1996). Although difficult to measure, Fullerton and Kinnaman (1996, pg. 971) found that illegal dumping possibly accounted for between 28 and 43% of the decrease in waste left for municipal disposal. However, this result is based on a very small sample of 75 households. Jenkins (1993) notes that illegal dumping does increase immediately following imposition of residential user charges, regardless of whether the fees are flat-rate or unit based, but also notes that illegal dumping declines over time. In addition, municipal authorities have found "*the benefits of a user fee programme to outweigh the costs imposed by illegal dumping*" (Jenkins, 1993, pg. 95). The problem of illegal dumping varies from community to community but the problem is generally most acute among disadvantaged residents, discussed below (Jenkins, 1993).

In the USA, public education programmes tend to focus on waste diversion as a means of lowering household costs, neglecting source reduction techniques (Bauer and Miranda, 1996, pg. 30). Bauer and Miranda also noted that municipalities with unit-pricing schemes spent more money on public education programmes than municipalities with flat-rate or tax-financed waste disposal schemes. By focusing on both waste reduction and waste diversion and targeting households across all waste disposal schemes (i.e. unit-pricing and other schemes), waste destined for landfill can be reduced. For unit-pricing schemes to succeed in diverting waste away from landfills, households must understand their disposal options (Bauer and Miranda, 1996, pg. 30).

Åberg *et al*. (1996) give a detailed account of the possibilities and difficulties with one diversion method, home composting. These problems included sanitation problems involving odour and flies, problems with the perceived fitness of use of decomposed material, and with emptying the composter.

Apartment buildings pose serious problems for the development of waste management schemes and incentives to increase levels of waste diversion. Lack of suitable space precludes storage and diversion options, such as home composting, whereas communal waste disposal facilities hinder the imposition of efficient and equitable economic incentives to divert waste.

"*With the exception of the possible need for a residential billing system, unit pricing has little impact on administrative costs*" (Bauer and Miranda, 1996, pg. 31). The cost of a residential billing system though is often shared across several services so its cost may be quite moderate and small relative to the residential solid waste management budget.

Increased solid waste disposal costs pose problems for low-income households. However, unit pricing does not necessarily increase a household's total waste disposal costs. Bauer and Miranda (1996, pg. 31) found that disadvantaged neighbourhoods had low diversion rates and were not taking advantage of cost-saving opportunities and that disadvantaged residents needed special assistance in public information and education programmes.

2.1.3 User fees for solid waste disposal

Communities in Ireland, like elsewhere, take time to adjust to the concept of a user fee for solid waste services (Jenkins, 1993). The difficulties in adjustment arise because households have to pay a user fee for something that previously seemed free. With the advent of user fees the normal progression of fees has been from a flat-rate fee, to a volume-based fee, to a weight-based fee. The volume-based fee, that is, based on bin size or charged per bag, is quite common in Ireland and elsewhere, whereas there are relatively few municipalities that operate a weight-based system. However, there is increasing interest in developing the weight-based system in Ireland. The two primary advantages of a weight-based

1. Possibilities include a monthly bulk goods pick-up service or free disposal of bulk goods delivered to the landfill by private households. Dundalk UDC runs one such system. An online service whereby households can pass on unwanted goods to other persons is hosted jointly by the four Dublin local authorities.

user fee for solid waste disposal services are that it provides a continuing incentive to increase waste diversion and it is more equitable.

As flat-rate fees provide no incentive at household level to reduce waste, any reduction in waste disposal occurring with the implementation of the fee is usually short-lived. In the case of volume-based fees, there is a continuing incentive to limit waste to the capacity of the container but no incentive to further reduce waste. In the case of a weight-based system, disposal fees relate directly to the amount of waste set out for disposal. In addition to providing a continuing incentive to reduce waste destined for landfill, the weight-based system is the most equitable in that households pay their relative shares for the amount of waste they dispose.

2.1.4 The impact of variable-rate fees

There is overwhelming empirical evidence that variable-rate fees generally increase waste diversion levels and participation rates in activities such as recycling and home composting.[2] There are a few studies that have found that variable-rate fees have faced some difficulties in diverting residential waste to recycling, composting or other diversion activities (Reschovsky and Stone, 1994; Coeck *et al.*, 1995); however, these studies appear to be a small minority. It is often difficult to isolate the exact impact of various elements within waste management initiatives but the key aspects are usually readily identifiable. In this section, we recount the experiences elsewhere with variable-rate fees, the degree of their successes or failures, and highlight special considerations and key elements of these waste management initiatives.

Bauer and Miranda (1996) compared the experience of three US cities that had unit pricing. The three cities were Grand Rapids, Michigan, Lansing, Michigan, and San Jose, California. San Jose introduced unit pricing in 1994 and in the first year of operation saw landfilled waste decrease by 21%, from 1.22 tons/household/annum to 0.96 tons/household. In 1991, Lansing increased an existing unit price by 50% and saw landfilled waste decrease by 57% from 0.76 tonnes to 0.44 tons/household/annum. Over 10 years and four increases in the unit price totalling as much as 340%, household waste in Grand Rapids fell from 1.32 to 1.03 tons/household. All three cities had recycling programmes with weekly kerbside collection that collected a wide variety of materials. In San Jose, the weight of recycling increased by 146%, diverted yard waste (garden waste) increased by 46% and the single-family residential diversion rate increased from 28 to 47% after the implementation of unit pricing.[3]

Fullerton and Kinnaman (1996) examined the effect of the change from a general tax-financed refuse service to a per-bag user fee in Charlottesville, Virginia. Although the unit fee in Charlottesville was volume based, Fullerton and Kinnaman also collected data on the changes in weight of residual waste disposed. After implementing the per-unit volume fee, residual waste decreased by 14% in weight and 37% in volume. The density of waste disposed increased by 43%[4] and the weight of recycling increased by 16%.

During 1994, the city of Marietta, Georgia, USA, used two pricing methods for residential solid waste services, either a pay-per-bag or a volume-based fee for bin collection, for the purpose of comparing the relative success of the two systems. Both programmes led to a reduction in residual waste disposal. In the case of the pay-per-bag scheme, the reduction was between 23 and 51% and between 8 and 20% in the bin scheme (Nestor and Podolsky, 1998; Van Houtven and Morris, 1999).[5] Both programmes also led to a reduction in total waste generated, with the bag programme having a significantly greater effect (Van Houtven and Morris, 1999).[6] The larger effect on waste generation under the pay-per-bag programme was attributed to the stronger financial incentive to reduce waste set out for collection.

2. Deisch, 1989; Katz, 1989; Riggle, 1989; Goldberg, 1990; Kourik, 1990; Adamec, 1991; Skumatz, 1991; Stone and Harrison, 1991; Harder and Knox, 1992; Grogan, 1993; Khator and Huffman, 1993; Richards, 1993; Woods, 1993; Cuthbert, 1994; Guerrieri, 1994; Miranda *et al.*, 1994; Moriarty, 1994; Reschovsky and Stone, 1994; Toomey, 1994; Strathman *et al.*, 1995; Bauer and Miranda, 1996; Fullerton and Kinnaman, 1996; Andersen *et al.*, 1997; Dengsøe and Andersen, 1999; Hong and Adams, 1999; Sterner and Bartelings, 1999; Van Houtven and Morris, 1999. OECD (2006) describes further schemes in Spain, Germany and Belgium.

3. Diversion rate = [Waste diverted (recycling or yard waste)/Total waste generated] × 100.

4. The increased density essentially means that households were compressing more waste into refuse bags or containers to avoid the additional cost of an extra bag or container of waste.

5. The two analyses of the Marietta demonstration project differ on the extent of the reductions in waste, hence the ranges in the extent of reductions.

6. Based on a different econometric analysis Nestor and Podolsky (1998) concluded that neither programme had an impact on total waste generation.

In 1995, the South Korean government instituted a national policy of unit pricing for refuse collection services with the aim of reducing waste generation and increasing recycling (Rhee, 1999). In the first year of operation, waste generation decreased by almost 18% and recycling increased by almost 27%, which resulted in a 26% decrease in waste disposal. Behaviour continued to adapt in the second year of operation with waste generation and disposal declining by a further 3% and 5% respectively, with recycling increasing by almost a further 1.5%.

Reschovsky and Stone (1994) examined the effects of the introduction of per-tag fees for waste disposal inTompkins County, in upstate New York in 1990. The county is mostly rural, the largest city being Ithaca, population 28,000. Prior to the implementation of the per-tag fee, waste disposal was financed through tax revenue. They concluded that even with a low per-tag fee, it had significant effects on the amount of recycling and composting.

Sterner and Bartelings (1999) report on a weight-based billing system of household waste disposal in Varberg, Sweden. Average waste per household has declined by 35% and the decrease in residual waste is attributed to increased participation in home composting and recycling, which is facilitated through free weekly kerb collection.[7]

2.1.4.1 The Netherlands experience

Oostzaan was the first municipality in the Netherlands to implement weight-based charges with waste collection/disposal. In the first year of the weight-based charges, waste per household declined by 30%, followed by a further decline in the second year before stabilising in the third year. After 3 years, annual total waste collection had dropped by 42%, with non-recyclable waste declining by 56% (Linderhof *et al*., 2001). Linderhof *et al*. undertook an econometric analysis of the outcome of the programme, which allowed them to estimate price elasticities for compostable and non-recyclable waste under the weight-based system.[8] Short-run price elasticities were estimated at –1.10 and –0.26, respectively, meaning that for a 1% increase in price of collection/disposal, the amount of compostable waste left for collection would decline by 1.1%, whereas non-recyclable waste would decline by 0.26%. These results are achieved either through home composting, reducing waste generated, or recycling. In the longer term, when households have had time to adjust behaviour, these elasticities are *circa* 30% higher at –1.39 and –0.34. Following the success of weight-based charges in Oostzaan, which were introduced in autumn 1993, by 2000 about 10% of the Dutch population living in municipalities faced some form of weight- or volume-based pricing.

2.1.4.2 The Danish experience

The Danish government introduced a waste tax in 1986, the purpose of which was to reduce the amount of waste going to incineration or landfills and to promote recycling and encourage companies to apply low-waste technologies (Andersen *et al*., 1997, pg. 19). The waste tax was charged in addition to existing collection and disposal fees and the chosen rate for the tax reflected the need to ensure the profitability of recycling plants for construction and demolition waste and collection schemes for glass. An evaluation of the waste tax by Andersen *et al*., undertaken in 1997, involved comparing the experiences of ten municipalities with different approaches to waste management, three of which introduced weight-based charges for residual waste disposal.

Residual waste in nine of the ten municipalities examined declined after the implementation of the waste tax. The rates of decline varied considerably between municipalities, which can be attributed to two main causes. The first is that lifestyles and consequently residual waste vary widely between municipalities and, secondly, that the pricing system and the waste management system as a whole play a decisive role (SBI, 1996). In some communities, residual waste accounted for 75% of total waste with the remaining 25% consisting of recyclables, organic and garden waste. In other communities, residual waste was as low as 25% of all waste generated (Andersen *et al*., 1997, pg. 81). The municipalities used different waste management systems and offered a variety of economic incentives for households to divert waste. The level of residual waste reduction during 1990 to 1994 was greater than 50% in four of the ten municipalities. Two of these four

7. In a survey of single-family households in one community within Varberg, people claimed to be recycling 9% of their glass, paper, batteries and hazardous waste, composting 75% of their garden waste and 60% of their kitchen waste (Sterner and Bartelings, 1999).
8. In Oostzaan, two types of waste are collected separately: compostable waste and non-recyclable waste, both priced at the same marginal rate.

municipalities used a weight-based charging system, whereas the remaining two used volume-based charges and complex recycling/composting schemes. Of the three municipalities with the lowest residual waste (approximately 100 kg *per capita* per year), two had a weight-based charge for residual waste disposal.[9]

The municipality with the highest *per capita* residual waste disposal both before and after the implementation of the Danish waste tax also used a weight-based system to charge for residual waste disposal. The annual *per capita* disposal of residual waste in this municipality was 300 kg, compared to an average of 100 kg *per capita* per year in the two other municipalities using a weight-based charging system. However, the weight-based system applied to tenancies only, and the charges were incorporated into the rent. Therefore, there was no direct benefit to householders to separate wastes, as rents are adjusted annually and discounts are based on previous years' waste disposal and also hidden by rent increases.[10] This example highlights the importance of having a clear and direct economic incentive for households to separate their waste for diversion to other disposal methods.

The two successful weight-based waste management initiatives were located in the municipalities of Tinglev and Bogense. In both systems, there was a fixed fee plus a variable element per kilogram of waste disposed in excess of a fixed amount.[11] Prior to the introduction of weight-based fees in Tinglev, a network of recycling centres was put in place, which initially led to a reduction of just 5% in collected residual wastes. When the full weight-based charging system was in place, there was a total reduction of 58% in residual waste. In Bogense, residual waste amounts were reduced by 60% *per capita*.[12]

Waste separation increased from 14 to 47% in Tinglev, with the largest increases in separation for garden waste, bulky waste and glass. Bogense experienced an increase in recycling of 124 kg *per capita.* In both municipalities, there was also a reduction in waste generation of between 17 and 29 kg *per capita* per year.[13]

The municipal authorities in Tinglev were quite satisfied with the success of the weight-based charging system, and they experienced no evidence that waste reductions were achieved by practices such as home burning of household waste or illegal dumping.[14]

In both systems, the frequency of waste collection was reduced from weekly to fortnightly and in both cases special arrangements were made for increased recycling facilities. In Bogense, a dual bin for separated wastes was provided for residual and organic wastes but the volumes within the bins did not correspond to needs. The result was a mixing of residual and organic wastes, and adecline in the quality of organic waste at the centralcomposting centre. In both municipalities, there was an increase in commercial waste but it was not clear whether part of domestic waste had been transferred to commercial sources, or whether it was due to unreliable earlier statistics.

In both Tinglev and Bogense, the financial cost to individual households varied considerably. In Bogense, the average household in 1992 paid more or less the same as before whereas in Tinglev costs decreased by an average of 26% per household.[15]

Within the ten Danish municipalities examined, Vejle is the only municipality that has managed to reduce residual waste to levels similar to that of Tinglev and Bogense, and did not use a weight-based system.[16] Vejle's system is based on source separation of organic and residual waste, deposited in coloured plastic bags and separated automatically by colour identification at a central site. The cost of the system is very high. In the 10 years after 1987, when the waste tax was introduced, household waste collection fees doubled. Average cost to single-family households in Vejle is substantially higher than costs to similar households in Tinglev and Bogense, by as much as double.[17]

2.1.5 Waste diversion

The success of unit-pricing user-fee schemes in all the cases above was dependent on parallel programmes to promote and facilitate diversion of waste to methods of disposal other than landfill. The most common initiatives

9. *Ibid*. pg. 80.
10. *Ibid*. pg. 82.
11. In the case of Tinglev, it was 3 kg/fortnight and 5 kg/fortnight in Bogense.
12. *Ibid*., pg. 84, pg. 85.
13. *Ibid*. pg. 85, pg. 86.
14. *Ibid*. pg. 85.
15. *Ibid*. pg. 85, pg. 86.
16. Residual waste averaged 112 kg *per capita* per year in Vejle compared to 94 kg *per capita* in Bogense and 105 kg *per capita* in Tinglev.
17. *Ibid*. pg. 85, pg. 86.

to increase waste diversion were collect- and bring-recycling schemes, and home or central composting of organic waste. Responses to these schemes varied but analyses of the schemes highlight information that would be pertinent to the development of a weight-based billing system for the collection and disposal of residual waste.

2.1.5.1 Recycling

Several studies examined participation in recycling programmes in the aftermath of unit pricing for solid waste disposal. The effect of a unit-fee scheme for solid waste disposal was found to have a significant effect on the decision to participate in recycling programmes (Nestor and Podolsky, 1998; Hong and Adams, 1999; Van Houtven and Morris, 1999). Nestor and Podolsky found that where households had both kerbside collection and bring-centre recycling that unit pricing led to an increased volume of recyclables left for kerbside collection but no change in recyclables brought to bring-centres. Hong and Adams found that though the price of solid waste disposal had a statistically significant effect on reducing demand for waste disposal and increased recycling, the net effects on the quantities of each were low. Van Houtven and Morris found that both per-bag and volume-based fee structures significantly increased the probability of recycling, by as much as 18%.

Other factors that appear to affect the probability that households participate in recycling schemes are household composition and occupancy levels, the proportion of full-time workers and seasonal factors. Households with more occupants (or with a child under age 3) unsurprisingly generate more solid wastes than households with fewer occupants (or without a child under age 3), but they also have lower recycling rates (Hong and Adams, 1999). Nestor and Podolsky (1998) found that when kerbside recycling is available, but not bring-recycling, the amount of waste recycled increases with the number of occupants in the household. Van Houtven and Morris (1999) found that the probability of recycling is significantly less when a larger portion of the household works full-time away from the home, perhaps reflecting greater time constraints for these households. However, Nestor and Podolsky (1998) found that when households with a higher number working full-time do actually recycle, the volume of recyclables is not distinguishable from other households. Therefore, the policy lesson may be to focus on education and inducements to help such households begin recycling. Hong and Adams (1999) also found that households' recycling rate and demand for recyclable collection service are higher in the autumn and winter seasons, whereas demand for disposal services is greatest in spring and lowest in winter. The lower demand for disposal services in winter is the result of lower generation of solid wastes rather than a higher rate of recycling.

There has also been some research on recycling decisions for various recyclable materials. Jakus *et al.* (1996) found that households were more likely to recycle paper and glass if they knew somebody else who recycled and if they felt their household generated enough recyclables to warrant recycling. In the case of paper recycling, as the time cost of recycling or household income increased, households were less likely to recycle. Also, in the case of paper but not glass, if storage space becomes a constraint, households are less likely to recycle.

Reschovsky and Stone (1994) found that married households compared to non-married households and more highly educated persons were generally more likely to recycle across several materials. Also, households that reported adequate space to store recyclable materials were more likely to recycle. Having knowledge of a nearby drop-off recycling centre was associated with increased recycling of all relevant materials except newspaper. However, only those interested in recycling are likely to seek out information on recycling programmes. Reschovsky and Stone found that of several waste disposal–recycling schemes they examined the most effective included kerbside pickup. Depending on the specifics of various programmes, the probability of recycling different materials increased by between 22 and 58% with availability of kerbside recycling compared to provision of bring-centre recycling only.

Jenkins *et al.* (2003) found that both drop-off and kerbside recycling programmes increase households' intensity of recycling for five materials examined (newspaper, glass bottles, aluminium, plastic bottles and yard waste), with kerbside recycling programmes having the greater effect. Local drop-off recycling centres have the greatest impact on the recycling of materials that are most difficult for households to store and transport, such as glass and plastic bottles. Of particular interest to policy makers is the finding that recycling programmes become more effective over time as households gain greater experience with

recycling and households do not appear to become less enthusiastic over time about recycling.

2.1.5.2 *Composting*

Home or central composting is the other significant possibility for diverting waste from landfill disposal. Although household waste usually has a high organic material component, reliance on composting to reduce residual waste is relatively low. There is little research on the factors that influence households' engagement in either home or central composting but the available research highlights several important points.

