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An econometric analysis of the recycling of containers within the Swedish deposit system

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Abstract

The level of recycling of PET bottles and aluminium cans within the container deposit system varies greatly between different municipalities in Sweden. By regressing a cross-section of average municipal deposit data for 2009 and 2010 on a range of economic, demographic and normative characteristics of the municipalities, we attempt to investigate these differences and quantify the factors hypothesised to affect the recycling rate. Our results show that age, education and infrastructure play important roles when determining the recycling rate and that controlling for tourism, consumption and cross-border trade is imperative when performing a study of this type. In contrast to our expectations, the direct effects of the monetary incentive of the deposit system as well as those of normative factors are indiscernible and further qualitative research with regard to these factors is recommended. In order to increase recycling rates we suggest policy makers to further facilitate recycling using infrastructural means, as well as to adopt measures to aid in the collection of containers leaving Sweden as a result of cross-border sales. We also wish to initiate a debate concerning the effectiveness of the current structure of the monetary incentive used in the container deposit system.

Keywords: recycling, deposit system, incentives, Sweden, municipalities

JEL classification: Q53, C21, Q28

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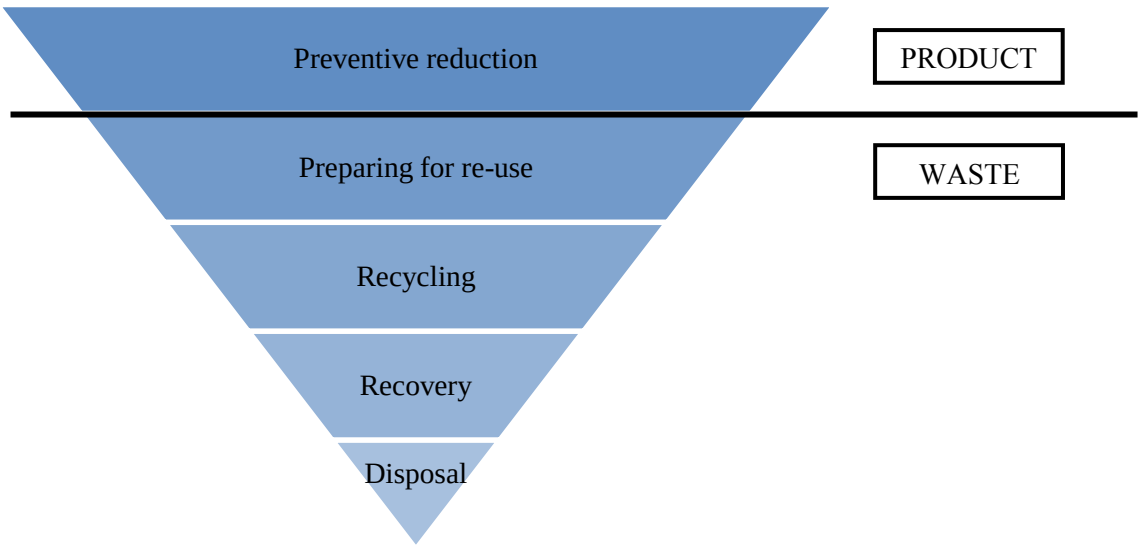
1. Introduction

As one of the United Nations Millennium Development goals, environmental sustainability has over the past decade become an increasingly important topic in both policy-making and business practice innovation (UNDPI 2010). The commitment to the environment and achieving sustainable growth has become a cornerstone of many Corporate Social Responsibility plans of both national and international businesses (Ernst & Young LLP 2011). In line with this, the awareness of the environmental impact of an individual's consumption decisions is growing and gaining importance in efforts towards developing an environmentally sustainable society (UNDESA 2003).

As the role of the individual in the work on reducing environmental impact has gained more focus, the importance of efficient household waste management has increased. "Reduce, reuse, recycle" (Commission Directive 2008/98/EC) have become important watchwords as the European Waste Hierarchy of the European Union (EU) Waste Framework Directive, depicted in *Figure 1*, has been implemented. Recycling forms an important part of this hierarchy, as it precedes the "recovery" and "disposal" tiers, making up the final stage where an individual or a household can affect their waste management before the waste is incinerated or disposed of in another manner.

Figure 1. The European Waste Hierarchy (Commission Directive 2008/98/EC)[1]



[1] Amended version

To what extent household recycling is promoted and regulated by the state differs greatly between the members of the Union even though common EU goals exist (European Parliament and Council Directive 94/62/EC). In terms of beverage packaging, the European Commission supports the development of individual member state regulations and deposit systems for environmental reasons, as long as measures are constructed in a manner that do not restrict the free flow of goods within the European Union (Commission Communication 2009/C). The Swedish government has set several national goals with regard to their recycling systems, which are enforced through regulation concerning the responsibility of producers to follow through the life cycle of the product - the Law of Producer Responsibility (*Lagen om producentansvar*) (SFS 1998:808).

The goals of the Law of Producer Responsibility are communicated by the Swedish Environmental Protection Agency (SEPA) (*Naturvårdsverket*). In terms of packaging material these goals regard metal, paper, cardboard, plastic, glass, aluminium, polyethylene terephthalate (PET) and wood. For both PET and aluminium beverage containers, the national goal is a recycling rate of 90% (SEPA 2011). According to SEPA, Swedish households show a strong dedication to recycling and are highly willing to engage in recycling efforts, with an estimated national recycling participation rate of 93% (SEPA 2006).

The Swedish recycling rate of 91% of glass containers in 2010 placed Sweden in the fourth place in the EU and well above the EU average of 68% (FEVE 2011). During the same year, the recycling rate for aluminium cans was 91%, large PET bottles 93% and small PET bottles 73%; these figures also placing Sweden among the top recycling countries in the world (Returpack 2012a). With such high container recycling rates, Sweden becomes an interesting market to analyse. Considering that PET bottles and aluminium cans are covered by a container deposit program, the equally high recycling rate of glass containers becomes more remarkable, since no economic incentives exist for recycling glass. This poses the question of how important the economic incentives are and to what extent other factors such as the moral and social values affect recycling among Swedish households.

In 2010, *Returpack AB,* which manages the Swedish container deposit system, raised the deposit fee for aluminium cans by 100%. This was the first raise in 23 years' time and only the second since the start of the program in 1984 (Returpack 2010). *Returpack AB* argued that raising the deposit rate on cans was one of their main efforts, alongside improving

accessibility of recycling stations, in trying to increase the recycling rate in Sweden (Returpack 2010). These investments and regulatory changes show that the Swedish recycling market is continuously developing. This once again raises the question of whether it is the economic incentives that are the strongest drivers for recycling and to what extent other factors affect household waste management decisions.

Studying the recycling rates of PET bottles and aluminium cans in Sweden, one can see substantial differences between the 290 municipalities in the country. Similar regional differences between Swedish municipalities have also been observed in waste recycling (Vencatasawmy, Öhman & Brännström 2000) as well as in the recycling of plastics (Hage & Söderholm 2008).

The existing research on Swedish recycling mainly focuses on one or few municipalities, and the recycling of paper, glass and plastic packaging.

Furthermore, there exist several studies regarding household waste management in the USA, UK as well as Southeast Asia. To some extent, this literature covers container deposit systems and the pertaining incentives for the individual consumer.

Taking into account the existing international research and Swedish literature, there exists a gap when it comes to studies on regional differences in the recycling of PET bottles and aluminium cans in Sweden.

2. Purpose

The purpose of this paper is to identify and quantify factors affecting the recycling rates of PET bottles and aluminium cans in Swedish municipalities as well as to recognise areas where further qualitative research regarding recycling incentives is needed. Using the identified factors, we will discuss potential policy implications.

Using an econometric approach, this analysis will describe the general tendencies of the effect of the identified factors on the recycling rate, rather than identifying explicit causal relationships. The paper should be seen as a complement to earlier qualitative studies concerning the determinants of recycling, which in turn are able to better address the importance of norms and values and their effect on recycling rates through surveys and interviews.

We will thus focus on a different recyclable good, with a new geographic scope, constituting a complement to existing qualitative studies and providing a basis for constructing future qualitative research within the field.

