

Used Waste or Wasted Policy?

An Analysis of Mandatory Participation in Food Waste Sorting Programmes

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Abstract: In the light of more stringent requirements for sustainable living and environmental concern, the goals for recycling are more ambitious than ever. As part of accomplishing the desired outcome, the sorting rates for households' food waste need to increase. New methods and incentive systems may be ways to stimulate a food waste sorting behaviour and different municipalities apply different policies for this. One policy adopted to increase the sorting levels is making participation in food waste sorting systems mandatory. Using economic theories and the Theory of Planned Behaviour, the effect of adopting such mandatory systems is evaluated with the help of data on waste statistics, demographics and behavioural measures. The results show an insignificant effect from mandatory food waste sorting, as well as differences in sorting levels between municipalities depending on average environmental interest. Whether a mandatory system is more effective in municipalities with high environmental interest is discussed since such indications are found, but no significant results are presented. Attention is drawn to the need for more comprehensive waste statistics for enabling confirmation of such results.

Keywords: Food Waste, Waste, Recycling, Regulation, Waste Management

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Table of contents

Definitions

1. Introduction	1
2. Theoretical Framework	4
2.1 Neoclassical Economics and Utility Curves	4
2.2 Theory of Planned Behaviour	6
3. Previous Research	7
3.1 Mandatory Kerbside Recycling	7
3.2 Preferences and Barriers to Recycling	8
3.3 Incentives and Recycling	10
3.4 Summary and Takeaways from Previous Research	11
4. Hypothesis	11
5. Method and Data Presentation	12
5.1 Working Method	13
5.2 Data Presentation	13
5.2.1 Waste Statistics	14
5.2.2 Behavioural Indicators	15
5.2.3 Demographics	16
6. Regression	18
7. Results	18
7.1 First Round of Regressions	18
7.2 Second Round of Regressions	20
7.3 Further Results	21
8. Measurement Errors	22
8.1 Potential Errors in the Dependent Variable	22
8.2 Potential Errors in the Controlling Variables	23
9. Discussion and Analysis of Results	24
9.1 Implications of Results	24
9.2 Evaluating the Results	26
9.3 Reflections for Future Research	27
10. Concluding Remarks	28

References

Appendix

Definitions

Anaerobic digestion is one of two techniques used for biological treatment of food waste. It is a process in which renewable methane is created as opposed to in the oxygen-consuming alternative *composting*. The net emission of carbon dioxide is zero in the digestion process hence anaerobic digestion is the most environmentally feasible alternative for handling *biodegradable waste*. The Swedish term for anaerobic digestion is ‘rötning’.

Biodegradable waste is a generic term for easily degradable waste that is well adapted for composting or digestion techniques. In this thesis, it refers only to the *food waste* of relevance although the general term can also include green waste (i.e. yard waste).

Composting is one of the two techniques used for biological treatment of food waste. In the context of this paper the term refers to the aerobic technique that is used by many municipalities for digestion of collected *biodegradable waste* from all households in the system. During the composting process oxygen is consumed to digest the food. See further the alternative *anaerobic digestion*.

Combustible waste is waste that is burned without any infusion of oxygen. In the setting of this thesis it refers to the household waste that is not sorted as *food waste* i.e. ‘the usual waste’.

Extended producer responsibility is the regulation stating that producers are responsible for the entire lifecycle of their products. The aim is to incorporate products’ environmental costs into market prices and increase recycling rates. Newspapers, cans and cardboards are examples of such products, and they are often dropped off and collected at recycling stations. *Food waste* and *combustible waste* do not fall under the extended producer responsibility.

Flat fee system is the term for *kerbside collection systems* where the annual fee paid by the households is a fixed fee. See further *volume-based fees* and *weight-based fees*.

Food waste is a form of *biodegradable waste* and is in this setting defined as discarded organic products from households. Organic yard waste is not included.

Kerbside collection is the service of ‘by-the-door’ garbage collection provided by municipalities to households. Normally it consists of personnel with specially built trucks that collect waste from the households’ waste bins. Kerbside collection is the default system in Sweden for waste and food waste collection.

Mandatory food waste collection is a system where necessary facilities for food waste sorting are provided by the municipality within the standard fee. There is however no obligation to use the facilities.

Optional food waste collection is a system where households have to make an active decision to participate in the food waste collection system and thereby receive necessary facilities. Once enrolled in the system there is no obligation to actually use the facilities.

Volume-based fees are commonly used as an incentive system with the aim of decreasing the amount of garbage generated by households. As with *weight-based fees* the idea is to make customers pay a fee that is increasing with the amount of garbage. The total fee can either be constructed by one fixed part together with a volatile part or be completely volume-based.

Weight-based fees are used as incentive system with the aim of decreasing the amount of garbage generated by households. As with *volume-based fees* the idea is to make customers pay a fee that is increasing with the amount of garbage. It is a newer system of which the effect has been subject to debate. The total fee can either be constructed by both a fixed and a weight-based part or be completely weight-based.

Unit-based pricing describes fees of *kerbside collection* that are depending on the amount of garbage bags collected. Both *volume-based fees* and *weight-based fees* are examples of unit-based pricing as opposed to *flat fee* pricing.¹

¹ Source for all definitions: Avfall Sverige (n.d.)

1. Introduction

Every week, an average Swedish household throws 5.6 kilo food in the bin. Over 35 per cent of it would have been possible to eat. Consequently, every fifth bag of food that a Swedish household buys ends up as waste. In a time of global warming and collective concern for the greenhouse effect one could argue that more attention should be drawn to this fact. The food thrown away generates carbon dioxide emissions of 1 425 000 ton each year, equivalent to emissions from 525 000 cars or 345 000 houses warmed by oil (Släng inte maten 2011). The first-hand solution to the problem would be to source reduce, that is to buy less food, eat more leftovers and avoid throwing food merely because it has passed its expiration date. Although this type of reduction in generated waste would be optimal, it is rather difficult for authorities to implement such a change in behaviour among individuals. Hence it is highly relevant to investigate the possibilities to better handle and control the levels of waste. In practical terms this implies improvements of food waste sorting systems as well as an improvement of the techniques used for extracting energy from the waste generated.

At the time of writing, the treatment of food waste differs a lot between geographical areas. Out of Sweden's 290 municipalities, 175 offer separate kerbside collection of food waste out of which 20 offer the service only to large-scale catering establishments. In the remaining municipalities, the systems differ practically in the sense that some systems provide the households with separate containers or disposals. Other systems are built upon optic sorting where differently coloured plastic bags are used to sort out biodegradable waste. More important from an environmental perspective is that the systems also differ in how the food waste is being handled. The two different treatment methods are regular composting and anaerobic digestion of which the latter is non-oxygen extracting hence more environmentally acceptable. Despite that, anaerobic digestion is relatively rare since many facilities find it hard to design a profitable system for transmuting the food waste into energy. (Avfall Sverige 2013b)

In all, this declares the presence of 135 municipalities that do not adapt any system for the handling of households' biodegradable waste. Even more municipalities do not have any functioning system for anaerobic digestion. As an intervention to adjust for this deficiency a new stage goal was recently set by the Swedish Government. It states that at least 50 per cent of the food waste is to be sorted and that 40 per cent shall be treated with anaerobic digestion

by 2018. As a consequence, the anticipations in the industry are that many municipalities will have to implement a new system within the upcoming years to be able to contribute to the fulfilment of the stage goal (Swedish Environmental Protection Agency 2013). Given the current status, some municipalities will have to change their existing treatment systems from composting to anaerobic digestion whilst the 135 municipalities that are currently not sorting out the households' food waste at all are in need of implementing a completely new system. The practical setting of waste management demands consumers perform the actual sorting themselves. Therefore, municipalities need not only to format recycling systems that meet up with the environmental goals but also to construct them so that they contain sufficient incentives for consumer performance. One can easily understand that a new digestion system will serve no purpose if the consumers do not perform the actual sorting correctly. There is a rather well-developed debate about which economic incentives in the shape of different waste fees that give most effect, and the current research leaves questions unanswered (Ferrara and Missios 2005; Jenkins et al. 2003; MORI 2002).