Åberg *et al.* (1996) give a detailed account of an experiment with household composting in Göteborg, Sweden. Factors that influenced households to participate in the experiment included a general concern for the state of the environment, and the possibility of a reduced fee for collection of residual waste. An interest in gardening and an appreciation of the benefits of mature compost also characterised participants. Among households participating in the composting programme there were very different opinions among household occupants about whether to participate in the composting project or not. The significance of this is that in order to increase levels of composting it may be sufficient to encourage just one household member who is interested in composting to increase composting rates rather than convince an entire household of the benefits of composting. After one year of the Göteborg project, only four of 36 households had discontinued composting due to dissatisfaction. However, the remaining households had experienced several problems, such as sanitation problems with odour and flies, perceived fitness of use of decomposed material, and with emptying the composter. Households themselves adapted to minimise these problems.

Reschovsky and Stone (1994) undertook a statistical analysis of the factors that influence the probability that a household composts its organic waste. Per-unit pricing was found to be an important determinant, raising the probability of composting by 14%. Larger households, married households and people with higher levels of education were more likely to compost household waste, whereas households with people aged under 45 were less likely to compost.

2.1.5.3 *Illegal waste diversion*

Undesirable effects of user fees for solid waste services include illegal dumping and burning of household trash. Little information is available on what characterises households that engage in such behaviour. Illegal dumping is sometimes associated with disadvantaged households but such a hypothesis has no empirical support. It may be equally likely that medium-income households illegally dump their waste. Reschovsky and Stone (1994) show that the probability that households burn their trash increases for households that are not well informed about recycling programmes, are less educated, have lower income levels, and live in rural areas in single-family dwellings.

2.1.6 *Measured response to unit-based fees – elasticity estimates*

In an overwhelming number of cases, the implementation of unit-based fees, or an increase in fees where unit-based fees are already in place, have led to reductions in residual waste for disposal. The reductions in residual waste are largely attributed to increases in waste diversion and a decline in waste generation. The levels of response by households to unit-based fees have varied widely, even between similar and adjacent communities. This section summarises the measured responses of households to unit-based fees in the form of elasticity measures. Price elasticities measure the proportionate response in waste disposal to a proportionate change in the fee.

Table 2.1 lists a number of studies that provide elasticity estimates, or where the published data allowed elasticities to be calculated. The price elasticity estimates presented show the proportionate response in households' demand for waste disposal service to changes in the volume-based fee and, in one instance, to the weight-based fee. The table draws a distinction between elasticity estimates based on aggregate and on household-level data because estimates based on household data can control for responses due to factors other than price.

While there are some significant outliers, the median elasticity estimate for volume-based schemes is –0.15, with most estimates in the interval –0.1 to –0.2. Based on an elasticity estimate of –0.15, we would expect a 10% increase in the unit fee in a volume-based scheme to result in a fall of 1.5% in waste set out for collection and disposal. A 1.5% reduction in waste destined for landfill

Table 2.1. Elasticity estimates for household waste disposal services.

Authors	System	Price elasticity	
Estimates based on aggregate data			
Hong and Adams (1999)	Volume	–0.01	
Bauer and Miranda (1996)	Volume	–0.84	
Bauer and Miranda (1996)	Volume	–0.15	
Strathman *et al.* (1995)	Volume	–0.11	Tip head fee
Strathman *et al.* (1995)	Volume	–0.45	Waste collection service
Jenkins (1993)	Volume	–0.12	
Skumatz and Breckinridge (1990)	Volume	–0.14	
Wertz (1976)	Volume	–0.15	
Estimates based on household-level data			
Linderhof *et al.* (2001)	Weight	–0.26	Non-recyclables (solid waste) –0.34 long-run elasticity
Hong (1999)	Volume	–0.15	Pay-per-bag
Van Houtven and Morris (1999)	Volume	–0.18	Pay-per-bag
Van Houtven and Morris (1999)	Volume	–0.14	Bin programme
Fullerton and Kinnaman (1996)	Volume	–0.23	

disposal amounts to a significant tonnage of waste but even larger reductions will be required to achieve national targets on waste diversion.[18] Larger reductions in wastes destined for landfill disposal would require substantially higher increases in unit-based fees but large fee increases risk higher levels of illegal dumping and other undesirable waste disposal.

In the Danish municipalities of Tinglev and Bogense, where there were residual waste reductions of 60%, changes in residual wastes were responding to the new fee structure in the weight-based system and not necessarily an increase in price. It is not possible to attribute the reductions in residual waste to a change in price but rather to the change in economic incentives and, therefore, it would not be correct to calculate elasticities.

One estimate of a price elasticity is given for a waste management programme that operates a weight-based user fee in Oostzaan in the Netherlands. The relatively high figure of –0.26 is suggestive of stronger effects from such charging. The authors state that the long-run elasticity being 30% larger still could indicate that the effects of weight-based pricing are permanent.

18. The government has set a target of a diversion rate of 50% of overall household waste away from landfill disposal by 2013 (Department of Environment and Local Government (DELG), 1998).

2.1.7 Summary

The literature is quite clear that unit-based fees for residual solid disposal lead to reductions in waste for landfill disposal and that the impact of unit-based fees compared to flat-rate fees is larger and provides long-lasting encouragement to households to divert appropriate wastes to alternative methods of disposal.

The expected effects of introducing unit-based fees (volume- and weight-based), given the experience with unit-based fees elsewhere, are a reduction in waste generation, increased levels of recycling, and increased levels of composting. It is not possible to quantify exactly how households' waste disposal behaviour will change because responses vary substantially depending on lifestyles and upon the incentives faced in the waste management system. Across a number of studies in different countries, an average price elasticity estimate for volume-based residual waste disposal is –0.15. For a 10% increase in the unit fee, we might expect a reduction in residual waste of the order of 1.5%. In the case of weight-based disposal, the response is higher, as expected, with a price elasticity of –0.26.

The key element to the success of unit-based fees is the availability of alternative disposal options. There appears to be no single programme structure that is necessary to improve waste diversion rates; rather, the chosen waste management system must include comprehensive and accessible recycling and composting alternatives.

With the appropriate incentives, households are likely to increase levels of recycling and composting. Research results show that certain types of households, e.g. those in apartments, are less likely to recycle. To improve recycling among such households, special provision or public education programmes need to be devised, but what characterises such households may differ in Ireland compared to elsewhere, or even within Ireland across urban and rural communities. A similar situation applies in the case of composting of organic wastes.

Increased illegal dumping is often offered as a major disadvantage of unit fees, especially weight-based fees. While experience elsewhere suggests that illegal dumping may increase with the introduction of unit-based fees, the level of illegal dumping where it does occur is relatively small. In addition, the incidence of increased illegal dumping tends to be short-lived, as people accommodate to the new waste management system, and the provision of, for example, special services for the disposal of bulk wastes helps minimise illegal dumping. It should also be noted that illegal dumping is not specific to unit-based fee systems.

Across all the waste management systems examined, the evidence available suggests that weight-based systems have the potential to achieve the highest rates of waste diversion. The most detailed evidence comes from Denmark, where residual waste *per capita* fell by 60% over 2 years, and the Netherlands where the reduction was 56% over 3 years. Such dramatic reductions in residual waste could be achieved by using other waste management systems, but it is likely that their cost would be higher.

3 Case Study of Introduction of Weight-Based Charges

3.1 Methodology for the Case Study

The main purpose of this project is to assess whether weight-based charging can contribute to achieving reductions in the generation of solid waste by households. In order to gain insights into how households respond, it is important that they be confronted by a real change, rather then a hypothetical one, so that alteration in their behaviour can be generalised.

In order to set the trial in a realistic context, the research team sought out local authorities that were introducing weight-based charging schemes and, more demanding, that were willing and able to co-operate in the research. Co-operation involved agreement on the part of the selected local authority to make available the recorded weights of waste for a sample of households **before** and **after** the introduction of weight-based charges.

In addition to the measured weights of household refuse, a second data set would be generated from a household survey. The survey data would be merged with the data on weights of waste collected. The survey would give information on household composition, socio–economic characteristics and other aspects that would be relevant to households' waste generation and their reactions to the introduction of the new charging regime.

At the time the project was proposed, the research team had discussions with several county councils. The county councils were at various stages of introducing the technology and associated systems for administering weight-based charging, and had expressed an interest in co-operating in the project. The required technology includes equipment attached to the refuse freighters to undertake weighing combined with a recording system and procedures set up for processing the information and sending out bills.

A prime reason for the dearth of adequate evaluation of schemes generally, in any field, is the omission of plans for collecting data **before** operations commence. The need for this is usually discovered when the analysis starts after the scheme is established, by which time it is often too late. In this project, the need for the local authorities to test the technology meant that there was a potential source of the necessary data for the period before the introduction of charges.

Negotiations with several local authorities took place and finally, West Cork County Council's introduction of weight-based charging was selected as the subject for analysis. The sample size of households that were interviewed concerning the new charging regime numbered some 1200 households. Of these, nearly 300 households had associated usable data on weights of waste collected, before and after the introduction of the charging regime, recorded by West Cork County Council.

A special subroutine was written in order to convert the data on the weights of waste collected from the format used in West Cork County Council's routines, into household-based files. All the data were then analysed by means of the *SPSS 12.00 for Windows* software package. Analysis of the demand for waste removal services, using Generalised Least Squares (GLS) was undertaken using the STATA software package.

The remainder of this section describing the study's methodology now outlines two aspects in more detail. First, West Cork County Council's introduction of its charging scheme and the assembly and delivery of data are explained and, secondly, the household survey is described.

3.1.1 Charging scheme introduced by West Cork County Council

At the beginning of 2002 West Cork County Council set in place the procedures for the introduction of weight-based charges for the collection and disposal of waste in the West Cork area. The area includes Bantry, Castletownbere, Clonakilty (the town and the environs being two separate areas for collection purposes), and Skibbereen. These areas consist of approximately 1160 households.

A brochure had been sent by the Council to all households on various dates between March and November 2001 to announce the introduction of the new regime (Appendix 1). It was timed to arrive with the distribution of new bins and it informed households that charges based on weight would be introduced in 2003 and that in the meantime

charges for 2002 would be based merely on bin size (H. O'Donovan, Cork County Council, personal communication, 9 November 2004).

Weight-based charges proper started on 1 January 2003. While prior to this the marginal cost of leaving out waste for collection was zero, from 1 January 2003 it became €0.23 per kg. This weight-based charge applied uniformly to all households. Bills were issued in 2003 on 2 April, 16 July, 10 October and 17 December. It had not been until February 2003, however, that households were advised of the actual rate of charge for weighed waste, owing to a search for clarification on Exchequer funding. This possibly accounts for the delayed reduction in the weight of waste collected as, it will be seen, January 2003 still had quite high levels of waste. This means that reductions reported here, calculated for the whole of 2003 compared to 2002, effectively constitute cautious estimates.

In addition to the introduction of the charge per kg, there was a change in standing charge. The standing charge in 2002 was €190 (unless the household used the larger bins for 360 litres, 660 litres or 1000 litres, in which cases the standing charges were €285, €520 or €790, respectively). In 2003, with the introduction of weight-based charges, the standing charge was reduced to a single rate of €160, regardless of the number and size of bins. The point to note is that given that the size of bin had been chosen in 2001, the altered standing charge at the beginning of 2003 did not represent a change in marginal cost attaching to the amount of the service that they buy, so that its impact is more like an 'income effect'. The impact on quantity of waste left out to be collected is unlikely to be affected unless, that is, the household feels significantly poorer.[19] This could possibly arise in the case of low-income households, except that there are waivers/reductions attaching to the standing charges incurred by these households.[20] Therefore, in the analysis of the effects of the introduction of weight-based charging, it is the uniform weight-related price that should be the focus of attention.

19. The shift in the household budget line is very small unless the household's income is extremely low. For a discussion of the issues and literature on marginal cost and standing charges, see Appendix 1 in Scott (1991).

In 2002, although not yet charging by weight, West Cork County Council initiated weighing of waste collected. This entailed collection lorries weighing the waste and recording the weight against the household's ID number on a RAM card. West Cork County Council's software, called *Waste2000*, assembles the information, issues invoices (from 2003), records receipts and produces required reports. As outlined above, the data provided to this study was a text file requiring the construction of a dedicated programme to reassemble the data in usable spreadsheet format.

As charging based on weight was not being introduced until 2003, the records of the weights lifted in 2002 were not comprehensively retained. Of the five areas listed above, only Clonakilty town and environs maintained adequate records for 2002. Clonakilty has approaching 300 households and these records, in usable format and with corresponding codes for linking them to the full household survey, became available for analysis in August 2005. The records still had gaps on 17% of the days when collections took place, owing to overwriting of some RAM cards. A method of imputation was devised whereby the missing weights of refuse were estimated on the basis of the typical behaviour of each household that would have had a collection on the day for which the record was missing.

The upshot is that analysis and discussion of the weights collected are based on 293 households in Clonakilty and the element of imputation ought to be borne in mind when assessing the results. It is to be noted that where the weights of refuse are discussed the analysis is based on weight data on 293 households plus their corresponding survey data, and where the weights are not involved, analysis is based on the survey of the approximately 1160 households.[21]

20. For example, according to the guidelines for West Cork, households with gross annual income of €8580 or below in 2003 were charged €35 in standing charge, and the standing charge rose in steps up to €106 on households in categories of income between €15,080.52 and €15,600.Cases are dealt with on their merits and any special hardship or extenuating circumstances are taken into account, according to the local authority.
21. Inadequate collection of data relating to before the introduction of schemes is not an unusual problem. It constitutes a lost opportunity to gather information that can enhance decision making on projects, *viz.* water infrastructure projects (Lawlor *et al.*, 2007).

3.1.2 Survey of households in the West Cork County area

3.1.2.1 Population and sample

The survey population comprises private households in the area affected by the pay-by-weight scheme introduced in West Cork in 2003. With the help of West Cork County Council, the ESRI sent a letter (reproduced in Appendix 2), to all customers in June 2003, to inform them about the study, describing its aims and methods. People who wanted to opt out could do so and a contact number and e-mail address were supplied so that people could make comments if they wished. They were asked to notify the County Council if they were not willing to have their name and telephone number released to the ESRI.

The Council forwarded the names, addresses and telephone numbers of 3764 customers. From these, a sample of 2250 numbers was selected at random for the main survey. Interviewing was conducted by telephone in January and February 2004. The questionnaire was piloted on 45 cases in early January 2004. After reviewing the results of the pilot, the main survey was fielded in late January to February 2004.

3.1.2.2 Outcomes

Table 3.1 below shows that, of the sample with valid telephone numbers, completed questionnaires were obtained for 1157 households, representing 58% of the valid telephone numbers. A small number of questionnaires were completed but not used (26)because of a large amount of missing information. The main reason for non-response was an inability to contactthe household (no reply, engaged, or answering machine) despite up to ten attempts at different times and days. Ten per cent of the households contacted refused to participate. About 10% of the numbers attempted were outside the scope of the survey, either because the account was a business account or (more rarely) the number was not in service.

Table 3.1. Outcome of main survey and response rates.

Outcome	N	Per cent of valid telephone numbers
Completed questionnaires	1157	58
Completed, not used	26	1
No contact	631	31
Refused	197	10
Valid numbers	**2011**	**100**
Non-valid numbers		
Number not in service	22	
Not a private household	203	
Total	**2236**	

As stated, information on the weight of the waste produced by 293 households was also made available by the County Council. This meant that for these households we could look at whether the weight of waste changed since the introduction of the pay-by-weight scheme and at how this was influenced by household characteristics and by recycling or other behaviour.

The timing of the survey in February 2004 meant that, by then, households had experienced a full year of weight-based charging. The household survey was designed to study the experiences of, and reactions to, the use of pay-by-weight charging for waste collection services in operation in West Cork. The survey was carried out by telephone interview with the person who was "*responsible for paying most household bills*".

The survey asked three main types of question. These concerned:

1. Household characteristics that could influence:
   (i) the amount of waste generated, such as numbers of occupants, ages (for example babies could influence the weight), and numbers of newspapers bought. If occupants were at work this could reduce the amount generated, and at the same time increase the amount if the purchase of more goods can be afforded.
   (ii) waste management behaviour such as the amount of waste recycled or reduced. Having had third-level education or having a car could increase recycling and also reduce the weight.
2. Actual waste management behaviour such as:
   (i) the amount of recycling that they undertook before and after the introduction of pay-by-weight,
   (ii) whether or not they compost organic waste and any changes in this,
   (iii) whether or not they burn their rubbish, and again any changes in disposal method since the introduction of pay-by-weight.

3. Attitudes and experience including:

   (i) views concerning waste management and the new pricing regime,

   (ii) experience of having other people use their bin.

The household questionnaire is reproduced in Appendix 3.

After coding and checking, records for 1157 households were available for analysis, of which 293 in Clonakilty and environs have data on the weights of the waste collected in 2002, before the introduction of weight-based charges, and in 2003, after the introduction of weight-based charges.

A comparison of the characteristics of the 293 households sampled in Clonakilty, for which weights of waste were available, with those of the full sample of 1157 households drawn from West Cork is given in Table 3.2. The major difference is, inevitably, that the Clonakilty sample has a high share of households living in the town, while the sample drawn from the whole of West Cork has a higher share living in the countryside or in a village.

In addition to the difference in location between the full sample and the subsample, there are minor differences in education levels attained. The Clonakilty households tend to have attained more third-level education and they also have slightly higher car ownership. The broad similarity between Clonakilty and all West Cork households means that the Clonakilty sample is generally representative of the West Cork population.

3.1.3 *Outline of the case study*

In the following subsections this case study now looks in turn at

- the measured weight reduction
- recycling behaviour
- composting
- other waste reduction methods
- the determinants of demand for waste collection
- burning
- other illegal disposal methods and, finally
- attitudes to weight-based charging.

The study finishes, in Section 4, with a summary and conclusions.

3.2 Effects of Weight-Based Charges on Weights

The introduction of weight-based domestic waste charges by West Cork County Council is the subject of this case study, the aim of which is to assess the effect on the amounts of waste generated. As described above, charges based on weight were introduced on 1 January 2003 and the rate of charge was €0.23 per kg. In the year prior to this date, the marginal cost of leaving rubbish out for collection was zero.[22] This meant that from this date, households had control over their waste collection bills, because they could reduce their rubbish by recycling or other means and consequently have lower waste bills to pay. During the two years under review, recycling facilities were enhanced somewhat. A bottle bank was in existence in Clonakilty in 2002 and about three more bottle-bank sites were added in 2003. But it was only towards the end of 2003, in September, that facilities for dropping off cardboard and plastic recyclable items were set up. There was no collection of recyclable materials. Reductions in rubbish put out were therefore mainly responses to the price change and, only to some extent, to the enhanced availability of drop-off recycling facilities.

3.2.1 *Reduction in weight of waste going to landfill*

There are two sources of information that can give us a measure of the weight reduction that resulted from the new pricing regime. The first is the overall figure of amounts going to landfill and the second is the waste collection figure, derived from this case study.

A global figure for the whole West Cork area on the weight of waste going to landfill is available from Cork County Council, and the results of the case study can be compared with this. Figure 3.1 and the corresponding data in Table 3.3 show the weights going to landfill during 2002–2005.

Figure 3.1 includes waste from non-domestic sources. Commercial customers were also being subjected to a change in charging regime. A previous volume-based charge was being replaced by a weight-based charge, which worked out at a higher cost than before.

