



Factors related to municipal costs of waste collection service in Spain

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ABSTRACT

Actual cost of services of local entities (CESEL, in Spanish) is the name of a new official source of statistics in Spain, provided by Ministry of Finance and Civil Service, which intends to bring some transparency to a very obscure question: the real costs of local public services, in this case, the collection costs of municipal solid waste (MSW). The study analyzes the factors that determine solid waste collection costs in 2014, using a cross-sectional dataset of municipalities of the Spanish Mediterranean Arch and Madrid, with special reference to urban development. The results of the regression reveal a positive relation between waste collection costs and factors such as higher wages, coastal municipalities, tourist areas, population and separated collection; in contrast, the increase in urban population density contributes to lower costs of MSW collection, as well as indirect management of the service is cheaper than direct public delivery.

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1. Introduction

Spain is one of the world's most fiscal decentralized countries that has suffered the brunt of the crisis most acutely, which could have prompted greater competition for scarce revenues and placed global financial stability in question (Lago-Peñas et al., 2017). After this global (and, consequently, local) financial crisis, Spanish governments – central, regional and local – proposed new legislative formulas to promote the economic recovery and greater transparency. Linking with that, the reading of the “Ley Orgánica 2/2012, de 27 de abril, de estabilidad presupuestaria y sostenibilidad financiera” (2/2012 Organic Act, dated 27 April, of budgetary stability and financial sustainability), in conjunction with the “Ley 27/2013, de 27 de diciembre, de racionalización y sostenibilidad de la Administración Local” (27/2013 Act, dated 27 December, of rationalization and sustainability of local administration), establishes the concept of actual cost of local services and the obligation to provide this information in public platforms.

The administration of waste legislation in Spain is carried out by

the relevant authorities at different levels (Dizy-Menéndez and Ruiz-Cañete, 2010): at the national level, the Ministry of Agriculture and Fishing, Food and Environment is responsible for the national plans; at the regional level, the autonomous regions are responsible for issuing strategic waste management plans for each specific region; and, at the local level, the municipal authorities are responsible for the management of the urban waste (domestic, industry and commerce, offices and services), including separate collection and transportation of municipal solid waste (hereinafter, MSW).

To complement national administrations involved, in terms of provision of information, data regarding actual cost of local services is published by Ministry of Finance and Civil Service of Spain, with data provided by local governments. In this database, there are files with disaggregated information on costs and details about all local public services, namely: water supply, sewerage collection, wastewater treatment, urban development, public parks, street paving, cleaning and lighting, etc. In this context, it should be possible for users to be informed of the real costs of services, which is recognized as one of the greatest concerns of such users (Pérez-Blanco et al., 2011).

In recent years, many municipalities have been forced to assess their solid waste management programmes, with specific emphasis given to the rise in costs (Greco et al., 2015). In this

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sense, the proposal for a Directive of the European Parliament and of the Council, amending the Waste Framework Directive, EU Directive 2008/98/EC on waste (EC, 2015), establishes that MSW is amongst the most complex ones to manage, and the way it is managed generally gives a good indication of the quality of the overall waste management system in a country. Moreover, the challenges of MSW management result from its highly complex and mixed composition, direct proximity of the generated waste to citizens, and a very high public visibility. The highly complex MSW management system, which is the main concern to be addressed in the aforementioned proposal, includes an efficient collection scheme, a need to actively engage citizens and businesses, a need for infrastructure adjusted to the specific waste composition, and an elaborate financing system. It is the latter element of management that is going to be addressed in this work.

There are different forms of levying charges for MSW (Chamizo-González et al., 2016): undesignated funds system, which is based on funding the service from general city funds with no attempt to relate the cost of the service; flat fee system (the form that prevails in Spain), with no formal attempt to relate to the cost of the service; or variable fee system, whose levy of the fee is overtly tied into quantifiable aspects of waste generation or measurable factors different to the waste generated, such as water consumption, for example.

Most of the Spanish municipalities do not relate the full cost of the MSW service to the required fees, which entails serious imbalances in local public funds and this would imply that the mismatch should be offset against the transfers of other government levels. This problem is heightened where tourism activity is an essential support for the local economies, because tourists generate income for local people, but they also may increase costs of providing some public services. Thus, until now, only two regional governments in Spain have implemented new taxes to cope with this additional expenditure, such as Catalonia and Balearic Islands.