One regulative approach applied in an increasing number of municipalities is the ordinance of mandatory participation in food waste collection programmes. In practice, this means that all participants in the waste management programmes are automatically provided with the proper equipment for separating their food waste from the regular household waste. This means that they are provided with two separate bins, two-folded litterbins or special bags for the food waste, depending on the system used in the particular municipality. In municipalities where it is not mandatory to participate, households must instead voluntarily announce that they want to participate in the food waste sorting programme. The Swedish Waste Management and Recycling Association, the Swedish organisation for waste statistics, has collected information from the 175 municipalities that adopt a system for food waste collection. Of these municipalities, 57 per cent have optional systems and the rest apply a mandatory system in which all households are connected to the sorting of food waste. The aim of the mandatory systems is to enhance the recycling rates by turning food waste sorting into the default option. By making the food waste sorting equipment a compulsory investment as a part of the price paid for the garbage collection, the expectation is that more households will sort out their food waste than if they would have to actively choose to be a part of the food waste programme. (Avfall Sverige 2013a)

Despite the widespread use there is surprisingly little research on the actual effects of setting up a mandatory sorting system. In most papers, 'mandatory system' is mentioned as a

controlling dummy variable in a multiple regression analysis and few well-founded conclusions are drawn regarding the effects from regulating the sorting of food waste (Van Houtven and Morris 1999; Ferrara and Missios 2005). These vague findings can certainly be seen as indications of the possible effects from adapting a mandatory sorting system, but research mainly devoted to the effects of mandatory food waste sorting is shining conspicuously with its absence.

By reason of the increased interest in food waste sorting expected from Swedish municipalities, this paper aims to investigate the effects of local government regulations of food waste sorting as mandatory. Adapting economic and behavioural theories when analysing a data set of waste management systems and current levels of recycling in all Swedish municipalities, this paper investigates the relationship between recycling levels and policy in use. The inhabitants' environmental concern is identified as potentially important for actual behaviour performed. Hence, such indicators are added with the intention of further investigating the circumstances under which a mandatory or optional sorting system might be useful. This is highly relevant due to the risk that an environmentally unconcerned household might not respond to the possibilities of food waste sorting despite the fact that it is included in the fee they are paying. For such a household, the fee paid can be seen as a sunk cost. Since the sorting of food waste demands a greater effort from each household in terms of time and space than throwing all garbage in the same waste bin, they need to be willing to pay this cost of effort to use the equipment provided. An analysis of the difference in actual behaviour between when being provided with the food waste sorting equipment automatically and when having to actively request for it will provide necessary information for policy makers to effectively decide on how to accomplish a high level of food waste sorting.

Thus we aim to answer the following research question:

Is mandatory participation in food waste sorting programmes an effective tool for policy makers in order to increase the sorting level of food waste?

With the subsequent question:

Is it possible to identify differences in the efficiency of such a policy tool depending on the degree of environmental concern among households?

2. Theoretical Framework

In order to analyse the effects of a mandatory system for food waste sorting we have included an extended framework of behavioural aspects in addition to the neoclassical view of rational agents as merely utility maximisers. This framework will be used when evaluating a data set of food waste levels in Swedish municipalities complemented with demographic information as well as with measures of environmental concern and indicators of current subjective norms. Due to the fact that households' incentives for food waste sorting are not purely monetary, the policy evaluation of mandatory food waste sorting needs to be done with respect to more than monetary interests in mind. A framework is built that is versatile enough to explain the variations found when analysing the data set of measured waste quantities. Based on neoclassical economics and the Theory of Planned Behaviour we aim to decide upon relevant variables to refine our econometric treatment of the data and further to explain the results we obtain.

2.1 Neoclassical Economics and Utility Curves

Using the neoclassical view of utility maximising behaviour we automatically introduce a few strong assumptions. The standard rational model of decision-making assumes that actors have clear preferences, conduct a thorough information search and evaluate all available alternatives before making a choice to thereafter take action. The assumption of rational decision-making processes implies that the actors will make decisions to maximise utility (Simon 1955). The utility maximisation is assumed to hold for every household as an entity hence they will try to gain as much utility as possible from resources invested. Viewing utility as a monetary phenomenon, households participating in a mandatory sorting programme will receive higher utility without actually sorting out food waste since they have the same monetary costs, but face a lower cost of time and effort. In a world where only time and money matter, the fee paid would be viewed as a sunk cost and the facilities provided would not be used for food waste sorting.

Perceived utility can also, and will during this thesis, be given by a trade-off between personal costs and benefits from using time and space for environmentally friendly causes. The perceived benefits will come from the joy of performing an environmentally friendly action

and possibly from having structured sorting systems at home, whilst the costs arise from the loss of time and space when sorting out the food waste. The trade-off between these costs and benefits will differ from household to household depending on their individual utility curve. A specification of the utility function will be defined, but before introducing the utility function we need to make a clear distinction between how households with different environmental concern are divided.

Environmental concern is in this scenario considered to be of great importance for how households value the costs versus benefits from the action of food waste sorting, hence they are predicted to respond differently to the policy of a mandatory system. We make the assumption that households can theoretically be divided into two groups, A and B, and that the households follow the standard rational model when making decisions. Group A consists of environmentally engaged actors who maximise utility of already paid services in a mandatory system by conducting the most environmentally friendly behaviour. Group B consists of households whose interest in environmental issues is not large enough to offset the increased inconvenience of sorting out and storing food waste. However if an optional system is applied, the households need to actively announce that they want to participate in the food waste sorting system. In such a system, Group A would theoretically maximise utility by making the effort to participate in the programme whereas Group B would not.

With the distinction between Group A and Group B households stated, we will proceed with presenting the expected utility curves. Drawing on the work of Akerlof and Kranton in ‘Economics and Identity’ (2000), we propose the following utility function describing the utility from sorting out food waste for a household j in whichever municipality.

$$U_j = U_j(a_j, a_j^*, E_j)$$

The utility of household j , U_j , depends on j ’s actions a_j , the actions of others a_j^* , and j ’s environmental concern E_j . Monetary and physical costs and benefits of waste sorting are captured within a_j and a_j^* , which are exogenous.

Environmental concern is defined as follows:

$$E_j = E_j(a_j, a_j^*; e_j, \epsilon_j, P)$$

Environmental concern depends on each household j ’s perception of the importance of the environment, e_j . At any given level of importance of the environment, P represents the

ideal behaviour hence the characteristics and behaviour to be expected from an individual with this perception. For example, when the environment is considered important, a recycling behaviour is expected and therefore included in P . Finally, ϵ_j indicates to which extent the household j 's characteristics and behaviour match the ideal, P .

As previously stated, households maximise their utility U_j in their decision to sort out food waste, and this maximisation depends on their concern for the environment E_j . Letting E_{jA} denote the environmental concern for households in Group A and E_{jB} denote environmental concern for Group B, the earlier distinction between households is applied. The expectation throughout this thesis is that $E_{jA} > E_{jB}$ so that households in Group A receive a higher utility U_j from each action of sorting represented by a_j . Since we use community level data, the variable representing this will be calculated as the density of Group A households in each municipality.

In order to apply this framework in practice and separate E_{jA} from E_{jB} , we need to extend the neoclassical framework to investigate what factors might affect ϵ_j for different e_j under a given P . The Theory of Planned Behaviour will work as a tool for identifying norms and attitude variables that can be used as indicators for actual characteristics and behaviour among households.

2.2 Theory of Planned Behaviour

In the neoclassical view described above we explain the need to find measures for what actually influences behaviour and environmental concern thus how e_j and ϵ_j interoperates in the shaping the utility curves. By including the Theory of Planned Behaviour, TPB, it is possible to investigate what affects actual behaviour and the decision to sort out food waste or not. The following section will describe the relevant foundations of TPB, and we will then conclude how this can be practically applied in the setting of this thesis.

The Theory of Planned Behaviour was first developed by Ajzen (1991) and the fundamental assumption needed is rational individuals that determine behaviour depending on their intention to perform. The intention is in turn influenced by 'attitude towards the behaviour', 'subjective norms' and 'perceived behavioural control'. Attitude is described as a favourable or unfavourable evaluation of performing a certain behaviour. The subjective norm is the perception of social pressure of whether to perform or not, and the perceived behavioural

control is whether the individual believes that she can perform the behaviour in question or not (Tonglet et al. 2004).

