DETERMINANTS OF MUNICIPAL SOLID WASTE MANAGEMENT IN PORTUGAL

DETERMINANTES MUNICIPAIS DE GESTÃO DE RESÍDUOS SÓLIDOS EM PORTUGAL

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ABSTRACT

Municipal solid waste management has been a topic of interest of several authors over time, in particular the implementation and maintenance of waste collection programmes. Initially, pioneering studies focused on the economic aspects of the provided services. However, many authors later argued the costs of providing solid waste collection services should also be influenced by socio-economic and behavioural factors, exogenous to the municipalities. The present study will be developed in this context, looking, more broadly, to explain the factors influencing the decision-making of the Portuguese municipalities in implementing and maintaining programs of selective collection of solid waste, considering the economic, financial, technological and sociodemographic factors. The results show that, indeed as presented by several authors before, economic factors aren't the only determinants that influence municipal costs concerning these services, as demographic, geographic and technological factors must be taken into account. Moreover, the enforced legislation also impacts the municipal costs due to municipalities being obliged to contribute to the success of these collection programs in order to fulfil the waste recovery targets. This implies that the costs of these services and the inherent infrastructures are usually financed by its citizens in the form of utilization taxes and also the state.

Keywords: Waste Management. Cost Function. Municipalities.

RESUMO

A gestão de resíduos sólidos municipais tem sido alvo de interesse de vários autores ao longo do tempo, em particular, a implementação e manutenção de programas de recolha de resíduos. Inicialmente, estudos pioneiros focaram-se nos aspetos económicos dos serviços prestados. No entanto, vários autores defenderam posteriormente que os custos envolvidos na prestação destes serviços também deveriam ser influenciados por fatores socioeconómicos e comportamentais, exógenos aos municípios. O presente estudo será desenvolvido neste contexto, procurando, mais amplamente, explicar os fatores que influenciam a tomada de decisão dos municípios portugueses na implementação e

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manutenção de programas de recolha seletiva, considerando fatores económicos, financeiros, tecnológicos e sócio-demográficos. Os resultados mostram que, efetivamente, conforme já apresentado por vários autores, os fatores económicos não são os únicos determinantes que influenciam os custos municipais atinentes a estes serviços, sendo que os fatores demográficos, geográficos e tecnológicos devem ser considerados. Além disso, a legislação em vigor também influencia os custos dos municípios devido à obrigatoriedade de contribuição para o sucesso destes programas a fim de cumprir os objectivos de valorização de resíduos. Isto implica que os custos destes serviços e infra-estruturas inerentes são geralmente financiados pela taxação do serviço aos seus munícipes e também o Estado.

Palavras-chave: Gestão de Resíduos. Funções Custo. Municípios.

1 Introduction

The excessive production of waste arising both from the manufacturing process and populational consumption is a pressing issue that requires an urgent and collective solution. Despite little time has passed since environmental problems began to be an academic and, later, a household subject, the efforts developed over time until nowadays are still insufficient, a fact verified by the continuous increase of pollution in all its forms, the loss of biodiversity and the impact of climate change in many regions of the planet.

With the increasing awareness of populations regarding environmental issues in general, and waste accumulation in particular, the pursuit for feasible solutions has become essential as proved by the continuous emerging legislation for environmental protection. Such led to the creation and subsequent implementation of policies and municipal solid waste (MSW) collection programs to divert refuse from open dump sites and direct them to appropriate infrastructures for treatment and recovery and, thus, fulfil the imposed legislative targets. However, as pointed out by several authors such as Fullerton and Kinnaman (1996), Palmer et al. (1997), Kinnaman (2005), Bohm et al. (2010), Bel and Fageda (2010) and Matsumoto (2011), municipal collection programs are expensive, often requiring funding from the state and/or citizens. Within this perspective, many studies were developed in order to analyse the impact of costs of solid waste collection services in municipalities through the use of economic variables inherent in the service: frequency of collection, type of financing, amount of waste produced, proportion of waste generated per capita, whether the service provided is

public or private, among others (STEVENS, 1978; TICKNER; MCDAVID, 1986; BEL; COSTAS, 2006; BEL; FAGEDA, 2010; TONJES; MALLIKARJUN, 2013; JACOBSEN et al, 2013; ROGGE; DE JAEGER, 2013).