3. Background

3.1 Economic factors

An important factor in determining the recycling rate for individuals and households has been researched to be the opportunity cost of time spent cleaning, sorting and transporting household waste as opposed to simply throwing it into the household waste bin (Halvorsen 2008). Several authors have used each household's willingness to pay for an external party to take care of the household recycling as a measure of opportunity cost of time (Bartelings & Sterner 1999; Berglund 2006; Halvorsen 2008). This research has been performed in qualitative surveys but has been limited by the fact that many households decline to answer the question or proclaim that they are unwilling to pay whatsoever since they consider recycling a matter of principle and a responsibility that every citizen should take for themselves (Bartelings & Sterner 1999). This has oftentimes led to the fact that both the sample and the responses have been skewed for this type of question, making it difficult to draw any conclusions from the results (Bartelings & Sterner 1999; Halvorsen 2008). Nonetheless, opportunity cost of time is an important factor and should be taken into consideration when performing quantitative surveys.

Income is theorised to have an ambiguous effect on household recycling. On the one hand, in terms of opportunity cost of time, higher income could result in lower recycling rates due to the loss of leisure time (Hage & Söderholm 2008; Halvorsen 2008). On the other hand, an "income effect" could potentially exist, where higher income levels would increase recycling efforts. This can be seen as a reflection of the idea that environmental goods are not necessities but luxury goods (Berglund & Söderholm 2003). Ando and Gosselin (2005) have also theorised that higher income is correlated with higher levels of education and thus awareness of the impact of waste management on the environment. Several authors have found statistically insignificant results (Hage & Söderholm 2008; Abbot, Nandeibam & O'Shea 2011) or no economically significant effect of income on the recycling rate (Vencatasawmy, Öhman & Brännström 2000). Research by Callan and Thomas (1997) found a positive effect, whilst other studies have found a negative effect (Halvorsen 2008; Ashenmiller 2009).

The impact of “hustling”, where one collects others’ recyclables in order to gain the deposit fee, has been proposed to be important when discussing economic incentives for recycling (Kulshreshtha & Sarangi 2001). Some unemployed and low-income takers use hustling as an extra source of income (Ashenmiller 2009). Unemployed can also be considered to have a lower opportunity cost of time and thus exhibit more intense recycling behavior (Hage & Söderholm 2008), making the proportion of the population with no income an important factor to consider when analysing regional differences in recycling rates.

Convenience and distance to recycling bins has been extensively researched as a factor affecting recycling and found to be of significance for multiple types of materials (Vencatasawmy, Öhman & Brännström 2000; Ando & Gosselin 2005; Saechao 2007; Hage, Söderholm & Berglund 2009). Distance to recycling bins has been theorised to affect both opportunity cost of time as well as being a factor affecting ease of recycling (Saechao 2007), in particular in property-close collection (Hage, Söderholm & Berglund 2009).

Some municipalities in Sweden have adopted weight-based pricing of household waste (Swedish Waste Management 2011). This means that households are given economic incentives to recycle rather than disposing of all waste in the regular household waste bin. If pricing is fixed, households lack the economic incentive to recycle to the same degree. This pricing methodology has been found to be an important factor in explaining the variation in recycling rates of paper in Sweden, as well as plastic, glass and metal, albeit to a less statistically significant degree (Hage, Söderholm & Berglund 2009). In an event study by Bartelings and Sterner (1999) on a single Swedish municipality, the introduction of a weight-based pricing system led to a significant increase in recycling. Abbot, Nandeibam and O'Shea (2011) have discussed mixed results of the effect of weight-based pricing on household waste production and recycling rates, highlighting the seemingly inelastic demand for waste collection.

According to Ando and Gosselin (2005) the opportunity cost of recycling should not only be considered in terms of time, but also in terms of the foregone space at home when storing sorted recyclables before transporting them to the recycling station. Looking at living space size, the effect on recycling rate in current literature has been ambiguous, showing no effect in a study by Vencatasawmy, Öhman and Brännström (2000) of a single Swedish municipality. Private residential ownership form has shown a positive effect on recycling, but this is theorised to correlate with ownership of a car and thus easier access to recycling

stations (Hage & Söderholm 2008). The amount of perceived space at home has shown to have a significant positive effect on recycling, showing that it is the amount of space and not the type of housing that plays a larger role (Ando & Gosselin 2005). This ambiguity in results and the large differences in type of factor used in previous studies complicates the choosing of a factor to capture this effect on recycling.

3.2 Normative factors

The importance of norms and values for determining the level of recycling has been highlighted in a vast number of studies (Hornik, Cherian, Madansky & Narayana 1995; Bartelings & Sterner 1999; Vencatasawmy, Öhman & Brännström 2000; Guerin, Crete & Mercier 2001; Saechao 2007; Halvorsen 2008; Hage, Söderholm & Berglund 2009; Lundmark & Samakovlis 2011).

Several papers have discussed the importance of individuals' values regarding the environment and the effect of these values on recycling behaviour. Hornik, Cherian Madansky & Narayana (1995) for instance found that consumers' commitment to recycling and consumer knowledge concerning environmental sustainability are more important than external motivators such as monetary incentives. As has been highlighted by Hage and Söderholm (2008), such norms and values are difficult to measure when performing a quantitative study, instead they used the proportion of votes for the Swedish Green Party in the national elections as a proxy for the household level of concern for the environment.

Other aspects found to affect recycling behavior positively are general environmental preferences of the inhabitants (Vencatasawmy, Öhman & Brännström 2000) and local green activism (Guerin, Crete & Mercier 2001).

3.3 Demographic factors

In previous studies the effect of age has been discussed from several perspectives. Ando and Gosselin (2005) and Hage, Söderholm and Berglund (2009) found that age had a small positive, but statistically significant, impact on recycling behaviour, though did not draw any conclusions as to why this pattern emerged. Another study performed by Hage and Söderholm (2008) included age as an explaining factor but was unable to find any statistically significant effect of age on recycling behaviour. Sterner and Bartelings (1999) found that with increasing age, the demand for household waste disposal decreased. Since they controlled for income as well as time spent recycling, they argued that the negative effect of

age on waste disposal was neither due to elderly having more time nor a lower opportunity cost of recycling.

According to some research (Hage & Söderholm 2008; Barteling & Sterner 1999), gender has not been found to have any significant impact on the amount recycled nor waste disposal demands, whilst Ando and Gosselin (2005) have suggested that if the household is all male or all female this will have a positive and significant impact on container recycling. No explanations for the increase in recycling in unisex households are suggested.

Saechao (2007) discusses how education can affect the level of knowledge concerning environmental issues, an important internal facilitator for recycling. The effect of education on recycling is however disputed. Education is in some studies found to have a statistically significant and positive impact on the propensity to recycle (Vencatasawmy, Öhman & Brännström 2000; Ando & Gosselin 2005), whilst others have observed contradicting results (Hage & Söderholm 2008). The negative impact of education on recycling has been suggested to reflect a strong correlation between income and education (Hage & Söderholm 2008).

Several studies discuss population density (Abbot, Nandeibam & O'Shea 2011) as well as urbanization rate (Hage & Söderholm 2008) as proxies for an individual's distance to the nearest recycling station. Population density has also been highlighted as an important factor regarding waste paper recovery, as higher rates of density allow for more cost-effective collection (Berglund & Söderholm 2003). In both respects population density was used as a representation of infrastructural development. Whilst Hage and Söderholm (2008) found a statistically insignificant effect, several studies have observed a positive effect of population density on recycling rates (Berglund & Söderholm 2003; Callan & Thomas 2007; Abbot, Nandeibam & O'Shea 2011). The importance of good infrastructure is further discussed in Hage, Söderholm and Berglund (2009), where they argue that psychological factors making consumers recycle can be offset when the lack of infrastructure for taking care of recyclables is perceived to be an obstacle.

3.4 Other factors

Within Scandinavia extensive cross-border trade in alcoholic beverages due to differences in taxation and pricing has been observed (Ivarsson, Åberg & Åsmundhavn 2004). Using the Eurostat Purchasing Power Parity indices of alcoholic beverages, much of the cross-border

sales of alcohol to foreigners in Sweden has been explained by the relatively higher prices in both Norway and Finland (Asplund, Friberg & Wilander 2005).