Tonglet et al. (2004) also suggests four additional variables to explain intention: ‘moral norm’, ‘past experience’, ‘situational factors’ and ‘consequences of recycling’. Moral norm is the individual’s view of behaviour as being morally correct or not. Past experience is added since studies have shown that it is an important factor for predicting recycling behaviour (Boldero 1995; Cheung et al. 1999; Terry et al. 1999) and situational factors such as skills, resources or lack of opportunities may constrain recycling behaviour. Finally, knowledge of consequences of sorting out food also affects actual behaviour (Tonglet et al. 2004). Starting out in the neoclassical framework, we can now extend the definitions of Group A and Group B with the concepts from TPB. These concepts provide an explanation of how ε_j can be measured. In section 5.2 Data Presentation, variables will be added into our regressions in accordance with the framework.

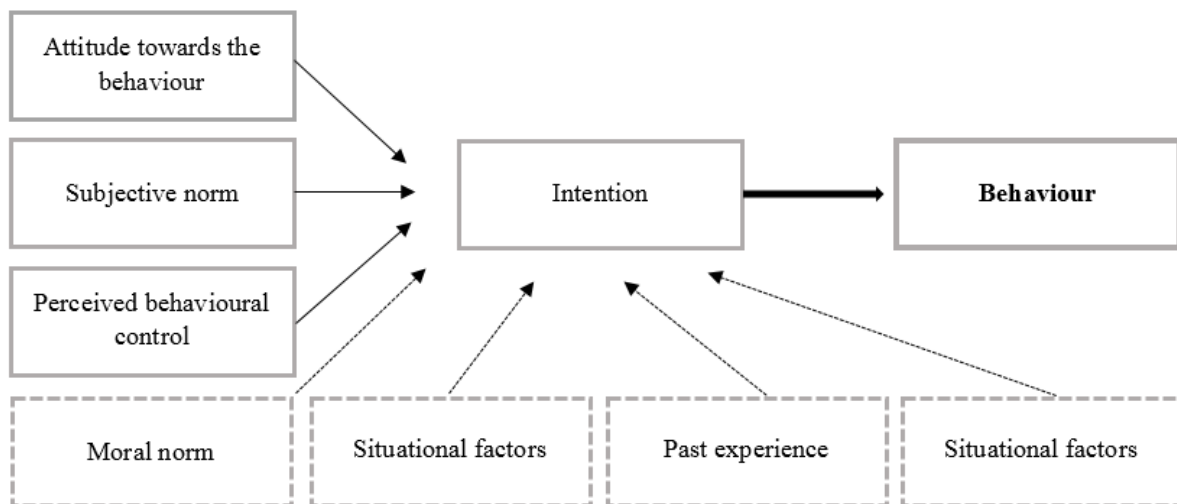


Figure 1. *Illustration of the extended TPB framework.*

3. Previous Research

3.1 Mandatory Kerbside Recycling

As mentioned in the introduction, research on the effects of mandatory regulations is limited. Extending the scope to investigate research not only on mandatory food waste sorting but also on other types of mandatory recycling, some indicators can be found. Jenkins et al. (2003) showed that regulations on mandatory recycling of glass bottles, plastic bottles, aluminium, newspaper and yard waste have an insignificant effect on recycled levels in their paper where

20 US metropolitan statistical areas were investigated on a household level. They also showed that the level of the unit pricing was insignificant, and instead found that the accessibility to kerbside recycling and in some cases the life time of the current waste management programme had a significant effect on the recycling rate. Thus, their research implies that habitual aspects and convenience are of greatest importance for the recycling rate. On the contrary, Everett and Peirce (1993) wrote a paper investigating the effects of convenience and mandatory participation on the recycling rate for 357 residential kerbside recycling programmes in the US. They showed evidence that the municipalities with mandatory participation in residential kerbside programmes were collecting more material than those with voluntary participation. Similar results of positive effects from mandatory recycling of different materials are shown in various papers (see Ferrara and Missios 2005) but some face evidence of persistent non-participants in the recycling programmes both before and after the regulation has been enforced (Ward and Gleiber 1993). Ferrara and Missios (2005) found that a mandatory system has large effect on recycling of newspapers, plastics and toxic materials but almost no effect on recycling of glass. The study did not measure food waste sorting.

The current research on mandatory kerbside recycling is hence too limited to confirm that the regulation give any significant increase in the actual food waste sorting. The obtained results are contradictory, and the lack of explanations of why the mandatory systems work or not is evident. The next section will complement this frugal information with research on perceived barriers to recycling to fill some of the gaps of information.

3.2 Preferences and Barriers to Recycling

A quite extensive amount of research has been made in attempt to identify the psychology and reasons underlying individuals' recycling behaviours. Many studies find a gap between attitude towards recycling and actual behaviour (Chung and Poon 1994; McDonald and Ball 1998) as well as between reported and actual behaviour (Perrin and Barton 2001). One major survey (Dorset Country Council 2001) shows that 20-25 per cent of the households studied are not willing to recycle even though the majority claim to have a positive picture of the concept of recycling, thus raising further questions about the congruence of attitudes towards recycling and the actual recycling behaviour.

Furthermore, the practical barriers to recycling has been subject to much research. McDonald and Oates (2003) summarised four identified barriers to participation in recycling schemes: effort, information, context and incentives. In their article 'Reasons for non-participation in a kerbside recycling scheme' they conducted a survey of 1690 non-users of a UK recycling scheme with kerbside paper recycling. 8000 residents in Sheffield were offered blue recycling bins for free and asked to return a card if they did not wish to participate in the pilot scheme. Households that wanted to join the scheme did not have to take any action, and the result was 1690 households actively turning down the offer. The main reasons for turning down the offer were found to be either insufficient amounts of paper thus no need for the bin, or lack of space for storing the bin (McDonald and Oates 2003).

The barriers to recycling were also investigated by Tonglet et al. (2004) when they used the Theory of Planned Behaviour to explain recycling behaviour. By extending the generic TPB framework they found that the statistically significant variables explaining recycling behaviour are mainly attitude followed by past recycling experience, consequences and concern for the community. However, the explanation rate was low and questions were raised about the validity of the results. Looking at local factors, the Swedish Waste Management and Recycling Association claims that the most important factor for recycling behaviour among Swedish citizens is knowledge (Avfall Sverige 2013b). This finding is in line with the results obtained from Tonglet et al. (2004) who stated that knowledge is one of the most important factors affecting attitude, which in turn is one of the significant explaining variables for recycling behaviour in their paper.

Attempts to identify groups of people adapting the same sorting behaviour has been successfully made when ENCAMS (2002) divided adults in England into five segments depending on their recycling habits. As an example, the 'Routine Recycler' (40 per cent) is a frequent recycler, often a retired homeowner, while 14 per cent are classified as so called 'Busy Dismissors' that may never recycle. This study showed that the main reason for recycling is having a collection service provided, and the most common reason for not recycling is a lack of collection facilities. Tonglet et al. (2004) further found strong correlation between attitudes and agreement with the statements that recycling is not too complicated or takes up too much time and space. The size of the recycling bin, also mentioned by Miranda and Aldy (1998) as an important factor, is pointed out to have some, but not decisive, effect on behaviour.

In all, the extended research on recycling behaviour provides input contingent with both attitude and behavioural aspects. In addition, factors mentioned as explanations for recycling behaviour are socio-economic factors (Emery et al. 2003) and pricing schemes. The effect of pricing programmes has been the subject of a large fraction of the previous research hence the next section is devoted to this area.

3.3 Incentives and Recycling

Many studies available within recycling discuss the pricing of garbage disposal as the only, or most important factor affecting the households' level of recycling. An overview of this research is crucial to understand the economic incentives applied within the field of recycling and to grasp the existing research. Much focus has been on whether to base the recycling service fees on weight or volume or to employ a regular flat fee where the latter alternative gives no particular economic incentives to adopt an environmentally friendly behaviour. Previous research has also underlined the importance and effect of adapting a weight-based fee to increase recycling, but the actual effects obtained from the system are debated (Sterner and Bartelings 1999; Linderhof et al. 2001)

Traditionally, recycling services have been priced using a flat fee including pick up and handling of all waste generated by households. Classic economic theory states that a flat fee would lead to inefficient use of the service since households would produce too much waste. A flat fee would make customers believe that extra waste is free of charge, even though it has a positive marginal cost where collectors have to pay for extra workers, truck space etc. (Kinnaman and Fullerton 2000). To adjust for this inefficiency, a price set equal to the marginal cost would lead to the maximal utility for the society at large but measuring the exact marginal cost is difficult and the administration has been shown to be costly. Average cost pricing and two-tier pricing has therefore been used in many cases instead, creating a unit price system (Miranda and Aldy 1998). Two-tier systems, consisting of a fixed fee and an additional variable fee dependent on waste amounts are common, but have in practice been proved to send less strong price signals than pure variable systems (Miranda et al. 1995). Recently, weight-based systems have been implemented in Sweden and 31 Swedish municipalities use such pricing today (Avfall Sverige 2014).

