

HOUSEHOLD WASTE RECYCLING: ECONOMICS AND POLICY

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One without the other? Behavioural and Incentive policies for Household Waste Management

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Abstract

This paper provides a review of economic studies that analyse the use of multiple policies to cope with waste management problems. We discuss the factors that influence selective sorting behaviour, and the most appropriate policies for their promotion. Based on the works analysed, our survey shows the original features of waste as an environmental problem requiring regulation. The traditional approach in which decisions respond to rational behaviour, particularly cost savings, has some limits. Although not all public policies seem justified, we argue that there might be a need for specific policies to promote recycling, preferably based on the provision of information to consumers or on behavioural instruments. Indeed, personal factors specific to each individual – such as emotions and the influence of social interaction – should be taken into account in the development of public policies. We review the literature related to different rationales and identify some avenues for future research.

Keywords: Household recycling, Waste, Behavioural economics, Public Policies

JEL Codes: Q530, Q580, D030, D040, D120

1 Introduction

Many studies highlight the evolution of consumption patterns and the increasing power of an ecological conscience as likely to change consumers' behaviours and choice criteria. A growing group of 'pro-environmental' consumers favour environmental and ethical criteria in their consumption choices. At the same time, consumers' requirements have resulted in the creation of products and services that generate significant waste. The increase in their volume is such that waste management currently is a major issue for public authorities.

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The European Commission estimates that ‘Today in the EU, each person consumes 16 tons of materials annually, of which 6 tons are wasted, with half going to landfill’.¹ Generally, law offers a broad definition for the concept of waste, and policy objectives are ambitious. For example, European Directive 75/442/CEE defines waste as ‘any substance or object of which the holder disposes or has a duty to dispose of under the national provisions in force’, and reducing residual waste to zero by 2020 is a declared aim for the European Commission.

This paper provides a review of the economic literature on household waste management and recycling, which considers unsorted waste (residual waste) as a source of negative externalities, and as wasted resources. This literature is important and diversified for several reasons. These reasons underline the original features of waste as an environmental problem requiring regulation.

First, dealing with an externality requires acknowledgement of a responsible polluter. In the case of waste, there are two entities that can be considered as the polluters: the original producer of the waste, and the ultimate holder of the waste. From an empirical point of view, the evolution of regulation shows that few constraints are placed on producers’ behaviour, and suggests that consumers will become strategic actors in the achievement of regulatory objectives. Producers are treated separately with mandatory financial contributions to the organizations responsible for waste management. The system is far from being an environmental policy and will not stem the rise of non-recycled waste. In France, for example, since the implementation of these provisions and until the 2000s, the costs of solid waste management have been increasing at an average of 4.74% a year (Dufeigneux et al., 2003). In this context, there are calls to economists to design economic policies to improve consumers’ selective sorting or to achieve the quantitative targets set by regulation.

Second, a historical feature is of great importance. The budgetary logic has for long been directed to the regulation of household waste, resulting in a substantial literature on whether household waste management should be delegated.

Third, the regulatory logic is not confined to budgetary logic since ignoring the external cost would result in non-optimal sorting. Were the regulatory focus to be solely on the external costs and their internalization, then, the development of incentive policies would make selective sorting ineffective. Individual sorting requires a public infrastructure which has budgetary consequences which generally are overlooked in conventional environmental policies. It is clear that public policy on waste management should be somewhere between these two extreme positions and should involve a combination of several policy tools (equipment, incentive pricing, etc.).

Fourth, economic research shows the positive impact of incentives while emphasizing illegal dumping by waste holders. To overcome these externalities, the regulator might

need to publish complementary policies, such as subsidies, and provide information on the role of recycling, how to recycle, etc. This reinforces the importance of a policy mix highlighted in research on household waste management (Lehmann, 2012).

Fifth, participating in recycling can be seen as contributing to a public good. Traditional approaches suggest that decisions respond to rational behaviour, particularly cost savings. However, as highlighted in the behavioral economics literature, households have both intrinsic and extrinsic values in relation to public goods. Deci (1975) considers that intrinsic motivations are defined by the absence of an external reward, as due to ‘the person’s attitude’, and extrinsic motivations as being external to the individual. Thus, personal factors such as emotions, the influence of social interaction, the importance of others’ opinions, social approval etc. need to be taken into account when developing public policies. Therefore, the management of household waste has become an important topic in behavioural economics. The proposition that behavioural tools, such as nudges, could be used to complement incentive pricing, for example, highlights the need for a policy mix.

The paper is organized as follows. Section 2 presents the regulatory and governance framework for waste management. Section 3 introduces the use of economic incentive instruments and their limits. Section 4 describes the incorporation of behavioural instruments into practice. Section 5 concludes.

2 The waste management framework

The economic literature on the general theme of household waste management is diverse and includes several different issues. It is useful first to define a unit of recyclable waste needing a public intervention to ensure its effective recycling in relation to the works reviewed. We consider a unit of waste which yields a Marginal Benefit (MB) when reused, and simultaneously implies a reduction in the marginal external cost MEC of waste. The justification for regulation depends on three criteria. First, the individual sorting *ex-ante* (i.e. at source) is not profitable for the individual and, therefore, will not be implemented automatically. This situation arises when the marginal cost of individual sorting MC_i is greater than the benefit it yields for the consumer: $MC_i > MB$. Second, the *ex-post* sorting operated by the local authority (i.e. sorting the mixed detritus collected) should not be profitable, even if it leads to the valorization of waste and allows for management of the externality of the residual waste. In the absence of this condition, sorting *ex-post* would automatically be implemented by the community, and regulation of individual behaviours would be unnecessary. This situation occurs when the marginal benefit of reusing MB and saving of the external cost of the non-recycled unit, MEC , do not cover the cost of the *ex-post* sorting MC_c : $MB + MEC < MC_c$. Finally, *ex-ante* individual sorting must be socially beneficial even if this requires an infrastructure whose reported

cost per unit of waste considered is α . This situation arises when the marginal benefit of reusing MB and the saving on the marginal external cost of the non-recycled unit, MEC , cover the marginal cost of sorting *ex-ante* MC_i plus the cost of the infrastructure α : $MB + MEC > MC_i + \alpha$. Thus, it is rational to introduce regulation to encourage individual sorting for the benefit of the community, if the marginal benefit MB is such that:

$$MC_i > MB \text{ and } MC_i + \alpha - MEC < MB < MC_c - MEC \quad (1)$$

These inequalities define the units of waste that are relevant according to the regulation, that is, those units of waste whose recycling generates an increase in the social surplus and which require regulation to ensure their recycling. This economic definition of a unit of waste for recycling implies that not all units of waste need to be recycled.²

Inequalities (1) implicitly consider an isolated agent looking only at his marginal cost and marginal gain of sorting. An emerging stream of the literature enlarges this picture considering more complex individual motivations for household recycling: peer effect, warm-glow, self-image, reputation effect, etc. (see section 4). For instance, consider that together with marginal benefit a unit of waste recycled implies a marginal individual reputation: MR_i . The unit is not recycled only if $MC_i > MB + MR_i$. With this decision rule, some units of waste that an agent does not recycled under (1) ($MC_i > MB$), can be recycled when taking into account of marginal reputation ($MC_i < MB + MR_i$). Therefore, the question whether public policies reinforce or weaken the marginal reputation (i.e. whether there is a crowding-in or a crowding-out effect) has to be addressed.

2.1 Regulatory framework

Environmental regulations such as ‘command and control’ are aimed at prohibiting and/or limiting the amount of pollution emitted by individuals. Through regulation, public authorities establish a pollution limit they consider socially acceptable and implement appropriate public policies to achieve it. This is the most common tool used by public authorities to curb pollution and can take many forms. It can (i) define environmental quality objectives, (ii) set a maximum acceptable level of pollution (x amount of non-recycled, recycled, incinerated or buried waste), or (iii) impose environmental infrastructure requirements (e.g. prioritizing incinerators with energy recovery), etc. Although this type of regulation helps to achieve environmental objectives (Barde, 1992), it rarely corresponds to an economic optimum in terms of pollution.³ Also, the social cost of this type of regulation is not minimized, and its effects are limited by its non-incentivizing nature.

For example, the French law n°92-646 (13 July, 1992) recommends a reduction in waste production through the implementation of separated waste collection and recycling schemes. Local regulation sets the rules related to the collection and treatment of waste. It

dictates the types of containers for collection, and the collection schedule (day and time, type of waste), etc. These rules constrain the users; for example, if the waste is to be collected twice a week and the container size is set, then the individual is limited in his or her ability to emit waste. The lower the frequency of collection, the more the individual must pay attention to the quantity of waste they produced. Also, if the municipality decides to increase the frequency of kerbside collection of recyclable and residual waste, this should encourage recycling and composting behaviour.