4. Hypotheses

Using previous research and our own understanding of the recycling market, we have developed hypotheses regarding which factors affect the recycling rate. These factors are shown in *Figure 2* together with our expectations of the effect of each factor, which are further explained below.

Figure 2. Table showing hypotheses for the factors included in the regressions

Factor	Expected sign
Economic factors	
No income	+
High income	-
Distance to recycle	+
Housing	+
Weight-based pricing	+
Normative factors	
Green politics	+
Concern	+
Demographic factors	
Age	?
Gender	?
Education	-
Population density	+
Control factors	
Border	+
Tourism	+
Consumption	+

4.1 Economic factors

Income

Even though previous literature has found an ambiguous effect of income on recycling we believe that municipalities with a higher percentage of null-income earners will have a higher number of deposited cans due to the monetary incentive to deposit and the relatively lower opportunity cost of time amongst these inhabitants.

For high-income earners on the other hand, we believe that the relatively higher level of opportunity cost will decrease their willingness to return the containers.

Distance to recycle

We predict that the shorter the distance needed to travel in order to recycle, the more containers will be deposited. We believe this since shorter traveling distances lower the opportunity cost of recycling, as well as facilitate recycling. In this study no attempt is made to differentiate between the two effects, since we hypothesize that they are indistinguishable and amplify each other.

Housing

We believe that the opportunity cost of space plays an important role for recycling. We predict that the larger the living area, the more room the inhabitants have for storing recyclables at a lower cost, thus increasing the rate of recycling.

Weight-based pricing

In accordance with the previous research performed in Sweden, we hypothesize that municipalities with weight-based pricing will have increased levels of recycling efforts.

4.2 Normative factors

Green politics

We hypothesize that the higher the proportion of the population that advocate emphasis on environmental issues in politics, the higher the number of deposited containers per person. This factor could affect the recycling rate both through the inhabitants' assigned level of importance to environmental issues as well as through local green activism. We hypothesize that the two effects are indistinguishable and amplify each other, wherefore we do not differentiate between them.

Concern

In line with previous research, we hypothesize that increased concern about environmental issues will increase the amount of deposited recyclable containers.

4.3 Demographic factors

Age

Since previous literature suggests a mixed impact of age on recycling, we are undecided as to the expected effect.

Gender

Although no distinct effect of gender on recycling or waste disposal demand has been found in the literature, the factor is included to measure the potential effect in this study. We are undecided as to the expected effect of *gender* on the number of recycled containers.

Education

We expect the level of education to be highly correlated with the proportion of inhabitants with high income. Thus, even though contradicting results on the effect of education on recycling have been observed in previous literature, we expect the effect to be negative. This is in line with our hypothesis for high-income takers, namely that higher income leads to fewer deposited cans and bottles due to a higher opportunity cost of recycling.

Population density

In line with previous research, we hypothesize that the higher the population density, the higher the rate of recycling. We argue that this is due to the infrastructural characteristics of an area with high population density.

4.4 Control factors

Border

The collection of cans and PET bottles in the Swedish deposit system is limited to being within the Swedish borders. Since there is Swedish cross-border trade with beverages, we expect border municipalities to have higher levels of deposited cans and bottles per inhabitant. This since we expect foreigners to systematically travel across the border to purchase beverages. Knowing that they will return to Sweden, there exists an incentive for them to collect their Swedish recyclables and deposit them during their next trip.

Tourism

Being that the dependent variable is measured in deposited cans per inhabitant it is desirable to control for any increase of consumption due to a large seasonal influx of consumers. We forecast that increased levels of tourism in a municipality will have a positive effect on the number of deposited PET bottles and cans.

Consumption

One important aspect that has only been dealt with indirectly by previous research is the effect of increased consumption on recycling. We believe that it is important to account for this effect and hypothesize that an increase in the consumption of beverages sold in recyclable containers will lead to an increase in recycling.

5. Data

Data has been collected for 15 factors, including the number of deposited recyclable containers per inhabitant. This data has been collected for all different regions in Sweden, namely the 290 municipalities which pertain to the 21 different counties. All data has been

collected on both levels of aggregation, except for some of the factors which were only available on county-level[2] or municipality-level[3].

Since data concerning deposited cans and PET bottles was only available for 2009 and 2010, the gathering of data has been restricted to these two years for the explanatory variables as well. For some factors there was solely one year of observations available[4]. In these cases the value of the observed year was also assigned to the unobserved. All factors used in the regressions are listed in *Figure 3.*

Figure 3. Table showing a description of regression variables including units and source

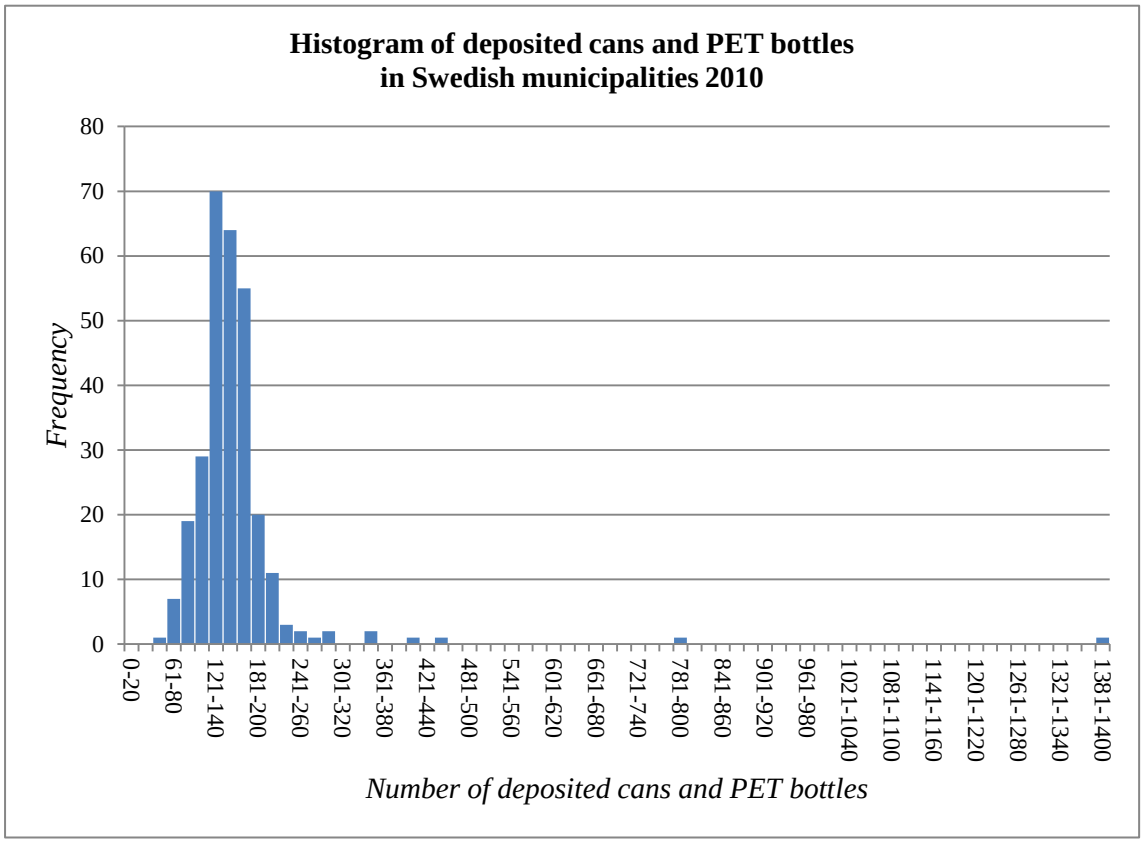
Variable	Description	Unit	Source
Dependent Variable			
Deposit	Number of deposited cans and PET bottles in the municipality	Number deposited per inhabitant and year	Returpack 2012b
Economic variables			
No income	Residents of all ages with no registered income	Percentage of population	Statistics Sweden (*Statistiska Centralbyrån* (SCB)) 2012a; 2012b
High income	Residents of all ages with a registered income of more than SEK 400 000	Percentage of population	SCB 2012a; 2012b
Distance to recycle	Inhabitants living within 10 minutes by car from the nearest grocery store	Percentage of population	Growth Analyis (*Tillväxtanalys*) 2009; 2010
Housing	Fraction of houses of all apartments and houses	Percentage of houses	SCB 2011a; 2011b
Weight-based pricing	Municipalities with weight-based pricing of household waste	Dummy	Swedish Waste Management (*Avfall Sverige*) 2010; 2011
Normative variables			
Green politics	Distribution of votes in the 2010 national election	Percentage of votes for green party	SCB 2010a
Concern	Proportion of the population which is concerned about the environment	Percentage of population	International Social Survey Program 2010

