



Determinants of behavior toward selective collection of batteries in Spain. A bivariate probit model



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ABSTRACT

The purpose of this paper is to identify the decision-drivers that affect the recycling efforts of Spanish individuals through the separate collection of batteries. To this end, we have carried out an empirical study using a bivariate probit model, where the dependent variable we want to analyze is the household attitude to recycling batteries, which we explain through a set of attitudinal and socio-economic factors, together with an endogenous factor representing the environmental concern of the individuals. The results of this estimation suggest that the respondent's concern for the environment is a very significant factor influencing the recycling of batteries. In general, the profile of individuals with higher probability of recycling batteries is an individual born in Spain, with a high level of income, student, living in a large city and who had knowledge of any environmental campaign in the last year. Another important result is that the probability of recycling increases with age, but this increases becomes smaller as the individuals get older until the age of 62. From 63 years old, an additional year reduces the probability of recycling. The results obtained would be useful in designing measures based on the characteristics of individuals in order to improve existing practices, and to establish long-term shifts in recycling attitudes.

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1. Introduction

The management of solid waste from households has become a pressing issue in modern society. The continuous growth of urban populations and the adoption of patterns of consumption based on *throw-away culture* (Toffler, 1970) have resulted in the generation of large amounts of solid waste. Within the European Union, measures to promote the reduction, re-use, and recycling of municipal solid waste have been increasingly adopted by the European Commission, and subsequently by Member States (e.g. ED 2008/98/EC, European Council, 2008; ED 2012/19/EU European Council, 2012; or ED 2015/720/EU, European Council, 2015). Nevertheless, the amount of waste sent to landfills remains high. In 2013, about 70% of the waste generated by Spanish households was deposited onto or into the soil (60.23%) or was incinerated (9.74%) (EUROSTAT, 2015).

The problem is not only the amount of waste generated but also its characteristics. Although overall, the waste generated by households is largely considered non-hazardous, some of it does contain highly polluting elements that pose significant risks to the

environment. In this work, we focus on one aspect: domestic batteries. Although batteries represent only a small percentage of the total waste generated by households, their potential for contamination is high because they could contain cadmium (Cd), mercury (Hg), and lead (Pb), making it crucial that these wastes are efficiently collected and recycled (Bigum et al., 2013). The overarching objective of the European Directive on batteries and accumulators (ED 2006/66/EC, European Council, 2006) establishes that “Member States shall, having regard to the environmental impact of transport, take necessary measures to maximise the separate collection of waste batteries and accumulators and to minimise the disposal of batteries and accumulators as mixed municipal waste in order to achieve a high level of recycling for all waste batteries and accumulators” (Art.7, ED 2006/66/EC). In Spain, the government implemented this European Directive in the Royal Decree (RD) 106/2008 of 1 February, on batteries and accumulators and environmental management of their waste (BOE, 2008). The central mandate was to achieve the following minimum collection rates in Spain: 25% by 31 December 2011 and 45% by 31 December 2015 (Art. 15 §2, RD 106/2008). In order to achieve the proposed targets, these regulatory measures, among other actions, establish the need to design information campaigns to ensure that end-users are fully informed of “the desirability of not disposing of waste batteries and accumulators as unsorted municipal waste and of participating in

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their separate collection so as to facilitate treatment and recycling” (Art.20 §1, ED 2006/66/EC).

Several studies show that to involve households in separating and recycling different kinds of waste, information campaigns should be designed on the basis of specific and individual information (Knussen et al., 2004; Refsgaard and Magnussen, 2009; Miafozdyeva and Brandt, 2013; Zen et al., 2014). That is, to be successful, recycling campaigns should take into consideration the local conditions and cultural, situational, or demographic factors of the households addressed (Tonglet et al., 2004; Timlett and Williams, 2008; Hadjimanolis, 2013; Keramitsoglou and Tsagarakis, 2013).

Most empirical studies have found that recycling behavior among households is influenced by socio-economic variables, degree of environmental concern, level of knowledge about environmental recycling issues and social norms (Hornik et al., 1995; Hansmann et al., 2006; Hadjimanolis, 2013; Miafozdyeva and Brandt, 2013).