These ideas were examined in [Wertz \(1976\)](#), [Gellynck and Verhelst \(2007\)](#), and [Ferrara and Missios \(2012\)](#), which show that a high frequency of residual waste collection has a positive effect on the quantities of waste produced. Conversely, a low frequency of residual waste collection results in lower amounts of waste produced because of waste storage problems. The result in [Yamamota and Yoshida \(2014\)](#) is ambiguous about the relation between collection frequency and illegal dumping. They show that the frequency of collection of recyclables is significant and negative, that is, that to reduce illegal dumping, recyclable material should be collected less frequently. [Stevens \(1978\)](#) focuses on the density, frequency and proportion of recovered material, and shows that all three have a significant effect on the total cost. The study by [Callan and Thomas \(2001\)](#) confirms this finding. The authors examine spending on waste management (including costs related to the disposal and recycling of waste) by 110 municipalities in Massachusetts. They estimate the cost of the disposal service and the cost of recycling as a functions of the quantities of waste recycled or disposed of, the frequency of separated collection, the location of disposal sites, access to infrastructure and state subsidies. They conclude that no economies of scale emerge in the case of waste disposal, which contrasts with what is observed for recycled waste.

From this viewpoint, the problem of waste management can be understood primarily as a public services problem. An important part of the literature focuses on the question of how to secure this service at least cost (see below). Compared to the ideas expressed by the inequalities (1), this literature does not question the value or the form of the regulation, but seeks an organization of waste management that generates the lowest cost (α) to the community.

2.2 Waste management

2.2.1 Infrastructure

Provision of an appropriate infrastructure is necessary to encourage recycling practices. The availability of services is a determining factor in the participation of residents in sorting ([Folz, 1999](#)). Municipalities offer different types of services based on the flows of collected waste (packaging, paper, glass, cardboard, etc.) and types of collection (kerbside

or garbage collection station). These vary by municipality and do not have the same effects on the behaviour of individuals.

[Sidique et al. \(2010\)](#) show that kerbside collection systems and garbage collection stations improve recycling rates because they reduce the opportunity costs of recycling. However, they are used by individuals who are already aware of environmental issues and are ready to expend more effort on waste recycling. The idea of effort is well developed in the literature. For example, [Oskamp et al. \(1991\)](#) and [Guagnano et al. \(1995\)](#) show that the simple fact of an available selective sorting container increases the volume of recycled materials. Many studies show that people are likely to participate in an activity if it does not require them to expend too much effort, that is, if it is not too constraining ([De Young, 1993](#); [Vining and Ebreo, 1990](#); [Folz, 1991](#); [Guagnano et al., 1995](#); [Knussen et al., 2004](#); [Peretz et al., 2005](#)). [Folz \(1991\)](#) shows that recycling behaviour is greater when the level of effort required is low (shorter distance to a recycling station, no need for sorting by materials, kerbside waste collection). In another study, [Folz \(2004\)](#) shows that what makes recycling services more convenient for individuals is waste collection on the same day as non-recyclable materials collection and collection of mixed rather than sorted recyclable materials.

[Abbott et al. \(2011\)](#) analyse the influence of introducing selective recyclable waste collection on household behaviour. They model the recycling rates of English local authorities based on socio-economic and political variables (community's average annual income, household size, population density, frequency of collection by recycling methods, size and type of container). Recycling rates are defined separately for green waste and recyclables. [Abbott et al. \(2011\)](#) conclude that the frequency of residual waste collection is inversely proportional to the amount recycled (but is more important for green waste than recyclable waste), meaning that a low frequency of collection increases recycling performance. Extension of kerbside collection, type of container for recycled materials, and the lower frequency of residual waste collection play important roles in improving the recycling performance. [Abbott et al. \(2011\)](#) show also that the collection method for recyclable materials has an effect on recycling rates (more for recyclables than for green waste). The rate is lower for 50 litre containers and higher for non-reusable bags and containers on wheels; for example, 120 litre containers show greater increase in recycling rates (+3.4%).

2.2.2 Private versus public management of waste collection

In addition to the choice of waste collection methods, controlling collection costs is a particular objective for local authorities. Direct and delegated (for all or part of the service) management of household waste is often compared. Direct management means that the community bears the infrastructure costs (garbage bins, trucks, containers, garbage col-

lection stations, etc.) and staff costs. Delegated management means that the municipality delegates these responsibilities to one or more companies, either public or private.⁴ Delegation is often preferred because operating a waste collection service requires significant specific investments and incurs several costs (of managing the containers, personnel, waste transportation, infrastructure, etc.).

In studies of the costs of solid waste management, many authors show that direct collection is more expensive than delegated collection by service providers. The first study of this type was conducted by [Hirsch and Engelberg \(1965\)](#). They conducted an econometric study of 24 municipalities in the region of St. Louis (Missouri), which showed that there was no difference in the costs of public and private provision. [Stevens \(1978\)](#) examined the cost structure of 340 waste collection companies (both public and private) in the US, which confirmed of [Hirsch and Engelberg \(1965\)](#)'s results for cities of 50,000 inhabitants or less, but showed also that in larger cities, private providers use more efficient technologies. Whatever the city size, private providers use fewer staff and larger capacity garbage trucks than public monopolies, which enables economies of scale. [Hart et al. \(1996\)](#) applied the theory of incomplete contracts and property rights to the choice between public and private provision. Their results suggest that there are greater incentives to reduce costs in the case of private provision. They show that public provision dominates if the decrease in non-compressible costs causes a decrease in the quality of the service. However, as long as the reduction in the quality of the services offered can be controlled by contracts or competition, privatization is more efficient. [Dijkgraaf and Gradus \(2003\)](#) studied the differences in the cost of waste management in the case of public or private provision for 85 Dutch municipalities. They find, in general, that private provision of waste collection is more effective, and achieves a 5% reduction in total costs compared with a public service provider.

Other studies show that differences in the costs of public and private collection are not necessarily significant. For example, [Bel and Costas \(2006\)](#) qualify these results considering the long term: Studying 186 Spanish municipalities, and comparing cities with privatized public provision to cities using a public service, they conclude that there is no significant cost difference. The authors explain this result as due to the benefits of privatization being eroded over time, which is confirmed by [Dijkgraaf and Gradus \(2007\)](#). Finally, [Bel et al. \(2010\)](#) conducted a 'meta-analysis' of 27 studies involving very different municipalities, to compare the costs of public and private waste management. The authors assume that competition among private service providers lowers the costs of waste management. However, their study does not reveal a systematic relationship between cost savings and private production.

Focusing on cost minimization of the supply of only the public service, the literature on delegated management ignores the environmental dimension of waste management.

Reasoning based on fiscal logic involves comparing two funding opportunities and identical amounts of waste. If we focus more specifically on selective sorting, the efficacy of the alternative providers becomes an issue that has not been tackled in the economic literature. The environmental dimension is crucially important and provides the economic rationale for public policy. A large part of the literature addresses the roots of this issue, that is, the individual Willingness To Pay (WTP) for waste management.

2.3 Evaluations of the willingness to pay

WTP evaluates the monetary value that people attribute to environmental goods and services. It can be assessed using a contingent valuation method that involves surveying individuals about their WTP for improvement to environmental quality. This method yields an estimate of the surveyed individuals' WTP for an environmental asset or their willingness to accept an environmental asset (Beaumais and Chiroleu-Assouline, 2001). It is generally used to value a public good to improve the service offered by public authorities. Individuals' WTP has been investigated also in relation to household selective sorting (Lake et al., 1996; Sterner and Bartelings, 1999; Caplan et al., 2002; Berglund, 2006; Aadland and Caplan, 2006; Koford et al., 2012; Beaumais et al., 2014). Common to these studies is the idea of rationalizing public intervention. In inequalities (1), public intervention is socially desirable if the value that individuals attribute to recycling ($MB + MEC$) is high enough compared to its cost ($MC_i + \alpha$).

For example, Lake et al. (1996) analyse the WTP for kerbside recycling. In their survey, the majority of respondents are willing to pay for this service. Apart from previous recycling behaviour, the demographic variables do not affect the individuals' WTP for kerbside recycling. Notably, although socio-economic characteristics affect people's decision to pay, they do not determine the effective payment level. Using a mail survey, Sterner and Bartelings (1999) studied the willingness of 450 households in the Swedish municipality of Valberg, to pay for better waste management (which did not involve any additional personal effort or work). Sixty per cent of households considered it unreasonable to pay someone else to sort their waste. However, when conditioning on non-recycling behaviour, 23% of households declared they would prefer to pay in money rather than in time (and effort) for the rational management of waste. Sterner and Bartelings (1999) show also that women, less well-educated people and young people are willing to pay more for waste collection.