22. Unless one had put in a request for, and obtained, a larger-sized bin, which was "*very rare*".

Table 3.2. Comparison of Clonakilty sample with all West Cork households by tenure, location, household type, social group, education, access to car and income category (%).

	Clonakilty households	West Cork households
Housing Tenure		
Owned outright	75	77
Purchasing (on mortgage)	18	14
Local Authority tenants	4	6
Other, incl. private rented	2	4
Location		
Town	63	36
Village	10	20
Countryside	27	44
Household type		
One person, 65+	14	16
One person, under 65	7	7
Adult(s), dependent children	39	35
Other, all adult, age 65+	19	18
Other, all adult	21	24
Socio–economic group		
Self-employed	19	19
Farmer	8	8
Professional/managerial	25	23
Other non-manual	12	10
Skilled manual	19	21
Unskilled manual	10	11
Never worked and not stated	7	7
Level of education		
Primary	22	22
Lower secondary	18	21
Upper secondary	32	33
Third level	27	24
Has car?		
No car	15	17
Has car	85	83
Household equivalised income		
Under €220 per week	26	28
€220 to €360 per week	36	34
Over €360 per week	38	38
Total for each category*	**100**	**100**

*Components are subject to rounding.

As can be seen from the table, the weight of waste going to landfill decreased by 28% in 2003 compared to 2002. The decline was not immediate as the chart shows. The slow start in January and February may have been due to uncertainty on the part of customers as to the date of introduction and level of weight-based charges, as described above. The weights for 2004 show a continuation of the declining trend and 2005 sees a small pick-up. These figures for waste going to landfill include the waste from commercial enterprises and other sources as well as the waste from households.

3.2.2 Reduction in weight collected from households

We can compare the above result of waste recorded at landfill sites with the data collected in this study on

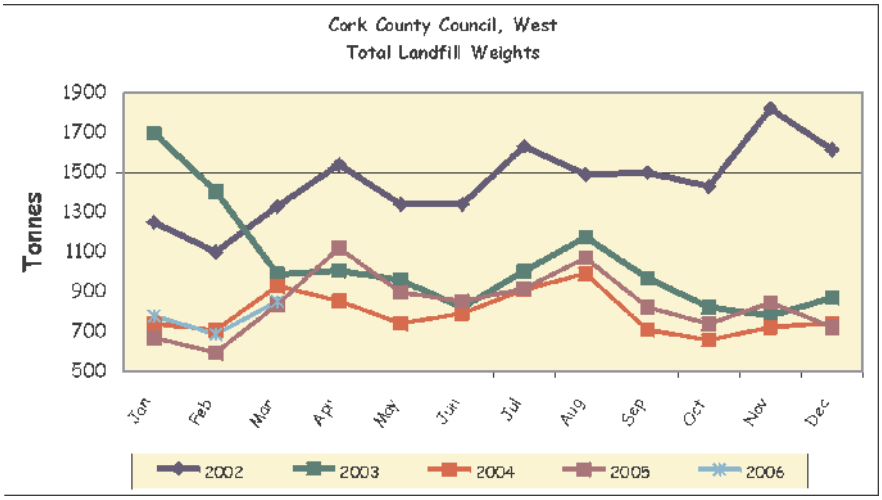

Figure 3.1. Measured waste recorded at landfill sites, tonnes per month. Source: Cork County Council (West).

Table 3.3. Measured weight of waste.

	Total weights to landfill (tonnes)			
	2002	**2003**	**2004**	**2005**
January	1250	1698	740	670
February	1100	1405	709	596
March	1330	990	930	837
April	1540	1006	855	1120
May	1340	960	742	898
June	1340	822	792	852
July	1630	1005	911	917
August	1490	1175	993	1071
September	1500	971	710	823
October	1430	823	659	740
November	1820	780	723	847
December	1613	871	746	723
Year	17383	12507	9509	10096
Change %		–28	–24	6

Source: Cork County Council (West).

domestic waste lifted from households in the town of Clonakilty. Table 3.4 summarises the annual amounts of waste collected in 2002, which is the year before the introduction of the pay by weight scheme, and in 2003, the year after. These are expressed as the total for the sample of households in Clonakilty and expressed per household. The amount collected from these households, at 282 tonnes and 155 tonnes for the two years, respectively, amounts to some 1% of the recorded total from all sources at landfill entered in Table 3.3.

The total amount of waste lifted from the 293 households in 2002 was, as stated, 282 tonnes. Given an average household size of 3.17 persons according to the sample, this works out at some 304 kg per person. This is somewhat less than the national figure of average waste collected per person in Ireland of 370 kg per year reported in the *National Waste Report 2004* (EPA, 2005a, Appendix A). The lower half of Table 3.4 expresses the amounts per week collected from the Clonakilty sample.

It is noteworthy that the percentage reduction in weight lifted from households in the year after, compared to the year before, the new charging regime is 45%. This is a much higher rate of reduction than the 28% reduction indicated from the figures in Table 3.3 for the West Cork area as a whole, which includes commercial and other waste.

Figure 3.2 shows the profile of weekly waste collections per average household in the Clonakilty sample. The same pattern of a slow reaction at the start of the year is seen. Owing to a high level of variation the graph charts 3-week moving averages of the weights lifted. A seasonal pattern is not discernible, owing probably to the fact that respondents were domestic and not commercial customers of the local authority's waste service. This would mean that sources of seasonal waste such as hotels, holiday homes and, most probably, guest houses were excluded. As mentioned in the methodology section, some data had to be imputed because there were some weeks when figures were missing but this should not have affected the general pattern.

Having established that there was a reduction in domestic waste collected and that the reduction was sizeable, the next questions to be addressed are: what were the methods used and who were the people that managed to reduce a lot or a little?

This study now proceeds to answer these questions for the sample by looking at the means that can be used to reduce one's waste. The following sections look at recycling behaviour, composting, burning, the determinants of demand for waste collection, the response to price, illegal waste behaviour and attitudes to the pricing regime. Summary and conclusions follow in Chapter 4.

3.3 Recycling

We saw above that households in the Clonakilty sample significantly reduced the amount of waste left out for collection in 2003 compared to 2002. Recycling can play an important role in reducing waste and we would like to know about the recycling activities of these households.

Table 3.4. Annual weight of waste lifted from households in Clonakilty sample in the year before and year after introduction of new charging scheme.

	Year before	Year after	Change in weight
Per year			
All households in sample (tonnes)	282.3	155.4	–126.9
Per household (tonnes)	0.963	0.530	–0.433
Per week			
All households in sample (tonnes)	5.43	2.99	–2.44
Per household (kg)	18.53	10.20	–8.33
No. of households	293	293	

Source: Cork County Council (West) and ESRI.

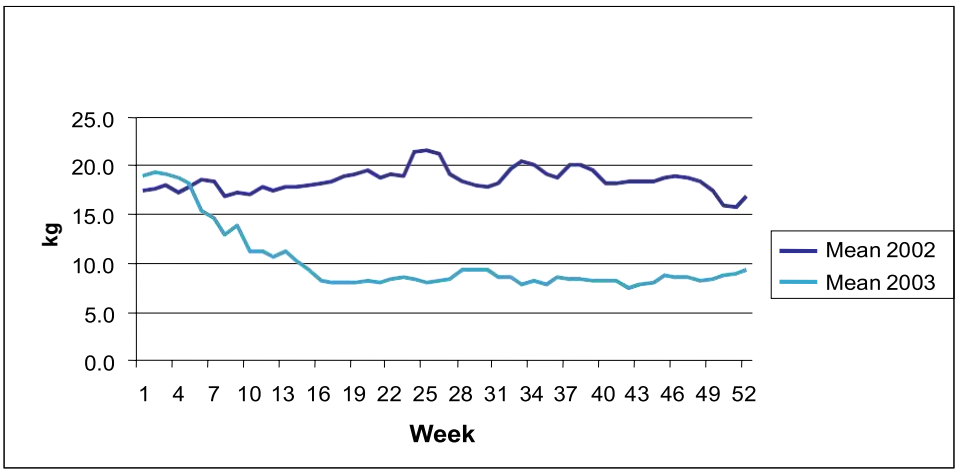

Figure 3.2. Waste lifted from households in Clonakilty sample in 2002 and 2003, kg per household per week, 3-week moving average. Source: ESRI and Cork County Council.

One can then view their reductions in waste against their own statements about their recycling activity.

Table 3.5 shows the average weight reductions, broken down by whether or not the household recycles regularly and by households with different levels of recycling. Households that claimed always to recycle four or more materials can be seen to have reduced the amount of waste put out for collection by 521 kg in 2003 compared with 2002. This is well above the average reduction per household in Clonakilty of 433 kg seen in Table 3.4. This reduction means that their annual waste bill was about €120 less than it would have been if their waste had stayed at its level prior to the new charge.

The recycled materials in question consisted of paper, glass, plastics, old clothes, food cans and beverage cans. Correspondingly, households that say they do not recycle regularly reduced by considerably less, by 135 kg. This pattern is perhaps only to be expected, unless people actively engaged in recycling were already recycling at their maximum. We should remember, however, that recycling facilities were to some extent extended, in terms of number of facilities and type of material accepted, so that increased recycling could thereby have been facilitated. This is probably reflected in the results.

The question as to whether or not **increased** recycling was consciously undertaken on foot of the new charging regime is addressed in Table 3.6. It can be seen that 80% of all West Cork households and 86% of Clonakilty households say that they increased recycling. By consequence, the latter reduced their waste by 105 kg , or by 29%, more than those who replied that they did not increase recycling. This indicates not only the scope for waste reduction when households face an incentive, but also that increasing one's recycling is a helpful option, provided that the facilities are in place.

Households were given the opportunity to describe their behaviour and express their views on a number of aspects relating to recycling. The socio–economic information in the remainder of this chapter relates to the West Cork area. A fundamental piece of information is the distance to the nearest recycling facility. Table 3.7 shows thestated distances as of February 2004. The percentage of households living at the specified distances is given in the final column. From this, it can be seen that over half of West Cork households live within a mile of their nearest recycling facility. Aside from these households, some of the others face considerable distances according to their statements, with 20% facing a 5-mile journey or more. The previous four columns show the intensity of recycling, from "*do not recycle regularly*" to recycling of increasing numbers of materials.

Table 3.5. Recycling activity and weight reduction between the year before and the year after introduction of weight-based charging, kg per household.

Intensity of recycling	% of West Cork households	% of Clonakilty households	Average reduction per Clonakilty household between year before and year after (kg)
Do not recycle regularly	8	5	135
Always recycle 1 material	18	13	361
Always recycle 2–3 materials	34	35	388
Always recycle 4+ materials	40	46	521
Always recycle 1 or more	**92**	**95**	**449**
Average all households			433
N cases	1157	293	293

Table 3.6. Weight reduction (kg) and whether recycling activity increased.

Increased recycling?	% of all West Cork households	% of Clonakilty households	Average reduction per Clonakilty household between year before and year after (kg)
Yes	80	86	464
No	20	14	359
N cases	1061	278	278

Note: Those who stated that they did not recycle on a regular basis were excluded as well as cases with missing information.

Table 3.7. Distance to recycling centre and intensity of recycling.

Stated distance to recycling centre	% of households at stated distance that do not recycle regularly	Recycling intensity (column %)				% of households living at stated distance
		Do not recycle regularly	Number of materials regularly recycled			
			1	2 to 3	4 +	
Up to 1 mile	6	37	49	53	51	50
From 1 to 3 miles	6	12	13	14	17	15
From 3 to 5 miles	6	8	13	10	8	10
From 5 to 10 miles	8	13	14	13	14	13
Over 10 miles	10	8	6	5	7	6
Unknown	31	23	5	5	3	6
West Cork households	8	100	100	100	100	100

Note: where the entries are subject to rounding they may not add precisely to 100.

There are two main points to be noted from Table 3.7. As the base of the first column shows, some 8% of households state that they do not recycle regularly. Not surprisingly, 31% of those who do not know the distance to the recycling centre say that they do not recycle regularly, and a slight distance effect in the first column is also discernible with those that state the distance.

Correspondingly, there is a somewhat inverse distance effect with those in the columns that do recycle regularly. A coherent pattern is also seen in comparing the second column with the last column. Six per cent of West Cork households do not know the distance to the nearest recycling centre, but this figure rises to 23% of those who do not recycle regularly. In all likelihood, many of these 23% live within 1 mile but do not realise it, judging from the 50% share of West Cork households in general living within 1 mile.

Secondly, looking in more detail at those that do recycle, it is possible to investigate the intensity of their recycling activity in terms of the number of different materials. The recycling intensity columns show that distance has little influence on whether few or many materials are recycled. The pattern of distances for varying numbers of materials recycled differs little among those who recycle regularly. For instance, almost half of those who regularly recycle one type of material live within a mile of a recycling centre, compared to just over half (51–53%) of those who regularly recycle two to three or four or more types. About a fifth of households recycling one, two to three, or four or more materials live over 5 miles away. One might have expected those recycling a higher number of materials, like four or more materials, to live closer to the facility but this is only marginally the case. An inference to be drawn therefore is that, if a household recycles, distance has little effect on the number of materials that it recycles. Recycling households exploit the potential for economies of scale by taking many materials to be recycled, which is the efficient thing to do.

The above result leads one to the question of car ownership. Owning a car, or having access to a car by virtue of someone else in the household owning a car, could facilitate the transport of items to the recycling centre. The vast majority, 92% of households, claim to recycle on a regular basis and the results in Table 3.8 do indeed bear out the advantage of having a car.

Seventeen per cent of households do not have access to a car. Some 22% of these ‘carless’ households do not recycle on a regular basis. By contrast, only 5% that do have access to a car do not recycle on a regular basis. Those without access to a car are also less likely to have increased their recycling when the new pricing regime was introduced in January 2003 and they are more likely to say that recycling involves an extra journey. It is to be noted that for a majority of car owners, if a slender majority, recycling does not entail an extra journey.

Wider socio–economic factors also have an important bearing on recycling behaviour. Asked when recycling started on a regular basis, housing tenure, location and education stand out as differentiating characteristics, as shown in Table 3.9. Appendix 4 gives tables showing greater socio–economic detail and just the salient points are described here.

Table 3.8. Recycling and households that have or do not have access to a car, row %.

Access to car	Recycle on a regular basis?		Recycling increased since Jan 2003?		Recycling involves extra journey?	
	Yes	No	Yes	No	Yes	No
No car	78	22	70	30	57	43
Has car	95	5	81	19	48	52
All households	92	8	80	20	49	51
N cases		1157		1061		1153

Table 3.9. When recycling began on a regular basis, row %.

	When did your household start recycling on a regular basis?				
	Before new pay-by-weight scheme announced	When new pay-by-weight scheme announced	When new pay-by-weight scheme was introduced	During the year that new scheme was introduced	All recycling households
Housing tenure					
Owned outright	48	17	14	21	100
Purchasing	45	21	13	21	100
Local Authority	34	24	10	32	100
Other	44	6	14	36	100
Location					
Town	42	18	12	27	100
Village	45	18	15	22	100
Countryside	53	16	15	16	100
Level of education					
Primary	39	15	13	33	100
Lower secondary	44	14	16	26	100
Upper secondary	48	20	13	19	100
Third level	56	17	14	12	100
All households	47	17	14	22	100
N cases	500	183	148	232	1063

Looking at all households that recycle on a regular basis, in the bottom row, the greatest number at 47% had started recycling before the scheme was announced. At the other end, there was over a fifth that started during 2003, that is, when the scheme was up and running. It is noteworthy that 17% started when the scheme was announced, even though not paying yet. This is called an 'announcement effect' in the literature: people start reacting to the announced charges, perhaps to familiarise themselves prior to the new regime.

With respect to the breakdown by housing tenure, it is to be noted that local authority tenants who recycle were more likely to have started once charging was announced and operating. With respect to location, it is seen that a majority of recycling households in the countryside had started before the announcement. This may reflect the traditional absence of a collection service in the countryside that encouraged early recycling habits.

Table 3.9 also shows that a higher level of education is associated with an earlier start to recycling (and also with a higher proportion recycling, shown in Appendix 4). It can be seen that 56% of those with third-level education had started before the announcement of the scheme compared to only 39% of those with primary-level education.

Some practical observations are shown in Table 3.10, which gives respondents' views on whether or not there is a recycling centre convenient to them, for each material specified.

The only recycling centre that is clearly considered to be convenient, by 95% of households, is the glass recycling facility. Convenient centres for paper, beverage cans and plastics are considered to exist by only 71% down to 53% of respondents. Batteries and white goods, items that have potential for considerable harm, were not seen as

Table 3.10. Whether there is a convenient recycling centre for each material, row %.

	Is there a convenient centre?			
	Yes	**No**	**Don't know**	**All households**
Glass	95	3	2	100
Beverage cans	66	20	14	100
Food cans	32	45	23	100
Batteries	8	66	25	100
White goods	10	70	20	100
Paper	71	23	6	100
Plastics	53	34	13	100
Wood/timber	9	75	16	100
Old clothes	30	58	11	100
Other materials	1	90	9	100

N = 1157.

having convenient centres. More notably, 25% did not know about centres for batteries – the most ignorance attaching to the worst item.

Households were also asked whether they would like to recycle more than at present and to give the main reason that they do not recycle more. Answers to this question are shown in Table 3.11.

As seen from Table 3.11, a good majority, at 67%, said that they would like to recycle more than at present. This positive response rose with the level of education of the respondent. The highest positive response, at 76%, was from households with adults and dependent children, which bodes well for the future. The lowest positive response, at 46%, was from the households consisting of one person aged 65 or over, evidence perhaps of difficulties facing this group.

When asked to indicate the main reason that they do not recycle more, nearly a quarter say that the recycling centres are too far away. The elderly single persons and those that never worked or do not state their occupations, as well as those with no car, were likely to say that they do not have enough waste or cannot transport the waste to the recycling centre. Over a fifth of those with lower secondary education stated that they had nowhere to store the waste at home prior to recycling or that it was too much mess or bother. The major reason in most cases, however, comes under the heading 'other' reason for not recycling more. This was elaborated on by respondents and consisted largely of claims that the facilities were not there, especially facilities for cans. Facilities for other materials were also stated to be absent, including for paper and organic waste. Many citing 'other' reasons said that the facilities were dirty and overflowing, and a few claimed that they did not know where the facilities were and some simply said that they needed to make up their minds to get round to it.

3.4 Organic Waste: Composting or Feeding to Animals

Composting of organic waste or feeding to animals are other effective ways for households to reduce the amount of waste that is left out for collection. Two sorts of organic waste were presented in the questionnaire. The first was garden waste and respondents were asked whether or not they have garden waste and, if so, how do they dispose of it. The second sort of organic waste is food waste and respondents were asked whether they composted it or fed it to animals. They were also asked when had they started these activities and whether these had increased since the introduction of the pay-by-weight regime.

3.4.1 Waste reduction and methods for dealing with organic waste

3.4.1.1 Garden waste

Dealing first with garden waste, the experience in Clonakilty and environs is that those households having garden waste appeared to have greater opportunities for waste reduction judging from the evidence of the weights collected. As Table 3.12 shows, those not having garden waste to deal with achieved a reduction of 430 kg per year. This is marginally below the average reduction of 433 kg for all households in the Clonakilty sample and well

Table 3.11. Whether household would like to recycle more and reason for not doing so, row %.