The present study analyzes, on this basis, factors that imply an impact on municipal costs for solid waste collection services in 2014, using a cross-sectional dataset of municipalities of the Spanish Mediterranean area and Madrid. This paper, in contrast with others previously published, as referred to in section 2, considers the net urban population density in order to test the hypothesis that such urban development variable plays a significant role in reducing provision costs of collection of MSW. Other differentiating elements are the geographic area studied, from which generalized conclusions on urbanized areas of Spain could be drawn, and the considerable number of observations, covering almost 85% of population of municipalities on the Mediterranean area of Spain and Madrid.

Focus on urban development, as a decisive cost determining factor, is due to the significant increase in the urban land area with residential use over the past decades in Spain, which has been particularly exposed to extremely intensive urbanization; specifically, considering the different regions of the Mediterranean area and Madrid, where adverse consequences have appeared with greater intensity (Catalan et al., 2008; Galacho Jimenez and Luque Gil, 2000; García, 2010; Morote and Hernández, 2016; Pons and Rullan, 2014).

Whereas it has been shown in other studies that more compact urban models are particularly suited to improve financial efficiency in the provision and maintenance of local public services (Carruthers and Ulfarsson, 2003; Hortas-Rico and Solé-Ollé, 2010; Fernández-Aracil and Ortuño-Padilla, 2016), evidence on waste management financial implications are yet to be verified.

2. Literature review

Empirical studies of the factors that have an impact on costs of MSW services, could be addressed by means of a series of methodologies, generally parametric or non-parametric methods, nonetheless, the use of non-parametric methods is not included in the scope of this paper, as the latter are more appropriate for efficiency analysis, such as the comparison of the performance of a set of municipalities. Therefore, a complete review of previous empirical studies dealing with factors related to MSW management and their multivariate econometric analysis can be found in Bel and Fageda (2010), Bel et al. (2010) or Bel and Mur (2009). Accordingly, Hirsch (1965) was the first researcher to propose an “ideal” econometric model to analyze five major groups of variables which could affect the cost of residential waste collection service in Missouri (USA), concerning the quantity of service, their quality, the service conditions affecting input requirements, the factor price level, and productivity. His concluding thoughts indicate that pickup frequency and pickup location are statistically significant cost determinants.

From Hirsch (1965) onwards, more parametric studies have been published with a considerably improved availability of data and methodological innovations, as can be seen in Bel and Fageda (2010). Some of these studies, conducted in different parts of the world, confirmed that contracting out residential solid-waste collection is associated with lower costs than those of public provision, for example: Reeves and Barrow (2000) analyzed 88 local authorities in Ireland, McDavid (2001) considered 327 local governments across Canada or Dijkgraaf and Gradus (2003) selected 120 municipalities in the Netherlands, while later, Dijkgraaf and Gradus (2013), gathered data from 548 Dutch municipalities. Conversely, other works show that public costs are lower than private provision costs, such as Ohlsson (2003) with 170 firms in 115 Swedish municipalities, among other authors.

Regarding research close to the geographical area of this study, Bel (2006) and Bel and Costas (2006) were the first authors to determine factors explaining why the costs imposed by the urban solid waste collection service vary in a region of Spain by looking at 186 Catalan municipalities in 2000. They consider the total expenditure on MSW management (including collection, transport, transfer and treatment) as the dependent variable. Their explanatory variables are the quantity of waste for elimination generated in the municipality, the quantity of recycled waste, the wage level in a given province, the frequency of collection, the total population density, the tourism activity index, the existence of a landfill in the municipality, and the mode of production, namely public or private. They find no effect of the mode of production on costs and population density is not significant, but finally, their results suggest that both intermunicipal cooperation and recent privatization are associated with lower costs.

Bel and Mur (2009) and Bel et al. (2012) focus attention on small municipalities in the region of Aragon in 2003 and 2008, respectively. Their results indicate that small towns that cooperate incur lower costs for waste collection service, but the form of production, public or private, does not result in systematic differences in costs. On the one hand, with regard to variables related to urban development in Bel and Mur (2009), no significant relation was found between population density and the municipal costs of the service, however a greater degree of dispersion within a municipal area affects total costs positively (in other words, dispersion contributes to increase costs), as the complexity of the service is necessarily increased. On the other hand, according to Bel et al. (2012), costs increase as the population density or dispersion rises.