[2] *Concern* and *consumption*
[3] *Weight-based pricing*, *tourism* and *border*
[4] *Green politics* and *concern*

Demographic variables			
Age	Mean age of population	Years	SCB 2012c; 2012d
Gender	Proportion of men	Percentage of population	SCB 2012c; 2012d
Education	Inhabitants with post-Secondary School education (*eftergymnasial utbildning*), aged 16+	Percentage of population	SCB 2012e; 2012f
Population density	Density of population	Inhabitants per square kilometre	SCB 2012g; 2012h
Control variables			
Border	Municipalities bordering Norway and Finland and municipalities with commuting distance to Denmark	Dummy	Swedish Tax Agency (*Skatteverket*) 2012a; 2012b
Tourism	Tourism municipality as defined by SKL 2011	Dummy	Swedish Association of Local Authorities and Regions (*Sveriges Kommuner och Landsting* (SKL)) 2011
Consumption	Estimated consumption of beer, cider and mixed drinks in deposit containers per county	Litres per inhabitant	*Systembolaget* 2012 and *Sveriges Bryggerier* 2010

Looking at the municipality density distribution for the dependent variable, we observe two anomalies which show extraordinarily high levels of depositing for both years. An example of this for 2010 can be seen in *Figure 4.*

Figure 4. Chart showing density distribution of deposit levels for 2010



The two municipalities, Eda and Strömstad, both border to Norway and are very important cross-border trade municipalities (Svensk Handel 2012). Strömstad is also the most popular tourist destination for Nordic tourists (HUI Research 2012). Due to these special circumstances, we choose to asymmetrically truncate the data in order to remove these two outliers both years.

Figure 5 shows descriptive statistics for the municipalities for both years, excluding Eda and Strömstad. Descriptive statistics for the data for both years on the county-level can be found in *Figure 6*.

Figure 5. Table showing descriptive statistics for the municipality-level data

	2009					2010				
Variable	*Mean*	*Min.*	*Max.*	*Std. Dev.*	*Obs.*	*Mean*	*Min.*	*Max.*	*Std. Dev.*	*Obs.*
Dependent variable										
Deposit	147.07	49.00	421.00	44.49	288	149.85	49.00	447.00	46.27	288
Economic variables										
No income	0.27	0.20	0.36	0.03	288	0.26	0.20	0.36	0.03	288
High income	0.06	0.02	0.24	0.03	288	0.07	0.02	0.24	0.04	288
Distance to recycle	0.96	0.76	1.00	0.05	287	0.96	0.76	1.00	0.05	287
Housing	0.62	0.03	0.93	0.15	288	0.61	0.01	0.90	0.15	288
Weight-based pricing	0.09	0.00	1.00	0.29	288	0.10	0.00	1.00	0.30	288
Normative variable										
Green politics						0.05	0.01	0.13	0.02	288
Demographic variables										
Age	42.80	36.30	48.50	2.52	288	42.94	36.40	48.90	2.57	288
Gender	0.50	0.48	0.53	0.01	288	0.50	0.48	0.53	0.01	288
Education	0.22	0.13	0.58	0.08	288	0.23	0.13	0.58	0.08	288
Population density	135.83	0.20	4410.40	465.83	288	137.68	0.20	4504.30	475.09	288
Control variables										
Border	0.10	0.00	1.00	0.31	288	0.10	0.00	1.00	0.31	288
Tourism	0.07	0.00	1.00	0.25	288	0.07	0.00	1.00	0.25	288

Figure 6. Table showing descriptive statistics for the county-level data

	2009					2010				
Variable	*Mean*	*Min.*	*Max.*	*Std. Dev.*	*Obs.*	*Mean*	*Min.*	*Max.*	*Std. Dev.*	*Obs.*
Dependent variable										
Deposit	152.24	129.00	196.00	19.21	21	153.90	130.00	200.00	20.55	21
Economic variables										
No income	0.07	0.04	0.10	0.01	21	0.06	0.04	0.10	0.01	21
High income	0.09	0.06	0.19	0.03	21	0.10	0.07	0.20	0.03	21
Distance to recycle	0.97	0.93	1.00	0.02	21	0.97	0.93	1.00	0.02	21
Housing	0.52	0.27	0.65	0.09	21	0.50	0.27	0.64	0.08	21
Normative variables										
Green politics						0.07	0.05	0.10	0.01	21
Concern						0.44	0.27	0.64	0.09	21
Demographic variables										
Age	41.98	38.90	43.60	1.29	21	42.07	38.90	43.70	1.31	21
Gender	0.50	0.49	0.51	0.00	21	0.50	0.49	0.51	0.00	21
Education	0.26	0.22	0.38	0.04	21	0.27	0.22	0.39	0.04	21
Population density	45.40	2.50	309.70	65.82	21	45.84	2.50	315.10	66.97	21
Control variables										
Alcohol sales	19.72	10.05	31.09	5.21	21	18.77	9.44	31.19	5.30	21

In order to increase the comparability of the coefficients, some formats of the units have been favoured, thus there has been some manipulation of the data for some variables. To the extent possible, the information has been changed into percentages or been divided by the number of inhabitants.

5.1 Dependent variable

Deposit

Using public data from *Returpack*, information was gathered concerning the amount of deposited cans and PET bottles per person in each Swedish municipality or county for the years 2009 and 2010.

In the regression we use the dependent variable in logarithmic form. Primarily this is due to the fact that the distribution is positively skewed, as can be seen in *Figure 4*. It is possible to use a logarithmic transformation of the variable since all values are positive and non-zero.

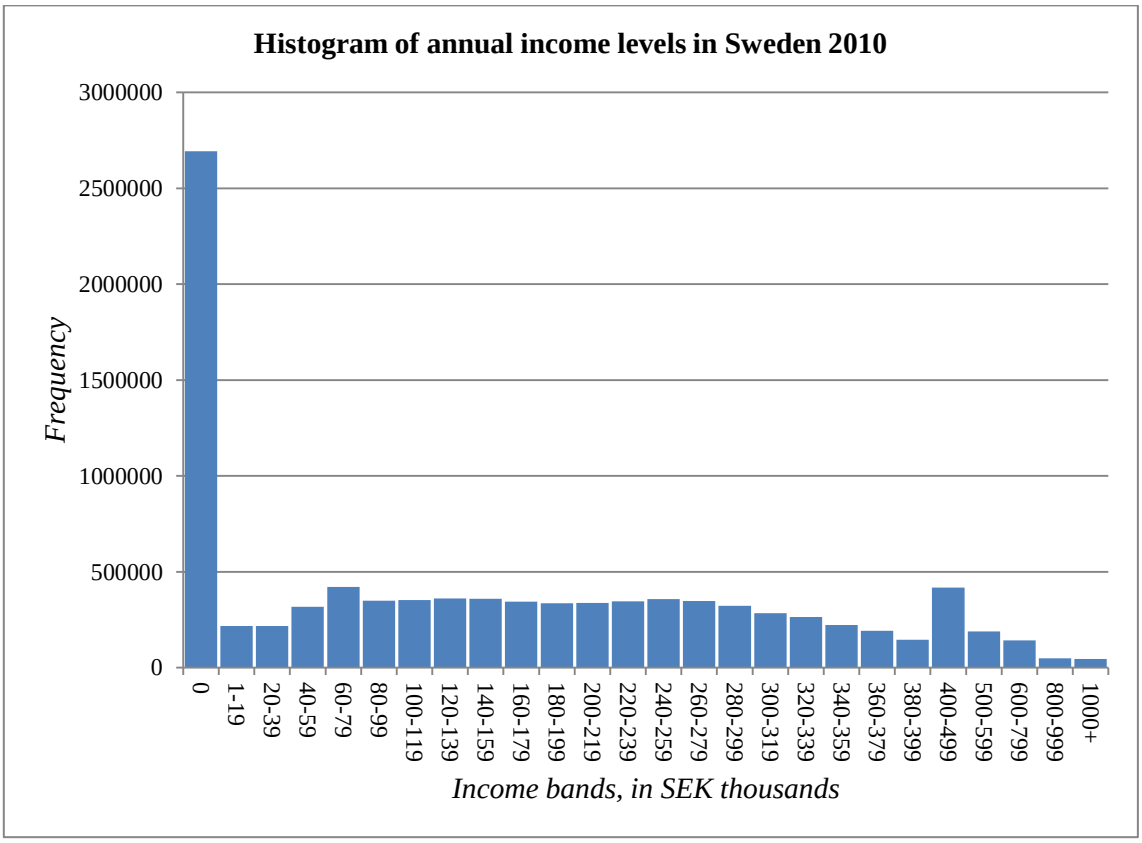
The data published by *Returpack* contains observations which have been rounded to the nearest integer. It is thus likely that the variable contains a measurement error. This error is however considered to be unsystematic, on average not affecting the observations and therefore not affecting the results of the regression.