	Would you ike to recycle more than at present?		Main reason for not recycling more					
			Recycling centres too far away	Can't transport material to centre	Don't produce enough waste/not worth it	Nowhere to store at home	Too much mess/bother	Other reason
Housing Tenure								
Owned outright	66	34	23	2	9	5	4	56
Purchasing	72	28	25	3	3	7	2	60
Local Authority	62	38	19	6	3	6	3	61
Other	53	47	26	5	11	0	0	58
Location								
Town	64	36	18	4	7	6	4	62
Village	70	30	32	2	8	5	3	49
Countryside	68	32	26	1	8	5	4	56
Household type								
One person, 65+	46	54	28	10	27	2	0	33
One person, under 65	67	33	30	2	7	7	0	54
Adult(s), dependent children	76	24	20	2	4	9	6	60
Other all adult, age 65+	55	45	27	2	9	1	3	59
Other all-adult	71	29	26	1	7	4	3	59
Socio–economic group								
Self-employed	69	31	18	3	10	7	7	56
Farmer	75	25	31	0	5	7	5	52
Professional/managerial	73	27	23	1	5	5	2	64
Other non-manual	64	36	26	1	10	1	1	59
Skilled manual	65	35	24	2	8	7	6	53
Unskilled manual	55	45	26	5	2	5	2	61
Never worked and not stated	50	50	23	10	23	3	0	42
Level of education								
Primary	53	47	32	4	18	4	3	40
Lower secondary	64	36	15	3	10	15	6	51
Upper secondary	70	30	25	2	5	2	4	60
Third level	75	25	23	0	4	3	3	66
Has car?								
No car	49	51	33	11	17	4	0	35
Has car	69	31	22	1	7	6	4	60
Household equivalised income								
Under 220 per week	56	44	20	7	13	5	4	51
220 to 360 per week	70	30	22	2	9	7	5	57
Over 360 per week	70	30	27	1	4	4	3	61
Total	67	33	24	2	8	5	4	57
N cases	709	356	167	16	54	38	27	404

Table 3.12. Method of disposal of garden waste and average reduction in waste per household between year before and year after introduction of weight-based charging.

Disposal of garden waste	% of West Cork households	% of Clonakilty households	Average reduction per Clonakilty household** comparing before and after the new charge (kg)
No garden waste	28	26	430
With rest of rubbish	4	5	312
In compost bin/pit	39	39	495
Put in pile in garden	27	26	405
Burn	4	3	378
Other	6	9	333
Total	108*	108*	433
N cases	**1157**	**293**	**293**

*Percentages need not sum to 100 as households may use more than one method.
**Note that those who compost may also recycle and use other means, so that waste reduction is the result of all means used, including recycling, etc.

below those who disposed of garden waste in a compost bin or pit, who succeeded in reducing their weight by 495 kg. This is not to say that this amount was placed in the compost bin or pit but simply that those people who availed of this option were able to reduce the weight of their waste, by whatever means, by more than other people. A broad rule of thumb of the annual amount of household waste that is composted is 100 kg, according to the *Compost Report* published by the EPA (2003).

Naturally enough those that simply disposed of garden waste by putting it out for collection showed the least weight reduction, at 312 kg, though it is a good weight reduction nonetheless.

The other method of disposing of garden waste consisted of putting it on their land, if they have land, and of disposing off-site, such as removal by the gardener. One respondent said that the waste disposal unit chopped it up and the waste went with the waste water – a method that could put severe demands on a local waste water treatment plant. It is useful to become aware of examples of evasive action such as this potentially damaging approach.

3.4.1.2 Food waste or other organic waste

Disposal of food and other organic waste by composting or feeding to animals also enabled households to reduce the amount of waste collected. Table 3.13 shows the proportions of households that dispose of organic waste in these ways, alongside the reductions in waste that occurred.

As can be seen from Table 3.13, composting food waste affords another opportunity to reduce one's amount of waste. The reduction of 480 kg by those composting is not quite on a par with that achieved by people who put their garden waste in a compost bin or pit, shown in the previous table, and some way off the reductions achieved by those who say that they always recycle four or more materials, at 521 kg shown in the previous section. Nevertheless, households that composted achieved reductions well above the average reduction of 433 kg. Feeding to animals reduced the weight only somewhat

Table 3.13. Disposal of food waste and average reduction in waste in year after compared to year before introduction of new charge.

Do you compost or feed to animals?	% of West Cork households	% of Clonakilty households	Average reduction per Clonakilty household comparing before and after new charge (kg)
Yes, compost	42	46	480
Yes, feed to animals	12	10	445
No	46	44	382
Total	100	100	433
N cases	**1157**	**293**	**293**

compared with the average reduction, consistent with the likelihood that animals tend not to eat more than they need and that they could already be near their limit. Those households that neither composted organic waste nor fed it to animals showed least reduction in weight, and less than the reduction achieved by the average household in the Clonakilty sample.

The question as to whether or not composting or feeding to animals increased when the pay-by-weight regime began is addressed in Table 3.14. Again, alongside the behavioural responses are the corresponding average weight reductions. As expected, stated increased activity resulted in larger reductions.

These results again show that many households avail of opportunities to reduce the amount of waste for collection, and thereby face lower waste bills. The saving by those who composted or increased composting and feeding to animals, at €0.23 per kg, was some €110 in 2003. (Note that this is not additional to the saving from recycling, calculated in the previous chapter. The saving is not calculated separately for each reduction activity.)

3.4.2 Organic waste disposal and socio–economic characteristics

3.4.2.1 Garden waste disposal and socio–economic characteristics

Turning to garden waste again, 28% of households sampled in the whole West Cork area have no garden waste. Of the 72% that have garden waste, over a half of them compost it and most of the rest put it in a pile in the garden; however, 4% of households dispose of it with the rest of the rubbish and the remainder burn or dispose of it by the other methods, described above. Appendix Table A4.4 shows the underlying figures and socio–economic detail.

Focusing on the 4% who dispose of garden waste with the rest of their rubbish, it is noticeable that the proportion is 11% of those that live in local authority houses, suggesting that they may have inadequate space for any alternative method. Space is likely to be an issue. The proportion was also above average, at 7% for persons living alone aged 65 and over and those households where the respondent had primary education. Correspondingly, those with third-level education had highest recourse to the compost bin or pit. It is noticeable, though unsurprising, that the higher the equivalised income of the household, the higher the share of households disposing of garden waste in a compost bin or pit.

3.4.2.2 Food and other organic waste and socio–economic characteristics

All households generally have to cater for disposal of food waste, unlike garden waste which only applies to those that have a garden. We saw that composting was associated with significant reductions in waste when charging by weight was introduced. However, composting requires separating and probably setting up a separate receptacle for food waste and having knowledge of what to do with it, as well as having a destination for the resulting compost. What are the characteristics of these households that compost? Appendix Table A4.5 shows the characteristics of the full sample from West Cork.

It is clear that most people, 71%, whose housing tenure is categorised as ‘other’ meaning that they live in privately rented accommodation or rent-free, do not compost or feed to animals. Also, the majority of local authority tenants, at 56%, do not compost or feed to animals.

Turning to the household category of one-person households, especially again those where the person is aged 65 or over, they tend not to compost or feed to animals. As is to be expected, those that live in the countryside would be more likely to engage in these activities. This is consistent with the socio–economic breakdown, also in Appendix Table A4.5, where it is seen that farmers are unlikely to say that they do not compost or feed to animals, and are naturally the most likely to do the latter. Those who never worked or do not state their

Table 3.14. Whether composting or feeding to animals increased with the new charging regime, and average waste reduction (excludes households that do not compost organic waste or feed it to animals).

Increased composting/feeding to animals?	% of West Cork households	% of Clonakilty households	Average reduction (kg)
Yes	41	47	479
No	59	53	374
N cases	**474**	**116**	**116**

work are least likely of all the groups to compost. The highest tendency to compost is found among the other non-manual group and the professional/managerial group. There is again a steady progression according to equivalised household income. Better-off households compost and feed to animals, at 47% in the case of those with equivalised income over €360 per week, compared to a lower figure of 35% in the case of those under €220 per week.

The question as to when the household started composting or feeding to animals was posed. Respondents were given four possible responses, that is, they were doing this before the announcement of the new pay-by-weight scheme, at the time that the scheme was announced, when the scheme was introduced or, fourthly, some time during the year after it was introduced. Table 3.15 shows the answers from the 54% of households in the full sample from West Cork that said that they compost organic waste or feed it to animals.

Table 3.15 provides three main observations relating to households that compost or feed organic waste to animals. There is an important majority of these, at 68%, that were already in the habit before the new charging regime. One-third, therefore, started subsequent to the announcement of the scheme. Starters before the announcement were somewhat more likely to be those in the other non-manual and professional/managerial socio–economic group and farmers.

Secondly, it is observed that a noticeable proportion, 12%, actually started when the announcement was made, evidence again of an 'announcement effect'. One can surmise that these people reckoned that it would be wise to be prepared for when the charge came in, and households that reacted to the announcement constitute over a third of those that changed their habits.

Thirdly, it is possible to see the timing of the change in habits of the different groups. Local authority dwellers, who at the end of the survey period still have low rates of composting plus feeding to animals, at 45% (Appendix Table A4.1), reveal a gathering momentum of change. Of these, over half have started since the charging scheme was announced, with successively greater numbers

Table 3.15. When the household started composting or feeding to animals, row %.

	When started composting or feeding to animals on regular basis			
	Before new pay-by-weight scheme announced	When new scheme announced	When scheme introduced	After new scheme introduced
Housing tenure				
Owned outright	69	12	8	12
Purchasing	69	12	10	8
Local Authority	46	11	18	25
Other	60	10	10	20
Household type				
One person, 65+	72	15	6	8
One person, under 65	67	10	8	15
Adult(s), dependent children	67	10	12	12
Other, all adult, age 65+	72	13	6	9
Other, all adult	66	13	8	13
Socio–economic group				
Self-employed	66	13	10	11
Farmer	73	13	8	6
Professional/managerial	71	10	8	12
Other non-manual	75	7	9	9
Skilled manual	61	13	8	18
Unskilled manual	66	14	12	9
Never worked and not stated	64	12	8	16
Total	**68**	**12**	**9**	**12**

Note: Table based on 616 cases (those who compost or feed to animals).

starting, that is, 11% when the scheme was announced, 18% on introduction and 25% when the scheme was in place. A somewhat similar pattern of increases over time can be seen in the case of 'other' housing, that is, households in privately rented or rent-free accommodation. It is possible that in the case of accommodation that one does not own, which could be an apartment, the opportunities for composting may not be readily available. By contrast, relatively strong announcement effects are witnessed in households consisting of one person aged 65 and over, though their rates are still low.

A further qualification on composting or feeding to animals relates to the question as to whether or not the household actually increased these activities. It was seen in Table 3.14 above that 41% said that they had increased composting and feeding to animals. Those standing out as having increased the activity included households in the professional/managerial and skilled manual groups and in the high-income group. Those indicating relatively low increases were local authority and other households.

Finally, it should be noted that the seeming continuing improvement in reduction is a normal feature of the introduction of environmental charges. As we saw, the household might find that immediate adoption of reduction methods is not feasible but, with the charge in existence, the pressure persists to avail of opportunities if and when they arise as household circumstances alter.

3.5 Other Conscious Efforts to Reduce Waste

3.5.1 Other means

Respondents were asked about other means of waste reduction. The questionnaire asked whether they had made a conscious effort to reduce the waste that they produced, such as by choosing products with less packaging. Table 3.16 shows the answers to this question and the corresponding reduction in weight of waste (by whatever means) recorded for these respondents.

In Table 3.16, the resulting weight reductions are consistent with respondents' statements. Those that gave a positive response when asked whether they made a conscious effort to reduce weight by other means were found to have made a greater than average reduction in waste. Those that gave a negative response reduced their waste correspondingly by less than average.

It is to be remarked that the proportion saying that they did make a conscious effort to use 'other means', at 61% according to the full sample, is quite high. They had already been asked about recycling, composting, feeding to animals and burning, and this question refers to the actual production of waste in the first place and constitutes additional effort. The question quoted an example of another means, namely, of choosing products with less packaging. There may indeed have been more effort, for example, to take a shopping bag and select more loose vegetables and fruit. The plastic bag levy was introduced in 2002 and this has led shoppers to bring in reusable bags when shopping and possibly to be more waste conscious. The results may reflect how waste consciousness itself makes a difference to the production of waste.

3.5.2 Other means and socio–economic characteristics

We now look in more detail at the 61% of households that responded positively to the question asking them whether they had made a conscious effort to reduce their waste, such as 'by choosing products with less packaging'. Table 3.17 gives the socio–economic detail.

Those that stand out as making a conscious effort to reduce waste by other means are all-adult households and farmers. Those least inclined to say they made a conscious effort include those living in private rented or rent-free accommodation, households with one person aged 65 or over, and those stating that they never worked or gave no occupation. There is a clear-cut rise in effort with higher levels of income and car ownership.

Table 3.16. Whether attempted to reduce waste by other means, and weight reduction.

Tried to reduce waste by other means?	% of West Cork households	% of Clonakilty households	Average reduction (kg)
Yes	61	59	460
No	39	41	395
N cases	**1150**	**293**	**293**

Table 3.17. Socio–economic characteristics of households that made a conscious effort to reduce waste by other means.

	% of households that made a conscious effort to reduce waste by other means
Housing tenure	
Owned outright	61
Purchasing on mortgage	63
Local Authority	58
Other, including private rented	38
Household type	
One person, 65+	45
One person, under 65	56
Adult(s), dependent children	66
Other, all adult, age 65+	58
Other, all adult	69
Socio–economic group	
Self-employed	64
Farmer	70
Professional/managerial	59
Other non-manual	56
Skilled manual	64
Unskilled manual	57
Never worked and not stated	46
Level of education	
Primary	56
Lower secondary	63
Upper secondary	62
Third level	63
Car ownership	
No car	47
Has car	63
Household equivalised income	
Under €220 per week	54
€220 to €360 per week	63
Over €360 per week	63
Total	61

N = 1150.

3.6 The Determinants of Demand for Waste Collection

So far, the data collected in the course of this case study have been analysed by means of tables using various cross-classifications. It is also useful to analyse the data in such a way as to provide a more comprehensive picture as can be achieved by modelling. Following Fullerton and Kinnaman (1994), the demand for waste collection is now modelled by using the data to construct an equation of the demand for waste collection.

3.6.1 Modelling demand for waste collection

Specifically an equation can be estimated that aims to explain what causes the demand for waste collection services. Demand will be defined as collected weekly household waste per head. Expressing waste per head in this manner overcomes the fact that households have different numbers of inhabitants. Demand can then be posited to depend on such factors as the price of collection per kg, and on other household characteristics. These include the number of newspapers or magazines

that the household purchases each week, whether or not the accommodation is owned, the proportion of persons in the household that are at work, the proportion of persons in the household that are under three years of age, whether the household respondent had third-level education and whether the household has a car or access to one. Other characteristics include the income of the household and the numbers living in the household.

For some of these characteristics, such as price and the number of newspapers bought, it is easy to see that they might influence the amount of waste left out for collection. Owning one's house could allow one to be more settled and therefore better organised with respect to waste disposal. Having third-level education, being at work, having a car and the level of household income are characteristics that could be related to each other. Education and work give one an income and enable one to buy goods that have associated amounts of waste. They also enable one to own a car, which in turn could be useful for recycling. The share of infants could raise the level of waste if disposable nappies are being used, and the number of persons in the household could reduce the household's average waste per head, in so far as packaging waste and suchlike does not rise correspondingly with numbers in the home, so that there are 'economies of scale'.

The benefit of developing a model is to be able to see which factors are likely to influence the demand for waste collection, while taking account of all the influences specified. This can give a more accurate indication of causative factors, though effects of factors that are related to each other may still be difficult to isolate. Details of the model and the various features are given in Appendix 5.

3.6.1.1 Results of modelling demand

The results from the model tell us what influences the average weekly waste collected per head over the two years in question. The effect of the introduction of a weight-based price is seen to be highly significant in reducing the amount of waste. The other significant influence is the number of persons in the household, which is seen to have a weight-reducing effect. Given that we are looking at weight per head, this means that households with larger numbers have less weight per head, as hypothesised above. In addition, it is found that the decrease in weight per head becomes weaker the higher the numbers in the household.

The impact of infants under 3 years old in the household is seen to raise the average weight of waste per head, as suggested above. The other factors were not found to be significant influences though increasing the number of newspapers and magazines may have a positive effect, also as expected. The other factors, as already described, are likely to be interrelated and factors such as income or education, for example, may on the one hand increase the amount of waste or conversely increase one's ability to recycle and raise awareness of recycling, composting and the like.

The unambiguous significance of the price effect is to be noted. A spin-off from the model is that the result for price can be used to calculate an important measure, namely the responsiveness of waste to the price of collection. Known as the price elasticity of demand, it can tell us how responsive people are to price changes. Such information is helpful to providers of services, to planners and policy makers, and in cost–benefit analyses and in forecasting. The price elasticity of demand, calculated at the sample average levels of price and weight, is –0.266. This means that if the price per kg of waste collection rises by 10%, for example, the amount of waste per head left out for collection will decline by 2.66%.

By comparison with other studies this is a plausible result for responsiveness to price change, though it indicates a stronger response than indicated by the elasticity value of –0.075 found by Fullerton and Kinnaman. Part of the explanation of the difference may lie in the fact that in their case the charge was specifically volume-based, and indeed their estimated volume-based price elasticity of demand is –0.227 which is remarkably close to the result found here. Strikingly, the elasticity is practically identical to the short-run figure of 0.26 found by Linderhof *et al.* (2001), described in the literature review in Chapter 2.

Concerning the result relating to the numbers in the household, it is again possible to quantify the effects. In this case, an increase in household size from two to three persons is found to reduce the weight of weekly waste per person by 1.3 kg, while an increase in household size from five to six is found to reduce waste per person by only 0.51 kg. These findings are also similar to the corresponding figures produced by Fullerton and Kinnaman, which were 1.1 kg and 0.44 kg, respectively. These results are helpful in the same way that the price elasticity was useful. In particular, since we are aware that the number of inhabitants per household is declining, the

result helps to predict the effect on waste left out for collection. The indications therefore are that waste per head will increase, a result that has parallels in other areas of resource use that have environmental implications, including water usage and energy usage per head.

It is also possible to see how behaviour influences the amount of waste left out for collection. Statements were collected on behavioural factors, such as recycling, composting and burning regularly, and increasing these activities. Positing these factors as influencing waste could be seen as tautological in that recycling, for example, means putting out less waste, which is bound to result in less waste and could confuse the model results. However, it is worth noting that the statement that the household had recycled more since the introduction of charges is associated with lower waste per head, which is consistent.

3.6.2 Modelling the change in demand – year 1 minus year 0

Thus far we have reported on what influences the weight of waste left out for collection. Further modelling investigated the factors that influenced the actual decline in waste collected between the two years. While themodel fits the data poorly, the results are similar to thosegiven above. Primarily, price and also numbers in the household are the major influences on the reduction in waste between the two years.