A study by Caplan et al. (2002), based on a telephone survey of 350 households in the city of Ogden (Utah), estimated the WTP for kerbside recycling. This work focuses on evaluating three options to divert parts of the waste stream away from landfill. The participants were asked to classify the three options in order of preference. The first option corresponds to the traditional system of waste collection, of depositing recyclables and

green waste in a container without separating them from other waste at a cost of USD10.65 per month. The second option offered to separate green waste only, for a maximum additional cost of USD2.00 per month. Finally, for a maximum additional cost of USD3.00 per month, the third option allowed for the separation of green waste and recyclables from residual waste. The results of the study show that two thirds of respondents supported the expansion of kerbside recycling, and that demographic characteristics influence household preferences for alternative waste management systems. More precisely, men, residents aged 45 years, residents who had lived in the city for more than 10 years, and those on low or moderate incomes (less than USD30.000 per annum) prefer the option of ‘trash can alone’ (option 1); women, residents aged under 45 years, new residents in the community, and residents in the medium and high income categories prefer the option of kerbside garbage and green waste collection (option 3). In a related study, [Aadland and Caplan \(2006\)](#) analysed the costs and benefits of kerbside recycling using a sample of households in 40 cities in the western US. They were interested in the WTP. Their results show that young people, women, highly educated people, individuals motivated to recycle for ethical reasons, members of environmental organizations, and those who consider their current collection recycling scheme to be satisfactory are willing to pay more.

[Berglund \(2006\)](#) uses a Tobit model to analyse individuals’ perception of recycling activities in a municipality in northern Sweden. The system of municipal waste management in this community is fairly representative of Sweden as a whole; households sort their waste at source and take it to a recycling centre. The WTP to leave this activity to someone else is estimated as a linear function of the socio-economic variables (income, gender, age, education, type of housing) and other specific indicators such as the distance to the recycling centre, whether waste recycling collection is a requirement imposed by the authorities, perception of recycling as an enjoyable activity, and, most importantly, the green moral index (GMI). The GMI measures the moral motivation for recycling. The results show that men, younger people, people living in apartments or at a distance from a recycling centre, people who perceive sorting as a requirement imposed by the authorities and people with the lowest GMI tend to have a greater WTP (GMI is a determinant of the individual’s WTP to avoid sorting waste at the source). In addition, ethical reasons for recycling result in a lower WTP for another person to take on the recycling activity. The financial cost associated with the recycling effort is lower than the time cost for recycling.

[Koford et al. \(2012\)](#) estimate the WTP for kerbside recycling based on a contingent valuation survey of 600 residents of large cities in the south-eastern US. The results show that people have a mean WTP of USD2.29 per month to participate in a kerbside recycling scheme. High income households and individuals who consider it an ethical duty to recycle are most likely to exhibit a positive WTP. [Koford et al. \(2012\)](#) estimate that an increase of USD1.000 in income leads to an increase in the WTP of 0.0014, and an ethical duty to

recycle increases the probability of consenting to pay by 0.24.

Beaumais et al. (2014) evaluate the WTP for the case of household waste in Corsica. Their results reveal that house owners and city dwellers have a greater WTP to reduce the externalities associated with waste. They explain this result as due to the fact that owners pay more attention to reducing the externalities of waste because it has a negative effect on the housing market and, therefore, the value of their home. Their results show also that people who understand that they are already paying a fee for waste (16% of respondents) and who respond best to monetary incentives are more likely to accept an increased fee, thus, showing a higher WTP to reduce externalities. Corsicans are aware of the issue of waste management on the island, and the resulting externalities, and want change.

Table 1 summarizes the studies on willingness-to-pay.

A too low individual WTP indicates that the local authorities cannot expect consumers to properly tackle the problem of selective sorting, and that public policy is required. The problem is related not so much to providing a public waste collection service, but rather to encourage households to recycle. Two broad categories of policy instruments have been studied applied to field: incentive policy, and information provision.

Table 1: Empirical Analyses of Willingness to Pay for Waste Management

Author/ Country	Topics investigated	Major findings
Lake, Bateman and Parfitt (1996)/ UK	The willingness-to-pay for kerbside recycling scheme in the village of Hethersett, South Norfolk.	Socio-economic factors were important in determining the willingness-to-pay for the scheme, but once people have accepted the payment principle, its magnitude depend mainly upon on the amount of recycling that they were already undertaking before the scheme's implementation.
Bartelings and Sterner (1999)/ Varberg, Sweden	The importance of behavioral variables on household waste management decisions.	Economic incentives are not the only driving force behind the observed reduction in municipal waste: Given the proper infrastructure that facilitates recycling, people are willing to invest more time than can be motivated purely by savings on their waste management bill.
Caplan, Grijalva and Jakus (2002)/ Ogden, Utah	Estimation of household's willingness to pay for varied curbside services.	A discrete choice contingent ranking approach is a cost-effective means for municipalities to evaluate waste disposal solution.
Aadland and Caplan (2006)/ 40 Western US Cities	Estimation of social net benefit of curbside recycling over state and local recycling policy.	The estimated mean social net benefit of curbside recycling is almost exactly zero. Several existing curbside recycling programs in our sample are inefficient use of resources.
Berglund(2006)/ Pitea, Sweden	Analyzes households' perceptions of recycling activities.	Moral motives significantly lower the costs associated with household recycling efforts.
Koford, Blomquist, Hardesty and Troske (2012)/ Lexington, Kentucky	Estimation of WTP for curbside recycling.	Monetary incentives had a greatest impact on household recycling, but the monetary incentives interact negatively with communication appeals which by themselves had little impact overall.

3 The use of economic incentives

The question addressed by the literature discussed in this section is how to encourage or persuade households to recycle using monetary incentives (and to support their cost MC_i as a consequence) when selective sorting is socially beneficial, that is ($MB + MEC > MC_i + \alpha$). For example, if communities require individuals to pay a tax or a fee for each unit of non-recycled waste, then these individuals will have an incentive to reduce their pollution by increasing selective sorting to avoid paying more. Similarly, if individuals receive a subsidy for each unit of recycled waste, it is in their interests to reduce their residual waste. [Hahn and Stavins \(1992\)](#) show that economic instruments give greater importance to the individual willingness to reduce polluting emissions (households choose their own level and means of waste reduction) than is given by regulatory instruments such as ‘command and control’ described above.

The public service of household waste disposal comprises its collection and treatment. As already mentioned, local authorities have an obligation to manage waste, which can be financed in three ways. First, it can be financed from the municipality’s general budget. Although this is a simple method, it does not provide individuals about the costs generated by the production of waste. Second, a garbage collection tax can be imposed to provide the resources to fund the collection and treatment of household waste. This form of tax is relatively simple to implement and enhances users’ awareness of the cost attached to managing their waste. However, this flat rate does not send a ‘price signal’ which might lead individuals to reduce their waste production. The third method is incentive pricing which operates by: (i) identifying the generator of waste, (ii) measuring the quantities of waste generated, and (iii) setting a price according to individual effort ([Bilitewski, 2008](#); [Reichenbach, 2008](#)). Incentive pricing corresponds to unit pricing, that is, billing based on the quantity of waste generated (which can be measured as weight, volume, per bag or same subscription). This encourages households to change their behaviour by internalizing the negative externalities generated. However, it can induce perverse effects, such as illegal dumping, to avoid paying the tax.

In the following, we discuss the analyses of three major types of incentive instruments (taxes, subsidies, and the deposit refund system) in the economic literature. We show that this literature considers that, to be effective, these incentive instruments need to be coupled with other forms of state intervention.

3.1 Taxes

The first articles to focus on incentive pricing are generally empirical. For instance, [Wertz \(1976\)](#) studied the city of San Francisco where incentive pricing was adopted to charge for waste services. [Wertz \(1976\)](#) seeks to explain households’ waste production decisions and

examines the effect of incentive pricing on the production of waste for different levels of household income. He compares the average production of waste in the city in 1970 to the average amount of garbage produced in other comparable US cities that had not adopted this pricing system. [Wertz \(1976\)](#)'s results suggest that the quantity of waste generated decreases as the waste tax increases (the estimated price elasticity is -0.15, which means that a 1% increase in the incentive pricing causes a decrease of 15% in the amount of waste generated). In contrast, waste generation increases with income.

This work was extended by [Jenkins \(1993\)](#), who modelled residential and commercial demand for waste management, including recycling as an option to reduce waste. Jenkins used data for nine American cities, five of which had an incentive pricing system. The author develops a model in which households utility depends positively on the consumption of goods, and negatively on the quantity of waste recycled. The model of households' utility maximization suggests that the household's income level, the price of consumer goods, the money received for recyclable materials (deposit), and incentive pricing have an effect on the demand for waste services. Jenkins concludes that incentive pricing is more effective for achieving a reduction in waste quantity than a flat-rate tax, in the absence of any possibility of illegal disposal. She estimates that the introduction of a USD0.8 incentive for a 32-gallon container reduced waste by 9.5% without a separate-collection system, and 16% with one.