Looking further into the pricing and economic incentives of recycling, welfare gains and negative price elasticity associated with amount of collected waste under unit pricing has been

proved after implementation of a unit-based pricing system. However, it is debated whether this negative price elasticity is actually increasing the recycling rate or if it only serves to decrease the total amount of garbage from each household (Fullerton and Kinnaman 1996). In a later study of 756 US towns, Kinnaman and Fullerton (2000) showed that by implementing a one dollar user fee, the quantity of garbage decreased with 412 pounds per person each year while the recycling only increased with 30 pounds per person. It is believed to be caused by source reduction and home composting, but also due to illegal dumping and burning.

The implications of the research on pricing programmes are that the economic incentives work to reduce waste to a limited extent, but are in some cases proven to have narrow effect on the actual recycling rate. More importantly, these incentives work to increase recycling of products falling under the extended producer responsibility. None of the studies have been exclusively about food waste.

3.4 Summary and Takeaways from Previous Research

In all, previous research provides us with some important input. The effect of pricing systems has been identified as important which makes it feasible to control for variables describing the characteristics of the pricing systems in different municipalities. We can also conclude that attitude and knowledge are frequently mentioned as important behavioural factors as well as sorting being easy and accessible. The potential friction between attitude and actual sorting behaviour and the contradictory results in research on mandatory policies within recycling further confirm that the thesis will fulfil a purpose in providing valuable input in these areas

4. Hypothesis

Stemming from the theoretical framework and previous research, a clear question can be formed about whether mandatory participation in food waste collection programmes will have a significant effect on the amount of food waste sorted. A question for discussion can also be formed about whether any difference in sorting rate between the different programmes is a consequence of policy decisions or if it is due to environmental interest among the inhabitants.

Starting out from the neoclassical framework we argue that, in the simplest setting, no one would sort out food waste in a mandatory system since it requires an extra effort, and the fee paid is considered a sunk cost. Moving a step further, we argue that the utility curves look different for people that value the environment per se. Therefore, the food waste sorting would not depend on whether the programmes are mandatory or not but rather on whether inhabitants in the municipalities perceive utility from doing environmentally friendly deeds. Our hypothesis is that a food waste sorting system regulated with mandatory participation has no significant effect on the obtained level of food waste.

The formal setting of our null hypothesis is:

$$H0: \beta_{mandatory} = 0$$

The null hypothesis is tested against a two-sided option.

$$H1: \beta_{mandatory} \neq 0$$

5. Method and Data Presentation

In order to reach valid conclusions useful in the field of food waste collection we apply a hypothetic-deductive approach starting out from economic theories and previous research. Hypotheses are formulated and tested through a multiple regression analysis on a cross-section data set from 2012. Starting out with a general regression including municipalities that are currently adapting either optional or mandatory food waste sorting we test for the policy effect. Municipalities without any food waste collection system at present are recognised as missing values hence excluded from the regression when regressing mandatory system on food waste sorting levels. Since the aim of this study is to compare the effectiveness of two competing policies for food waste collection the municipalities without any food waste sorting provide no information. To avoid biased results from omitted factors we then add several controlling variables to disentangle the policy effect from other aspects that may affect the households' sorting behaviour in different municipalities. Finally we analyse the obtained results to in order to answer whether there is any policy effect from mandatory sorting and, in addition, whether environmental engagement among the households matter. To sum up, learnings, conclusions and validity of the results will be discussed together with implications for future research.

5.1 Working Method

First, we run a regular bivariate OLS regression of mandatory system on food waste sorting rate, allowing for heteroscedasticity. Performing a Breusch-Pagan test with a p-value of 0.0017 the presence of heteroscedasticity is confirmed hence all tables are presented with robust standard errors to account for this. The data set is also checked for extreme outliers before regressions are made since these influential observations might disrupt the accuracy of our results. Second, we run the same regression including the controlling variables that we believe are of importance to avoid presenting results suffering from an omitted variable bias.

By excluding variables suspected to contain measurement errors after the first round of regressions is made, we modify our sample to increase the accuracy of the estimates. Six municipalities are dropped due to their short time in use. Since the reported sorting levels from these new systems are not measured over a full year, as in the other municipalities, these observations are incomplete. In addition, the levels of immeasurable information and knowledge among the inhabitants risk being very low with a system that has been used for less than one year. Another 140 observations are dropped due to a sorting level below 10 per cent. A majority of them (104) have already been omitted in the regressions due to missing values in the independent variable ‘mandatory’. Six more observations are dropped due to a sorting level above 90 per cent. The bias included in the results as a cause of narrowing data on the dependent variable is consciously undertaken, and thoroughly discussed under section 8. Measurement Errors.

After running all regressions again (round 2), we generate a new variable dividing all municipalities into either Group A or Group B municipalities. Group A municipalities have an environmental concern rate above average and vice versa. The same regressions as described above are then performed on both groups individually, presenting results specific for Group A municipalities in one table and those specific Group B municipalities in another table.

5.2 Data Presentation

Previous sections have described the method that will be applied in order to answer our research question, and we have presented the existing research and theoretical foundations that support the chosen method. We will now present the data that in practice will be used,

starting out by presenting the origin and then arguing for the importance of the controlling variables. First, empirical data of actual food waste sorted and policy in use are needed. In the theoretical framework and previous research sections it is explained why both demographic and behavioural variables are important to add as controlling variables to get valid results. Accordingly, the data presentation will be divided into the following sections: waste statistics, behavioural indicators and demographics. Behavioural indicators will be given some extra focus since they are of importance for the discussion of our subsequent research question.

5.2.1 Waste Statistics

Cross-sectional data of waste statistics have been collected from the Swedish Waste Management and Recycling Association's yearly report about Swedish Waste Management (Avfall Sverige 2013a). The data in use is from 2012 and gathered at community level from all Swedish municipalities. The collection of data on community versus household level has been frequently debated in previous research (Allers and Hoeben 2010) hence the decision to use community level data has been taken on a practical as well as empirical basis. For the purpose of this thesis where a policy evaluation is to be done, the community level data is easier to handle in the sense that differences between municipalities such as pricing systems and social norms can be controlled for conveniently. One disadvantage related to the theoretical framework, in particular TPB, is that there are difficulties in matching conscious choices with actual food waste quantities forcing us to simplify the use of TPB. There is also a risk of missing out on unobserved local characteristics that ought to be taken into account. However, a relevant argument in this setting is that community level data shields the results from self-selection which has proven to bias the results in previous research when applying household level data (Allers and Hoeben 2010). Furthermore, since there is no system for automatically matching collected waste with individual households, data on a household level needs to be collected from surveys. Given the scope of this thesis we have too limited resources to conduct a survey on household level in sufficiently many municipalities for any valid conclusions to be drawn, hence a community level data set is most reasonable.

Our dependent variable 'sorting_level' describes, as a percentage number, how much food waste in the municipality that is biologically treated i.e. composted or digested. The independent variable of interest 'mandatory' is a binary variable describing whether a municipality adapts a mandatory system for food waste sorting. The benchmark group is

defined as municipalities using an optional food waste sorting system, thus the variable will equal 0 if a system is optional and take the value 1 if a system is mandatory. From the data collected through the Swedish Waste Management and Recycling Association we also collect a variable that describes the number of years passed since implementation of the system in use, 'years_in_use', a binary variable describing whether the municipality is adapting weight-based fees, 'weight_based', and a variable describing the fraction of the total fee that is volatile, 'volatile_part'. This is in accordance with previous research where controlling variables describing characteristics of the fee system in use are suggested to be of importance.

5.2.2 Behavioural Indicators

Based on the theoretical foundations provided by the Theory of Planned Behaviour in use, it is necessary to include variables accounting for factors emphasized by the framework. Introducing these behavioural variables will define the E_j hence the differences in utility curves between Group A households and Group B households. With this in mind, the TPB factors are evaluated for inclusion in the regression. The factor 'past experience' is already included in the variable 'years_in_use' added in the previous section. Likewise, the factor 'consequences of recycling' is captured in the same variable. The logic is that consequences from recycling are synonymous with knowledge of the system, which in turn increases with time. As for 'situational factors', the possible problem with food waste sorting is lack of space. In accordance with previous research, the difference in space needed compared to generating only combustible waste is marginal hence the variable can be disregarded. The factors 'perceived behavioural control' and 'moral norm' are reasonable to neglect since we can assume that any household can fully control whether the sorting is made or not, and that the action of sorting out food waste is viewed as morally correct by all inhabitants.