An increase in numbers in the household between the two years has a negative effect on the change in weight per head, i.e. reduces the per-head weight further, another indication of economies of scale. The larger households in general in 2003, however, and those with higher incomes tended to have smaller reductions. Additional infants might also be to the detriment of waste reduction. Being at work on the other hand tended to enhance the reduction.

The behavioural variable of note is again recycling, but in this instance where the reduction is being investigated, it is not 'recycling more' that has the effect but rather those that stated that they recycled regularly. The message from this is that recycling is an effective influence on waste collected. This reinforces the view that promoting a recycling culture is a key to waste reduction.

3.7 Burning

If the household has an open fire or a stove, or has a garden, then it has the option of burning waste.

Burning of waste is restricted however. Emissions from domestic premises are covered under the Air Pollution Act 1987. This Act gives local authorities the lead role in control of air pollutants from premises.

Section 24(2) of the Act
"*imposes a general obligation on the occupier … not to cause or permit an emission in such a quantity or in such a manner as to be a nuisance*." .

The Act, though somewhat unspecific, is of significance to domestic burning. The extent to which householders are aware of the Act is not known. Nor is it exactly clear what constitutes a nuisance. The responses to the survey could under-represent the amount of burning if householders are aware of the Act and it is possible that there is uncertainty in the public mind about the legality of burning and about differentiation by material.

In fact, burning of items that have been treated, such as newspapers by ink, emits dioxins. In turn, the damage from dioxins derives from their persistence and consequent accumulation in the environment (EPA, 2005b). Almost 73% of the dioxins emitted to air in Ireland come from the uncontrolled, low-temperature burning of waste. This makes backyard burning of waste the single biggest source of dioxins released into the Irish environment and local authorities are engaged in curtailing this activity (DEHLG, 2005).

3.7.1 Weight reduction and burning

Households were asked whether or not they burned any of their waste. A remarkable 42% of households replied that they burn household waste, as shown in Table 3.18. They were also asked whether they had changed the amounts that they burned, that is, whether they were burning more, the same, or less than before the introduction of the pay-by-weight scheme. Owing to the restrictions on burning, the figures could understate the actual numbers that do burn their waste and also the numbers that are changing the amount that they say they burn compared to before the pay-by-weight scheme was introduced.

Indeed, the results in Table 3.18 reveal strange patterns in that a higher reduction in waste, at 462 kg, is recorded

Table 3.18. Whether household waste is burned, whether burning increased, and waste reduction by Clonakilty households compared to year before weight-based charging.

	% of West Cork households	% of Clonakilty households	Average waste reduction (kg)
Burn any of your household waste?			
Yes	42	42	393
No	58	58	462
N cases	**1157**	**293**	**293**
Burn more waste than a year ago?*			
Burning more	33	34	366
Burning same	49	47	405
Burning less	17	19	409
N cases	**481**	**122**	**122**

*Excludes those who burn no waste.
Note: Waste reduction refers to recorded reduction by whatever means.

for those that do **not** burn compared to those that do, at 393 kg. On the other hand, conscientious or law-abiding citizens or those who know about the regulations on burning may simply be the types of persons who generally engage in more waste reduction and use permitted means. And there again, respondents who burn may not have been willing to state the exact truth.

Similarly, the replies in Table 3.18 to the question as to whether the household now burns more, the same, or less than a year ago show that the lowest, rather than highest, reduction is achieved by those who say they burn more.

The remarkable feature is the 42% of the full sample and the Clonakilty sample who say they burn household waste. In addition, the number who say that they are burning more, at 33%, is practically double the number who say that they are burning less, at 17%.

This important finding backs up reports that that there has been an increase in burning occurring since the introduction of the pay-by-weight regime. Although the numbers of complaints about burning recorded in data from the West Cork Laboratory are small, they reveal an increase in complaints since the introduction of the new charging scheme, from an average of one per year between 1998 and 2002, to seven in 2003, 15 in 2004 and nine in 2005. The numbers undoubtedly understate the true extent of burning as people are likely to be reluctant to complain. Nevertheless, they suggest that illegal means of waste disposal, such as burning, are likely to increase in response to such charges.

3.7.2 Burning by socio–economic characteristics

As the authorities are clamping down on burning activity, it is useful for them to know the profile of those who engage in it in order to help understand why burning occurs and how to prevent it.

Given the extra harm caused by burning in urban as opposed to rural areas it is also useful to know the amount of burning occurring by location. Table 3.19 shows burning activity broken down by various household characteristics including location.

Table 3.19 shows a high propensity for burning household waste among those located in the countryside, unsurprisingly. However, the share of households in the town that burn is also significant, at 34%, and is to be noted given the already higher pollution intensity in towns. Among the household types, those consisting of all adults show a high propensity. Farmers represent the highest proportion that burns household waste, at 57%.

Many of the other patterns in Table 3.19 are driven by the association between living in the countryside and the propensity to burn waste. This is true of the apparent association between burning and high levels of income and education; for instance, nearly half of those in the highest income category and of those with third-level education live in the countryside of West Cork, compared to less than one-third of those in the lowest income and education categories.

Turning to the change in burning activity, it is informative to compare the proportion in the ‘burning more’ column with the proportion in the ‘burning less’ column. Every category, bar one, has a positive balance of households

Table 3.19. Burning activity and socio–economic characteristics, row %.

	Do you burn any household waste?	Do you burn more household waste than you did 12 months ago?		
	Yes	Burning more	Burning same	Burning less
Location				
Town	34	34	51	14
Village	47	39	44	16
Countryside	48	30	50	20
Household type				
One person, 65+	36	21	65	15
One person, under 65	44	34	46	20
Adult(s), dependent children	41	42	39	19
Other, all adult, age 65+	38	20	61	19
Other, all adult	49	38	45	16
Socio–economic group				
Self-employed	43	37	49	13
Farmer	57	31	37	33
Professional/managerial	39	30	49	21
Other non-manual	39	30	48	22
Skilled manual	35	33	55	12
Unskilled manual	45	39	47	14
Never worked and not stated	46	35	57	8
Level of education				
Primary	40	26	54	20
Lower secondary	45	39	46	15
Upper secondary	39	37	45	18
Third level	44	31	52	17
Household equivalised income				
Under €220 per week	37	34	54	13
€220 to €360 per week	43	35	42	23
Over €360 per week	43	32	52	15
Total	**42**	**33**	**49**	**17**

Based on full sample N = 1157.

burning more. Many categories have double the number burning more than burning less. These include households in towns and villages, households with all adults or adults plus dependent children, the self-employed, skilled and unskilled manual and those that never worked or did not state their occupation, those with secondary education, and those with low- or high-income levels. In other words increased burning takes place across a broad spectrum. The only category to state that they are burning less is farmers, and only marginally so. Possibly if they burned most of their waste already they could not burn more.

3.8 Other Illegal Waste Behaviour

As discussed in Chapter 2, the introduction of charging for waste by weight could increase the incentive for some people to dump their waste and avoid the charge. This can be a serious drawback to the introduction of such market-based instruments. The likelihood, scope and incidence of evasive activity are important issues.

It is unlikely that a question that asked households if they engaged in such activity would elicit a truthful response. Therefore, an indication of illegal activity was sought by asking respondents whether they themselves had ever experienced anybody putting waste in their wheelie bin without their permission, and whether the incidence had increased since the introduction of the pay-by-weight scheme.

Another approach is to consult with the local authority on its own observations on illegal waste activity. These two

approaches toinvestigating illegal activity will now be discussed in turn.

3.8.1 *Experience of other people using one's bin*

The large majority, 78% of respondents, said that they had never experienced anybody putting waste in their wheelie bin without permission. Twenty-two per cent had experiencedthis, of which 5% said theyhad experienced it regularly, 7% occasionally and 10% 'once or twice'.

One might expect the experience of someone else using one's bin would be more prevalent in rented accommodation or in towns, but there is no evidence of this. Furthermore, people with lower levels of education and with lower incomes tend, if anything, to experience less of this activity.

The pattern is slightly different when looking at whether or not the activity had increased. Of those 22% who had experienced other people using their bin, just over a half felt that it had increased since the introduction of the new charging regime. There is no particular pattern to the characteristics of respondents reporting such a rise, except a difference by housing tenure. Table 3.20 shows that those in rented accommodation, in the form of local authority or other, are more likely to report an increase in other people using their bin.

3.8.2 *West Cork County Council's reports of fly-tipping and burning*

An attempt was made to discover whether or not there were increased reports of fly-tipping. West Cork County Council was asked about this and it maintained that there were no strong indications of increased instances of fly-tipping. This is in contrast to burning where, as described, there was an increase in complaints.

It is also informative to look at respondents' comments, if any were recorded during the interview. Under the category 'other' in the 'methods of disposing of garden waste', over 3% of respondents volunteered the information that they disposed of garden waste on land, or buried it and one said they deposited it in open country. It is possible that some non-garden waste was added in, though there is no evidence of this. Ten respondents mention that the gardener or person who cuts the grass removes the clippings.

Under the category of 'other materials regularly recycled', five respondents mention spreading ashes in the garden or mixing them with soil. Others mention a wide variety of materials that they recycle such as recycling ink cartridges, used clothing, returning unused medicines to the pharmacy and feeding vegetable peelings to a neighbour's animals.

3.9 Attitudes to Weight-Based Charges

In order to find out what respondents think about the new pay-by-weight scheme, they were given a list of statements that people have made about it. They were asked to state whether they agreed with each statement, neither agreed nor disagreed, or disagreed.

Table 3.21 gives the percentages for the different levels of agreement/disagreement with each statement, for the full sample of households in West Cork.

Looking at the statements in turn, a firm majority consider that pay-by-weight is fair. However, over one-quarter disagree and this may reflect the fact that they are unfamiliar with the waiver system or that they do not think that the waivers adequately meet the needs of certain households. They may also feel that some people generate waste through no fault of their own and yet have to pay. There is also the issue that tax relief on the waste charge is granted to compliant customers, but those that are not earning sufficient money to be in the tax net cannot avail of the relief.

Table 3.20. Respondents experiencing other persons using their bins* saying whether this had increased or not, row %.

Housing tenure	Increased	Not increased
Owned outright	52	48
Purchasing on a mortgage	57	43
Local Authority tenants	64	36
Other, including private rented	63	38
Total (N = 260)	53	47

*Note: These are the 22% of respondents who said that they had experienced this.

Table 3.21. Perceptions of the new pay-by-weight scheme, row %.

Possible views about the new pay-by-weight scheme	Agree	Neither agree nor disagree	Disagree
New pay-by-weight scheme is fair	64	8	28
New scheme encourages households to reduce waste	93	4	3
Makes people more aware of the cost of waste disposal	90	4	5
Better than the old flat annual charge	56	13	31
Better than paying through an increase in income tax	78	15	8
Scheme has increased mess and bother of waste disposal	47	11	42
Feel I have enough information on recycling and other methods	71	3	26

N = 1156.

On the other hand, the scheme could be viewed as fair in that households have control over their waste bill because they can reduce their waste by various means. The charge that they face reflects the amount of waste that they leave out, and this may have been in the minds of those agreeing that it was fair.

The vast majority, at 93%, agree that the weight-based charge encourages households to reduce their waste. Similarly, people are widely agreed that the charges make people aware of the cost to the local authority of waste disposal.

Only 56% say, however, that the new charging regime is better than the old flat annual charge. It is not clear whether the old charge was in fact cheaper, owing to lower disposal standards and/or less than full-cost recovery on the part of the county council. Nevertheless, when confronted with the reality – that costs not recovered by local authorities would mean reversion to government subvention funded by raised income taxes for example – the new scheme is preferred to that: nearly 80% of respondents prefer the new scheme to an increase in income tax. People holding this view may be cognisant of the reality that resources for improved standards will have to come from somewhere, a likely source being raised income tax, and endorsement of pay-by-weight may reflect a preference for the new more transparent payment method.

Turning to the practicalities of the new scheme, only 47% consider that it has increased the mess and bother of waste disposal. This is surprising considering the extra space required for sorted waste and time spent, not to mention the mess at recycling centres noted in some comments.

Nearly three-quarters consider that they have enough information on recycling and other ways to reduce waste. This needs to be read in conjunction with the statements about the absence of convenient recycling centres, in the section on recycling. There it was seen that two-thirds did not consider there to be a convenient centre for recycling batteries, for example. So perhaps this agreement level indicates that respondents know what to do but absence of facilities prevents them from doing it.

Some variation in responses by socio–economic group is seen, particularly in relation to the statements that pay-by-weight is better than the old flat-rate charge and better than an increase in income tax. Table 3.22 gives the percentages that agreed with these two statements, broken down by the household socio–economic characteristics where responses varied.

The first column of the table shows that those respondents who live in local authority housing are less likely to agree that the new charging regime is better than the old annual flat charge. Even less agreement, from not much over a third, comes from those who never worked or did not state their occupation.

By contrast, the new system is strongly endorsed by professional/managerial groups, by those with third-level education (not shown here) and by households in the high-income bracket. Such endorsement is to some extent strange, because it is well known that better-off households produce more waste and consequently will face higher bills under the pay-by-weight system than under the flat-rate scheme. But this is without factoring in the reduction possibilities of recycling, composting and so forth, that the better-off can probably avail of more easily. Having a car and more space gives more scope for reduction.

Table 3.22. Per cent of households that agree, row %.

	Paying-by-weight is better than:	
	the old flat-rate annual charge	paying through an increase in income tax
Housing tenure		
Owned outright	56	77
Purchasing	58	84
Local Authority	49	83
Other	53	66
Household type		
One person, 65+	53	61
One person, under 65	58	75
Adult(s), dependent children	59	86
Other, all adult, age 65+	53	77
Other, all adult	55	78
Socio–economic group		
Self-employed	52	75
Farmer	59	78
Professional/managerial	62	82
Other non-manual	57	73
Skilled manual	54	84
Unskilled manual	59	75
Never worked and not stated	38	63
Household equivalised income		
Under €220 per week	53	69
€220 to €360 per week	51	78
Over €360 per week	62	84
Total	**56**	**78**

N = 1157.

The alternative to financing waste removal by charges would entail increased taxes of a general nature, as is currently the case in water supply and waste-water treatment, such as through increased income taxes. The second column in Table 3.22 deals with this comparison between the new charges and increased income taxes. While nearly 80% agree that paying by weight is better than by increased income tax, there are again some variations by socio–economic group. There is agreement, though relatively low, in the 60+% range, from elderly one-person households and those households where the main earner never worked or did not state their occupation. This may reflect their difficulties with waste reduction methods or it may reflect the fact that financing waste removal through increased income tax would not impact on them as they would be unlikely to be subject to income tax in their circumstances. They may also feel that the progressive nature of the income tax system makes it fairer.

By contrast, households that are in stronger agreement that the new charges are better are those consisting of adults with dependent children. Perhaps this is because they feel heavily taxed already. It is noticeable that support for this statement rises solidly with household income level. Perhaps richer people are unenthusiastic about paying more tax in a system that would not encourage recycling, which they (the rich) can do more easily in any case. They may also perceive that income tax would become more progressive, impacting on them so that they would feel that they are paying for more than their fair share of other households' waste disposal.

3.9.1 The issue of ability to pay

The idea of fairness hinges to some extent on whether or not households on low incomes are able to pay for waste

charges. The issue of ability to pay may have helped to fuel negative attitudes towards waste charges held by some. These in turn have ensured that charges are a contentious issue that have not been subjected to the serious debate that the topic deserves.

The issue of ability to pay has been highlighted by Combat Poverty in its report entitled *Waste Collection Charges and Low-Income Households* (CPA, 2003). It describes how the Money Advice and Budgeting Service (MABS) identified refuse collection charges as a primary concern among low-income households. There are two sorts of relief in existence. One is the universal tax relief on waste charges that is available to all who pay sufficient taxes, which may not be helpful to households on low incomes that pay no tax or insufficient tax. The second is the waiver system which is unsatisfactory in its present form. This is because the waiver granted varies from one local authority to another and, in certain areas where refuse collection has been contracted out to private operators, there may be no waiver available at all. In some cases, collecting the waiver can be time-consuming as people are required to submit applications for refunds at the end of the year.

The CPA report highlights this absence of a national approach to waivers. Absence of a coherent approach can make for difficulty in implementing environmental policy, a drawback that has been flagged repeatedly (Scott and Lawlor, 1997; CPA, 2003). It might be argued that the variation in charges between different local authority areas reflects the fact that waivers are the responsibility of the local authorities, rather than a national issue. Ability to pay, however, is at the root of the problem. The fact that the costs vary by locality does not necessitate local resourcing for waivers, as there are already methods within the social welfare system for dealing with differing regional costs, such as through the Supplementary Welfare Allowance (Rent and Mortgage Supplement), for example.

Combat Poverty points to the need for local authorities to be adequately resourced to deal with waivers and for national guidelines to be drawn up. This would not only help deal with difficulties faced by low-income families but would also ease the introduction of effective environmental policies and perhaps help generally to soften attitudes to charges.

4 Summary and Conclusions

4.1 Summary

The aim of this study was to investigate the effects of the introduction of weight-based charges for domestic waste collection. The objective of these charges is to reduce waste going to landfills and to reduce waste generated. The study is based on the experience of introduction of such a scheme and it analyses the data arising from a practical application of weight-based charges introduced by West Cork County Council in 2003.

4.1.1 Context

In order to set the context for the study, a literature review was undertaken of papers on unit-based fees in the academic journals. These revealed that there is considerable experience with such fees and that the issues that may influence success are well identified. Among other things, these issues include parallel policies to facilitate recycling to combat undesirable diversion of waste and to help disadvantaged residents.

As predicted by economic theory, the literature review revealed convincing evidence of waste reductions from countries ranging from the USA to South Korea and, within Europe, in the Netherlands and Denmark in particular. The measured response to user fees in terms of elasticities (a measure of responsiveness) on the part of households ranged from –0.14 to –0.23, indicating that a 10% rise in price would lead one to expect a reduction in waste of between 1.4% and 2.3%. These relate to volume-based charging, such as charging by the bin lift or the tagged bag. The elasticity with respect to weight-based pricing was found, in one study, to be stronger, at –0.26.

Across the waste management systems examined in the literature, the available evidence suggests that introduction of weight-based as opposed to volume-based systems has the potential to achieve the highest rate of waste reduction. Declines of 30% or more are not uncommon. A further decline can occur in subsequent years, before stabilising. A key to success was found to be the availability of alternative disposal options, such as recycling centres.

4.1.2 The case study – Clonakilty households in West Cork

The introduction of weight-based charging by West Cork County Council in 2003 was selected as the subject for analysis. A representative sample of some 1200 households was interviewed about the new charging regime. Of these, nearly 300 households had associated usable data on weights of waste collected, both in the year before and the year after the introduction of the charging regime, recorded by West Cork County Council.

Flagged to households in 2001, weight-based charging started on 1 January 2003. Prior to this the marginal cost to households of leaving out waste for collection was zero. From 1 January 2003 households were confronted by a price of €0.23 per kg, though clarification on the actual charge was slightly delayed. In addition to the introduction of the charge per kg, there was a change in standing charge. The standing charge in 2002 had been €190 for the standard bin. With the introduction of weight-based charges the standing charge was reduced to a single rate of €160, regardless of the number and size of bins. The point to note is that given that the size of bin had been chosen in 2001, the altered standing charge at the beginning of 2003 did not represent a change in marginal cost. Therefore, in the analysis of the effects of the introduction of weight-based charging, it is the weight-related price of €0.23 per kg that is the focus of attention.