Several studies ([Fullerton and Kinnaman, 1996](#); [Nestor and Podolsky, 1998](#); [Linderhof, 2001](#); [Dijkgraaf and Gradus, 2004](#); [Ferrara and Missios, 2012](#)) show that incentive pricing (based on weight, volume, bag, or subscription) has a positive impact on waste reduction and increases the quantity of recycled waste, thus, acting as a Pigouvian tax. It also provides individuals with information about the quantity of waste they produce and encourages responsible behaviour and the funding of a waste management service. Non-recycling households pay more, and recyclers pay less. [Glachant \(2003\)](#) and [Ferrara and Missios \(2005\)](#) show that this system of unit pricing not only increases households recycling but also causes a decrease in waste at source. Indeed, the tax encourages individuals to buy products with less packaging, and pushes the industry to change their offers to the provision of 'greener' products.

The study by [Fullerton and Kinnaman \(1996\)](#) is interested in the effect of introducing unit pricing, on the quantity of waste produced, the number and weight of waste containers, and the amount of waste recycled. The authors estimate the quantities of waste generated by 75 households⁵ in Charlottesville, Virginia, before and after the introduction of an incentive pricing. In this city, traditional collection is provided by the city and financed by local taxes, and recycling is voluntary (waste is deposited in landfills, and there is no kerbside waste collection). In 1991, the community provided each household with a recycling container and developed a kerbside recycling scheme. In 1992, the city went

from a voluntary to an incentive pricing programme based on stickers (unit pricing for weight). The stickers indicate USD0.80 for a 120 litre bag collected at the kerbside, and USD0.40 for a 60 litre bag; bags with no sticker were not collected. A comparison of the waste stream was made four weeks before and four weeks after the tax was introduced. The results show a 14% reduction in the weight of waste collected and a 37% increase in the volume and 16% increase in the weight of recyclable materials. However, after estimating illegal waste diversion, the decrease in collected waste weight reduced to 10%.

The consequence of the introduction of illegal waste disposal (illegal dumping, depositing waste in the workplace or in neighbours' bins, and burning of waste) is an important topic in this literature. It is considered a negative effect of incentive pricing (Fullerton and Kinnaman, 1996; Linderhof, 2001). Controlling for such antisocial behaviour is costly and difficult to implement, particularly for collective housing, where individual households' practices are difficult to isolate. Fullerton and Kinnaman (1996) propose several arguments against incentive pricing. First, they consider that the administrative and implementation costs are too high. Second, they estimate that 28% to 43% of total waste is diverted away from legal waste flows. However, these results should be interpreted with caution because a study by Linderhof (2001) estimates that illegal disposal represents 4%-5% of total flows, that is, 13%-17% of total waste reduction. These antisocial behaviours can be explained by differences in individual levels of environmental awareness. However, the negative externalities generated by the tax are difficult to measure and these studies show that, when they occur, antisocial behaviours are insignificant or remain at the margin and diminish over time. According to Fullerton and Kinnaman (1996), the effect of the incentive pricing remains positive and is a source of income which, by encouraging individuals to control the amount of their waste, also reduces waste management costs.

Several empirical studies that compare different pricing systems followed the study by Fullerton and Kinnaman (1996). Using a Tobit model, Nestor and Podolsky (1998) estimate the total waste generated based on the chosen pricing system. In particular, they compare a unit pricing rule based on bags, to one based on subscription. Individuals who opted for bags were obliged to buy them. Therefore, the costs associated with waste disposal depend on the number of bags used and the waste produced. Individuals who opted for subscription, could choose the number of collections per week, the cost increasing with the frequency. The results in Nestor and Podolsky (1998) show that a system based on unit pricing for bags compared to subscription, leads to a greater reduction in the quantity of waste.

Taking different approach, the study by Linderhof (2001) evaluates the effects of the introduction of the first weight-pricing system in the Dutch municipality of Oostzaan. The authors compare the behaviour of households before and after the introduction of the tax in this municipality. They interviewed 3,437 households (accounting for almost the entire

population), between 2 to 42 times up to July 1993, that is, before the implementation of the weight pricing system, and in September 1997 (a total of 42 months). These panel data allow the effects of the new pricing system to be distinguished over the short and the long terms. The authors separately investigate behaviour regarding compostable waste (vegetable, fruit and garden waste) and recyclables (glass, textiles and paper). The weight of waste (alternatively compostable and recyclable) is estimated as a function of the marginal price of waste, household composition, household size and other determinants. Both regressions consider the tax to be effective for reducing waste, and its effect is more significant for compostable waste. In addition, the long-term effects are more important than the short-term effects: Price elasticities are 30% greater over the long term. This suggests that the effects of pricing based on weight are permanent. The results show that three years after the introduction of this system, annual collection of all waste had decreased by 42%, and the share of non-recycled waste had decreased by 56%. However, as underline by the authors, the success of such a scheme can be explained by the fact that the Oostzaan citizens are more environmentally conscious than the average Dutch citizen.

[Dijkgraaf and Gradus \(2004\)](#) also study Dutch municipalities over a three year period (between 1998 and 2000). They extend [Linderhof \(2001\)](#)'s study by estimating the effects of four unit pricing systems (based on waste weight, waste volume, bags, and collection frequency) on the production of total, unsorted, compostable and recyclable waste. As determinants of the quantity of waste under the different pricing systems, [Dijkgraaf and Gradus \(2004\)](#) consider a range of socio-economic characteristics.⁶ They also test whether neighbouring municipalities with no incentive pricing received some of the waste from municipalities with unit pricing. Their results show that with respect to unsorted waste, unit pricing is effective because it reduces the quantity of waste by approximately 50% in the case of pricing based on weight or on bags, by 27% in the case of pricing based on collection frequency, and by 6% if based on waste volume. Similarly, for recyclable waste, the amount increases by 21% in the case of a system based on weight and by 10% in a system based on frequency, while the volume-based system does not yield a significant effect on the quantity of recycled waste. In the case of total waste, all four systems have a significant negative effect on the quantity of waste produced. The systems based on weight and bags are the most effective (they reduce the quantity of waste produced by 38% and 36%, respectively), followed by the frequency system (21% decrease) and the system based on volume (6% decrease only). Concerning illegal dumping in neighbouring municipalities without unit-based pricing systems, the result of the statistical analysis of Dutch citizens does not provide evidence that surrounding municipalities collect part of the waste of municipalities that have unit-based pricing systems. The recent studies by [Kinnaman \(2009\)](#) and [Ferrara and Missios \(2012\)](#) shows weaker results for incentive pricing. However, [Ferrara and Missios \(2012\)](#) emphasize that a volume-based system is

more efficient than a weight- and frequency- based system.

Also, in case of monetary incentives, pro-environmental behaviour usually lasts only as long as the incentive is in place, and may even cause motivational crowding-out if it is discontinued [Frey and Jegen \(2001\)](#). The authors use the example of children who receive money to mow the lawn and stop doing it if the monetary reward is withdrawn.

3.2 Subsidies vs Deposit-Refund

Subsidies are financial transfers towards individuals, communities and the private sector to encourage waste reduction and the choice of a more sustainable waste treatment ([Taylor, 2000](#)). They represent a price signal by increasing the revenue of individuals who perceive them and, therefore, are understood as promoting selective sorting.⁷

[Palatnik et al. \(2005\)](#) examine the use of economic incentives in the management of municipal waste to assess the potential benefits of recycling schemes. Their study is based on in two Israeli cities: Tiv'on and Misgav. Forty-eight percent of Israel's household waste consists of organic material, yard waste and disposable diapers which can be separated from residual waste and recycled. The people of Tiv'on have a choice between a voluntary and a mandatory policy. The voluntary policy enables participants to purchase 500 litre concrete containers for USD105 (50% of their real price) in order to separate organic waste from other waste. The mandatory policy involves installation of a 90 litre container outside a group of residences, to store non-recyclable waste. Recyclable waste is stored at home, and kerbside collection takes place once a week. The voluntary system is more user friendly since residents are not required to store any waste at home; they can drop it directly into the concrete containers. The residents of Misgav can buy backyard composters at a subsidized price equal to 50% of their real value. If at least 80% of households opt to buy a home composter, they receive a discount of USD11.5 on the tax for local environmental services. The results show that when the invoice price of waste disposal services increases, the socio-economic characteristics of households have a positive effect on the household decision to buy or not a container for sorting. They show also that if the container prices are not subsidized, people are unwilling to pay the real price. This indicates that the opportunism effect generally attributed to this type of policy is not at work in this example.