5.2 Independent variables

Income

This study uses two classifications of income groups, the percentage of the population with no taxed income and that with more than SEK 400 000 in taxed income. The cut-off point for the high-income group has been chosen using a natural division in the observed density distribution, as can be seen for 2010 in *Figure 7*.

Figure 7. Chart showing density distribution of income levels 2010



Distance to recycle

Swedish households recycle PET bottles and aluminium cans in grocery stores (Returpack 2012c). According to key account manager Erik Ebbeson at *Returpack*, almost all grocery stores in Sweden provide this service (Ebbeson, E 2012, pers. comm., 10 May). We therefore use the distance to the nearest grocery store as a measure of the traveling distance needed in order to recycle.

Using data available from Growth Analysis[5], the percentage of the population in the municipality living within 10 minutes by car to the nearest grocery store is used to measure the distance to recycle. This time frame was chosen based on the available data[6] and what we believe is perceived as an obstacle to recycling.

[5] This data is not available for the municipality of Öckerö, since it lies in the archipelago.
[6] Growth Analysis classifies the distance to the nearest grocery store into four groups: less than 5 min, 5-10 min, 10-30 min and more than 30 min by car.

Housing
In order to proxy for the living area, the proportion of houses amongst all houses and apartments is used. We assume that a house on average provides a larger living space than an apartment.

Weight-based pricing
A dummy variable for whether a municipality has weight-based pricing of household waste or not is used[7].

Concern
In order to proxy for the perceived importance of environmental issues, the International Social Survey Programme (ISSP) 2010 results regarding opinions on the environment are used. The data is available on a Swedish county level and maps the inhabitants' level of concern about the environment. The variable is constructed using the percentage of the population that is 'concerned' or 'very concerned' about the environment[8].

The ISSP uses a fixed percentage of the population for each county in the survey and therefore some counties have very few respondents. For these counties the national average is imputed[9].

There is a risk that there exists a systematic measurement error with this data. This is because respondents may overrate their level of environmental concern when responding to a survey since there exists a pressure to conform to the social expectations of being environmentally involved. This could result in an attenuation bias, where the estimated coefficient of the variable is biased towards zero.

Green politics
This study includes the proportion of the population in each municipality and county which voted for the Green Party in the 2010 national elections. The elections for the national government are used as opposed to those for the municipality or county councils. This in order to equalize effects of for example strong local leaders or differing standpoints for the parties on a local level. Even though not all those who advocate emphasis on environmental issues in politics will vote for the Green Party, the factor can be considered as a proxy for measuring this emphasis.

[7] Gothenburg had, according to Swedish Waste Management, only introduced this system in parts of its districts but is included as a municipality with weight-based pricing for 2009.
[8] Inhabitants that answered 4 or 5 on a 5-point scale to the question "Generally speaking, how concerned are you about environmental issues?"
[9] Blekinge Län, Gotlands Län, Kronoberg Län and Örebro Län all have fewer than 25 respondents.

Age

The mean age of all inhabitants in the county or municipality is used. This measure does not account for the distribution of different age groups within a region, but does give an indication of one aspect of the population demographics without being excessively detailed.

Gender

The proportion of men in each municipality or county is used in this study. It is important to highlight that the variance of the sample is relatively low, with a mean of 0.50 and a standard deviation of 0.01 on the municipality level.

Education

The percentage of the population with post-Secondary School studies is used for each municipality and county. This measure does not account for different levels or types of education, but allows for some tracking of the schooling of the population and is in line with previous research.

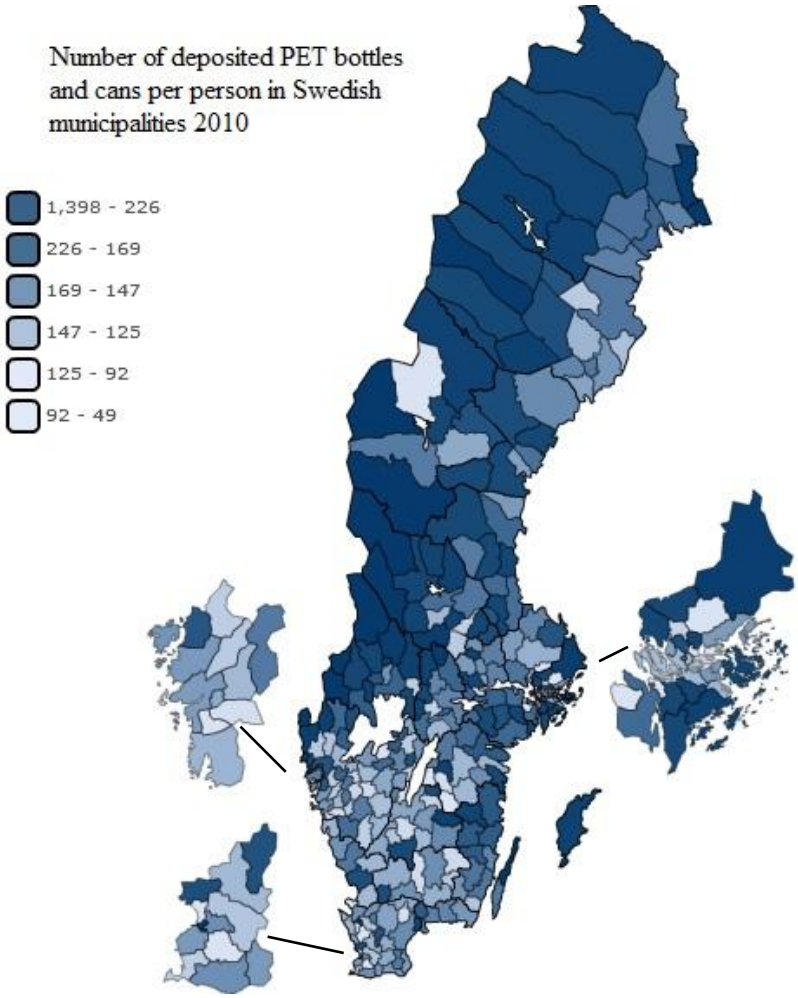
Population density

The number of inhabitants per square kilometre in each municipality or county is used as a measure of population density.

Border

Mapping the recycling data, one can see a geographic pattern with high recycling levels in the municipalities along the borders of the country, as can be observed in *Figure 8*.

Figure 8. Map showing the geographical distribution of municipality recycling levels 2010 (Returpack 2012b)



In order to control for the effect of cross-border trade, a border dummy variable is constructed for all municipalities along the Finnish-Swedish and Norwegian-Swedish borders. Furthermore the municipalities Malmö and Helsingborg are included since they are popular traveling routes for day-commuters between Sweden and Denmark. This inclusion is also in line with previous research (Asplund, Friberg & Wilander 2005).