In a different geographic area of Spain, Bel and Fageda (2010) analyze the factors that determine solid waste service costs in

Galician municipalities in 2005. The results reveal that private delivery is not cheaper than public delivery, while authors do not study variables related to urban development.

Focusing on most recent studies, [Greco et al. \(2015\)](#) analyzes the factors that determine the solid waste collection costs in 67 Italian municipalities identifying population size and density, percentage of separate collection, percentage of home collection and private delivery as significant drivers.

Nevertheless, previous studies had not paid attention on variables related to urban development, but they have focused on effects of economies of scale or variables such as the form of provision of the service, whether it is public or private. In addition, sample sizes of the aforementioned works are significantly smaller than the number of observations considered in this analysis. This is the direct consequence of the publication of the database on the actual cost of local services, which enables a calculation on MSW costs in a geographical area that has never been considered before concerning MSW.

3. Methods and calculation

The study area covers the Mediterranean arch of Spain and Madrid ([Fig. 1](#)), which are the most sprawled areas of Spain ([EEA, 2006](#); [Moliní and Salgado, 2012](#); [Hennig et al., 2015](#)) and where problems of inefficiencies in land development cannot ensure suitable levels of productive investments with serious budgetary restrictions ([Fernández-Aracil and Ortuño-Padilla, 2016](#); [Lara-Galera et al., 2011](#)). Additionally, in this area, there is very intense pressure to build due to tourism and the demand for a second residence ([Rubiera-Morollón et al., 2015](#)) and the distinct political, social and cultural history of Mediterranean cities has sculpted dispersed patterns of urbanization in particular forms ([Catalan et al., 2008](#)) with environmental, social and economic consequences which must be given more careful study.

Focusing on public financial consequences of sprawled urban patterns, the sample considers 54.64% of the total number of municipalities in the area of study, which includes the provinces of: Alicante, Almeria, Balearic Islands, Barcelona, Castellon, Girona, Granada, Madrid, Malaga, Murcia, Tarragona and Valencia ([Table 1](#)). These provinces are included in the following regions or autonomous communities, as they are identified in Spanish: Catalonia,

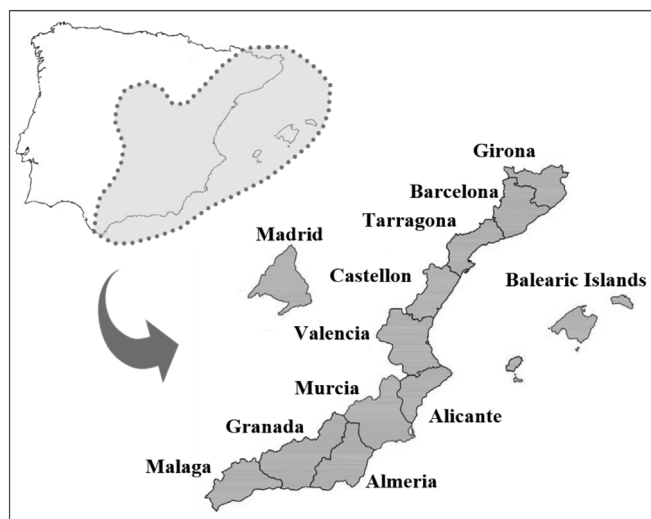


Fig. 1. Area of study.

Table 1
Representativeness of the information.

Province	All municipalities of the provinces studied		Sample of municipalities considered in this study	
	Number of municipalities	Total population (inhab)	Number of municipalities	Total population (inhab)
Alicante	141	1,868,438	94	1,427,727
Almeria	102	701,082	15	486,903
Balearic Islands	67	1,103,442	38	958,972
Barcelona	311	5,523,784	182	5,014,486
Castellon	135	587,508	78	367,374
Girona	221	756,156	146	617,085
Granada	168	919,455	110	818,923
Madrid	179	6,454,440	81	5,551,011
Malaga	100	1,618,539	45	1,345,525
Murcia	45	1,466,818	39	1,388,625
Tarragona	183	795,155	60	504,571
Valencia	266	2,548,898	160	2,204,827
Total area of study (100%)	1918	24,343,715	1048	20,686,029
		(100%)	(54.64%)	(84.97%)

Valencian Community, Murcia, Andalusia, Madrid and Balearic Islands.