The deposit-refund system assumes that when a consumer buys a product, the individual pays an amount that will be refunded on the return of the product or its despatch to a collection centre. The literature review by [Lehmann \(2012\)](#) considers the deposit-refund system as a policy mix, and shows its superiority. [Lehmann \(2012\)](#) considers the deposit-refund system as representing an indirect combination of two public policies: taxes and subsidies. [Lehmann \(2012\)](#) cites [Fullerton and Kinnaman \(1995\)](#) which focuses on waste tax. [Fullerton and Kinnaman \(1995\)](#) show that, to avoid paying more tax, individuals

resort to illegal disposal. Policy control is very costly and generates high transaction costs. To reduce these costs, the regulator can subsidize recycling with a deposit–refund system. Lehmann considers this as providing a double advantage. First, the polluter, in order to receive the subsidy, must provide proof of recycling, so it encourages polluters to recycle. Second, it facilitates control because the recycling proofs disclose information about behaviour and, thus, reduce transactions costs.

Several authors (Dinan, 1993; Palmer and Walls, 1997; Palmer et al., 1997; Calcott and Walls, 2000) show the effectiveness of a deposit scheme to decentralize the social optimum in alternative to incentive pricing. Palmer and Walls (1997) present a theoretical partial equilibrium model of the market for a consumer good (consisting of raw and recycled material) that ultimately will be disposed of in a landfill. The model takes account of both individuals decisions about consumption and waste disposal and producers' decisions about inputs. The authors study the consignment and norm of a minimum content of recycled materials (i.e., a product that contains some proportion of recycled material) to achieve a socially efficient outcome. They show that without a tax on production inputs and a subsidy on recycling, the norm is not sufficient to achieve an optimal situation (i.e., an optimal amount of production). They show that this norm encourages use of recycled materials, and discourages use of virgin material. When the marginal productivity of recycled materials is high, the norm increases production, when it is low, it reduces production. In the first case, it should be taxed to reduce waste, and in the second case, it is necessary to subsidize the output to avoid a below optimum result. For the authors, the deposit system is an adequate tool to achieve an optimal situation that equalizes the marginal social cost of disposal by, combining a production tax with a subsidy for recycled products. This means it is unnecessary to combine the deposit with an additional tax. However, the authors specify that subsidizing recycling encourages substitution of raw materials, which might indirectly encourage consumption and waste generation. (The subsidy reduces the real price of a good for consumers even though it is potentially polluting.)

A different partial equilibrium model of waste production and recycling is developed in Palmer et al. (1997). This model analyses public policies to reduce quantities of waste, and evaluates the impact of different policies to reduce waste. It models a deposit/refund system, advance disposal fees and recycling subsidies in relation to five recyclable materials (aluminium, glass, paper, plastic and steel). Palmer et al. (1997) assume that the price of a product includes a deposit, which is partly or entirely reimbursed when the product is returned (recycled). The deposit acts as a tax on the final material by increasing its price by the amount of the deposit for non-recyclers. The authors then calibrate the model with supply and demand elasticities based on the economic literature; they consider 1990 price and quantity data for each type of material. They then compare the three policies with respect to a 10% reduction in total waste. Palmer et al. (1997) show that to achieve such

a reduction requires a deposit equal to USD45 per ton. The same reduction in the total amount of waste can be achieved by the application of other policies - advance disposal fees costing USD85, and a subsidy for recycling activity of USD98 per ton. However, these costs are around twice those of the deposit scheme. The deposit has a doubly positive effect because it promotes both source reduction and recycling. A more recent study by [Loukil and Rouached \(2012\)](#), concludes that the deposit system reduces the cost of waste collection, but is not efficient for irregular recyclers.

[Fullerton and Wu \(1998\)](#) develop a general equilibrium model which takes account of households, producers and the influence of production processes decisions⁸ on flows of materials. In the same paper, the authors consider the different pricing instruments that act upstream or downstream. They are interested in how these instruments can be used to solve market failures in waste management and achieve the social optimum. [Fullerton and Wu \(1998\)](#) show that a deposit-refund system is not sufficient to achieve the social optimum and should be coupled with a tax on packaging. This is based on the hypothesis the packaging is not recyclable. [Fullerton and Wu \(1998\)](#) examine several other policies, many of which include a subsidy for recyclability and generate the social optimum. [Calcott and Walls \(2000\)](#) show that when taxes and subsidies vary perfectly with recyclability, a tax on products combined with a subsidy of recycling, such as a deposit-refund system, can achieve the social optimum. This is similar to one of the conclusions in [Fullerton and Wu \(1998\)](#). [Choe and Fraser \(2001\)](#) highlight that different combinations of taxes and subsidies can achieve the social optimum and show that flexibility of the instruments occurs only if the individual actions of agents can be targeted by different economic instruments. The authors show that the flexibility of policies depends on the ability of public authorities to introduce appropriate policy instruments to target the specific behaviour of economic agents.

The deposit-refund system is possible for reusable or recyclable products and packaging. Therefore, it assumes that there is a market for recyclable and recycled goods that is more attractive than the market for residual waste. Also, implementation of such a system requires a sufficient number of conveniently accessible sorting centres. It requires the refund to be sufficiently high in relation to the required recycling. Finally, deposit allows people to both report reusable products, but also to return hazardous materials that should not be mixed with other waste and high-value recyclable products ([Attar, 2008](#)).

The above studies show that incentives act on extrinsic motivations because they involve monetary or material rewards as defined by [Deci \(1975\)](#).

Table 2 summarizes the studies on incentive instruments.

Table 2: Empirical Analyses of incentive instruments in Waste Management

Author / Country	Topics investigated	Major findings
Jenkins (1993) / USA	The impact of a waste service pricing policy (based on an incentive pricing) on waste generation.	The amount of waste generated is sensitive to the price of waste collection. Incentive pricing is more effective for achieving a reduction in waste quantity than a flat-rate tax, in the absence of any possibility of illegal disposal.
Fullerton and Kinnaman (1995)/ Charlottesville, USA	Estimation of the implementation of a unit-pricing program on the weight of garbage, the number of containers, the weight per can, and the amount of recycling.	Households reduced the number of bags, but not necessarily the actual weight of their garbage (households stomped on their garbage to reduce their costs). The weight of recycling increased, and illegal dumping too.
Nestor and Podolsky (1998)/ Georgia, USA	Examine the two most common forms of unit pricing (based on bags vs based on subscription) practiced in the United States.	Households in neither program engaged in source reduction and households in the can program increased total waste generation. Compared to the subscription program, the unit pricing program leads to a greater reduction in the quantity of waste.
Linderhof, Kooreman, Allers and Wiersma (2001)/ Oostzaan, Netherlands	Test the effects of weight-based pricing on the collection of household waste.	The weight-based pricing has a strong effect on the amount of waste presented for collection. This pricing appears to be cost effective, and thus to yield a significant social benefit. Illegal dumping is small.
Dijkgraaf and Gradus (2004)/ Netherlands	Estimate the effects of four unit-based pricing systems (Bag/ Weight / Volume/Frequency) on waste collected in Dutch municipalities.	Unit-based pricing is more effective in reducing unsorted and compostable waste and in increasing recyclable waste. The bag- and weight-based systems perform better than the frequency- and volume-based systems.
Palatnik, Ayalon and Shechter (2005)/ Israel	Examine the use of economic incentives in municipal waste management.	With low levels of effort needed, households' participation rates in a curbside recycling program are mainly influenced by economic variables and age. When the required effort level is relatively high, however, households is influenced mainly by their environmental commitment and by economic considerations. In both cases a subsidy is required in order to achieve an efficient level of recycling.

3.3 Information policies

The origin of waste as an environmental problem arises because a tax (or subsidy), on its own, is not the solution to the environmental issue. Without an efficient infrastructure policy, individual recycling will not be efficient. Similarly, if information on recycling possibilities (where, how, what, etc.) is not made available to consumers, they will under-recycle. Therefore, the literature considers information and infrastructure policies as complementary to economic incentives to promote selective sorting (Aadland et al., 2005).

Information-based instruments are tools that allow for the transmission of knowledge needed by individuals to adopt ecological behaviour. A change in voluntary waste behaviour can reduce the amount of residual waste and increase recycling. This is why information-based instruments are considered voluntary instruments. Grolleau et al. (2004) understand individual voluntary commitment as individuals not being forced by the community.