More recently, there have been authors such as Kinnaman (2005), Ekere et al (2009), Lombrano (2009), Bohm et al (2010) and Passarini et al (2011) who believe that economic factors shouldn't be solely considered when analysing costs because the quantity of waste generated depend on exogenous factors to municipalities - the idiosyncrasies of the citizens - and therefore should be considered the effects of other variables, including socio-economic and behavioural. Thus, there have been studies whose objective relates to the determination of the factors influencing municipalities' decision to implement selective collection programs for their residents and the consequent investment in infrastructures that allow an adequate recovery of the different waste streams (MATSUMOTO, 2011; CHIKASADA; USUI, 2011).

Following the contributions of the previously mentioned studies, this research intends to fill the shortage of literature regarding the Portuguese case, distinguishing itself from others not only by the used sample - the Portuguese municipalities -, but also due to the inclusion of explanatory variables of economic and financial nature such as the municipal costs with waste management. The developed econometric model showed that the decision to implement and maintain sorted collection programs is not explained solely by economic factors; demographic variables have a strong impact on the explanation of the annual spending on environment with municipal waste management, as well as geographical and behavioural factors. The technological factors have mixed impacts as the type of waste management system has a negative effect on the cost, while the presence of organic and energy recovery infrastructures of MSW has a positive effect.

2 Empirical study

This research applies the regression method to panel data from a sample of 308 Portuguese municipalities between 2004 and 2012, to determine the factors influencing municipal decision-making in implementing and maintaining selective collection programs. The proposed model to explain the spending on environment with waste management for the municipality i in year t (Y_{it}) includes the following explicative

factors attending to their nature – Management, Technological, Geographical, Demographical and Behavioural.

We consider the management factor measured by the public or private nature of the waste management system, revealing a political option with a dummy variable (DSGRPV) where 0=public and 1=private. The 3 selected variables of technological nature are related to the available infrastructures - dummy variables DINCIRSU and DCOMPOST, referring, respectively, to the solid waste incineration plants and composting plants, where the variables assume the values 1 (in the case of existence of the equipments) and 0 (in the contrary case), besides the percentage of solid waste collected selectively (PCRSU_RECSEL). Geographically, the indicator used relates to the 2 metropolitan resident areas of the country (Greater Lisbon and Greater Oporto). Demographic variables refer to the municipal monthly earnings (G_MD), population density (DNSPOP) and the resident population in the municipality (POPMDRESID). Finally, the selected behavioural indicator refers to the number of environmental non-governmental organizations (ONGAMB). The estimation was performed using panel data – with 308 municipalities, the cross-section units, observed 9 times during 9 years - and the GLS estimation taking into account the heterogeneity of the cross-section unities (the municipalities) with EVIEWS version 8 software.

The regression model's estimation results show that the coefficient of determination obtained for the proposed model was 0.749, and the global significance of the model is verified by F-statistic. Table 1 shows the coefficients of the regression model and statistical tests. The model shows the specific time effects, revealing the difficulties in the years of the actual crisis (namely the negative values for the years of 2010, 2011 and 2012).

One can see that the type of waste management system has a negative effect (when the type of management is private) on municipal spending, and therefore special attention must be paid to its characteristics. In the country, there are two types of systems responsible for waste management: inter and multi-municipal. Inter-municipal systems consist of sets of municipalities that are established through public deed, while the multi-municipal systems take the form of joint stock company. In contrast, one can observe there has been a positive effect of the variables related to the existence of organic and energy recovery infrastructures, and selective collection. That is, the maintenance of these types of infrastructure and the selective collection service itself

contribute greatly to the municipal spending on environment. It should also be pointed out that there are only three energy recovery infrastructures of MSW in Portugal, located in Greater Oporto, Greater Lisbon and Madeira (there are, however, several other infrastructures of energy recovery, but for biogas).

All the proposed technological variables are significant for explaining the dependent variable – spending on environment (MSW); this means that the expenses with equipments – for incineration, composting and waste collection – directly affect the municipalities' budget.