The behavioural indicators applied is thus the concepts of 'attitude' and 'subjective norms'. In the application of these variables, there are practical difficulties in respect of finding measures that can serve as quantifiable indicators. The fact that the research is conducted at community level obstructs the addition of variables directly reflecting each individual's attitudes and perceptions of social norms, and the solution is to find measures describing the characteristics of the typical inhabitant in a certain municipality. As a foundation for our analysis of the behavioural aspects in sorted food waste levels we have collected data as follows:

‘Attitude’ is found to be the most important factor for affecting actual behaviour, ϵ_j , and in turn E_j . It will thus, in this setting, be defined as ‘environmental_concern’ even though some of the other variables also contribute to E_j in reality. To make the distinction between different attitudes, inhabitants are divided into segments after characteristics and lifestyle. This is similar to the division on recycling habits made by ENCAMS (2002) but based on expressed attitude towards environmental questions and sustainability. The data in use is based on a target group analysis gathered by a Swedish parliament party (Centerpartiet 2014), collected with the aim of finding potential voters with a clear environmental profile. By dividing the absolute number of inhabitants from a relevant target group with the total number of inhabitants within the municipality in question, a variable is created that describes the relative amount of environmentally interested inhabitants in each municipality. Thus, this variable indicates the aggregated attitudes towards the environment within the municipality. As proved by the previous research using TPB, ‘attitude’ is the single most important factor influencing actual behaviour and can thus be a good proxy for ϵ_j . The variable ‘environmental_concern’ is therefore used when dividing municipalities into either Group A or Group B.

The factor ‘subjective norm’ is reflected by the behaviour of the public sector. In each municipality, the local government is elected by the local inhabitants based on a rational selection process, where each individual chooses a party or candidate that one sympathises with in general opinions. This process results in the actions of the local government to be considered normative. In selecting a good estimate for quantifying the current norm one must regard a measure that describes an action where the local government’s behaviour is clearly visible hence signalling the norm to the inhabitants. As an indicator of this, the net costs of the public’s spending on environmental issues are used to create the variable ‘subjective_norm’. Municipalities investing a lot of money in, and making great efforts to solve, environmental issues are hence assumed to put higher pressure on inhabitants to act accordingly.

5.2.3 Demographics

Previous research has shown that socio-economic factors such as education and income are significant factors when analysing the recycling rate of different materials (Emery et al. 2003). Cross-sectional data is collected from Statistics Sweden, SCB, describing average income on a community level used as the variable ‘income’ (Statistics Sweden 2014a). A variable describing the fraction of the inhabitants that have finished a higher education is also

included as ‘education’ (Statistics Sweden 2014b). The two mentioned variables are added as controlling variables to the regression of policy on fraction of food waste sorted.

Table 1. Variable definitions

Variable	Variable name	Definition
sorting_level	Level of sorting	Household food waste sorting level as per cent of total food waste produced, expressed as a decimal proportion
mandatory	Mandatory/optional system	Dummy variable of sorting system, mandatory system = 1
environmental_concern	Environmental concern	Environmental concern among inhabitants expressed as percentage of total with a certain specified lifestyle.
subjective_norm	Subjective norm	The social pressure for performing food waste sorting, stemming from actions made in public by the municipality. Proxy is the public sector’s investments in environmental issues expressed in SEK/inhabitant
education	Higher education	Per cent of inhabitants with a higher education (post-secondary school), expressed as a decimal proportion
income	Average income	Average income in SEK thousands per year within municipality
weight_based	Presence of weight-based fees	Dummy variable where presence of weight-based system = 1
volatile_part	Volatile part of fee	Part of yearly fee that is volatile within present system expressed as a decimal proportion
years_in_use	Years in use	Years since food waste sorting system was implemented

6. Regression

The discussed variables are summarized in the regression of policy for food waste sorting on level of sorted food waste, controlling for environmental concern, public sector's normative pressure by environmental spending, education, average income, sorting system's time-in-use, weight-based fees and fraction of volatile fee. In the regressions, β_1 is the coefficient for difference in average sorted food waste levels with a mandatory system compared to with an optional system. It is equivalent to the coefficient $\beta_{\text{mandatory}}$ in our hypothesis.

$$\text{sorting_level} = \beta_0 + \beta_1 * \text{mandatory} + \beta_2 * \text{environmental_concern} + \beta_3 * \text{subjective_norm} + \beta_4 * \text{education} + \beta_5 * \text{income} + \beta_6 * \text{weight_based} + \beta_7 * \text{volatile_part} + \beta_8 * \text{years_in_use} + \epsilon^2$$

7. Results

In the following section we will present the results from our regressions. Table II shows the results from the eight OLS regressions in round 1, allowing for heteroscedasticity, on food waste sorting level in all municipalities which apply either a mandatory or an optional system. Table III shows the same regressions in round 2 after observations are dropped in accordance with what is described in the method section. We have dropped observations with sorting levels below 10 per cent and above 90 per cent as well as systems less than one year old to control for measurement errors. A discussion of measurement errors is presented in a later section.

7.1 First Round of Regressions

The simple regression of a mandatory system on food waste sorting level shows a positive effect of 0.0607. This indicates that municipalities with a mandatory system show an average food waste sorting rate more than six per cent above the average level in municipalities with an optional system. With a t-statistic of 1.10 this result is not statistically significant. It does not support any actual difference in sorting rate between municipalities depending on system

² ϵ is here the residual term which is equal to zero by assumption

applied, and shows an R-squared of only one per cent. An F-test testing for differences in obtained food waste sorting levels is rejected at all relevant significance levels.

Adding a variable controlling for environmental concern does not increase the R-squared nor does it show any significant effect on sorting level. Adding the other controlling variables one by one, first the behavioural variables and thereafter the demographic and waste technical ones, R-squared increases to a maximum of 11.5 per cent. The last regression (8) contains a variable controlling for the number of years passed since the current waste system was implemented. As the variable shows an insignificant effect on sorting level, decreases R-squared and has a negative coefficient, of which the last contradicts results from previous research and theory, we find it reasonable to focus on regression (7) in the analysis. It shows the effect of a mandatory system on sorting level when controlled for the variables we have collected from previous research and theoretical framework, excluding the deficient years_in_use variable.

Table II. Regression with all observations (Round 1)

VARIABLES	(1) sorting_level	(2) sorting_level	(3) sorting_level	(4) sorting_level	(5) sorting_level	(6) sorting_level	(7) sorting_level	(8) sorting_level
mandatory	0.0607 (0.0550)	0.0606 (0.0550)	0.0515 (0.0560)	0.0536 (0.0555)	0.0625 (0.0547)	0.0597 (0.0536)	0.0526 (0.0532)	0.0538 (0.0621)
environmental_concern		0.0109 (0.168)	0.0239 (0.172)	-0.0102 (0.174)	-0.00720 (0.175)	0.0276 (0.178)	0.0341 (0.175)	0.110 (0.169)
subjective_norm			0.000404 (0.000566)	0.000373 (0.000538)	0.000359 (0.000521)	0.000298 (0.000508)	0.000211 (0.000504)	0.000341 (0.000599)
education				0.685** (0.332)	1.674*** (0.578)	1.604*** (0.580)	1.523*** (0.575)	1.156* (0.625)
income					-0.00323** (0.00127)	-0.00315** (0.00128)	-0.00303** (0.00129)	-0.00217 (0.00152)
weight_based						-0.175*** (0.0634)	-0.193*** (0.0660)	-0.174** (0.0795)
volatile_part							0.151* (0.0904)	0.0812 (0.103)
years_in_use								-0.00157 (0.00542)
constant	0.257*** (0.0348)	0.249** (0.122)	0.221* (0.131)	0.0769 (0.156)	0.653** (0.262)	0.646** (0.263)	0.581** (0.268)	0.433 (0.300)
Observations	128	128	126	126	126	126	125	97
R-squared	0.010	0.010	0.012	0.037	0.068	0.094	0.115	0.083

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Studying regression (7) it is clear that a mandatory system shows no significant effect on obtained sorting level, with a t-statistic of only 0.99. Neither environmental concern nor subjective norm give any significant results. Education, income, weight-based fees and a volatile fee seem to have effect on level of food waste sorted at least on a 10 per cent significance level. The first and last mentioned variables are of higher significance since they show effect also on a 1 per cent level. The income coefficient shows a negative value of $\beta = -0.00303$ which is unexpected in relation to previous research.