Unlike the instruments discussed so far, information-based instruments can be introduced by local authorities and by organizations, such as public institutions, associations, educators, etc., always with the same purpose of making individuals aware of their duty to adopt more responsible behaviour. Information-based instruments teach individuals to adopt good attitudes, and inform them of the means available. They sensitize people to waste and its characteristics, that is, the materials that constitute waste, and the potentially useful resources that are thrown away. In other words, education and information shape responsible individuals willing responsibly towards the environment, not only to respect nature but also to achieve more rational management of resources. ‘Waste Reduction Week’, which was launched in 2009 at the European level, is an example of an information campaign. Alternatively, municipalities could provide interactive information maps showing the location and type of garbage collection stations. The earliest communication campaigns employed ecological arguments to highlight the importance of recycling and communicate good behaviour. However, over time, communities have sought to discipline and educate individuals regarding the norms of good environmental conduct (Rumpala, 1999). Information campaigns might focus on the benefits (or harm) of (not) recycling (Lord and Putrevu, 1998). Waste must be perceived as a reusable resource and a source of income. It is impossible to grab the attention of individuals with different environmental sensitivities using one means. However, it is possible to identify groups of individuals and to design specific awareness and education campaigns. The advantage of information-based instruments is precisely the flexibility of their design which allows them to reach the greatest number of people.

Some of the work in the literature (Grodzińska-Jurczak, 2003; Aadland et al., 2005; Kinnaman, 2005) examines the influence of information on individual behaviour, other

studies focus on the knowledge necessary to overcome environmental problems (Granzin and Olsen, 1991; Pieters, 1991; Oskamp et al., 1991). All of this work confirms the importance of awareness and information in individual recycling or waste reduction behaviour. From a general perspective, to motivate green behaviour, Owens (2000) shows that it is better to inform people about the future environment. Information campaigns that emphasize the catastrophic state of the world motivate people to change their behaviour to become more environmentally friendly, even if it involves personal sacrifices (Griskevicius et al., 2010). Grodzińska-Jurczak (2003)'s study analyses the effect of a good understanding/knowledge of waste on selective sorting. He compares the behaviour of residents in different municipalities, some of whom have been exposed to information through communication campaigns, and some who have not. The author shows that combining an information campaign and a sorting programme has a positive effect on reducing waste. Aadland et al. (2005) study a costly kerbside recycling scheme. With the help of a cost/benefit analysis of 4,000 US households, the authors propose that individuals should subscribe to a scheme that involves sorting and taking their waste to a landfill. They recommend that communities make the necessary infrastructure available and conduct a parallel communication campaign. Along the same lines, Kinnaman (2005) highlights the need for information campaigns on waste minimization through waste sorting. Individuals exposed to such information acquire a greater knowledge of environmental issues, which has a positive influence on recycling (Granzin and Olsen, 1991; Pieters, 1991). Oskamp et al. (1991) show that recyclers are better informed about recyclables and recycling locations compared to non-recyclers.

However, Iyer and Kashyap (2007) show that, although the information can be effective, it is much less effective than economic incentives. However, they add that the effect of an information policy persists, which does not apply to incentives which are withdrawn. Thus, the short-term/long-term distinction is important for policy choice. If communities are aiming at quick results related to behaviour changes, then incentives are the right instrument. If they are seeking outcomes that will endure over time and produce real change in the individual habits, they should develop information-based instruments which will have a more permanent effect on behaviours. Information-based instruments are not alternatives to incentives, rather they are complements. Furthermore, to complement information campaigns a public infrastructure policy would seem necessary. In the absence of an efficient infrastructure to facilitate sorting behaviour, recycling will not increase (Knussen et al., 2004).

Taxes, subsidies, deposit-refunds, infrastructure policy, and information on sorting do not constitute the complete range of public policies to increase individual selective sorting. This is the second original feature of waste management understood as an environmental problem. Recycling is part of broader consumer behaviour. The literature on behavioural

economics shows that individuals' decisions respond to factors other than maximizing private interest that can be exploited by other public policies. Social norms, social approval, others' esteem, altruism and others' choices are all important determinants of individual actions. The individual choice of recycling is no exception, as demonstrated by an emerging literature on waste management which is underpinned by behavioural economics.

4 The incorporation of behavioural instruments into practice

Applying behavioural economics to waste management reveals that in equation (1) the MB an individual obtains from recycling is complex. As explained below, MB includes various measures such as the importance given to the environment, the benefit derived from peers' esteem and the value attributed to social norms. We define behavioural instruments as public policies that seek to influence individuals to lead them to adopt behaviours that are aligned to the public interest.

A recent survey by [Van den Bergh \(2008\)](#) highlights studies that show that people are not motivated solely by financial compensation. [Van den Bergh \(2008\)](#) notes that non-monetary instruments can also be used to induce desired behaviour. Therefore, to change individual behaviour, it is important to focus also on social factors such as attitude, social norms and peer pressure. Behavioural incentives are being offered increasingly by public authorities to encourage individuals adopt socially desirable behaviours.

Psychologists and sociologists have conducted extensive studies on the influence of social norms on individual behaviour. These works focus on warm-glow, social pressure and surroundings ([Hornik et al., 1995](#); [Courcelle et al., 1998](#); [Cheung et al., 1999](#)) and, more recently, nudges. Economists are incorporating these concepts into analyses of waste management ([Brekke et al., 2010](#); [Viscusi et al., 2011](#); [Abbott et al., 2013](#); [Cecere et al., 2014](#)) defined in various ways. For example, [Andreoni \(1990\)](#) defines warm-glow as a feeling of inner welfare that comes from performing a good deed while [Brekke et al. \(2003\)](#) translate it as a positive self-image and consider it the threshold to what individuals believe is socially responsible behaviour. [Halvorsen \(2008\)](#) interprets warm-glow as respect for social and moral norms.

4.1 Understanding more complex individual motivations to recycle

Although the study by [Bénabou and Tirole \(2006\)](#) is not focused on waste, it provides guidance to understand this literature. [Bénabou and Tirole \(2006\)](#) distinguish individual actions based on two motivations: the importance of appearing pro-social versus being seen as greedy. The authors model the effect of these arguments on reputation: the

individual's perception of others' opinions his or her motivations based on observation of the individual's actions. They stress that this is at the heart of the crowding-out effect.

The decision to recycle can have other motivations. The psychologist [De Young \(1985\)](#), highlights intrinsic motivation (i.e., based on altruism or environmental awareness) and personal satisfaction. He suggests that people may 'do a good deed' for the personal satisfaction they derive from it with no promise of another reward. For [Deci \(1975\)](#), pure altruism and warm glow are considered intrinsic motivation because the reward is personal and invisible to others. For example, [De Young and Kaplan \(1985\)](#) show that people interested in ecology try to do what they consider to be useful and beneficial and do not seek an economic advantage. [McCarty and Shrum \(2001\)](#) distinguish between people displaying individualistic behaviour and those displaying collectivist behaviour. Collectivists focus more on the group and on shared objectives compared to individualists. Collectivists attribute a high importance to recycling because they consider the future benefits to society from recycling. Individualists assign low importance to recycling because they focus only on the short-term benefits. Collectivists consider recycling to be important which belief leads to their involvement. [D'Amato et al. \(2014\)](#) show that intrinsic motivation for environmental preservation (resulting from the level of knowledge of environmental issues and individual pro-environmental behaviour) positively affects waste reduction. For this authors, there are reciprocal positive and significant links between recycling and waste reduction behaviours. They suggest that recycling and pollution prevention behaviour tend to be self-reinforcing. [Ferrara and Missios \(2012\)](#) consider that intrinsic motivation contributes to moral/social aspects, and show that individuals who show consideration for society tend to engage more extensively in recycling.

We can also distinguish between those who support recycling and those who implement recycling behaviour. This is discussed in the social psychology literature to determine how behavioural and cognitive strategies can change behaviour. [Hopper and Nielsen \(1991\)](#) study both strategies and pay particular attention to the hypothesis that recycling is a form of altruistic behaviour guided by social and personal norms. They point out that recycling is costly to the individual (e.g., in time and effort) and its benefits are neither personal nor immediate, although they are advantageous to the whole society in the long term. [Andreoni \(1990\)](#) develops the concepts of pure and impure altruism. Pure altruism occurs when an individual can improve the lot of his or her friends (e.g., by purchasing a green product); impure altruism refers to a situation where the individual derives no benefit from improving the lot of his or her friends, but, instead, derives a feeling of personal satisfaction from achieving something good.

Peer effects or social approval can act as secondary motivations. [Bénabou and Tirole \(2006\)](#) consider that, although some people are sincerely altruistic, motivations to adopt 'pro-social' behaviour can be explained by the desire to create a positive self-image, but also

to establish a certain type of social esteem. The authors assume that the behaviour of some people may not appear rational since individuals adopt pro-social behaviour despite its cost in terms of time, effort and money. The authors emphasize that monetary incentives can crowd out reputation effects. For an individual to gain reputation effect, his or her behaviour must be seen by others as the least greedy. Reputation effects can decrease if individual behaviour is perceived as due to monetary incentives.