The household survey asked three main types of question. These concerned:

1. Household characteristics which could influence:
   (i) the amount of waste generated, and
   (ii) waste management behaviour such as recycling frequency.
2. Actual waste management response to the new pay-by-weight price such as:
   (i) their recycling behaviour before and after,
   (ii) changes in disposal of organic waste including composting, and
   (iii) changes in burning of their rubbish.

3. Attitudes and experience including:

   (i) experience of other people using their bin, and

   (ii) views concerning the new pricing regime.

A noteworthy result of the survey is that the percentage reduction in weight collected from households in the year after compared to the year before the new charging regime is 45%. The average reduction per household in the year after the new pricing regime was 433 kg. At €0.23 per kg the reduction amounts to a saving of €100 per year compared to what their bill would have been with no reduction. There may have been further reductions in subsequent years, as seen in the pattern of total waste (including commercial waste) recorded at landfill sites by West Cork County Council and in experience abroad. Improved recycling facilities and greater familiarity with recycling may have increased the subsequent amounts reduced, though we have no evidence of this as the sample did not cover the following years. A major question to be asked is how was the observed reduction achieved.

4.1.2.1 Analysis of recycling behaviour

Recycling offers major potential for reduction and the vast majority say that they always recycle one or more materials. Of note is that some 8% of households state that they do not recycle regularly. Not surprisingly 31% of those who do not know the distance to the recycling centre say that they do not recycle regularly, but when a household does recycle, the actual distance has little effect on the number of materials that they recycle. Recycling households exploit the potential for economies of scale by taking many materials to be recycled, which is the efficient thing to do.

Having access to a car helps recycling activity, but of those 17% of households without access to a car nearly 80% still recycle regularly.

Nearly half the households had already been recycling before the scheme was announced. But there were late starters too, with over a fifth that started during 2003 when the scheme was up and running. It is noteworthy that 17% started recycling when the scheme was announced, even though not having to pay by weight yet, suggesting that there was also an 'announcement effect'.

It is seen that 56% of those with third-level education had already been recycling before the announcement of the scheme, compared to only 39% of those whose highest schooling was primary-level education.

The only type of recycling centre that is clearly considered to be convenient, by 95% of households, is the glass recycling facility. Batteries and white goods, items that have potential for considerable harm, were not seen as having convenient centres, and 25% did not know about centres for batteries – the widest ignorance attaching to the worst item.

A good majority, at 67%, said that they would like to recycle more than at present. This positive response rose with the level of education of the respondent. The highest positive response, at 76%, was from households with adults and dependent children, which bodes well for the future.

4.1.2.2 Organic waste and composting

The experience in Clonakilty and its environs is that those households having garden waste appeared to have greater opportunities for waste reduction in general.

Significantly, households that composted achieved reductions well above the average reduction.

Of those respondents that live in local authority houses, 11% dispose of garden rubbish with the rest of their rubbish, suggesting that they may have inadequate space for any alternative method. The numbers in the sample however are very small. Persons living alone aged 65 and over may have similar difficulties.

The majority of local authority tenants do not compost, and one-person households, especially those where the person is aged 65 or over, tend not to compost either. Those who never worked or do not state their work are least likely of all the groups to compost. There is again a steady progression in composting according to household income. Local authority dwellers, who at the end of the survey period still had low rates of composting, reveal a gathering momentum of change.

4.1.2.3 What influences the amount of weight left out for collection?

The various household characteristics and the price were combined in an exercise that modelled the demand for waste collection. The aim was to investigate the influence exerted by each of these factors on the weight of waste per head collected per week, controlling for the other factors. The results confirm that responsiveness to price is significant, with the price elasticity of demand estimated to be –0.266, meaning that a 10% rise in the unit charge would result in a 2.66% decrease in weight of waste. This

is in line with, and indeed remarkably close to, the elasticity found in the case study of weight-based charging in Oostzaan in the Netherlands.

The model also finds that there are economies of scale in the demand for waste collection, as larger households leave out less weight per person. As the household size increases further, however, the reduction in weight per person decreases. The model also suggests that the presence of infants under 3 years of age increases the amount of waste.

Turning to what influences the reduction in waste between the two years, it is found that rising numbers in the household improve the reduction per head and of course the introduction of the price is significant. Of the behavioural variables influencing waste reduction, 'recycling regularly' is the one that helps, suggesting that for those that have embarked on recycling, waste reduction is easier.

Behaviour is set out comprehensively in Table 4.1. The recycle row bears out the message that recycling seems to pave the way for using other reduction methods: 83% of recyclers also compost. However, it is those that compost who may be considered to be most 'virtuous': 98% of composters also recycle and they have the highest share, 68%, that makes an effort to reduce by other means.

4.1.2.4 Illegal activities

Burning household rubbish is an undesirable and illegal activity but it was found to be widespread even in towns, with over 40% of households engaging in it. Furthermore, every category of household had double the number stating that they were burning more than stating that they were burning less. Complaints about burning also rose but they were very few in number in any case.

Asked about whether they had experienced other people putting waste in their bin without their permission, just over a fifth of respondent households replied that they had, of which half thought that it had increased since the new price regime. Local authority tenants were most likely to state that there had been an increase.

Fly-tipping can also be expected to increase with the introduction of pay-by-weight charges but there was no strong indication that this had happened, neither was there a noticeable increase in complaints about fly-tipping.

4.1.2.5 Attitudes

Attitudes to pay-by-weight charging were on balance positive. The most negative attitude was reflected by the 47% of respondents who felt that it had increased the mess and bother of waste disposal. There are convenient compartmentalised kitchen bins but these may not be widely available on the Irish market. Nearly two-thirds thought that the new charging system was fair.

Table 4.1. Association between recycling, composting, reducing and burning, row %.

	Recycling		Composting		Other means		Burning	
	Never recycle	Recycle	Never compost	Compost	No effort to reduce	Makes effort to reduce	Never burn	Burn
Recycling								
Never recycle	–	–	53	47	69	31	60	40
Recycle	–	–	17	83	37	63	58	42
Composting								
Never compost	8	92	–	–	34	66	49	51
Compost	2	98	–	–	32	68	56	44
Other means								
No effort to reduce	14	86	19	81	–	–	62	38
Effort to reduce	4	96	18	82	–	–	56	44
Burning								
Never burn	8	92	16	84	42	58	–	–
Burn	8	92	20	80	36	64	–	–
Total	**8**	**92**	**18**	**82**	**39**	**61**	**58**	**42**

A small majority thought the pay-by-weight charges were better than the old flat charge, while nearly 80% said they were better than paying for waste through an increase in income tax.

Over a quarter did not feel that they had enough information on recycling and other methods.

4.2 Conclusions

The results lead to several conclusions. The main ones are listed here, with a focus on those that could help to inform policy.

1. Charges by weight are a strong incentive to reduce one's weight of rubbish. The move from a flat-rate charge to the pay-by-weight charge resulted in a 45% reduction in waste collected in the Clonakilty sample. From experience abroad the reduction might continue, especially with improved provision of recycling facilities. The responsiveness to price is highly significant indicating that incentives are important.

2. Weight reductions varied by socio–economic characteristics of the household and the category that appeared to have most difficulty in reducing consisted of local authority tenants, the elderly living alone and people in 'other' accommodation, including rented accommodation.

3. Recycling was the key to waste reduction, but at the time it was only glass recycling facilities that were widely considered to be convenient. The recycling facility least known about related to batteries – one of the worst materials.

4. The number stating that they engaged in burning was alarming and the numbers increasing this activity under the new price regime more so. This activity may have been innocent and the message about the dangers may not have been received, pointing to the important role of education in this area.

5. There are economies of scale with respect to numbers in the household, which are estimated in this study. The amount of waste per head decreases with increasing numbers in the household, though at a diminishing rate. With the decline in household size projected for Ireland, this indicates that the waste *per capita* is likely to rise and the results can be used to help quantify the amount.

6. Nearly 80% of respondents had never experienced anybody putting waste in their bin without their permission. Of those who had experienced this however, those in rented accommodation, in theform of local authority or other accommodation, are most likely to say that the incidence has increased with the new pricing regime. This suggests that information and facilities could usefully be targeted at these households.

7. With respect to attitudes to charges, an overwhelming majority say that they would prefer the new pay-by-weight system to having to pay through other means, such as through increased income taxes. As this would be the reality, other things being equal, and in so far as the reality is understood that resources must come from somewhere, this preference supports the reform.

8. The majority say that the new pay-by-weight scheme is fair. However, fairness is not the verdict of over a quarter of respondents. This points perhaps to the importance of a coherent and centrally resourced approach to waivers and to the production of national guidelines for local authorities, in order to make charges entirely fair.

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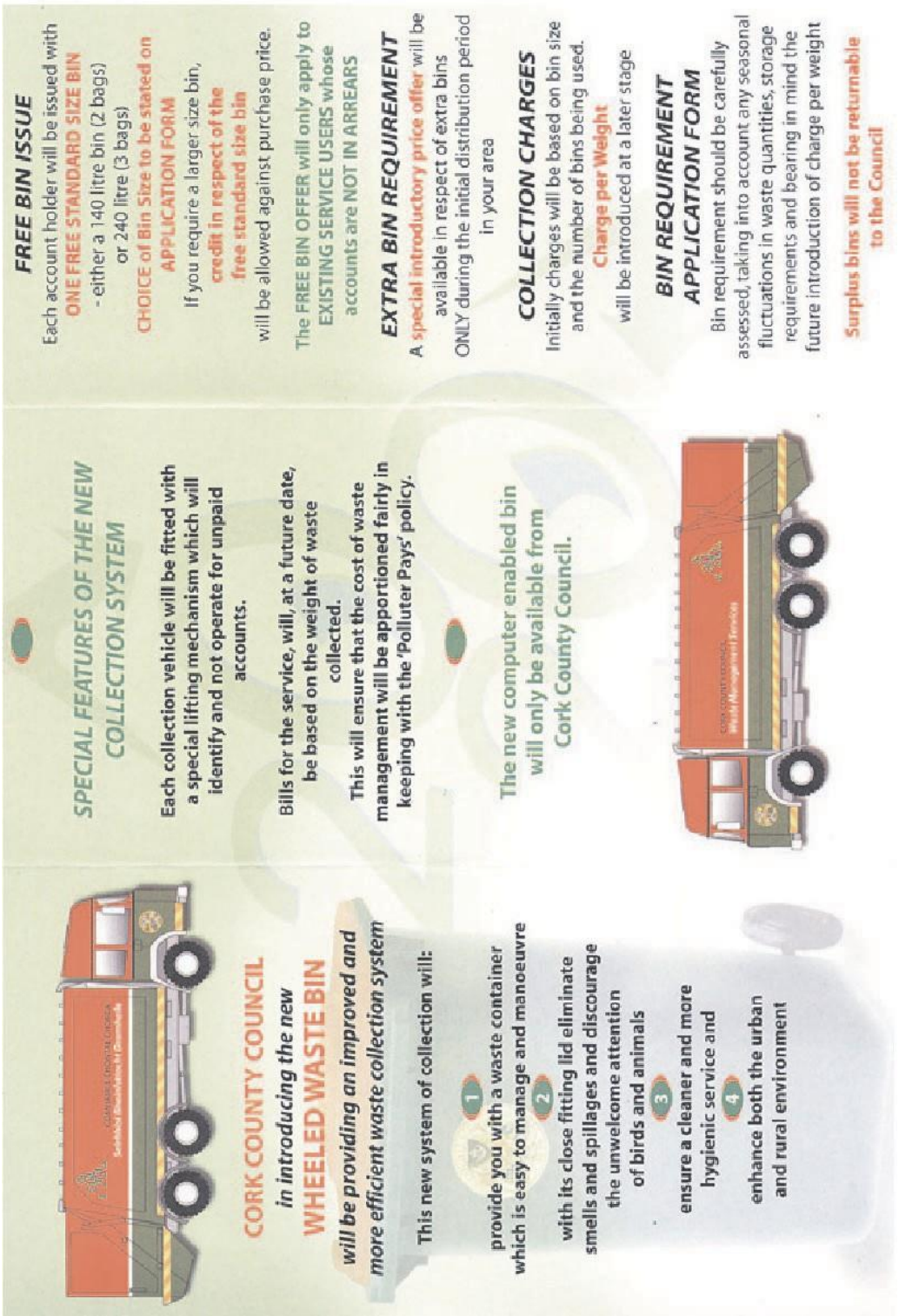
Appendix 1 Brochure Sent to Households by West Cork County Council in 2001 Informing them of the Change in Charging Regime



CORK COUNTY COUNCIL

in introducing the new

WHEELED WASTE BIN

will be providing an improved and more efficient waste collection system

This new system of collection will:

1. provide you with a waste container which is easy to manage and manoeuvre
2. with its close fitting lid eliminate smells and spillages and discourage the unwelcome attention of birds and animals
3. ensure a cleaner and more hygienic service and
4. enhance both the urban and rural environment

SPECIAL FEATURES OF THE NEW COLLECTION SYSTEM

Each collection vehicle will be fitted with a special lifting mechanism which will identify and not operate for unpaid accounts.

Bills for the service, will, at a future date, be based on the weight of waste collected.

This will ensure that the cost of waste management will be apportioned fairly in keeping with the 'Polluter Pays' policy.

The new computer enabled bin will only be available from Cork County Council.

FREE BIN ISSUE

Each account holder will be issued with **ONE FREE STANDARD SIZE BIN** - either a 140 litre bin (2 bags) or 240 litre (3 bags)

CHOICE of Bin Size to be stated on APPLICATION FORM

If you require a larger size bin, **credit in respect of the free standard size bin** will be allowed against purchase price.

The **FREE BIN OFFER will only apply to EXISTING SERVICE USERS whose accounts are NOT IN ARREARS**

EXTRA BIN REQUIREMENT

A **special introductory price offer** will be available in respect of extra bins ONLY during the initial distribution period in your area

COLLECTION CHARGES

Initially charges will be based on bin size and the number of bins being used. **Charge per Weight** will be introduced at a later stage

BIN REQUIREMENT APPLICATION FORM

Bin requirement should be carefully assessed, taking into account any seasonal fluctuations in waste quantities, storage requirements and bearing in mind the future introduction of charge per weight

Surplus bins will not be returnable to the Council

BIN PLACEMENT

Customers should on the morning of collection, place their bins at the front curtilage of their property, with the handles facing the road. Public areas should not be used to store bins on a permanent basis.

BIN COLLECTION

Only waste placed in the ***new bin*** will be collected when the system is operational in your area.
Waste placed in any other container including existing bins, or in any other manner,
WILL NOT BE COLLECTED
and will be the subject of
ON THE SPOT FINES (£50)

BIN IDENTITY

In view of the impending charges per weight you should carefully record the ***reference number(s)*** on your bin(s).
Any other form of bin personalisation should be done clearly and neatly

BIN MAINTENANCE

Hot ashes, soil, bricks, plaster, corrosive materials or large amounts of garden waste should NOT be put into the wheeled bin.
The Wheeled Bin becomes your property and responsibility.
If the bin is damaged through negligence or is lost, you will be liable for the cost of the replacement bin in order to continue the service with Cork County Council.

BIN MEASUREMENTS

BIN SIZE (LTRS)	BAG EQUIV.	HEIGHT	WIDTH	DEPTH
140	2	43" 1075mm	19" 480mm	21" 540mm
240	3	43" 1075mm	23" 580mm	28" 715mm
360	5	44" 1100mm	24" 600mm	35" 870mm
660	8	49" 1235mm	54" 1360mm	31" 765mm
1000	12	54" 1345mm	55" 1380mm	44" 1100mm

for further information

FreeFone
1800 240 360

COMHAIRLE CHONTAE CHORCAÍ
Seirbhísí Bhainistíocht Dramhaíle
CORK COUNTY COUNCIL
Waste Management Services
OLD MILL KENT STREET CLONAKILTY
April 2001
Printed on recycled paper

COMHAIRLE CHONTAE CHORCAÍ
Seirbhísí Bhainistíocht Dramhaíle
CORK COUNTY COUNCIL
Waste Management Services
introducing the
NEW WHEELED WASTE BIN
and collection service

2020

Appendix 2 Letter to Households Advising of Survey

June 2003

(sent to each customer)

Waste collection services
Study of experiences and reactions to the pay-by-weight system

BACKGROUND TO THE STUDY
There is widespread interest in having an independent assessment of the effectiveness of the pay-by-weight element of the new waste collection charges introduced in West Cork. Accordingly, the Environmental Protection Agency (EPA) in association with the Council has commissioned the Economic and Social Research Institute (ESRI) to undertake an independent study of the effectiveness of the new scheme of charging.

EPA
The Environmental Protection Agency (EPA) is the government agency charged with implementing the highest practicable standards of environmental protection, including waste management. The EPA, using monies from the National Development Plan (NDP) 2000–2006, is funding this research project.

ESRI
The Economic and Social Research Institute (ESRI) is a private, independent research organisation largely engaged in research on public policy issues. Personnel from the ESRI will be undertaking a survey of customers and completing the report on the effectiveness of the pay-by-weight system for waste collection/disposal in West Cork.

SURVEY OF CUSTOMERS
A survey will be undertaken to collect information on how customers' reactions to the new system, whether they recycle, etc., and also their attitudes to the new pay-by-weight scheme. To facilitate the ESRI in conducting the survey and research the County Council intends to allow the ESRI access to the Council's customer details, i.e. telephone numbers and weights presented for collection. Individual customer details will not be made public.

If you do not wish your details to be provided to the ESRI and want to be excluded from the research please advise the Council accordingly using the Council's freephone number 1800 240 360.

John Curtis of the ESRI will be managing the research project and you may contact him if you have any other queries (01 667 1525 or john.curtis@esri.ie)

Appendix 3 Household Questionnaire

ESRI

The Economic and Social Research Institute
4 Burlington Road Dublin 4
Tel (353-1)-6671525; Fax (353-1)-6686231

Household Waste Disposal in West Cork 2003/2004

ID Number: ___ ___ ___ ___

Interviewer Number: ___ ___ ___ ___ ___ **Interviewer Name:** _____

Date (DD/MM/YYYY) ___ ___ / ___ ___ / 2004 **Time Began (24 hr clock)** ___ ___ :___ ___

Hello, my name is _____. I'm calling from the Economic and Social Research Institute (ESRI) on behalf of the Environmental Protection Agency (EPA) in association with Cork Co. Council. We are doing a study of experiences and reactions to the pay-by-weight element of the waste collection services in operation in West Cork. Could I just check, is this the *[name from assignment sheet]* household?

You may remember that the pay-by-weight scheme was introduced in January of 2003. The purpose of the study is to gather information to monitor the effectiveness of the new scheme.

The survey is completely confidential and anonymous. Your phone number was selected at random from the list of accounts with Cork County Council.

Q1. Could I check whether your waste account is for domestic or commercial premises?
Domestic ..... ☐1 → Go to Q2 Commercial ..... ☐2 → End Interview

Q2. I would like to conduct the survey with the person who is responsible for paying household bills. Would that be [insert name from assignment sheet] **?**
[Interviewer: Check who is responsible for paying most household bills. Ask to speak to that person and proceed with interview.]