[Table 1](#) shows the total number of municipalities and their registered population in the provinces studied, followed by variables describing the sample considered in the study in order to cross-check the representativeness of the information. Municipalities that reported inconsistent data on the costs of the MSW service were omitted from the dataset. Consequently, it can be seen that the information has been available for municipalities that encompass the 84.97% of the total population of this area of study.

Having revised the specific geographical context and how to analyze data, it is possible to draw a model for estimating the factors that impact on MSW collection costs, as well as the variables involved. With that in mind, dependent and independent variables have been selected on the basis of the variables considered by the previous empirical studies, in addition to the specific variables of this area of study, owing to its dynamic socio-economic characteristics, such as tourism and land development. Besides, the possibility of finding highly disaggregated variables, at municipal level, on as broad a geographical area as possible, has been considered.

Hence, data regarding MSW collection costs is the dependent variable of the model and it was gathered from a new source called actual cost of local services, which is published by Ministry of Finance and Civil Service of Spain (2016). The figure below ([Fig. 2](#)) shows the average collection costs of MSW and the average net urban population density, the main independent variable, at provincial level, where can be seen a first approximation to the relationship between the urban factor and overall costs.

The explanatory variables used in the model are described below, as well as in [Table 2](#):

- Net urban density (DENSITY). Defined as the number of inhabitants per urban hectare, in other words, population shouldn't be divided by total municipal surface area, but by built-up areas of municipality identified as urban land in the Cadastre or [Property Assessment Office of Spain \(2016\)](#). The main hypothesis of the study suggests a negative effect on costs.
- Collection route (ROUTE). Sum of distance covered by trucks from waste containers to waste treatment plants (landfills, incineration or recycling plants), defined as kilometres travelled. It is expected to find a positive relation between collection route and costs, due to higher transportation costs.

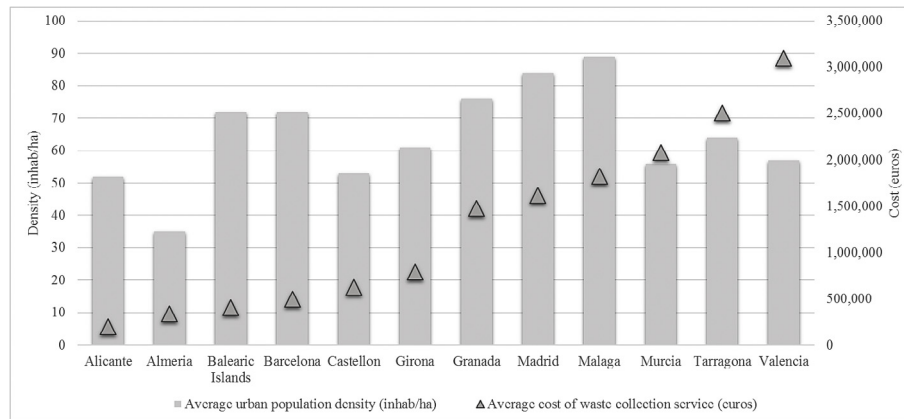


Fig. 2. Average urban population density and cost of MSW collection service of municipalities considered in this study.

Table 2

Summary description of independent variables considered in the model.

Independent variable (unit)	Description	Expected sign
DENSITY (inhabitants/ha)	Net urban population density	–
ROUTE (km)	Kilometres travelled from waste containers to waste treatment plants or landfills	+
WAGE (euros)	Mean wage level at regional scale	+
INDIRECT	A dummy variable that takes the value 1 if the public service is delivered indirectly	Undetermined
TOURIST (overnights)	Number of overnight stays in municipalities classified as a tourist area	+
COAST	A dummy variable that takes the value 1 if the municipality is coastal	+
POP (inhabitants)	Total municipal population	+
SEP (percentage)	Separated collection percentage	+

The adoption of this variable is similar to that referred in [Bel and Mur \(2009\)](#) or [Bel and Fageda \(2010\)](#) as municipal landfill or incineration plant, respectively. Data was gathered from [Ministry of Finance and Civil Service \(2016\)](#).