In a study of the factors affecting individual recycling and waste reduction behaviour, [Cecere et al. \(2014\)](#) assume that agents only respond to government economic incentives, such as taxes and subsidies, and consider motivations that extend beyond economic incentives. In responding to intrinsic motivation, agents may be altruistic and make environmentally friendly choices, maximizing both their individual welfare and the social welfare. [Cecere et al. \(2014\)](#) show that in the case of extrinsic motivations, agents are encouraged to engage in pro-environmental behaviour because of external pressures, corresponding to the reputational concerns defined by [Bénabou and Tirole \(2006\)](#). However, note that, as underlined by [Deci \(1975\)](#), social norms and reputation are difficult to classify as intrinsic or extrinsic motivations. For example, if individuals conform to social norm, this may be out of a desire for a good self-image (intrinsic motivation), but may also be to obtain the approval of others (extrinsic motivation).

4.2 Facing social pressure: from peer effects to reputation effects

Social norms correspond to the rules of conduct in a particular group. [Ajzen and Fishbein \(1980\)](#) related social norms to social pressure. Social pressure is measured by the individual's beliefs concerning the expectations of others (i.e., family, neighbours, friends) regarding his or her behaviour. [Ajzen and Fishbein \(1980\)](#) assume that an individual will adopt a behaviour if it seems that his or her family, neighbours or friends attach importance to it. In the case of waste, many studies, not always convergent, show a relationship between social norms and recycling ([Nyborg et al., 2006](#); [Brekke et al., 2010](#); [Viscusi et al., 2011](#)). For example, [Oskamp et al. \(1991\)](#) and [Schultz et al. \(1995\)](#) show that participation in kerbside recycling is more prevalent if neighbours and friends also recycle because it creates a social pressure which encourages greater participation in order to avoid negative judgments. Similarly, when social norms are visible to everyone (e.g., using a recycling bin), [Vining and Ebreo \(1992\)](#) show that recycling rates are higher. [Berglund \(2006\)](#) confirms the importance of social pressure for recycling behaviour, especially for children. [Nyborg et al. \(2006\)](#) model peer pressure. They assume that a society can be completely 'green' (i.e., everyone makes efforts to preserve the environment) or completely 'grey' (i.e., everyone chooses to pollute). The model equilibrium occurs when everyone acts according to the green or the grey norm. The social norm is based on the hypothesis that moral motivation to act 'green' is important if enough people act in this way; if not,

moral motivation is low.

Social pressure can also arise from self-image. [Ek and Söderholm \(2008\)](#) considered whether the consumption of certain goods conveys a self-image of social responsibility. The utility of this self-image does not result from the consumption of the good as such. It arises instead, from the individual decision to purchase a good based on a selfish desire not to be judged by peers, rather than altruism. For example, a person may decide to use reusable bags for shopping, not out of consideration for the environment, but in order to show this behaviour to others. [Brekke et al. \(2003\)](#)'s model assumes that individuals prefer to achieve and maintain a socially responsible self-image. The more that individual's behaviour approaches what he or she considers to be socially responsible, the more his or her self-image improves. The authors conducted a survey to determine the moral motivations for recycling and obtained 1,102 responses. Eighty-eight per cent of individuals claimed to recycle because they believed in behaving in the way they would like others to behave. However, 41% recycled in order to be perceived as responsible by their peers. However, declarative surveys have some limitations. For example, individuals may make a particular response in order to be perceived as someone who cares about the environment, but might act quite differently. [Czajkowski et al. \(2014\)](#) study individual preferences with respect to households' recycling behavior. The authors show that behaviors are mainly determined by a feeling of personal moral responsibility to recycle. Fear of social pressure is less important.

[Brekke et al. \(2010\)](#) tests social interaction of 'duty-orientation' using the results from a survey on glass recycling behaviour among Norwegian households. A duty-oriented individual is defined by [Brekke et al. \(2003\)](#) as someone who prefers a socially responsible self-image and who suffers from loss of self-image if his or her perceived duty to recycle is not fulfilled. [Brekke et al. \(2003\)](#) conclude that for a duty-oriented person, responsibility ascription is an inference (i.e., the result of a learning process) and not a choice. Like [Nyborg et al. \(2006\)](#), the authors suppose that if there is some doubt over the right thing to do, people infer their individual responsibility by considering others' behaviour.

Concerning responsibility ascription, [Brekke et al. \(2010\)](#) suppose that responsibility is accepted if the percentage of others who recycle is greater than a certain individual threshold. Decisions may be motivated by duty-oriented recycling leading to interaction effects from social learning about individual responsibility. A duty-oriented individual will feel loss of self-image if he or she does not fulfil his or her perceived responsibility to recycle. A duty-oriented individual will distinguish the effects of direct social interaction caused by a preference for compliance, and indirect social interaction stemming from responsibility ascription. The direct effect is not affected by the degree of uncertainty of the individual concerning the supposed behaviour of their peers, whereas the indirect effect is completely affected by the supposed behaviour of peers (e.g., the more respondents are

confused about the recycling behaviour of their peers, the less they will be willing to accept responsibility). Nyborg et al. (2006) show that duty-orientation is a major determinant of declared recycling. They show also that the willingness of respondents to accept recycling is influenced by beliefs about the others' behaviour. This means that their responsibility changes depending on others' behaviour or the certainty on their peers' behaviour. Social learning of responsibility is statistically significant and positive, indicating that the people's propensity to assign responsibility increases with common thinking about how to recycle in their social group. When responsibility is already assigned, a change in perception of the behaviour of others will only affect individual behaviour directly. However, if responsibility is not assigned, an upward revision of the belief that recycling is common practice in the immediate social group of an individual will increase the probability of taking responsibility, which has a positive indirect effect on recycling and increases the probability of direct recycling.

4.3 Personal norms vs. social norms

Knussen et al. (2004) suggest that social pressure does not influence recycling (i.e., there is not a significant correlation). They suggest that social norms may operate at an early point in a recycling scheme, or when a recycling scheme is well-established, after individuals have had time to develop strong attitudes (positive or negative) and are not influenced by external social pressure. The empirical study conducted by Viscusi et al. (2011) is important because it investigates the role of 'social norms'⁹ on 'pro-environmental' behaviour based on recycling of plastic bottles. The authors evaluate the roles of personal norms (i.e., norms a person imposes on others) and external norms (i.e., norms people perceive as imposed by others). External norms act as a societal reference for appropriate behaviour or pressure to adopt environmentally friendly behaviour. Personal norms can lead to pro-environmental social pressure on others if they are adopted by a part of the population, and can serve as a benchmark for appropriate behaviour that affects the decisions of others. The authors show that, although the variable 'internal private value' is important, 'social norm', reflecting individual guilt, due to the behaviour of neighbours, from not recycling, is not statistically significant.

This results of Viscusi et al. (2011) contradicts the findings from the studies discussed earlier, and suggests that social pressure cannot be considered an effective method to change recycling behaviour. Hage and Söderholm (2008), in a Swedish study, qualify these results. The authors show that individual recyclers do not tend to be influenced by friends, family or other important people, but that 'new immigrants' are. They explain this as being due to the fact that, in general, when immigrants arrive in a new country, they are unfamiliar with the laws and regulations, and may not have a good grasp of the local language, which can lead to initially low levels of recycling participation. However, over

time, immigrants adjust to the social norms of behaviour and sort (on average, immigrants recycle more than Swedish citizens).

Fornara et al. (2011) stress the importance of spatial distance in developing norms. They believe that people living close to each other behave more similarly than people living at a distance. They show that this applies particularly to recycling if it takes place in a specific location. Abbott et al. (2013; 2014) study the concept of social norms and adhere to the aspect of visibility. Abbott et al. (2013) provide a theoretical and empirical analysis of how social norms and ‘warm-glow’ affect the relationship between the quality of recycling facilities and recycling efforts. Abbott et al. (2014)’s, empirical results confirm the theoretical model’s hypotheses of a social norm effect and a slight effect of environmental concern. However, this empirical study fails to establish a significant relationship between warm-glow and recycling. Abbott et al. (2013; 2014) believe that rather than imposing recycling levels on individuals or implementing measures to guide individual behaviour, governments should introduce measures that activate social norms. For example, implementing kerbside collection programmes that make recycling more visible to neighbours might encourage the emergence of a social norm to recycle.

If selective sorting by others and the recycling social norm more generally, are recognized as key determinants of individual choices to recycle, the question for public authorities is how to activate these factors. From this perspective, the use of nudges seems particularly promising.

4.4 Nudges to the rescue

The willingness of individuals to act in a certain way does not necessarily translate into real action. The 2009 study by the European Commission shows that 93% of French citizens believe that climate change is an important problem. However, the same survey shows that only 33% use a transport means with low CO₂ emissions. Similarly, the fact that an individual is informed does not lead necessarily to the right choice. For example, being aware of the fact that failure to recycle increases the cost of household waste disposal does not encourage all individuals to recycle. Several public authorities have experimented with ‘nudges’, to control the production of waste. Nudges first emerged in the US. Thaler and Sunstein (2003) consider that a nudge ‘guides the choice of individuals to favourable decisions for the community while respecting everyone’s freedom to act in his convenience.’ The idea is based on work in psychology and behavioural sciences, aimed not at understanding the tools to bring out decision making, but rather to understand those who adopt the reported behaviour. It consists of giving a ‘boost’ to those individuals who adopt solutions that benefit communities and generally are consistent with the public interest.