I'd like to begin by asking about recycling? Does your household currently recycle any waste on a regular basis. By this I mean using bottle banks, clothes banks; paper banks or recycling centres?
Yes ..... ☐1 → Go to Q4 No ... ☐2

Q3 What is the MAIN reason you do not recycle? [Int: Pause; read list if necessary; Tick ONE box]
a) Recycling centres too far away ..... ☐1
b) Don't know where recycling centres are ..... ☐2
c) Cannot transport materials to recycling centre ..... ☐3
d) Don't produce enough waste /not worth it ..... ☐4
e) Nowhere to store at home ..... ☐5
f) Too much mess/bother ..... ☐6
g) Not interested/waste of time ..... ☐7
h) Other (record in full) _____ ..... ☐8
i) Don't know/never thought about it ..... ☐9
→ Go to Q9

Q4. When did your household start recycling on a regular basis? Was it …
before the new pay-by-weight scheme was announced in 2002 ..... ☐1 → Go to Q5
during 2002, when the new scheme was announced ..... ☐2 → Go to Q5
when the scheme was introduced in January 2003 ..... ☐3 → Go to Q6
Some time during 2003, after the pay-by weight scheme was introduced? ..... ☐4 → Go to Q6

Q5. Since January 2003, when the pay-by-weight scheme began, have you increased the amount of waste that you recycle? Yes ..... ☐1 No ... ☐2

1

Q6 **Could you tell me how often you recycle the following materials? Is it always, often, sometimes or never?**

		Always	Often	Sometimes	Never
a)	Paper	☐1	☐2	☐3	☐4
b)	Glass	☐1	☐2	☐3	☐4
c)	Plastics	☐1	☐2	☐3	☐4
d)	Old Clothes	☐1	☐2	☐3	☐4
e)	Food cans	☐1	☐2	☐3	☐4
f)	Beverage cans	☐1	☐2	☐3	☐4

Q6a Is there anything else that you recycle regularly? Yes...☐1→ **Please specify** No....☐2→ Go to Q7

_____

Q7 **Would you like to recycle more than you do at present?** Yes ..☐1→ Go to Q8 No. ☐2→ Go to **Q9**

Q8 **What is the MAIN reason you do not recycle more than you do at present?** [Int: Pause; read list if necessary; Tick ONE box]

a) Recycling centres too far away..... ☐1
b) Cannot transport materials to recycling centre .... ☐2
c) Don't produce enough waste /not worth it ..... ☐3
d) Nowhere to store at home ..... ☐4
e) Too much mess/bother ... ☐5
f) Other (record in full)..... ☐8

_____
_____

Q9 **How close are you to the nearest or most convenient recycling facility?** _____ miles
Don't Know ..... ☐99

Q10 **Now I'd like to read you a list of materials that can be recycled. Perhaps you could tell me whether there is a convenient centre where you could recycle each material.**
[Interviewer: Read list of items a to j and mark one box for each material]

		Yes	No	DK
a)	Glass	☐1	☐2	☐3
b)	Beverage cans	☐1	☐2	☐3
c)	Food cans (aluminium)	☐1	☐2	☐3
d)	Batteries	☐1	☐2	☐3
e)	White goods, e.g. fridge, cooker	☐1	☐2	☐3
f)	Paper	☐1	☐2	☐3
g)	Plastics	☐1	☐2	☐3
h)	Wood/timber	☐1	☐2	☐3
i)	Old clothes	☐1	☐2	☐3
j)	Other (specify)	☐1	☐2	☐3

_____

Q11 **Does [Would] recycling involve an extra or extended journey for you?** Yes ....☐1 No ....☐2

Q12 **I'd like you to think now about all of the things involved in recycling: sorting, cleaning, storing and any extra travel time in bringing things to the recycling centre. About how many minutes in total does [would] your household spend each week on these tasks [if you recycled regularly]?**

_____ minutes per week Don't know ☐999

Q13 **Perhaps you could give me a rough estimate. Would it be ...** [Read list; tick one box]?

a) Less than 5 minutes ..... ☐1
b) 5 to under 10 minutes ..... ☐2
c) 10 to under 15 minutes .... ☐3
d) 15 to under 20 minutes .... ☐4
e) 20 to under 30 minutes .... ☐5
f) 30 minutes to under 1 hour ..... ☐6
g) Over 1 hour..... ☐7

Q14 **Do you have garden waste?** Yes..... ☐1 No ..... ☐2 → Go to Q16

Q15 **How do you currently dispose of your garden waste? (Tick all that apply)**

a) With rest of rubbish ..... ☐1
b) In special compost bin or pit in your garden . ☐2
c) Put in pile in garden..... ☐3
d) Burn ..... ☐4
e) Other (specify)_____ ...☐5

Q16 **Do you compost or feed to animals any food waste or other organic waste, such as vegetable peelings, tea bags etc.?**

Yes, compost ☐1 Yes, feed to animals ☐2 No ☐2 → Go to Q19

Q17 **When did your household start composting or feeding organic waste to animals on a regular basis, was it … ?** before the new pay-by-weight scheme was *announced* in 2002 ☐1 → Go to Q18
during 2002, when the new scheme was announced ☐2 → Go to Q18
when the scheme was *introduced* in January 2003 ☐3 → Go to Q19
Some time during 2003, after the pay-by weight scheme was introduced? ☐4 → Go to Q19

Q18 **Since January 2003, when the pay-by-weight scheme began, have you increased the amount of waste that you compost or feed to animals?** Yes ☐1 No ☐2

Q19 **Do you burn any of your household waste? This could be either inside the house in an open fire or stove or outside the house.** Yes ☐1 No ☐2 → Go to Q21

Q20 **Are you currently burning more household waste, the same amount of household waste or less household waste than 12 months ago?**

Burning More ☐1 Burning Same ☐2 Burning Less ☐3

Q21 **Since the new pay-by-weight scheme was introduced, have you made a conscious effort to reduce the amount of waste you produce by other means, such as choosing products with less packaging?** Yes ☐1 No ☐2

Q22 **Here are some things people have said about the new pay-by-weight scheme. We would like to know whether you agree or disagree with each.**

	Agree	Neither Agree nor Disagree	Disagree
a. The new pay-by-weight scheme is fair	☐1	☐2	☐3
b. The new scheme encourages households to reduce waste	☐1	☐2	☐3
c. The new scheme makes people more aware of the cost to the Local Authority of waste disposal	☐1	☐2	☐3
d. The pay-by-weight scheme is better than the old flat annual charge	☐1	☐2	☐3
e. The pay-by-weight scheme is better than paying for waste disposal through an increase in income tax	☐1	☐2	☐3
f. The pay-by-weight scheme has increased the amount of mess and bother associated with waste disposal.	☐1	☐2	☐3
g. I feel I have enough information about recycling and other ways to reduce waste	☐1	☐2	☐3

Q23 **Have you ever experienced anybody putting waste in your wheelie bin without your permission?**

Yes ☐1 No ☐2 → Go to Q26

Q24 **How often?** Once or twice ☐1 Occasionally ☐2 Regularly ☐3

Q25 **Has the incidence of people putting waste in your wheelie bin without your permission increased since the new pay-by-weight scheme began?** Yes ☐1 No ☐2

Q26 **How many newspapers would your household buy *each week*?** _____

Q27 **And in general about how many OTHER magazines, comics etc. – such as the RTE Guide, glossy magazines and so on - would your household buy each *month?***

_____ magazines, comics etc *per month*

Q28 **Which of the following would best describe the situation in your household regarding the main meal?**

a. Main meal is usually home cooked, using mainly fresh foods prepared from scratch ☐1
b. Main meal is usually oven-ready foods, or take-aways etc. ☐2
c. Main meal is a roughly equal mixture between home cooking and prepared oven-ready meals ☐3

Q29 Approximately how often do you eat the main meal of the day outside the home?

More than once a week ..... ☐1 Occasionally, but less often than once a week..... ☐3
Roughly once a week ..... ☐2 Never or only rarely ..... ☐4

Q30 Cork Co. Council would like to have its customers' views on the frequency it issues bills for waste collection services. How frequently would you like to receive your waste collection bill?

Every 2 months.....☐1 Every 3 months....☐2 Every 6 months.....☐3 Don't know....☐4

To allow us to classify your responses I'd like to ask you a few questions about your household and location. Again, I'd like to remind you that all the information you give me is completely confidential.

Q31 Would you say your household is located in a ...

Town .....☐1 Village .....☐2 Rural Area .....☐3

Q32 Do you live in a house or an apartment?

House.....☐1 Apartment.....☐2 Other.....☐3

Q33 Is the dwelling owned or rented by your household?

Owned outright.....☐1 Being purchased.....☐2 Rented from Local Authority..☐3
Other rented.....☐4 Occupied rent-free.....☐5

Q34 Do you or anyone else in your household have a car? Yes.....☐1 No.....☐2

Q35 How would you best describe your household? Is it a person living alone, a family household or friends sharing accommodation?

Live alone.....☐1 Family .....☐2 Friends sharing .....☐3

Q36 How many people usually live in this household? _____

Q37 I would like you to think now of all the members of your household. Could you please tell me (a) whether each person is male or female, (b) their age last birthday; (c) whether they are at work; and finally, (d) whether they were in the household during 2002. Could I begin with the person responsible for the accommodation ...

[Int: Person responsible for accommodation should be on line 1]

	Name/Initial	(A) Male or Female?	(B) Age last birthday	(C) Whether at Work		(D) Was person in household in 2002?	
Person No.		M or F		At Work	Not at work	Yes	No
1		☐1 ☐2		☐1	☐2	☐1	☐2
2		☐1 ☐2		☐1	☐2	☐1	☐2
3		☐1 ☐2		☐1	☐2	☐1	☐2
4		☐1 ☐2		☐1	☐2	☐1	☐2
5		☐1 ☐2		☐1	☐2	☐1	☐2
6		☐1 ☐2		☐1	☐2	☐1	☐2
7		☐1 ☐2		☐1	☐2	☐1	☐2
8		☐1 ☐2		☐1	☐2	☐1	☐2
9		☐1 ☐2		☐1	☐2	☐1	☐2
10		☐1 ☐2		☐1	☐2	☐1	☐2
11		☐1 ☐2		☐1	☐2	☐1	☐2
12		☐1 ☐2		☐1	☐2	☐1	☐2

Q38 Interviewer: Record the person number in the table above of the respondent: _____

Q39 Could you tell me who in the household is mainly responsible for recycling? _____

Interviewer : Record person number of person who does most of the recycling. If household does not recycle waste, write in '99'.

Q40 **Is there anybody else who was living in the household in 2002 or 2003, but who is not living there now?** Yes ☐1 No ☐2 → Go to Q41

Q40a **How many people have left the household?** _____

Q40b **Perhaps you could tell me whether this person [each of these people] was male or female and how old this person [each one] was when they left, and when they left the household.**

Person No.	Name/Initial	(A) M or F	(B) Age when left	(C) When left Month Year
1		☐1 ☐2		/
2		☐1 ☐2		/
3		☐1 ☐2		/

Q41 **What is the occupation of the main earner in the household? If retired or unemployed give previous occupation. If never worked write 'NEVER WORKED'**
[Write full title and tick appropriate box below]

Self-employed (not farmer) ..... ❑1
Farmer (self-employed) ..... ❑2
Professional/Senior Managerial..... ❑3
Other non-manual worker..... ❑4
Skilled manual worker..... ❑5
Unskilled manual worker..... ❑6
Never worked ..... ❑7
Other ..... ❑8 Don't Know ..... ❑9

Q42 **What is the highest level of educational qualification that you have attained?**
[Int: Pause; read list only if necessary;]

Primary education or less (Include 'no formal education')	❑1
Lower secondary: Junior/Intermediate/Group Certificate (include 'O' Levels/GCSEs, NCVA Foundation Certificate, Basic Skills Training Certificate or equivalent	❑2
Technical or Vocational Qualification but not Upper Secondary: Completed Apprenticeship, NCVA Level 2/3 Certificate, NCEA Foundation Certificate, Teagasc Certificate/Diploma or equivalent	❑3
Upper Secondary: Leaving Certificate (including applied and vocational programmes, also include 'A' Levels, NCVA Level 1 Certificate or equivalent)	❑4
Both Upper secondary and Technical or Vocational qualification	❑5
Third Level Non-Degree: National Certificate, Diploma from NCEA/Institute of Technology or equivalent	❑6
Primary Degree: Third Level Bachelor Degree (include Professional Qualification of Degree Status at least, both Degree and Professional Qualification)	❑7
Postgraduate qualification: Postgraduate certificate or Diploma, Masters Degree, PhD)	❑8

Q43 **Could I ask about the approximate level of net household income? This means the total income, after tax, PRSI and other statutory deductions, of *all* members of the household. It includes all types of income: income from employment, social welfare payments, rents, interest, pensions etc. We would just like to know into which broad groups the total income of your household falls. I'd like to assure you once again that all information you give me is entirely confidential. I can read you the categories either in terms of an amount per week, per month or per year. Which would you prefer?** [Int: Tick one box as appropriate]

Amount per year	*Amount per month*	*Amount per week*	*[Tick one]*
under €15,000	under €1,250	under €290	☐1
€15,001 - €22,500	€1,251 - €1,875	€291 - €430	☐2
€22,501 - €30,000	€1,876 - €2,500	€431 - €575	☐3
€30,001 - €45,000	€2,501 - €3,750	€576 - €875	☐4
€45,001 - €60,000	€3,751 - €5,000	€876 - €1,150	☐5
€60,001 - €75,000	€5,001 - €6,250	€1,151 - €1,450	☐6
over €75,000	over €6,250	over €1,450	☐7

Q44 **Interviewer: Record Time Ended (24 hr clock)** ___ ___ :___ ___

Thank you for participating in this survey.

5

Appendix 4 Tables Giving Detailed Survey Results

Table A4.1. Disposal of organic waste by tenure, location, household type, social group, education, access to car and income category, row %.

	Do you compost or feed to animals any organic waste?		
	Yes, compost	Yes, feed to animals	No
Housing tenure			
Owned outright	43	12	45
Purchasing on mortgage	42	16	42
Local Authority tenants	37	8	56
Other, incl. private rented	24	5	71
Location			
Town	38	9	53
Village	38	14	48
Countryside	49	14	37
Household type			
One person, 65+	25	6	69
One person, under 65	40	9	51
Adult(s), dependent children	47	15	38
Other, all adult, age 65+	42	10	48
Other, all adult	48	15	37
Socio–economic group			
Self-employed	44	15	42
Farmer	43	25	32
Professional/managerial	48	6	46
Other non-manual	50	7	43
Skilled manual	41	15	44
Unskilled manual	33	14	52
Never worked and not stated	24	8	69
Level of education			
Primary	31	13	56
Lower secondary	40	14	46
Upper secondary	44	14	43
Third level	53	8	39
Has car?			
No car	28	5	67
Has car	45	13	42
Household equivalised income			
Under €220 per week	35	9	56
€220 to €360 per week	43	13	44
Over €360 per week	47	14	39
Total	42	12	46

N cases = 1157.

Table A4.2. When began composting or feeding of organic waste to animals by tenure, location, household type, social group, education, access to car and income category.

	When started composting on regular basis			
	Before new pay-by-weight announced, 2002	During 2002, when new scheme announced	When scheme introduced Jan 2003	During 2003, when new scheme introduced
Housing tenure	69	12	8	12
Owned outright	69	12	10	8
Purchasing on mortgage	46	11	18	25
Local Authority tenants	60	10	10	20
Other, incl. private rented				
Location				
Town	59	12	13	17
Village	73	8	7	11
Countryside	72	13	7	8
Household type				
One person, 65+	72	15	6	8
One person, under 65	67	10	8	15
Adult(s), dependent children	67	10	12	12
Other, all adult, age 65+	72	13	6	9
Other, all adult	66	13	8	13
Socio–economic group				
Self-employed	66	13	10	11
Farmer	73	13	8	6
Professional/managerial	71	10	8	12
Other non-manual	75	7	9	9
Skilled manual	61	13	8	18
Unskilled manual	66	14	12	9
Never worked and not stated	64	12	8	16
Level of education				
Primary	67	14	4	15
Lower secondary	59	15	13	13
Upper secondary	65	13	11	11
Third level	76	7	8	9
Has car?				
No car	61	11	11	16
Has car	68	12	9	11
Household equivalised income				
Under €220 per week	64	12	10	13
€220 to €360 per week	65	11	11	13
Over €360 per week	71	12	7	10
Total	68	12	9	12

N cases = 617. Includes those who compost on a regular basis.

Table A4.3. Whether composting of food waste or feeding organic waste to animals increased since January 2003 by tenure, location, household type, social group, education, access to car and income category, row %.

	Increased composting/feeding to animals since Jan 03?	
	Yes	**No**
Housing tenure		
Owned outright	43	57
Purchasing on mortgage	34	66
Local Authority tenants	19	81
Other, incl. private rented	14	86
Location		
Town	44	56
Village	40	60
Countryside	39	61
Household type		
One person, 65+	41	59
One person, under 65	17	83
Adult(s), dependent children	42	58
Other, all adult, age 65+	38	62
Other, all adult	45	55
Socio–economic group		
Self-employed	37	63
Farmer	27	73
Professional/managerial	46	54
Other non-manual	37	63
Skilled manual	48	52
Unskilled manual	38	62
Never worked and not stated	42	58
Level of education		
Primary	36	64
Lower secondary	37	63
Upper secondary	43	57
Third level	43	57
Has car?		
No car	32	68
Has car	41	59
Household equivalised income		
Under 220 per week	33	67
220 to 360 per week	41	59
Over 360 per week	43	57
Total	41	59

N cases=474. Includes those who compost food waste or feed it to animals and began before 2003.

Table A4.4. Disposal of garden waste by socio–economic characteristics, row %.

	Disposal of garden waste					
	No garden waste	With rest of rubbish	In compost bin/pit	Put in pile in garden	Burn	Other
Housing tenure						
Owned outright	27	4	40	27	5	6
Purchasing	24	4	42	31	3	8
Local Authority	41	11	27	16	2	6
Other	61	0	13	24	0	3
Household type						
One person, 65+	44	7	20	21	4	9
One person, under 65	33	6	30	28	6	9
Adult(s), dependent children	23	3	43	30	3	6
Other, all adult, age 65+	30	3	40	28	5	4
Other, all adult	22	5	47	24	4	6
Level of education						
Primary	39	7	28	23	6	5
Lower secondary	32	5	34	25	4	7
Upper secondary	28	3	42	26	3	5
Third level	16	2	49	32	4	8
Household equivalised income						
Under €220 per week	39	6	30	21	3	6
€220 to €360 per week	26	5	41	30	4	4
Over €360 per week	23	3	44	28	5	8
Total	28	4	39	27	4	6

Rows add to 100 or more because households may use more than one disposal method. Table based on 1157 cases.

Table A4.5. Composting activity and socio–economic characteristics, row %.

	Do you compost or feed to animals any organic waste?		
	Yes, compost	**Yes, feed to animals**	**No**
Housing tenure			
Owned outright	43	12	45
Purchasing	42	16	42
Local Authority	37	8	56
Other	24	5	71
Household type			
One person, 65+	25	6	69
One person, under 65	40	9	51
Adult(s), dependent children	47	15	38
Other, all adult, age 65+	42	10	48
Other, all adult	48	15	37
Socio–economic group			
Self-employed	44	15	42
Farmer	43	25	32
Professional/managerial	48	6	46
Other non-manual	50	7	43
Skilled manual	41	15	44
Unskilled manual	33	14	52
Never worked and not stated	24	8	69
Household equivalent income			
Under €220 per week	35	9	56
€220 to €360 per week	43	13	44
Over €360 per week	47	14	39
Total	42	12	46

Note: Table based on 1157 cases.