7.2 Second Round of Regressions

After running the first regression, a total of 152 observations are dropped. Further discussions about the upper and lower caps are presented under section 8. Measurement Errors below. When running a simple OLS regression on this sample, with robust standard errors allowing for heteroscedasticity, the positive relationship between a mandatory system and sorting level is not statistically significant. When controlling variables are added one by one, the coefficient of a mandatory sorting system is negative in most of the regressions. In regression (7), concluded to be of highest interest, the coefficient indicates a 2.77 per cent lower sorting rate in municipalities that adopts a mandatory system, ceteris paribus, but the effect is still not statistically significant.

Table III. Regression with dropped observations (Round 2)

VARIABLES	(1) sorting_level	(2) sorting_level	(3) sorting_level	(4) sorting_level	(5) sorting_level	(6) sorting_level	(7) sorting_level	(8) sorting_level
mandatory	0.0192 (0.0551)	0.0213 (0.0549)	-0.00838 (0.0546)	-0.0140 (0.0539)	-0.00573 (0.0544)	-0.0113 (0.0564)	-0.0277 (0.0581)	-0.0181 (0.0761)
environmental_concern		0.167 (0.166)	0.207 (0.145)	0.260* (0.153)	0.272* (0.154)	0.273* (0.157)	0.278* (0.151)	0.290 (0.179)
subjective_norm			0.00113** (0.000550)	0.00122** (0.000595)	0.00110* (0.000602)	0.00106* (0.000622)	0.00116* (0.000634)	0.00104 (0.000741)
education				-0.450 (0.342)	0.219 (0.604)	0.193 (0.613)	0.216 (0.600)	0.00103 (0.678)
income					-0.00227* (0.00125)	-0.00218* (0.00128)	-0.00229* (0.00132)	-0.00153 (0.00149)
weight_based						-0.0707 (0.0924)	-0.0786 (0.0781)	-0.0723 (0.0886)
volatile_part							0.146 (0.0925)	0.134 (0.107)
years_in_use								-0.00425 (0.00618)
constant	0.446*** (0.0377)	0.334*** (0.120)	0.263** (0.105)	0.347*** (0.119)	0.752*** (0.226)	0.745*** (0.229)	0.709*** (0.239)	0.593** (0.256)
Observations	67	67	65	65	65	65	65	55
R-squared	0.002	0.021	0.081	0.105	0.140	0.144	0.176	0.134

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The effect from a mandatory policy seem to be hard to evaluate in both data sets. We cannot, in any of the regressions, reject the null hypothesis which states that mandatory programmes have no significant effect on sorted food waste rates. Since the null cannot be rejected, we cannot conclude that the mandatory policy shows any effect on the sorting rate in Swedish municipalities. Consequently we confirm that the effect of a mandatory system on sorted food waste levels is vague, non-existing or non-visible in the data set.

Investigating the regressions in Table III more closely we find a significant effect of environmental concern and subjective norm on sorting level on a 10 per cent significance level. A 1 per cent increase in ‘environmental_concern’ leads to a 0.278 per cent increase in sorting level, and an increase in the measure of the subjective norm also has a positive effect of 0.1 per cent on sorting level. The findings in these regressions are highly interesting for our research question and the validity will be discussed further in the coming sections.

7.3 Further Results

Dividing the observations into Group A or Group B municipalities to perform the regressions on one group at a time, more interesting but insignificant findings are made. Both in mandatory and optional systems, the Group A municipalities show a higher mean of waste sorted than the Group B societies do. In Group A municipalities all regressions, both with the total amount of observations kept as well as when observations are dropped, show a positive but insignificant coefficient of mandatory systems on recycling. In Group B municipalities the same coefficient is negative (see appendix Table IV; Table V; Table VI; Table VII). The results indicate that environmentally interested households maximise utility by using the facilities provided, and that unconcerned households rather use the facilities when they have made an effort to be enrolled in the system. However, these results are statistically insignificant and the information shall rather be treated as input for discussions and further research hence the tables are found in the appendix for the interested reader.

8. Measurement Errors

Highly important in the use of this data set is the understanding of the difficulties in gathering valid data on Swedish food waste sorting. We have identified two specifically precarious measures: the dependent variable ‘sorting_level’ and the controlling variable ‘environmental_interest’. The following section is devoted to enlighten the flaws in the data set and how these might affect the results.

8.1 Potential Errors in the Dependent Variable

As mentioned, in some regressions we have chosen to drop a number of observations. Observations with reported sorting rates lower than 10 per cent are dropped since it is known that some municipalities with particularly low sorting rates are still in an implementation phase of offering food waste collection. In these municipalities, the service of food waste collection is limited to a selection of their customers living in ‘test areas’. To control for this, individual calls would be needed to each municipality, an effort outside the scope of this thesis. It is known that these municipalities report extremely low rates of sorting (Avfall Sverige 2013a) and thus the lower cap is a reasonable method of handling the problem. The deficiency in the data otherwise provides a clear risk of biased results since the relationship between the dependent variable ‘sorting_level’ and the independent variables would be disrupted. The disruption would occur due to the fact that independent variables are measured including all inhabitants in the municipality, and the effect of them on ‘sorting_level’ cannot be disentangled when the percentage of inhabitants able to sort is unknown. To control for this a 10 per cent lower limit is estimated to exclude test area rates from the regression.

As a complement to this a restriction of maximum 90 per cent ‘sorting_rate’ is set. These observations are dropped rather because of the risk of measurement errors in the dependent variable existing due to practical issues in actual measurement of sorted food waste. It is a highly unlikely scenario that no food waste at all would end up among combustible waste. There is much goodwill to collect from being exceptional in food waste collection with regards to the stage goal, thus it exists incentives to exaggerate measures. As a cause of this, the upper 90 per cent limit is used to minimise the risk of both unaware and conscious measurement errors in the dependent variable.

When excluding data based on the dependent variable we add bias to the results. On the contrary, there is a need of restricting the data set from including observations that are misleading hence give defect results. Based on the knowledge that the existing data is incomplete and that the incompleteness is likely to occur in the extremely high and low values of ‘sorting_rate’ we determine the specified range to be necessary despite the risk of added bias.

8.2 Potential Errors in the Controlling Variables

We have already discussed the difficulties in finding a measure that captures a subjective value such as ‘attitude’. With this in mind we need to enlighten the actual flaws of the measure in use. The groups presented in the target group analysis are defined as being ‘environmentally interested’ but the degree of interest is only defined as believing that it is of great importance to care about the environment and to support climate investments. The variable suffer a relatively high risk of measurement error since we cannot validate that the observed value ‘environmental_interest’ is equal to the true value ‘environmental_interest*’³. The potential difference between observed value and true value of ‘environmental_interest’ impose a risk of a lowered reliability ratio hence an attenuation bias. Assuming that the classical errors-in-variables assumption (CEV) holds, this would imply not only inconsistency in the variable for ‘environmental_interest’ but possibly for the all estimators⁴ (Woolridge 2009). To ensure the avoidance of such measurement error an instrument variable would be needed such as an additional index for environmental interest. In the scope of this thesis however the ‘environmental_interest’ variable is alone indicating the inhabitants’ attitudes. The aim of this paragraph is therefore to enlighten this occurrence and the importance of regarding this when reviewing the results. Concluding remarks regarding this will be made under 9.3 Reflections for Future Research, where thoughts for future investigation are raised.

³ Defining observed value as x_I and true value as x_I^* we face the relationship $x_I^* + e_I = x_I$ where e_I is the potential measurement error. If the observed value is a perfect measure of the true value then $e_I = x_I^* - x_I = 0$.

⁴ The reliability ratio is defined from using the probability limit of the estimated coefficient and true coefficient of ‘environmental_interest’. If a measurement error is present $\frac{plim \hat{\beta}_1}{\beta_1} < 1$ is imposed. The CEV assumption implies that the measurement error is uncorrelated with the true value of ‘environmental_interest’ i.e. $Cov(x_I^*, e_I) = 0$. It is assumed to hold for all x .