- (c) Wage level (WAGE). Mean salary cost, in euros, per employee at regional level, which is the spatial level of disaggregation offered by National Institute of Statistics of Spain (2016) as there is no information available on municipal wages. As occurs with transportation costs, salary costs are expected to be associated positively with the dependent variable; in other words, higher wages might result in increased MSW collection costs.
- (d) Indirect provision of the MSW collection service (INDIRECT). A dummy variable that takes the value 1 if the service is delivered indirectly and the value 0 in other case or institutional form in which waste is collected. According to the 1985 Local Government Regulatory Law (*Ley 7/1985, de 2 de abril, Reguladora de las Bases del Régimen Local*), and as described in [Cuadrado-Ballesteros et al. \(2013\)](#), an indirect provision of the service considers, in this study, the following ways: externalization (outsourcing or out-contracting) and mixed companies. No clear consensus exists about the expected sign of this variable.
- (e) Tourism activity (TOURIST). In the geographical context of Spain, the inclusion of tourism activity results suitable due to the additional efforts derived from tourism's seasonality; consequently, the effect of tourism intensity on costs may be positive ([Bel and Costas, 2006](#)). The tourism variable is defined as overnight stays in tourist municipalities in 2014 according to [National Institute of Statistics \(2016\)](#). This variable takes the value 0 if a municipality is not classified as a tourist area based on the same source of data. A tourist area is defined by [National Institute of Statistics \(2016\)](#) as a

municipality where the concentration of tourist amenities is significant.

- (f) Coastal municipality (COAST). The variable takes the value 1 if the municipality is located on the coast, which is not necessarily linked to the previous variable but completes it because TOURIST doesn't consider all Spanish municipalities with tourism activity and some most of the coastal municipalities experience seasonality due to tourism. There are 150 tourist areas in Spain, 60 of which are in the area of study, but not all tourist areas have a beach. Inversely, there are 1918 municipalities in the area of study, but only 209 are in the coast, and not all municipalities located in coast are tourist areas. Moreover, both tourism and the presence of coastline in the municipality could increase costs related to public services. Hence, COAST and TOURIST are complementary factors, and both together are relevant to the analysis in this area of study.
- (g) Total municipal population (POP). The population of the municipality is taken as a proxy of production of waste according to the 2014 municipal register of inhabitants. A positive relationship is expected between population and the dependent variable.
- (h) Separated collection (SEP). Is the percentage of the amount of selective collection regarding separated fractions as plastic, paper or glass, which are designated for recycling. A scheme where all fractions are collected and treated separately may attain higher prices and [Ministry of Agriculture and Fisheries, Food and Environment \(2017\)](#) provides data on MSW treatment and management per Spanish regions to check this sustainability indicator.

In [Table 3](#), the general characteristics with descriptive statistics for the variables of the study can be seen, where it is worth

Table 3

Summary statistics of variables considered in the model, with 1048 observations.

Variable (unit)	Mean	Std. Dev.	Min.	Max.
COST (euros)	1,045,369.00	5,765,714.00	2392.95	146,000,000.00
DENSITY (inhabitants/ha)	62.71	49.33	2.48	530.24
ROUTE (km)	27,355.19	441,131.8	0	13,800,000.00
WAGE (euros)	21,091.95	2147.57	19,034.49	26,394.04
INDIRECT	0.33	0.47	0.00	1.00
TOURIST (overnights)	133,066.00	980,291.30	0.00	17,500,000
COAST	0.15	0.36	0.00	1.00
POP (inhabitants)	19,738.58	117,624.50	16.00	3,165,235.00
SEP (percentage)	12.18	4.88	6.4	18.2

mentioning that few econometric studies include such a large number of observations in Spain. According to the published empirical studies addressed in the literature review, it is possible to formulate a double logarithmic cost function which represents the model for estimating the factors that influence the costs of the MSW collection service and has been analyzed by Stata software package. The β coefficient of a double logarithmic equation is referred to as an elasticity of the dependent variable with respect to the independent variable.