Tourism

Using the SKL 2011 definition of municipalities we include a dummy for all the municipalities with high levels of tourism[10]. One issue with this variable is that it does not allow for differences in the levels of the tourism within those municipalities that are classified

[10] SKL 2011 defines a tourism municipality as one where "the number of overnight stays in hotels, hostels and campings exceed 21 per inhabitant or when the number of holiday cottages exceeds 0.20 per inhabitant". Using these criteria Sweden has 20 tourism municipalities.

in accordance with SKL 2011. A better measure would be the levels of tourism revenue per inhabitant, but this data was not available.

Consumption

In order to approximate the consumption of alcohol, sales data from *Systembolaget* regarding the sales of beer, cider and blended beverages has been used. In conjunction with data from *Sveriges Bryggerier* on how much of the respective alcoholic beverages were sold in the different container types, an approximation of litres of alcohol per inhabitant sold in recyclable containers has been generated. This data is available on county level. One issue with this approximation is that this measure will not reflect any regional differences in preferences of container types that may exist.

Consumption of non-alcoholic beverages in recyclable containers is also an important factor to include, however the lack of data prohibits us from accounting for it in this analysis.

6. Method

In investigating the regional differences in containers within the deposit system in Sweden, an econometric approach is used. Using ordinary least squares (OLS) techniques, all variables that are expected to affect container recycling rates are regressed as explanatory variables on the deposit data, the dependent variable. Since some of the factors identified as affecting the level of recycling are not available on municipality-level, we choose to complement our municipality-level regression with an analysis of county-level data. This in order to study the factors related to environmental concern and consumption. The regression used for the municipality-level data and variables is as follows:

$$\log(deposit_m) = \beta_{m_0} + \beta_{m_1} nullincome + \beta_{m_2} highincome + \beta_{m_3} distance + \beta_{m_4} housing + \beta_{m_5} weightbasedpricing + \beta_{m_6} greenpolitics + \beta_{m_7} age + \beta_{m_8} gender + \beta_{m_9} education + \beta_{m_{10}} popdensity + \beta_{m_{11}} border + \beta_{m_{12}} tourism + \varepsilon_m$$

The regression used for the county-level data and variables is as follows:

$$\log(deposit_c) = \beta_{c_0} + \beta_{c_1} nullincome + \beta_{c_2} highincome + \beta_{c_3} distance + \beta_{c_4} housing + \beta_{c_5} greenpolitics + \beta_{c_6} concern + \beta_{c_7} age + \beta_{c_8} gender + \beta_{c_9} education + \beta_{c_{10}} popdensity + \beta_{c_{11}} consumption + \varepsilon_c$$

Since the data is available for both 2009 and 2010, we perform both regressions using the mean of each variable for the two years. This is done to improve the stability of the results. Firstly, we are interested in long-term trends and not short-term variation, thus we do not want to account for annual variation. Secondly, by taking an average we partly equalize the randomness of the observations. Taking an average is possible due to the fact that we have data for two consecutive years where the variables are relatively stable over the time period[11].

Looking at the functional form of the model, we perform a Ramsey RESET test for specification error on both regressions. This test does not give an indication of functional form misspecification in either regression, thus confirming our a priori choice to use the independent variables in linear form, constructing a log-linear model. Performing a Davidson-MacKinnon test for functional form misspecification using logarithmic independent variables, we find no indication of misspecification in either regression. This is in line with Callan and Thomas (1997) and Hage and Söderholm (2008) who also choose to use the dependent variables in linear form.

A Breusch-Pagan test for heteroskedasticity is performed on both regressions. For the county-level data, we obtain a χ^2-value of 3.07, allowing us to reject the null hypothesis of homoskedasticity at the 10% level of significance. Since this indicates that there could be heteroskedasticity in the data, the regression is performed with robust standard errors. For the municipality-level data, we obtain a χ^2-value of 2.59, meaning that even though it is not as statistically significant as the county-level data, we can still reject the null hypothesis at the 10.57% level. This also indicates that there could be heteroskedasticity in the data. This regression is thus performed with robust standard errors as well.

We assume that the error has an expected mean of zero. For the municipality-level data we also assume that the error is normally distributed conditional on the regressors, however this

[11] We test this method by running year-by-year regressions and comparing the coefficients between the two years.

assumption may be violated in the county-level data since the observations are so few. Although correlation exists between some of the independent variables, none are perfectly multicollinear.

When analysing particularly unexpected results or surprising significance levels, correlation coefficients are used as support for interpreting the estimated effects of the factors.

Having analysed the results of our two regressions, we perform the regressions with reduced models using only the statistically significant variables.

7. Results

Performing an econometric analysis of the determinants of recycling behaviour on the number of deposited cans and PET bottles, a number of different conclusions can be drawn from the results. Depending on the statistical significance of the coefficients of the variables, the relationship between the dependent and each independent variable can be interpreted. We choose to focus our analysis of the results generated by the regression using average municipality-level data for the two years[12], but complement this analysis with the results of the county-level regression, with a particular focus on the variables measuring environmental concern and the level of alcohol sales. The obtained results are found in *Figure 9.*

[12] Performing year-by-year regressions we obtained similar coefficients for the two years, confirming the choice of method.

Figure 9. Table showing regression results

Variable	Municipality	Reduced-form municipality	County	Reduced-form county	Expected sign
Economic variables					
No income	1.5182		2.5223**	2.6664****	+
	(1.13)		(2.79)	(4.21)	
High income	0.1272		0.7877		-
	(0.13)		(0.65)		
Distance to recycle	-0.1218		1.1727		+
	(-0.37)		(1.11)		
Housing	-0.9125****	-0.9677****	0.6622**	0.3940*	+
	(-7.05)	(-8.26)	(2.80)	(1.77)	
Weight-based pricing	0.0727*	0.0649			+
	(1.70)	(1.53)			
Normative variables					
Green politics	0.9447		1.5939*	2.2000***	+
	(0.68)		(2.11)	(3.13)	
Concern			-0.0919		+
			(-1.26)		
Demographic variables					
Age	0.0346**	0.0211**	0.0254**	0.0445**	?
	(2.53)	(2.15)	(2.45)	(2.71)	
Gender	-3.8706		-2.9777		?
	(-1.45)		(-1.24)		
Education	-1.5056****	-1.1502***	-0.5786		-
	(-3.34)	(-3.28)	(-1.04)		
Population density	-0.0001***	-0.0001***	0.0002		+
	(-2.73)	(-3.31)	(0.67)		
Control variables					
Border	0.2332****	0.2259****			+
	(3.59)	(3.49)			
Tourism	0.2346****	0.2282****			+
	(3.87)	(3.95)			
Consumption			0.0234****	0.0179****	+
			(10.03)	(7.88)	
Constant	5.9491	4.8772	3.3522	2.2859	
R-squared	0.3934	0.3861	0.9809	0.9282	
Adjusted R-squared	0.3668	0.3708	0.9576	0.9043	
N	287	288	21	21	

t stats in parentheses, calculated from robust standard errors

* p<0.10; ** p<0.05; *** p<0.01; **** p<0.001

7.1 Municipality-level data

Economic variables

Looking at the first economic variables, one finds that both *no income* and *high income* are statistically insignificant. This surprising result may be due to the fact that two variables are strongly correlated with other variables in the regression. *No income* is highly negatively correlated with *age* and *high income* is highly positively correlated with *education*, as can be seen in *Figure 10* in the appendix. The high correlation with *education* could explain the unexpected sign of *high income*.

Surprisingly, the larger the proportion of the population living within 10 minutes by car to the nearest grocery store, the lower the number of deposited containers per person. This result is however statistically insignificant, which could be a result of the fact that the chosen time frame is inadequate or that the perceived obstacle to recycling may not be the actual time needed when traveling to the nearest grocery store. More relevant obstacles could for example be whether one needs to travel by car to the grocery store or if the geographical distance to the nearest store is long.