9. Discussion and Analysis of Results

9.1 Implications of Results

In the beginning of our thesis we addressed a few stressing policy problems for Swedish municipalities that are currently without any food waste sorting systems. There is an urgent need of implementing well-functioning incentive systems in order to reach the 2018 stage goal. During the thesis we have specified a theoretical framework for hypothesising and testing the effect of using mandatory enrolment in food waste sorting programmes. Also, we have argued for the importance of environmental interest for satisfying the effects of the policy, both from a theoretical perspective and through previous research. The results are somewhat in line with what was expected, yet undesirably insignificant and questionable.

The main question to be answered is whether a mandatory system seem to generate higher levels of sorted food waste than an optional system. Testing for differences in sorted levels shows no significant effect in any regression. This implies equal or almost equal rates of food waste sorted in municipalities regardless of system, *ceteris paribus*. Such result confirms our initial hypothesis, in line with the predictions from the theoretical framework, but does not provide evidence strong enough to neither confirm nor reject results from previous research of mandatory participation in sorting programmes. Looking at a scatter plot of sorting levels split up by system reveals an even spread both between and within systems (see appendix Figure 2). The fact that the coefficients on mandatory system show both negative and positive signs depending on regression made would additionally, if significant, indicate a very ambivalent effect. Because of the ambiguous results we would be very careful before drawing too strong conclusions from the regressions but we find it reasonable to conclude that there is an absence of effects of a mandatory system within Swedish municipalities.

As for the regressions with fewer observations (Table III) we note some interesting, significant results. The regressions in Table III are more likely to show real effects of the independent variables since it focuses on values that we have argued for are more reliable. Both the variable for environmental concern and subjective norm show a significant positive effect on food waste sorted in this setting. As discussed in previous sections, the measures for the variables are rather blunt but in total it seems as if being environmentally concerned has a larger effect on sorted food waste than being unconcerned within a mandatory system. A

significant result is an indicator of the importance of using these sort of variables when analysing sorting levels.

Another interesting finding is the positive coefficients of the mandatory variable on food waste sorting level when only concerning Group A-municipalities. The results imply that the fee paid for a mandatory system is not perceived as a sunk cost among Group A households, but rather, they seem to maximise utility by using the system. This finding supports our subsequent research question, although it is important to emphasize the lack of significance in this regression. Looking further at the regressions on Group B societies alone, the opposite trend seems to be present. The coefficient for a mandatory system in these societies is negative, and that a mandatory system has a negative effect on food sorting level might be perceived as a bit puzzling. The reasons causing the negative coefficients are unknown, however, some qualified speculations can be applied. One plausible explanation is that the amount of information reasonably could be higher in a municipality that adopts an optional system. Since such a municipality needs to inform and incentivise the inhabitants to enrol in the optional food waste system, it is sensible to think that the amount of advertising and information spread is larger in such a municipality. With knowledge and information stated as important factors affecting food sorting behaviour, this possible difference in information could be the reason for Group B households to sort more in an optional system. Another speculation regards the behaviour provoked by being forced into doing something versus having the chance to make an active choice. In this scenario, it might be that a mandatory system provides the Group B households with a sunk cost only, but that they in an optional system after actively making the decision to get enrolled want to make use of the effort of announcing their participation. Still the questions remain about why they would choose to make the effort if they are environmentally unconcerned. If not as a cause of information, it could also be that time-limited campaigns and special offers possibly exists in the municipalities that want to increase participation rates in the optional systems, which in that case would be attractive for some unconcerned households.

Despite the insignificance in the results and the speculative character of the reflections, it is however a result of discussions based on our theoretical framework and of interest for future research in the field of both economics and psychology. If it to some extent proves to reflect the reality, there are important implications to collect for policy makers. It would imply that, in a municipality with environmentally concerned inhabitants, a mandatory system for food waste sorting would be sufficient in order to increase the level of sorted waste. In

municipalities identified as Group B however, other activities such as perhaps information and campaigns are more important to convince inhabitants to take action.

9.2 Evaluating the Results

Problematic in the setting is the quality of the data, which affects the results from the regressions. Even if some results are significant they are dubious in comparison with previous research. As an example we turn to the income variable where we in numerous regressions find a negative correlation with sorting level, whereas all previous research implies the opposite. The data gathered on income is regarded highly reliable coming from the Statistics Sweden, hence the data questioned is the waste statistics. Clear risks of defects in the data are present, including municipalities reporting the sorting levels themselves combined with technical differences in how the levels are measured. The risk of presenting somewhat self-serving results is hence evident. On the contrary, if one was to assume that the waste statistics were correct, a plausible explanation for the deficiency in proven income effect is the character of the income measure per se. Since it is presented as an average number on community level one could also argue that the development of well-functioning recycling systems actually are unrelated to mean income level in the municipality. The fact that weight-based fees indicate a negative effect on sorting level also contradicts previous research. One reason could be the low number of municipalities that have adopted such a system among our observations which might misguide the result. A large volatile part to create incentives and a well-educated population have as predicted by previous research a positive effect on sorting level, but results are only significant in the first round of regressions.

The obtained results raise questions about whether the controlling variables are correctly chosen. The rather low R-squared numbers throughout the regressions implies a risk of omitted variable bias and we do admit the possibility to find more variables to capture households' reasons for generating much or little sorted food waste. Except from the waste statistics being insufficient we do believe that much explanatory effect is lost when not using household level data. To better narrow down the regression we believe that more variables could be found on household level rather than community level, since there is a need of finding the relationship between attitudes and actual behaviour. However, as discussed earlier, this imposes difficulties in adapting the waste statistics since they are reported on a community level. In conclusion, the main problem in this case is probably too imprecise data on existing variables rather than omitted factors.

9.3 Reflections for Future Research

The fact that the data on sorting level from the Swedish Waste Management and Recycling Association is the best available data for Swedish municipalities and also used for measuring the performance of Sweden's recycling efforts makes the suspected faulty data problematic. It is important from a regulative view to have precise data, in order to implement effective systems. If the Swedish government takes the 2018 stage goal seriously it is important to have proper tools for evaluating it.

In analysing efficient policy making in the view of this thesis, our results clearly highlights the problematic setting of inadequate data in policy making. Recalling the introduction paragraph, the reason for investigating whether mandatory recycling programmes are efficient is the need of a policy evaluation. The ambitious goals for recycling rates set in the 2018 stage goal cause clear needs to provide local authorities with guidance of how to reach them. Reaching a 50 per cent sorting rate of food waste is possible under the presumption that appropriate systems for sorting out, collecting and handling food waste are present. Since the existing data of Swedish waste management such as collected waste, policy in use and fee systems on municipality level is not complete many observations had to be dropped due to lack of information provided by the municipalities. The specified range of sorting levels included in the final analysis is at present necessary to clear the data from observations that are invalid for the purpose of policy testing. For researchers to be able to truly draw any conclusions of what works or not in municipalities where a food waste sorting system is already adopted, there are large areas of improvement in the collection of data. Small local differences in systems also make comparisons harder and a quantitative study might be needed as complement for a thorough policy evaluation.

The results from this thesis should be treated in a restricted manner and seen as an indicator, opening up for further research within the field. Adding more extended measures of attitudes and subjective norms could amplify the degree of explanation, and more comprehensive waste statistics would increase the amount of valid observations. A larger, more informative, set of data would both decrease the standard errors of the estimated coefficients and give significance also to small β -values. Above all, a complete data set where no restrictions on the dependent variable are made is required to obtain an unbiased estimate of the policy effect. With the data existing today the dependent variable restriction is necessary since it is the only manageable solution to the problem of removing defect observations.

The existing data on food waste characteristics is too defect to provide statistically significant results for policy effects. For local authorities this becomes problematic in the sense that investments in different incentive systems are very uncertain and lessons from already existing ones are hard to learn. Today, quantitative measures probably give more feedback for policy makers for future investments but also lead to larger regional differences which might further complicate comparisons. Investing in a malfunctioning system can be costly but not investing at all means missing the 2018 stage goal with unwanted effects on our environment. More resources put on sufficient data collection are therefore to wish for.

10. Concluding Remarks

Using mandatory participation in food waste collection schemes for increasing levels of sorted food waste collected from households does not prove to be an efficient policy tool. No statistically significant differences in obtained levels are found between the mandatory systems and the alternative optional ones. There are indications of some differences in sorted food waste levels depending on environmental interest among inhabitants within the municipality, leading to the rather intuitive conclusion that environmental interest seem to affect sorting behaviour.