$$\log(\text{COST})_i = \beta_0 + \beta_1 \cdot \log(\text{DENSITY}) + \beta_2 \cdot \log(\text{ROUTE})_i + \beta_3 \cdot \log(\text{WAGE})_i + \beta_4 \cdot \text{INDIRECT}_i + \beta_5 \cdot \log(\text{TOURIST})_i + \beta_6 \cdot \text{COAST}_i + \beta_7 \cdot \log(\text{POP})_i + \beta_8 \cdot \log(\text{SEP})_i + \varepsilon \quad (1)$$

4. Results and discussion

The estimation method is ordinary least squares (OLS) with the robust tool of Stata to correct potential problems of heteroscedasticity in the perturbation term through White's estimator of the variance-covariance matrix (White, 1980). Table 4 shows the correlation matrix of the variables used in the empirical analysis and, as can be noted, the correlations between independent variables of the multivariate analysis are not too high and a problem of multicollinearity is not considered. The variance inflation factors (VIFs), whose average is lower than 2, confirm that there is no problem of multicollinearity.

Results of the estimation are shown in Table 5, where the explanatory power of the model is very high since R-square is 91.6%. Coefficients associated to wages (WAGE), indirect provision of the service (INDIRECT), coastal municipalities (COAST), tourism activity (TOURIST), urban population density (DENSITY), total population (POP) and separated collection (SEP) are significant. Contrary to expectations, but according to the results of Bel y Mur (2009), regarding a longer distance to the landfill site, transportation costs are not significant in this study.

Table 4

Correlation matrix of coefficients of the model.

Variable	log (DENSITY)	log (ROUTE)	log (WAGE)	INDIRECT	COAST	log (TOURIST)	log (POP)	log (SEP)
log (DENSITY)	1							
log (ROUTE)	0.0423	1						
log (WAGE)	0.1422	−0.0428	1					
INDIRECT	0.0517	−0.0708	0.0686	1				
COAST	0.1450	−0.0533	0.2193	−0.0285	1			
log (TOURIST)	−0.0462	−0.1842	0.0202	−0.0639	−0.3791	1		
log (POP)	−0.4808	−0.2583	−0.1893	−0.0469	−0.3144	−0.1123	1	
log (SEP)	0.074	−0.0428	−0.2723	0.1725	−0.1137	−0.0254	0.1053	1

Table 5

Estimation results from the cost equation.

Variable	Estimate	t-statistic values	Robust standard error
log(DENSITY)	−0.179***	−6.02	0.030
log(ROUTE)	0.008	1.24	0.007
log(WAGE)	0.849***	5.32	0.026
INDIRECT	−0.060**	−2.68	0.035
COAST	0.418***	8.02	0.052
log(TOURIST)	0.025***	4.71	0.005
log(POP)	0.952***	73.89	0.012
log(SEP)	0.414***	7.08	0.058
Intercept	7.333***	2.90	2.533

N = 1048.

F (8, 1039) = 1391.87.

Prob > F = 0.0000.

R-squared = 0.9160.

VIF (average) = 1.62.

Notes: *** Indicates significance at the 0.01 level; ** indicates significance at the 0.05 level.

With regard to the main independent variable, and one of the most innovative inputs of the equation, the coefficient of DENSITY, indicates that a 1% increase in the net urban population density corresponds to a 0.179% decrease in the costs of collection of MSW. This result is remarkable because previous studies have not analyzed urban development factors in terms of net urban area, but have considered total municipal area (Bel, 2006; Bel and Costas, 2006; Bel and Mur, 2009; Bel and Fageda, 2010), with the result that their related coefficients were not statistically significant. Subsequently, the variable related to density reflects the link between urban sprawl and its socio-economic damages; according to the DPSIR-concept (driving forces—pressure—state—impact—response concept), which is described in Haase and Nuissl (2007), is proved that urban sprawl has a considerable environmental impact and the response by authorities and civil society could impact on driving forces. Similarly, taxation instruments or improved regulatory frameworks could serve as a response in order to change driving forces of urban sprawl and minimize its socio-economic and environmental impacts.