As for the demographic factors considered, they are significant and positive. This can be explained by the fact that municipalities with a high population density produce more MSW than municipalities with fewer residents per square kilometer. Similarly, higher average monthly earnings imply a greater purchasing power, prompting citizens to consume more and thus produce more waste. The fact that population positively influences the spending suggests that there is a dimension effect, and a seasonal effect (particularly in the most touristic destinations), that have an impact in the form of higher quantities of MSW to be collected and consequently the frequency of collection.

Geographically, the significance of the municipalities of Greater Lisbon and Greater Oporto, explain an additional positive effect on municipal spending: there is a larger population, more demanding and more concerned with environmental issues. This means that more fuel, other raw materials and human resources are required during the collection service. It also affects the location of the infrastructures, since economies of scale can be achieved by negotiation, avoiding more scattered infrastructures in order to maximize collection efficiency.

Table 1 - Coefficients of the estimated model.

Dependent Variable: DESPAMBGR

Method: Panel EGLS (Cross-section weights)
Sample (adjusted): 2004 2012; Total observations: 2692
Periods included: 9; Cross-sections included: 308

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-449950.2	39859.86	-11.28830	0.0000
DSGRPV	-211557.2	16927.35	-12.49796	0.0000
DINCIRSU	96764.08	24842.69	3.895072	0.0001
DCOMPOST	203613.1	17048.66	11.94306	0.0000
PCRSU_RECSEL	8068.916	1361.397	5.926939	0.0000
POP_MD_RESID	24.80143	0.452920	54.75898	0.0000
DNSPOP	171.7276	32.59960	5.267784	0.0000
G_MD	580.0680	53.99557	10.74288	0.0000
ONGAMB	351547.3	22162.55	15.86222	0.0000
DGLISBOA OR DGPORTO	1481701.	91954.91	16.11335	0.0000
YR=2005	-26669.53	21146.64	-1.261171	0.2074
YR=2006	-6700.833	21486.62	-0.311861	0.7552
YR=2007	19555.84	21498.38	0.909642	0.3631
YR=2008	26105.40	22041.11	1.184396	0.2364
YR=2009	10897.71	22686.72	0.480356	0.6310
YR=2010	-5191.560	23806.33	-0.218075	0.8274
YR=2011	-3963.934	23873.35	-0.166040	0.8681
YR=2012	-12463.61	23967.40	-0.520023	0.6031

Weighted Statistics

R-squared	0.745594	Mean dependent var	2164051.
Adjusted R-squared	0.743977	S.D. dependent var	2050972.
S.E. of regression	1170930.	Sum squared resid	3.67E+15
F-statistic	460.9867	Prob(F-statistic)	0.000000

Lastly, the existence of environmental non-governmental organizations refers to the population's pro-environmental behaviour. These organizations are comprised of citizens with major environmental concerns that, on one hand, put pressure on the government and municipalities to implement additional control of environmental policies, and, on the other, the local population to the attention of the importance of adopting "green" behaviours in order to thus protect the common future.

3 Conclusions and further research

The focus of this investigation was related with the determination of the factors influencing the decision to implement and maintain selective municipal waste collection programs in Portugal by the econometric analysis of the annual municipal spending on the environment with waste management. It was found that, as advocated by several

authors, in particular Kinnaman (2005) and Bohm et al (2010), the economic factors aren't the only determinants influencing municipal costs and there should also be considered other types of factors, including demographical ones (in order to know the characteristics of the attended population and possible effects of seasonality motivated by tourism), the geographical aspects of the municipality (that influence the routes and the inherent costs both to the collection service and the location of the recovery infrastructures), and the effect of behavioural variables that have an impact on the lives of citizens. We should also consider the technological aspects, such as the infrastructures the city has available to MSW collection and treatment, since its implementation and maintenance result in considerable costs.

Summing up, and acknowledging the effects of the enforcing law, all municipalities have the responsibility to contribute to the success of their selective collection programs, because there are established targets to the country for the recovery of MSW that need to be fulfilled. This implies the absorption of costs related to the services and "green" infrastructures that, as can be observed at national level, are often financed by the citizens (in the form of service taxation) and by the state.

Note: This article is a corrected and updated version (including two years of observations and a new panel data econometric model) of a previous one.

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