Throughout this thesis we have argued and reasoned from an economic perspective with utility maximising households, complemented with a framework for behavioural aspects. Previous research is used to evaluate and map the existing state of knowledge within the field. Our objectives have been to provide insight on how to better regulate for food waste collection but also to open up for further discussions. Hopefully the insights from this thesis can contribute to more extensive research in the future.

It has been a difficult task to compare the effects of this particular policy tool since the ideal case requires very specific data on food waste collected as well as of the municipalities and sorting systems. This data does not exist today and consequently undesired simplifications and intrusions in the data set had to be done. It is a fine balance between the perks of using accessible community level data to obtain information of overall system traits and the need to analyse more individual information.

To reach the environmentally optional solution for waste handling our takeaway is that policy makers must find ways to give consumers high utility for sorting out food waste. For this to

be possible, knowledge of inhabitants' environmental interest as well as other key drivers for their actions need to be understood. In addition, higher demands on reporting systems are needed for proper evaluations to be attainable. Whether mandatory or optional systems are to be implemented does not seem to be the most important factor, but rather to find other incentives and increase the common knowledge about the actual costs and benefits from food waste sorting. A first step for municipalities is to offer the service of food waste collection at all and to keep the households informed about their choices. The best strategy for getting people to actually use the system is probably yet to be found.

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Appendix

14 May 2014

Table IV. Regressions on Group A municipalities, all observations included (Round 1)

VARIABLES	(1) sorting_level	(2) sorting_level	(3) sorting_level	(4) sorting_level	(5) sorting_level	(6) sorting_level	(7) sorting_level	(8) sorting_level
mandatory	0.122 (0.0790)	0.121 (0.0805)	0.107 (0.0842)	0.107 (0.0829)	0.123 (0.0803)	0.122 (0.0777)	0.118 (0.0723)	0.112 (0.0851)
environmental_concern		0.0160 (0.410)	0.0739 (0.466)	-0.00725 (0.472)	-0.127 (0.478)	-0.139 (0.475)	-0.0294 (0.481)	-0.228 (0.627)
subjective_norm			-2.29e-05 (0.000740)	9.44e-06 (0.000682)	-1.85e-05 (0.000673)	-0.000107 (0.000667)	-0.000235 (0.000659)	-0.000427 (0.000928)
education				1.006** (0.495)	1.866** (0.788)	1.810** (0.778)	1.595** (0.712)	0.675 (0.874)
income					-0.00317* (0.00177)	-0.00321* (0.00179)	-0.00312* (0.00179)	-0.00106 (0.00247)
weight_based						-0.202** (0.0800)	-0.219** (0.0839)	-0.203** (0.0957)
volatile_part							0.272** (0.129)	0.210 (0.150)
years_in_use								0.00484 (0.00793)
constant	0.235*** (0.0468)	0.222 (0.329)	0.177 (0.392)	-0.00864 (0.410)	0.683 (0.554)	0.747 (0.559)	0.593 (0.573)	0.437 (0.777)
Observations	69	69	68	68	68	68	68	53
R-squared	0.036	0.036	0.030	0.082	0.105	0.147	0.212	0.171

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table V. Regressions on Group A municipalities, observation dropped (Round 2)

VARIABLES	(1) sorting_level	(2) sorting_level	(3) sorting_level	(4) sorting_level	(5) sorting_level	(6) sorting_level	(7) sorting_level	(8) sorting_level
mandatory	0.0713 (0.0735)	0.0753 (0.0732)	0.0720 (0.0788)	0.0673 (0.0761)	0.102 (0.0745)	0.0845 (0.0757)	0.0627 (0.0746)	0.0821 (0.0973)
environmental_concern		-0.307 (0.375)	-0.289 (0.391)	-0.193 (0.372)	-0.417 (0.363)	-0.452 (0.353)	-0.318 (0.307)	-0.159 (0.385)
subjective_norm			-4.17e-05 (0.000907)	9.40e-07 (0.000978)	-0.000428 (0.000989)	-0.000722 (0.00106)	-0.000415 (0.00118)	-0.000419 (0.00125)
education				-0.508 (0.422)	0.644 (0.641)	0.590 (0.644)	0.573 (0.584)	0.251 (0.796)
income					-0.00414*** (0.00143)	-0.00429*** (0.00146)	-0.00440*** (0.00134)	-0.00352* (0.00186)
weight_based						-0.234** (0.0993)	-0.237*** (0.0831)	-0.205* (0.104)
volatile_part							0.245** (0.107)	0.250** (0.114)
years_in_use								-0.00469 (0.00710)
constant	0.469*** (0.0552)	0.715** (0.308)	0.702** (0.325)	0.765** (0.309)	1.733*** (0.427)	1.852*** (0.424)	1.675*** (0.398)	1.417** (0.516)
Observations	36	36	35	35	35	35	35	29
R-squared	0.027	0.047	0.040	0.074	0.198	0.252	0.350	0.314

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table VI. Regressions on Group B municipalities, all observations included (Round 1)

VARIABLES	(1) sorting_level	(2) sorting_level	(3) sorting_level	(4) sorting_level	(5) sorting_level	(6) sorting_level	(7) sorting_level	(8) sorting_level
mandatory	-0.0107 (0.0759)	-0.0147 (0.0802)	-0.0267 (0.0806)	-0.0249 (0.0819)	-0.0150 (0.0839)	-0.0155 (0.0842)	-0.0226 (0.0879)	0.00627 (0.0898)
environmental_concern		-0.108 (0.405)	-0.0473 (0.439)	-0.0626 (0.453)	-0.0606 (0.464)	-0.0321 (0.478)	-0.0611 (0.477)	0.661* (0.375)
subjective_norm			0.00107 (0.000862)	0.00104 (0.000872)	0.000932 (0.000875)	0.000892 (0.000884)	0.000772 (0.000904)	0.00119 (0.00107)
education				0.189 (0.493)	1.198 (0.854)	1.164 (0.871)	1.251 (0.910)	1.306 (0.991)
income					-0.00285 (0.00188)	-0.00279 (0.00190)	-0.00294 (0.00195)	-0.00294 (0.00194)
weight_based						-0.102 (0.116)	-0.106 (0.121)	-0.137 (0.181)
volatile_part							-0.00571 (0.144)	-0.172 (0.152)
years_in_use								-0.00625 (0.00771)
constant	0.282*** (0.0528)	0.339 (0.230)	0.257 (0.264)	0.221 (0.275)	0.696* (0.398)	0.682* (0.402)	0.730* (0.405)	0.437 (0.308)
Observations	59	59	58	58	58	58	57	44
R-squared	0.000	0.003	0.036	0.038	0.064	0.070	0.071	0.207

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table VII. Regressions on Group B municipalities, observation dropped (Round 2)

VARIABLES	(1) sorting_level	(2) sorting_level	(3) sorting_level	(4) sorting_level	(5) sorting_level	(6) sorting_level	(7) sorting_level	(8) sorting_level
mandatory	-0.0617 (0.0786)	-0.0849 (0.0825)	-0.0869 (0.0716)	-0.0870 (0.0711)	-0.0886 (0.0735)	-0.0852 (0.0766)	-0.0736 (0.0872)	-0.0567 (0.106)
environmental_concern		-0.243 (0.384)	0.0238 (0.271)	0.0960 (0.352)	0.0603 (0.354)	0.0659 (0.361)	0.0670 (0.354)	0.312 (0.407)
subjective_norm			0.00170** (0.000675)	0.00179** (0.000760)	0.00168** (0.000761)	0.00170** (0.000787)	0.00168* (0.000810)	0.00181 (0.00105)
education				-0.270 (0.547)	0.698 (0.992)	0.723 (1.012)	0.729 (1.026)	0.545 (1.142)
income					-0.00285 (0.00186)	-0.00304 (0.00197)	-0.00308 (0.00193)	-0.00248 (0.00195)
weight_based						0.0681 (0.0735)	0.0755 (0.0778)	0.0619 (0.0753)
volatile_part							-0.0722 (0.169)	-0.0697 (0.216)
years_in_use								-0.0109 (0.0107)
constant	0.423*** (0.0526)	0.558** (0.223)	0.336** (0.156)	0.364** (0.153)	0.863** (0.352)	0.898** (0.372)	0.928** (0.352)	0.759** (0.348)
Observations	31	31	30	30	30	30	30	26
R-squared	0.020	0.036	0.234	0.241	0.284	0.287	0.294	0.305

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 2. Scatter plot of sorted food waste levels