In the same way, an indirect provision of the waste collection services generates the decrease in their costs a 0.060%. This result is innovative compared with the obtained in Bel (2006), Bel and Costas (2006), Bel and Mur (2009) or Lombrano (2009), which did not obtain significance in this variable. In this regard, these previous analyses support the inter-municipal cooperation of small municipalities to save costs. Bel and Fageda (2010) and Benito et al. (2015) obtained a significant performance with the variable of private provision of the service showing that private delivery is not cheaper than public delivery; contrary to the obtained in Greco et al. (2015), whose results are in line with the findings of the present paper. It is worth remembering, however, that previous

studies have analyzed smaller geographical areas with smaller sample sizes which strengthens the new findings. Additionally, this outcome could contribute to the policy debate about the municipal trend to move towards re-integration of public services rather than privatization in Europe (Pöldnürk, 2015).

On the one hand, Molina-Giménez (2016) summarized a number of reasons, that are usually argued, for supporting re-integration processes of public services, such as: the defense of public goods, assumptions on global municipal cost savings, less corruption, inequality of power between multinationals and public authorities, tendering procedure and monitoring costs are unnecessary, improving the transparency and improving the quality of employment. On the other hand, typical reasons given for privatization of public services in Spain are: greater efficiency and business know-how, a flexible labor framework, economies of scale, increased capacity for investment which is not considered as a deficit, the possibility to optimize payment schemes and legal constraints on re-integration processes (for instance, the above-mentioned 27/2013 Act). Hence, in this paper, assumptions on global municipal cost savings have been refuted and maybe the real problem is not contracting out the service, but regulating it to be adequately monitored. Inflexible ideological positions should be avoided, and it would be right for the society to analyse, on a case-by-case basis, systems not functioning efficiently.

According to the works mentioned in the literature review, the estimated coefficients for WAGE and POP imply that a 1% increase in these variables increase the collection costs of MSW a 0.849% and 0.952%, respectively. The price of inputs, as wage costs, and a proxy of the output generated, as population, are basic determinants of a cost function and their coefficients are the highest identified among the variables considered. In this sense, Savas (1977) was the first to disclose a relationship between collection costs and population size, while Abrate et al. (2014), estimated, on a unique sample of more than 500 Italian municipalities, that as far as the population size of the municipality increases, scope economies increase.

Tourist related variables show a positive relationship with the dependent variable as the increase of 1% in overnight stays in tourist municipalities leads to a 0.025% increase in collection costs of MSW and the existence of coastline in a municipality implies a 0.418% increase, consistent with the conclusions of other studies which have considered a tourism variable (Bel, 2006; Bel and Costas, 2006; Bel and Fageda, 2010), nevertheless an element is different in this analysis: the elasticity of the tourism variables results higher. Furthermore, this activity implies the provision of public services to a temporary (Sánchez-Galiano et al., 2017), ephemeral and massive population which cannot be financed by internal sources and these municipalities are dependent on external financing, either the regional or central government (Ivars et al., 2013).

The waste management sustainability indicator, fraction of separated collection, indicates that a 1% increase in their percentage generates a 0.414% increase in the collection costs of MSW, as expected (Bel, 2006; Bel and Costas, 2006; Greco et al., 2015). This outcome might mean that, by addressing sustainable development issues, it has a price, nevertheless, the approach of this paper is only based on the costs perspective. As is well known, local entities derive economic benefit from recovering materials, but this specification cannot be implemented in this paper because of the lack of such a disaggregated data on public municipal revenues.

5. Conclusions

Data supports the hypothesis of the increase in MSW collection costs due to a sprawled urban development in Mediterranean Arch and Madrid, as well as confirms a positive relation between MSW

collection costs and factors such as higher wages, coastal municipalities, tourist areas, population and separated collection; in contrast, a cost reduction is found as a result of an indirect management of this public service.

While there is some empirical literature analyzing factors explaining cost of MSW service in Spain, the recent availability of a larger sample of data provides more accurate and rich results, with a comprehensive approach which can be extended to and replicated in other case studies or considering the study of other public services. Moreover, few previous studies have analyzed urban development factors in terms of net urban area, in contrast to other models which have considered total municipal area (Bel, 2006; Bel and Costas, 2006; Bel and Mur, 2009; Bel and Fageda, 2010). The specification of the urban development model makes it possible for this study to obtain an acute and innovative significance of the impact on municipal costs of factors related to a more sustainable urban pattern.