For every one percentage point increase in the proportion of houses, the amount of recycled containers per person falls by an average of 0.91%, at a 0.1% level of significance. This result is not in line with the expected effect, nor with current literature (Hage & Söderholm 2008). One reason for this negative correlation could be the fact that the variable is an inadequate proxy for living space, since it does not take into account the domestic area, but rather represents the type of living space. In order to be able to draw better conclusions regarding living area, one would need a more accurate measure, such as average square metres of living space per household. As constructed, the variable is likely to be picking up infrastructural characteristics of the municipality, where municipalities with higher proportions of houses have an infrastructure that negatively affects the level of recycling.

The question of whether a municipality charges waste collection using weight-based fees or fixed rates plays a significant role, where municipalities with a weight-based fee on average recycle 7.27% more containers per person. This result is significant at the 10% level of significance. As expected, households are more likely to recycle if they are charged a weight-based fee, since there exists an economic incentive to decrease the weight of the waste by recycling.

Normative variables

The effect of more people voting on the Green Party is positive, but statistically insignificant. It is thus difficult to draw any conclusions regarding its effect on the level of recycling in the municipality.

Demographic variables

The ambiguity of the effect of age on recycling, as depicted in current literature, makes it difficult to reason as to how and why age affects recycling rates. The mean age of the population of a municipality in this study shows a significant effect on the level of recycling, with a one year increase in the average age of 42.87 leading to an average increase of 3.46% recycled containers per person. This result is significant at the 5% level. One theory is that a higher average age indicates a larger proportion of pensioners, who in turn have a lower opportunity cost of time and thus are more likely to spend time recycling containers (Hage, Söderholm & Berglund 2009). In an attempt to distinguish between the effect of higher age and that of other circumstances associated with being a pensioner, we include a factor representing the proportion of retired people in the municipality. When doing this, we obtain statistically insignificant results for both variables. This is most likely due to the fact that the factors representing age and the proportion of retired people have a correlation coefficient of 0.98, i.e. are almost perfectly correlated. Thus we cannot draw any conclusions regarding this theory.

The coefficient for the *gender* variable is negative, but statistically insignificant. One reason for this could be the relatively low variance of the explanatory variable, as highlighted when presenting the data.

Education shows a highly statistically significant effect, a one percentage point increase in the proportion of inhabitants with a post-Secondary School education resulting in an average decrease of 1.51% recycled containers per person. This effect could reflect the fact that individuals with a higher level of education are able to obtain jobs with a higher wage, thus leading to a higher opportunity cost of time when it comes to recycling. The strong correlation between *education* and *high income* potentially supports this hypothesis.

For every one person increase in the number of inhabitants per square kilometre, the amount of deposited containers per person falls by 0.01% on average. This result is statistically significant at the 1% level. Even though the effect may seem small, one must take into

account the large spread of the variable, ranging from 0.20 to 4457.35 persons per square kilometre.

Control variables

Municipalities bordering Norway, Finland and Denmark on average recycle 23.32% more containers per person. This is result is significant at the 0.1% level, indicating that it is an important factor to include in the analysis. The effect, which is expected, is line with the discussion that foreigners cross the border to Sweden to purchase alcoholic beverages and soda.

Municipalities classified by SKL as being tourism municipalities, recycle on average 23.46% more containers per person, the result being significant at the 0.1% level. This finding is in line with the expectations and indicates that an influx of visitors to a municipality has a large effect on the average number of recycled containers per person.

Robustness check

In an attempt to test the robustness of the regression, as well as to highlight the significant factors we have found, we perform a reduced-model regression using only the variables significant at the 10% level. This regression exhibits relatively similar results both in terms of coefficients and significance levels for each variable, as shown in *Figure 9*.

7.2 County-level data

Economic variables

Looking at the variable representing the proportion of no income-takers in the county, we see that for a one percentage point increase, the number of recycled containers per person increases by 2.52% on average. This result is significant at the 5% level. Both *high income* and *distance to recycle* are insignificant. For every one percentage point increase in the proportion of houses in the municipality, the number of recycled containers increases on average by 0.66%, at a 5% level of significance.

Normative variables

The results regarding the normative preferences in the county are partly in line with our expectations, a one percentage point increase in the proportion of inhabitants voting for the Green Party in the national elections leading to a 1.59% average increase in the number of recycled containers. This result is significant at the 10% level.

One of the two variables that is of particular interest in this regression, namely that representing environmental concern, is unfortunately statistically insignificant. This means

that we cannot interpret the seemingly negative effect of higher levels of environmental concern on the recycling rate. One reason for this could be the fact that we performed an imputation of the national average on four of the county observations. This data manipulation is likely to distort the observed effect significantly, since almost 20% of the observations have been replaced by the average observation.

Demographic variables

Analysing the demographic factors included in our regression, we see that only the variable measuring the effect of age is statistically significant. For every one year increase in the average age, the number of recycled containers increases by 2.54% on average. The variables representing gender, education and population density are all statistically insignificant.

Control variables

The factor representing the consumption of alcohol in the county is our only control factor in this regression and is the second variable of particular interest. This since the data was not available on municipality level. The coefficient of this variable is significant at the 0.1% level and shows that for every one litre increase in the sale of alcoholic beverages in recyclable containers per person, the number of recycled containers increases by 2.34% on average. This result is in line with our expectations and highlights the importance of controlling for consumption when performing studies on the factors affecting recycling.

Robustness check

In an attempt to test the robustness of the regression, as well as to highlight the significant factors we have found, we perform a reduced-model regression using only the variables significant at the 10% level. This regression exhibits relatively similar results both in terms of coefficients and significance levels for each variable, as shown in *Figure 9*.

8. Analysis

Performing an econometric analysis of the regional differences in the recycling of PET bottles and aluminium cans in Sweden, we identify several factors that have an effect on the recycling rate, some of which are surprising. These findings regarding income levels, education, weight-based pricing, infrastructural factors and control factors construct a basis for further research as well as allow for discussion concerning potential policy implications.

Most striking when looking at the economic factors is that neither the proportion of no income earners nor high income takers play a statistically significant role in explaining the

recycling rate on the municipality level. This could be an indication of the fact that the monetary incentive of the deposit system is weak. Comparing the equally high recycling rates for deposit containers and glass, where no economic incentive exists for recycling glass, one can discuss whether the economic incentives play any role whatsoever compared to other aspects such as moral and social values or recycling information campaigns.

The statistical insignificance of the income variables could however, as discussed in the results, stem from the high levels of correlation with *age* and *education*. The effect of the monetary incentives that exist could thus be captured by the negative coefficient of the education variable, as an increase in the level of education could lead to higher opportunity cost of time due to higher income.

Weight-based pricing of household waste has a significant positive effect on the levels of recycling, indicating that these economic incentives and structural initiatives play an important role, even though the effect is smaller for multi-family dwellings. We argue that even though a strong and significant covariance between weight-based pricing and depositing exists, the relationship is most likely not direct. Weight-based pricing will promote general recycling behaviour, in particular of heavy materials such as paper, glass and metals. Individuals who change their recycling patterns of these materials in a response to the economic incentive are likely to also adopt better recycling habits with regard to PET bottles and aluminium cans.

The effect of a high municipality house-to-apartment ratio is a lower level of recycling, which could be indicative of certain infrastructural differences in municipalities with more houses than apartments. The statistical significance of the variable measuring population density also indicates that infrastructure is important, cities with high population density on average recycling at a lower rate. An interpretation of this could be that the facilitating effect of having a short travelling distance to the nearest store, as is the case for most inhabitants in areas of high population density, is offset by the infrastructure promoting traveling the distance on foot as opposed to going by car.

The highly statistically and economically significant effects of *border*, *tourism* and *consumption* indicate that these are important parameters to control for in an analysis of this type. The factors representing tourism and consumption could potentially be relevant for future studies on recycling rates of various materials. The *border* variable could also be included in recycling studies where cross-border trade is important.

Looking at the method chosen for this analysis, we recognise that a number of potential issues exist. These include omitted variables, inference of causality, reverse causality and the difficulty of measuring normative factors. Firstly, there are variables that have been omitted from the regression. This means that we cannot isolate the true effect of each factor since there could be an underlying omitted variable which explains the movement of several of the included variables. What we can observe on the other hand, is how the factors covariate with each other. Omitted variables could include the consumption of non-alcoholic beverages in deposit containers as well as measures of environmental awareness and the perceived pressure of social norms related to recycling.