Appendix 5 Modelling Demand for Waste Collection

It is assumed that utility-maximising individuals have a demand for waste collection that is a function of the prices, of income and of taste parameters that depend on socio–economic characteristics. Following Fullerton and Kinnaman (1994, 1996), a demand function is specified where the dependent variable is average weekly household weight per head during the year before (t = 0) and the year after (t = 1) the introduction of charging.

Y_{it} expresses the weight per head collected from household i in year t, as a linear function of:

price per kg (P_t)

equivalised income and other household variables that are for the large part constant across time regimes for household i (the 1 × k vector X_i) and

a household-specific, time-invariant unobserved factor, μ_i.

The model of demand, following Fullerton and Kinnaman (FK), is then:

$$Y_{it} = \alpha + P_t \beta + X_i \gamma + \mu_i + \varepsilon_{it} \quad (1)$$

where the unknown parameters are α, β, and the k × 1 vector γ.

Because the error term μ_i for a particular household will be correlated across the two pricing regimes t, Generalised Least Squares (GLS) is used to provide efficient estimates of the unknown parameters. The Breusch–Pagan Lagrange multiplier test confirms this need as it rejects the null hypothesis that var(μ) = 0, at the 0.99 confidence level. The Hausman test does not reject the null hypothesis that μ_i is independent of X_i and we therefore treat μ as random, and use the random-effects model. These tests are detailed later.

An outline of the variables used is as follows (full details of the variables are given in Table A5.3 at the end).

Details of variables: (a full listing is given in Table A5.3 at the end).

Dependent variable:

WEIGHT: Y_{it} = [pcWk03 and pcWk02]
= Average weekly weight *per capita* in 2003 and 2002, kg
This is in order to be comparable with other studies that also divide quantity of waste by numbers in the household.

Independent variables:

PRICE: P_t = [price03 and price02]
= The marginal price per kg, 23 euro cent and 0 in 2003 and 2002, respectively. Waivers are not involved, as these only affect the standing charge and not the price per kg – this pricing policy is to stop "*the friends and relations from bringing along their rubbish*".

NEWSP: Weekly number of newspapers and/or magazines, expected to raise the weight of rubbish.

OWNHO: 1 = Household occupants own or are purchasing the house.
0 = Household occupants are renting or live rent-free.

WORK: The fraction of those in the household who work full-time.

INFANT: [infant03 and infant02] the fraction of those in the household under 3 years of age in 2003 and in 2002, respectively (as specified in FK).

EDU3RD: 1 = The respondent has third-level education.
0 = The respondent has no third-level education.

HASCAR: 1 = Has (or someone in the household has) a car.
0 = Does not have a car.

LNINC:	Natural log of equivalised weekly household income.
LNNOS:	[lnnos03 and lnnos02] are natural logs of numbers in the household in 2003 and 2002, respectively. The log form allows the weight to vary across household size so that one can see if there are dis/economies of scale.

Results of the model of demand for waste collection

GLS estimates of the results of the model of demand for waste collection are given in Table A5.1 below. The dependent variable is household waste collected, expressed in weekly kg *per capita*.

This table shows that the coefficient on price is negative and significantly different from zero. Using the procedure in Fullerton and Kinnaman, this coefficient of –12.14 is an estimate of β or dY/dP that can be used to calculate the price elasticity of demand for waste collection at mean levels of price and weight. This can be achieved despite the fact that the marginal price went from zero to a positive figure, as follows.

In its usual form the price elasticity of demand is:

$$\varepsilon_p = \frac{dY}{dP}\frac{P}{Y}$$

$$= \frac{\beta\ P}{Y}$$ (where (1) yields β and neither Y nor P is logged).

At means of P and Y this is an arc elasticity. From Table A5.3 the means of P and weight Y for the GLS model are 0.115 and 5.25, respectively, giving a price elasticity of demand of –0.266.

The income elasticity, where the independent variable X (income) is expressed in natural logs in Eqn 1, would be:

$$\varepsilon_x = \frac{dY}{dX}\frac{X}{Y} = \frac{\gamma}{Y}$$ calculated at the mean of Y.

Table A5.1. GLS model of household demand (weekly kg *per capita*) for waste collection.

```
. xtreg pcwk price newsp ownho work infant edu3rd hascar2 lninc lnnos, re i(ref)


Random-effects GLS regression                   Number of obs      =       580
Group variable (i): ref                         Number of groups   =       290

R-sq:  within  = 0.4905                         Obs per group: min =         2
       between = 0.1590                                        avg =       2.0
       overall = 0.2424                                        max =         2

Random effects u_i ~ Gaussian                   Wald chi2(9)       =    331.09
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       pcwk0 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      price0 |   -12.1444   .7390144   -16.43   0.000    -13.59284   -10.69596
       newsp |   .0493006   .0439412     1.12   0.262    -.0368226    .1354238
       ownho |    .172026   .7807975     0.22   0.826    -1.358309    1.702361
        work |   .7066409   .8364011     0.84   0.398     -.932675    2.345957
     infant0 |   2.719724   1.703314     1.60   0.110    -.6187109    6.058159
      edu3rd |  -.0323756   .4507299    -0.07   0.943    -.9157899    .8510387
     hascar2 |   .0279312    .606644     0.05   0.963    -1.161069    1.216932
       lninc |  -.2236296   .6646861    -0.34   0.737     -1.52639    1.079131
       lnnos0 |  -2.554008    .343823    -7.43   0.000    -3.227889   -1.880128
        _cons |   9.519217   3.447109     2.76   0.006     2.763008    16.27543
-------------+----------------------------------------------------------------
     sigma_u |  2.8843169
     sigma_e |  2.0302475
         rho |  .66868882   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

but the income coefficient is not significant and so this calculation is omitted.[1]

The same formula applies for household size elasticity, where the independent variable X represents household size expressed in natural logs, lnnos0. The coefficient in a lin-log formulation is (dY/dX)X, and its estimated value is –2.554 according to the coefficient on lnnos0 in the table above. Therefore, with dY/dX = –2.554/X, the change in weight per head ΔY due to a change in numbers of ΔX from X_0 to X_1 can be approximated:

$$\Delta Y = -2.554\ \Delta X / X_0$$

For an increase in household size from two to three persons, the change in weight (–2.554 × 1/2) is –1.277 kg per head.

For an increase in household size from five to six persons, the change in weight (–2.554 × 1/5) is –0.51 kg per head.

A few comments are due on these estimated effects. The price elasticity of –0.266 is a stronger price response than the –0.075 weight-based elasticity estimated by Fullerton and Kinnaman (1994, page 12). Part of the explanation may lie in the fact that in their case the charge was in fact volume-based, and indeed their estimated volume based price elasticity of demand at –0.227 is close to our estimate.

The other significant coefficient relates to the effect of numbers in the household. The resulting reductions in waste per head on foot of changes in numbers are remarkably similar to those estimated by Fullerton and Kinnaman, with our 1.3 kg to their 1.1 kg for an increase from two to three persons and our 0.51 kg to their 0.44 kg for an increase from five to six persons.

Other regressors are not statistically significant. However, the indications are that the variable infant0, which is the proportion of persons in the household that are aged under 3, may have a positive effect on weight of waste which would include disposable nappies. Logging the dependent variable in the formulation of the model in fact brings this out, as shown below.

1 When the dependent variable is logged and not the independent variable X:

$$\beta = \frac{1}{Y}\frac{dY}{dX} \quad \text{and} \quad \varepsilon_x = \beta X$$

The 'overall R-squared' at 0.2424 is low, though not unusually so for this type of model.

Effects of household characteristics on reduction of weight of waste

We turn now from determinants of the level of waste to determinants of actual reduction in waste. The incorporation of interaction terms between price and demographic characteristics allows the coefficient on price to vary over household types. The effect on the response to price of different characteristics can then be estimated as follows.

Equation (1) above can be modified by the addition of an interaction term consisting of P_t times every X_i, giving:

$$Y_{it} = \alpha + P_t \beta + X_i \gamma + P_t X_i \delta + \mu_i + \varepsilon_{it} \qquad (2)$$

Taking first differences gives the change in weight. Several terms cancel out but the interaction terms remain, as follows:

$$\Delta Y_i = \Delta P \beta + \Delta P X_i \delta + \Delta \varepsilon_i \qquad (3)$$

where $\Delta\varepsilon_i$ is an error with mean zero, distributed independently of X_i.

Because P is 0 at time t = 0 and 23 euro cent per kg at timet = 1, ΔP is a constant 0.23. The equation that can be estimated by OLS amounts to the change in weight expressed as a function of the variables X_i that represent income and other household characteristics. The equation to be estimated becomes:

$$\Delta Y_i = \alpha_1 + \alpha_2 X_i + \Delta \varepsilon_i \qquad (4)$$

where intercept $\alpha_1 = \Delta P \beta$, that is, the intercept contains the price effect and is expected to be negative.

Results of model of reduction in household waste (Table A5.2)

The constant contains the price effect and is negative and significant. Other significant variables are the change in numbers in the household between the two years, where a positive change has a negative effect on the change in weight per head, i.e reduces it further, reflecting the economies of scale found already. The larger households in 2003, however, and those with higher incomes tended to have smaller reductions. Being 'at work' on the other hand tended to enhance the reduction.

Table A5.2. OLS model of reduction in household demand for waste collection (weekly kg per head in year 1 minus weekly kg per head in year 0).

```
. reg reducekg newsp ownho work  edu3rd family child infant03 retire03 hascar2
lninc lnnos03 chinfant chnos

      Source |       SS       df       MS              Number of obs =     290
-------------+------------------------------           F( 13,   276) =    2.72
       Model |  282.443355    13  21.7264119           Prob > F      =  0.0013
    Residual |  2208.13071   276  8.00047359           R-squared     =  0.1134
-------------+------------------------------           Adj R-squared =  0.0716
       Total |  2490.57406   289  8.61790334           Root MSE      =  2.8285

------------------------------------------------------------------------------
    reducekg |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       newsp |    -.04887   .0405276    -1.21   0.229    -.1286525    .0309126
       ownho |   .1042341   .7107489     0.15   0.884    -1.294944    1.503412
        work |  -1.575616   .8515467    -1.85   0.065    -3.251968    .1007353
      edu3rd |   .0295492   .4054649     0.07   0.942    -.7686474    .8277459
      family |  -1.226067   .7444187    -1.65   0.101    -2.691527    .2393926
     child03 |   .0278315   1.166644     0.02   0.981     -2.26882    2.324483
    infant03 |   1.628087   2.855053     0.57   0.569    -3.992359    7.248534
    retire03 |  -.7145289   .6498608    -1.10   0.273    -1.993842    .5647847
     hascar2 |   -.369294   .5415496    -0.68   0.496    -1.435386    .6967986
       lninc |   .9818189   .5939657     1.65   0.099    -.1874597    2.151098
     lnnos03 |   1.206394   .6502307     1.86   0.065     -.073648    2.486435
    chinfant |   3.390795   2.407273     1.41   0.160    -1.348155    8.129744
       chnos |  -1.858748   .3933271    -4.73   0.000    -2.633051   -1.084446
       _cons |  -7.293789   3.083385    -2.37   0.019    -13.36373   -1.223848
------------------------------------------------------------------------------
```

The explanatory power of this model is small with an Adjusted R-squared of less that 0.1, which is somewhat poorer than the corresponding Adjusted R-squared of just under 0.2 in Fullerton and Kinnaman's model.

The tests for the GLS model of demand for waste collection described above are now reported.

Breusch and Pagan Lagrangian multiplier test

```
. xttest0

        pcwk0[ref,t] = Xb + u[ref] + e[ref,t]

        Estimated results:
                         |       Var      sd = sqrt(Var)
                 --------+------------------------------
                    pcwk0 |    16.05589         4.00698
                        e |    4.121905        2.030248
                        u |    8.319284        2.884317

        Test:   Var(u) = 0
                                 chi2(1) =    125.94
                              Prob > chi2 =     0.0000
```

This confirms that var(μ_i) = 0 is rejected.

Hausman test

If the model is correctly specified and μ_i is uncorrelated with X_{it} then the subset of coefficients that are estimated by the fixed-effects estimator and the same coefficients that are estimated by the random-effects estimator should not differ statistically:

Fixed-effects model

```
. xtreg pcwk price newsp ownho work infant edu3rd hascar2 lninc lnnos, fe i(ref)


Fixed-effects (within) regression               Number of obs      =       580
Group variable (i): ref                         Number of groups   =       290

R-sq:  within  = 0.4950                         Obs per group: min =         2
       between = 0.1473                                        avg =       2.0
       overall = 0.2172                                        max =         2

                                                F(3,287)           =     93.79
corr(u_i, Xb)  = -0.2653                        Prob > F           =    0.0000

------------------------------------------------------------------------------
       pcwk0 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      price0 |  -12.41915   .7531253   -16.49   0.000     -13.9015    -10.9368
       newsp |  (dropped)
       ownho |  (dropped)
        work |  (dropped)
     infant0 |   .6940146   2.345726     0.30   0.768    -3.922993    5.311022
      edu3rd |  (dropped)
     hascar2 |  (dropped)
       lninc |  (dropped)
      lnnos0 |  -3.977346    1.02748    -3.87   0.000    -5.999699   -1.954993
       _cons |    10.5431   1.029064    10.25   0.000     8.517626    12.56857
-------------+----------------------------------------------------------------
     sigma_u |  3.3677755
     sigma_e |  2.0302475
         rho |  .73344841   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(289, 287) =     4.91                 Prob > F = 0.0000

. estimates store fixed
```

Random-effects model

```
. xtreg pcwk price newsp ownho work infant edu3rd hascar2 lninc lnnos, re i(ref)

. estimates store random
```

Hausman test

```
. hausman fixed random

                ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+------------------------------------------------------------
      price0 |   -12.41915     -12.1444        -.274754        .1451052
     infant0 |    .6940146     2.719724       -2.025709        1.612808
      lnnos0 |   -3.977346    -2.554008       -1.423337        .9682468
------------------------------------------------------------------------------
           b = consistent under Ho and Ha; obtained from xtreg
           B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        3.41
                Prob>chi2 =      0.3330
```

The verdict is that we cannot reject the null hypothesis that the coefficients are the same and can treat μ_i as random. Use of the random-effects model is called for.

Table A5.3. Variables used in the models.

Variables for OLS model of weight change	N cases	Min.	Max.	Mean	Std. dev.
pcwk03 **Weekly *per capita* weight 2003**	293	0	18.99	3.87	3.20
pcwk02 **Weekly *per capita* weight 2002**	293	0	28.17	6.63	4.25
pc2003 ***Per capita*** **weight in 2003**	293	0	990.00	201.86	166.63
pc2002 ***Per capita*** **weight in 2002**	293	0	1468.92	345.61	221.43
reducekg **Weekly *per capita* weight reduction**	293	–12.62	5.97	–2.76	2.93
price03 **Price per kg 2003**	293	0.23	0.23	0.23	0.00
price02 **Price per kg 2002**	293	0	0	0.00	0.00
newsp **Weekly newspapers/magazines**	293	0	24.46	7.60	4.54
ownho **Home ownership**	293	0	1	0.94	0.25
work **Proportion of persons at work**	293	0	1	0.38	0.33
infant03 **Proportion under 3, 2003**	293	0	0.33	0.02	0.07
infant02 **Proportion under 3, 2002**	293	0	0.67	0.03	0.11
child03 **Proportion under age 18, 2003**	293	0	0.83	0.18	0.25
retire03 **Proportion age 65 and over, 2003**	293	0	1	0.26	0.40
edu3rd **Whether household respondent has third-level education**	293	0	1	0.27	0.44
family **Family household**	293	0	1	0.79	0.41
hascar **Has car?**	290	0	1	0.85	0.36
eqvinc **Equivalised household income**	293	106.18	841.24	334.41	153.42
LNinc **Natural log of equivalised household income**	293	4.67	6.73	5.71	0.45
hhsize03 **Household size 2003**	293	1	9	3.12	1.71
hhsize02 **Household size 2002**	293	1	9	3.17	1.67
lnnos03 **LN Household size, 2003**	293	0	2.20	0.97	0.61
lnnos02 **LN Household size, 2002**	293	0	2.20	0.99	0.60
recyclereg **Recycle regularly**	293	0	1	0.95	0.22
recycle4 **Always recycle 4+ materials**	293	0	1	0.46	0.50
compostgw **Use compost bin for garden waste**	293	0	1	0.39	0.49
burnhh **Burn household waste**	293	0	1	0.42	0.49
recyclemore **Increased recycling since 2003**	293	0	1	0.43	0.50
burnmore **Increased burning of household waste since Jan 2003**	293	0	1	0.14	0.35
compostmore **Increased composting of organic waste since Jan 2003**	293	0	1	0.18	0.39

Table A5.3. ***Contd.***

Variables used in GLS model (observations for 2002 and 2003 treated as separate cases)	N cases	Min	Max	Mean	Std. dev.
Year	586	2	3	2.50	0.50
Weekly *per capita* weight	586	0	28.17	5.25	4.00
Annual *per capita* weight	586	0	468.92	273.74	208.59
***reducekg* Weekly *per capita* weight reduction**	586	–12.62	5.97	–2.76	2.92
price0 Price per kg	586	0	0.23	0.12	0.12
***newsp* Weekly newspapers/magazines**	586	0	24.46	7.60	4.53
***ownho* Home ownership**	586	0	1	0.94	0.25
***work* Proportion of persons at work**	586	0	1	0.38	0.33
***infant0* Proportion persons under 3**	586	0	0.67	0.03	0.09
***child03* Proportion under age 18, 2003**	586	0	0.83	0.18	0.25
***retire03* Proportion age 65 and over, 2003**	586	0	1	0.26	0.40
***edu3rd* Whether household respondent has third-level education**	586	0	1	0.27	0.44
***family* Family household**	586	0	1	0.79	0.41
***hascar* Has car?**	580	0	1	0.85	0.36
***eqvinc* Equivalised household Income**	586	106.18	841.24	334.41	153.29
***LNinc* Natural Log of equivalised household income**	586	4.67	6.73	5.71	0.45
***hhsize0* Household size**	586	1	9	3.14	1.69
lnnos0 LN Household size	586	0	2.2	0.98	0.61
***recyclereg* Recycle regularly**	586	0	1	0.95	0.22
***recycle4* Always recycle 4+ materials**	586	0	1	0.46	0.50
***compostgw* Use compost bin for garden waste**	586	0	1	0.39	0.49
***burnhh* Burn household waste**	586	0	1	0.42	0.49
***recyclemore* Increased recycling since 2003**	586	0	1	0.43	0.50
***burnmore* Increased burning of household waste since Jan 2003**	586	0	1	0.14	0.35
***compostmore* Increased composting of organic waste since Jan 2003**	586	0	1	0.18	0.39
Change in number persons age under 3	586	–0.42	0.33	–0.01	0.07
Change in number of persons	586	–2	2	–0.05	0.46