In relation to other factors, higher wage costs and population are variables which increase significantly MSW collection costs, but they are, generally, inherent characteristics of a given municipality and economic policy's ability to act is restricted. Tourism and proximity of the coastline are important economic and financial foundations in the municipalities analyzed, but remains an ongoing concern bearing in mind the "chronic deficit" situation caused by higher public expenditures in tourist areas (Voltes-Dorta et al., 2014), as supported in this study regarding the increase in MSW collection costs. Considering, as well, that the MSW management system is subject to the generator's willingness to collaborate, the task becomes even more challenging to set incentives to tourists in order to get their involvement, which is a further reason why the tariff system still need to improve (Arbulú et al., 2016).

Addressing environmental sustainability issues in waste management practices, as separated collection designated for recycling, it generates increases in costs as expected, but it must be borne in mind that there is some economic benefit unaccounted from local revenues of recovering materials due to the lack of disaggregated data. Mandatory goals of reducing mixed collected MSW and the augmentation of selective collection of recyclable materials, among others, were set by the European Union and the Spanish legal framework and their cost should be notice (Expósito and Velasco, 2018). In this connection, there are some environmentally friendly management practices related to treatment which could increase the overall costs such as biodegradable fraction collection or low land-filling rates and high incineration rates as treatment. Nevertheless, this question should be detailed in future research provided that official and precise statistics were available within a geographical area sufficient to draw conclusions; for instance, recent studies have shown that a local administration does not need to have a high economic level or be highly populated to reach a satisfactory level of eco-efficiency (Díaz-Villavicencio et al., 2017). Moreover, to offset a hypothetical increase in management costs, waste could produce inputs to promote the transition to a circular economy, such as the introduction of Waste-to-Energy systems (Fernández-González et al., 2017).

With regard to the form of provision of the service, when a municipality choose an indirect way, the MSW collection costs are reduced, which involves an innovative result compared with previous studies carried out in different and smaller areas of Spain. This overall outcome could contribute to the debate about the re-integration processes, but these types of decisions should be balanced against the need for local contextualization in every particular case.

Conclusions of this study could help to develop, on the one hand, policies to promote cost-efficiency, and, on the other hand, an

elaborate financing system, considering fiscal discrimination or, in other words, differentiated taxation. As to the second issue, this could encourage, in the first place, denser urban areas (Brueckner and Kim, 2003); and, after land has been built, differentiated taxation should be directed primarily to sharing equitably the costs between denser and sprawled areas, due to the latter result in increased MSW collection costs, as with other public services (Fernández-Aracil and Ortuño-Padilla, 2016). In fact, this mechanism may contribute to both distributing wealth more fairly and generating equitable economic growth (Alfranca-Burriel, 2007).

Similar to the pay-as-you-throw (PAYT) scheme, and contrary to undesigned funds or flat fee systems (Chamizo-González et al., 2016), this semi-variable fee system based on differentiated taxation could be operationalized in MSW management formulas via a sort of pay-as-you-reside (PAYR) schemes. These preventive measures may have the indirect but sustainable effect of reducing the volume of waste produced, as denser the city (for instance, comprising more apartment buildings rather than detached or semi-detached houses), lower the amount and the rate of municipal solid waste generation (Henry, 2007). However, the first step to implement such a system would be to find the most “efficient price” for each taxpayer or ratepayer, as suggested in Simões et al. (2012), in order to fully cover real costs, avoiding abuses. In addition, the aim of developing a tax must be to ensure a balance between sustainability and fiscal justice (Conde-Antequera, 2012).

The findings of this study may shed some light on the strategy approach and policy measures designed to increase the efficiency of municipalities, which have a key role to play in supporting changes towards sustainable development because, as the government level closest to the citizen, they have an important influence on the environmental habits of the general public (Zotos et al., 2009). Finally, future research could analyze MSW management by focusing on social and environmental parameters related to sustainability, for example, by including data regarding MSW treatment or by considering the overall balance between municipal costs and revenues.

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