Using cross-sectional data means that we cannot infer causality based on the results that we have found. Instead a randomised trial would be needed. Another issue with our method could be reverse causality, where it could be argued that one or more of the independent variables is affected by the dependent variable rather than vice-versa. This could be relevant for the normative variables, where the lower the rate of recycling in the municipality, the more concerned one could become about the environment. We do however expect this effect to be marginal and do not find it relevant to investigate it further.

The normative variables included in our regression are statistically insignificant. This does however not mean that these factors are unimportant, but could rather be an indication of the fact that they are being measured in an inadequate manner. As discussed, an econometric analysis should be seen as a complement to qualitative analyses where one better can account for values, norms and ideas of individuals.

Further research within this field could not only take the form of qualitative analyses but one could also develop new quantitative tests. Event studies could be performed in order to test the effects of changing the deposit fee or introducing weight-based pricing of household waste. One issue with this could however be that deposit containers could be purchased in one municipality and deposited in another, thus not allowing for absolute control of the treatment. In order to avoid this, one could perform the experiments in isolated regions where one could control for the inflow and outflow of deposit containers. An example of such a region is the island of Gotland. In this type of setting one could infer causality and explore direct effects of policy changes.

The results of our investigation can be interpreted in terms of their implications for policies constructed in order to promote recycling. Since the strength of the monetary incentives of

the Swedish container deposit system is questioned, the development of a different collection system for recyclables could be discussed. Channeling the importance of infrastructure, an improvement could be to implement property-close collection in areas of high population density. Another manner of developing the system could be to raise the deposit fees in order to provide stronger economic incentives. One must however consider the effect of such a measure on internal motivators since individuals still want to be perceived as recycling for the "right" reasons, social norms regarding concern for the environment playing an important role.

The impact of cross-border sales of beverages in Sweden is highly significant in our regression, indicating that further recycling policy developments should take this into account. Perhaps collection of Swedish containers in Norwegian, Finnish and Danish cities along the border would aid in further increasing the recycling of PET bottles and aluminium cans. Even though the results show a significant impact of the cross-border sales, one can expect a significant volume of containers to be disposed of abroad instead of being returned to the Swedish deposit system. By lowering the opportunity cost of recycling to those who otherwise would need to travel across the border in order to recycle, more of the sold containers would be collected.

9. Conclusion

Having performed an analysis of the regional differences in the recycling of PET bottles and aluminium cans between all Swedish municipalities, we have found a number of factors which appear to drive recycling. The factors that have a positive impact on recycling rates are high mean age, if the municipality lies along the national border of Sweden and if it has high levels of tourism. Larger proportion of houses to apartments, higher levels of education and higher population density all indicate negative effects on the level of recycling.

These results provide a basis for policy development in order to develop the deposit container recycling system in Sweden. Our findings call for a discussion regarding the existence or alteration of a monetary incentive, even though the relationship of income and education and their respective effects on the recycling rate must be taken into account. In addition, channeling the importance of infrastructure and better facilitating cross-border depositing of containers are potential measures that could help to encourage recycling.

This research develops a method with new control factors that can be applied in future quantitative work. This study should be seen as a complement to existing and future qualitative research. Infrastructural facilitation as well as the effects of age and education should be further investigated through surveys and similar means of research in order to determine the best manner of capturing these effects through recycling policies and regulations.

10. Summary

In this study we have investigated the observed regional differences in recycling within the Swedish container deposit system. By comparing the number of deposited PET bottles and aluminium cans per person in all Swedish municipalities, we have attempted to identify and quantify which factors affect the level of recycling.

Through complementing our own ideas with factors identified in previous research, we compiled a list of potential regressors. Taking the average number of deposited containers between 2009 and 2010 for each municipality, we obtained a cross-sectional data set on which we performed an OLS regression using the identified independent variables. We complemented our analysis with a county-level regression in order to include the factors where data was only available on a county level.

We found that high mean age, high levels of tourism and if the municipality lies along the national border of Sweden has a positive impact on the recycling rate. Larger proportions of houses to apartments, higher levels of education and higher population density all indicated negative effects on the level of recycling in a municipality. On a county level, a higher level of consumption had a positive impact on the number of deposited containers. Unexpectedly, the direct effects of the monetary incentive of the deposit system as well as those of normative factors proved indiscernible and further qualitative research with regard to these areas is recommended.

Based on these findings we suggest that future policy development take into account the importance of infrastructure for recycling, as well as better facilitate cross-border depositing of containers. Our findings welcome a discussion regarding the effectiveness of the monetary incentive used in the container deposit system.

The study should be seen as a complement to qualitative research and paves the way for future studies on the underlying workings of age, education and infrastructural factors and their effect on recycling rates.

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12. Appendix

Figure 10. Table showing correlation coefficients between variables, municipality-level data

	No income	*High income*	*Distance to recycling*	*Housing*	*Weight-based pricing*	*Green politics*	*Age*	*Gender*	*Education*	*Population density*	*Border*	*Tourism*
No income	1.0000											
High income	0.5974	1.0000										
Distance to recycling	0.4267	0.3974	1.0000									
Housing	-0.2851	-0.3711	-0.3064	1.0000								
Weight-based pricing	0.0013	0.0897	0.0092	0.0074	1.0000							
Green politics	0.3867	0.5282	0.4290	-0.5781	0.0661	1.0000						
Age	-0.8343	-0.6803	-0.4906	0.4228	-0.0417	-0.5931	1.0000					
Gender	-0.2770	-0.4800	-0.4805	0.5155	-0.0528	-0.5389	0.3742	1.0000				
Education	0.5527	0.8595	0.3918	-0.5131	0.1493	0.6984	-0.6664	-0.5976	1.0000			
Population density	0.3095	0.4935	0.1924	-0.5234	0.0286	0.3995	-0.3397	-0.2861	0.4993	1.0000		
Border	-0.0060	-0.0640	-0.2781	0.0737	0.0028	-0.2001	0.1378	0.2356	-0.0448	0.0105	1.0000	
Tourism	-0.3168	-0.1232	-0.1998	0.1455	0.0541	-0.0263	0.2846	0.1015	-0.1072	-0.0674	0.2755	1.0000

Figure 11. Table showing descriptive statistics for municipality-level data, two year average

Variable	*Mean*	*Min.*	*Max.*	*Std. Dev.*	*Obs.*
Dependent variable					
Deposit	148.46	49.00	434.00	44.83	288
Economic variables					
No income	0.26	0.20	0.36	0.03	288
High income	0.06	0.02	0.24	0.03	288
Distance to recycle	0.96	0.76	1.00	0.05	287
Housing	0.62	0.02	0.91	0.15	288
Weight-based pricing	0.10	0.00	1.00	0.30	288
Normative variable					
Green politics	0.05	0.01	0.13	0.02	288
Demographic variables					
Age	42.87	36.35	48.70	2.55	288
Gender	0.50	0.48	0.53	0.01	288
Education	0.23	0.13	0.58	0.08	288
Population density	136.75	0.20	4457.35	470.46	288
Control variables					
Border	0.10	0.00	1.00	0.31	288
Tourism	0.07	0.00	1.00	0.25	288

Figure 12. Table showing descriptive statistics for county-level data, two year average

Variable	*Mean*	*Min.*	*Max.*	*Std. Dev.*	*Obs.*
Dependent variable					
Deposit	153.07	129.50	198.00	19.86	21
Economic variables					
No income	0.07	0.04	0.10	0.01	21
High income	0.10	0.07	0.19	0.03	21
Distance to recycle	0.97	0.93	1.00	0.02	21
Housing	0.51	0.27	0.64	0.08	21
Normative variables					
Green politics	0.07	0.05	0.10	0.01	21
Concern	0.44	0.27	0.64	0.09	21
Demographic variables					
Age	42.02	38.90	43.65	1.30	21
Gender	0.50	0.49	0.51	0.00	21
Education	0.27	0.22	0.39	0.04	21
Population density	45.62	2.50	312.40	66.39	21
Control variables					
Alcohol sales	19.24	9.75	31.14	5.25	21