Nudges influence decisions and individual actions by acting on the individual’s per-

ception of the conduct adopted by a group. They impose an environment friendly option by making the option seem unique. For example, a ban on the provision of free plastic bags in shops resulted in the default option for individuals to opt for reusable bags. This initiative helped to limit overconsumption and pushed individuals to choose reusable bags. In France, the number of disposable bags distributed in stores decreased from 10.5 billion in 2002 to 1.6 billion in 2008 (Ministry of Ecology, 2010). In Washington DC in 2010, in order to promote the reuse of plastic bag, a tax of 5 cents on plastic bags was introduced. It indirectly caused a 66% decrease in the number of bags retrieved from the Potomac River between 2009 and 2010.

Another effect achieved by nudges consists of encouraging good environmental practices so that they become social norms. For example, [Schultz \(1999\)](#) conducted an experiment on waste recycling in 120 households in the city of Laverne, CA. Every day for a month, households were informed about the number of families (i.e., their neighbours) who participated in recycling household waste, and the quantity of recycled waste. To obtain this information and create proximity, a handwritten note, was glued to their door. The author observed an immediate 19% increase in the volume of recycled waste. [Schultz \(1999\)](#) adds that the effect persisted and the observed increase continued after the end of the experiment. A nudge informs participants about the behaviour of their neighbours by providing information on the social norm of recycling in their neighbourhood.

However, using nudges to disseminate social norms can have adverse effects and social norms can have positive as well as negative effects on individual behaviour. If the social norms of behaviour adopted by the majority of population correspond to behaviour that does not respect the environment, then these social norms will have a negative effect. A study by [Schultz et al. \(2007\)](#) focuses on energy consumption in 1,000 Californian households and shows that a nudge can have a negative effect. Informing households about their energy consumption compared with the consumption of others in the neighbourhood acts as a nudge diffusing a social norm. However, although their results showed a decrease in energy consumption among high consuming households, they showed also that low-energy households increased their consumption. In addition, nudges do not have the same impact on all individuals. This is confirmed by a study of [Schultz and Zelezny \(2003\)](#) which shows that receptiveness to nudges depends on the individual's level of altruism and the importance given by the individual to environmental issues. Nudges are likely to become important elements in future regulatory systems.

Table 3 summarizes the studies on behavioural instruments.

Table 3: Empirical Analyses of behavioral instruments in Waste Management

Author / Country	Topics investigated	Major findings
Hage, and Soderholm (2008)/ Swedish	The determinants of recycling efforts (in particular packaging waste) in the case of Swedish households.	Economic and moral motives influence inter-household recycling rates. The property-close collection in multi-family dwelling houses leads to higher collection rates. The strength of moral (self-enforced) norms explains a large part of the variation across households, but the importance of such norms in driving recycling efforts partly diminishes if improved collection infrastructure.
Brekke, Kipperberg and Nyborg (2010)/ Norway	Examine if recycling decisions may be motivated by duty-orientation, and if this can lead to interaction effects through social learning of individual responsibility	Responsibility ascription is influenced by the perception of what others are doing. People are reluctant to accept responsibility based on uncertain information.
Viscusi, Huber and Bell (2011)/ USA	The determinants of recycling behavior for plastic water bottles.	Private values of the environment are influential in promoting recycling, while the external norm is not. Households' recycling behaviour are influenced by policies that create economic incentives to promote recycling (recycling laws to reduce the time and inconvenience costs of recycling).
Abbott, Nandeibam, O'Shea (2013)/ UK	Examine the role of social norms and warm-glow.	The empirical analysis failed to establish a significant relationship between warm-glow and recycling. In the context of household recycling it may be more attractive to policymakers to rely on social norms rather than other measures to guide behaviour.
Abbott, Nandeibam, O'Shea (2014)/ UK	Examine the importance of social norms for recycling behaviour.	The study confirms the existence of a social norm effect but fails to establish a significant relationship between warm-glow and recycling.
Cerere, Mancinelli and Mazzanti (2014)/ EU	Examine whether individual waste reduction behaviour is more strongly driven by extrinsic motivations like social norms, or intrinsic motivations like purely altruistic preferences.	In the case of food waste prevention, sustainable behavior is firmly dependent on intrinsic motivations. Waste reducers tend to exhibit a sort of altruistic motivation, which does not relate to economic incentives or social norm pressures.

5 Conclusion

Since the 1970s, many directives and laws have been implemented to regulate waste management to limit its production. New services, such as kerbside recycling, drop-off centres, incinerators and garbage collection stations, have emerged and incentive policies have been implemented. However, the production of household waste countries continues to grow.

The studies presented in this article show that regulatory solutions alone, although necessary, are failing to reverse the trend of increased waste or to change consumer behaviour. However, economic incentives, which act via a price signal, encourage changes in individual behaviour. Environmental taxation appears particularly effective in the case of household waste. Indeed, empirical studies on the OECD countries show that incentive pricing in the form of progressive taxation based on the weight of garbage, is efficient. This form of taxation encourages and rewards individuals to recycle, and minimizes the amount of residual waste. However, it is difficult to assess and control the negative effects of these policies, as individuals reluctant to comply, may resort to illegal dumping to minimize their tax burden.

Although the effectiveness of economic incentive instruments is not challenged, there are no studies showing whether their withdrawal results in cessation of this behaviour. In addition, tax mechanisms achieve maximum welfare gains only if they are paired with informational and behavioural instruments. These instruments appear to be complementary.

In addition, the studies reviewed show that information-based instruments by increasing consumer awareness of the adverse effects of pollution, encourage the adoption of environmentally-friendly behaviour and foster its persistence even if the tax is discontinued. Without information, people cannot understand the consequences of their behaviour. However, knowledge of environmental issues alone does not guarantee adoption of the desired behaviour or eradication of the problem. This is because there is a difference between individuals' intentions and effective actions. The willingness to adopt behaviour and, therefore, to change habits may be limited by the costs involved (e.g., financial, time and convenience costs). Several recent studies highlight the social aspect: awareness of individuals exposed to environmental information depends on the behaviour of their neighbours, social norms or self-image with respect to society, as well as financial incentives. In targeting change in habits and individual practices, informational and behavioural instruments seem to provide the underpinnings of waste management policies.

Although the literature suggests that some policies have stronger effects on the behaviour of individuals, it also suggests that a definitive hierarchisation of policies is not possible. Different policies have different effects, some act on the long term and the others on the short term, some affect the volume of waste and some affect behaviour. Most

work evaluates the effectiveness of single policies in isolation from other measures. In real life, these instruments coexist, and the complementarities between them need to be taken into account and discussed in depth. In our view, incentive mechanisms that force people to quickly adopt the desired behaviour need to be combined with behavioural instruments that change the preferences of individual agents towards more environmental friendly behaviour.

Finally, public policies on household waste will be effective if producers produce goods for which the ‘waste’ part of the product is recyclable. Therefore, taxing producers for the non-recyclable part of their product could be considered a useful complementary policy unless changes in households’ purchasing behaviour towards products that generate less waste are sufficient to generate a change in the supply of goods.

Notes

¹Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *Roadmap to a Resource Efficient Europe*, COM(2011) 571 final, Brussels, 20.9.2011.

²Therefore, the legal definition proposed in the introduction focusing on the ‘nature’ of waste appears broader. However, note that as MB increases because of resources scarcity, residual waste decreases.

³The economic optimum for pollution is achieved when the marginal cost of reducing the quantity of waste is equal to the marginal cost of the environmental damage associated with the production of waste.

⁴Generally, communities employ private companies for the treatment of waste.

⁵97 out of 400 households agreed to participate in the study. The final sample included 75 households with complete data.

⁶These comprised the municipality’s area, average family size in the area, number of non-Western foreigners per inhabitant, percentage of total inhabitants earning a median income, number of houses sold per inhabitant, number of flats sold per inhabitant, an indicator variable for small and large municipalities, and percentage of the population aged over 65.

⁷Taking a different point of view, [De Beir et al. \(2007\)](#) explain that it is necessary to subsidize the recycling sector when there is no competitive waste sector and when the cost of recovery/recycling is high. Conversely, they argue that as soon as recycling activity is profitable, the subsidy becomes unnecessary.

⁸The amount of waste generated by the consumption of goods depends on the production process (Producers need to take account of the design of their products and the recyclability of the waste part product).

⁹They define social norms as ‘normatively appropriate’.

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