Of the many socio-economic variables included as independent variables in the studies on recycling, the most commonly analyzed are education, income, age, gender and different variables related to household characteristics. The results regarding influence of these variables on recycling are inconclusive. Regarding education, several works have found that higher levels of education have positive impact on recycling behavior (Hadjimanolis, 2013; Czajkowski et al., 2014; Yin et al., 2014). However, there are also a similar number of studies founding no such significant relation between education and recycling (Sidiqie et al., 2010; Rioux, 2011; Wang et al., 2011; Pearson et al., 2012). Age is the most frequently analyzed socio-economic variable (Miafozdyeva and Brandt, 2013). Several authors report a significant and positive correlation between age and recycling behavior (Hage et al., 2009; Sidiqie et al., 2010; Hadjimanolis, 2013; Keramitsoglou and Tsagarakis, 2013). However, there are also studies showing a negative relationship between these two variables (Czajkowski et al., 2014). Furthermore, other studies have not found a significant correlation between them (Barr et al., 2001; Rioux, 2011). Another usually analyzed variable is income. Most studies found that income and recycling have a significant correlation (Nnorom et al., 2009; Gellynck et al., 2011; Hadjimanolis, 2013; Czajkowski et al., 2014; Zen et al., 2014; Babaei et al., 2015), whilst some few works have reported no correlation (Hansmann et al., 2006; Hage et al., 2009; Rioux, 2011; Pearson et al., 2012). However, this correlation is ambiguous. Several works indicate that households with higher income recycle more than households with lower incomes (Nnorom et al., 2009; Czajkowski et al., 2014; Zen et al., 2014). In contrast, other works show that households with higher income not necessarily have a rate of recycling higher than other households (Hage and Söderholm, 2008; Gellynck et al., 2011). Regarding gender, some studies consider that this variable has not a relevant influence on recycling behavior (Hansmann et al., 2006; Hage et al., 2009; Sidiqie et al., 2010). Nevertheless, several works have found evidence that women are more likely to recycle than men (Chung and Poon, 1996; Pearson et al., 2012; Hadjimanolis, 2013; Babaei et al., 2015). Among household characteristics included in previous research, we can note, household size (Tadesse, 2009; Wan et al., 2014), marital status (Sidiqie et al., 2010; Pearson et al., 2012), or the type of house (Hage et al., 2009; Sidiqie et al., 2010; Zen et al., 2014), among others.

Moreover, the literature contains references to other socio-economic variables. For example, with the increase in migration processes, studies including the origin of the individuals have become more common (Hage et al., 2009; Pearson et al., 2012; Zen et al., 2014). The relationship with the economic activity is also analyzed recently in some works (Omran et al., 2009; Babaei et al., 2015; Nguyen et al., 2015).

The analysis of influence of knowledge of environmental issues on recycling is very usual in the empirical studies. It is well documented that environmental concern affects recycling behavior positively (Hornik et al., 1995; Hage and Söderholm, 2008; Hage et al., 2009; Nnorom et al., 2009; Refsgaard and Magnussen, 2009; Tadesse, 2009; Best and Kneip, 2011). Most of studies that include this variable conclude that environmental concern has a positive correlation with recycling behavior. Other studies, however have shown that no significant relationship or a very weak relationship between this variable and recycling behavior (Barr et al., 2001; Tonglet et al., 2004; Wang et al., 2011).

Similarly, several researchers found a direct link between the recycling behavior of households and their knowledge about specific recycling issues (Hansmann et al., 2006; Sidiqie et al., 2010; Hadjimanolis, 2013; Keramitsoglou and Tsagarakis, 2013; Nguyen et al., 2015).

It is well documented that social norms have a substantial influence on recycling behavior of a person. The social norms are often defined as norms that the individual perceives to be held by significant others who are important for he or she (Hansmann et al., 2006; Miafozdyeva and Brandt, 2013). In this context, several works conclude that person's interest to show a social desirable behavior (i.e. a pro-environmental behavior) is positively linked to recycling behavior (Hornik et al., 1995; Chu and Chiu, 2003; Sidiqie et al., 2010; Rioux, 2011; Videras et al., 2012; Czajkowski et al., 2014; Wan et al., 2014; Zen et al., 2014; Nguyen et al., 2015). In contrast, some few studies report that social norms have not relevant influence on recycling (Chan, 1998; Knussen et al., 2004; Hage et al., 2009).

As we have seen, the relative influence of analyzed variables on recycling behavior varies greatly in the literature. This is due to these studies has been carried out in different countries by researchers of different disciplines (economics, psychology, engineering, etc.) that address different concerns (Hornik et al., 1995; Miafozdyeva and Brandt, 2013). Furthermore, it should be pointed out that prior empirical works focus on general issues of recycling behavior, considering the solid waste from households as a homogeneous whole (Barr et al., 2001; Gellynck et al., 2011; Miafozdyeva and Brandt, 2013; Czajkowski et al., 2014; Zen et al., 2014). Nevertheless, since domestic solid waste is heterogeneous, an individualized analysis of factors that influence behavior toward recycling specific waste containing potentially hazardous materials, such as batteries, can be very useful in designing the most effective educational and information campaigns to improve the percentages of correct disposal. This is an issue that only a few recent studies have tried to analyze (Hansmann et al., 2006; Nnorom et al., 2009; Wang et al., 2011; Yin et al., 2014).

In this context, the purpose of this paper is to identify the important decision-drivers that affect the recycling efforts of Spanish individuals through the separate collection of batteries. Specifically, we want to answer the following questions:

- What factors influence the decision to deposit used batteries into collection points?
- Which factors are the most influential in this decision?

To this end, we carry out an empirical study estimating a bivariate probit model where the dependent variable is the household attitude to recycling batteries, which we explain through a set of attitudinal (environmental concern, awareness of some environmental problem and knowledge of environmental campaigns) and socio-economic (age, education level, type of household, etc.) factors. Studies which deal with recycling issues using binary models can be found in the literature. Most of them estimate a one-equation model, using logistic regressions, ordered probit and multinomial logit models (Hage et al., 2009; Nnorom et al., 2009; Wang et al.,

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