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Economic viability of packaging waste recycling systems: a comparison between Belgium and Portugal

Article (Accepted version) (Refereed)

Economic Viability of Packaging Waste Recycling Systems:

A Comparison between Belgium and Portugal

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Abstract

The Packaging and Packaging Waste Directive has had an undeniable impact on waste management throughout the European Union. Whereas recycling and recovery targets are the same, member states still enjoy a considerable degree of freedom with respect to the practical organization and management strategies adopted. Nevertheless, in all cases, the industry (which brings packaging material onto the market) should be responsible for the costs associated with packaging waste recycling/recovery (following the extended producer responsibility principle). The current paper compares and contrasts the institutional frameworks and financial costs and benefits of waste management operators for Belgium and Portugal. The unit costs of selective collection and sorting of packaging waste are provided for both countries. In Belgium, the extra-costs of recycling seem to be fully supported by the industry (through Fost Plus, the national Green Dot agency). In Portugal the fairness of the recycling system depends on the perspective adopted (economic or strictly financial). Adopting a strictly financial perspective, it seems that Sociedade Ponto Verde (SPV, the Portuguese Green Dot agency) should increase the transfers to local authorities. However, the conclusions differ for this country if the avoided costs with refuse collection and other treatment are taken into account.

Keywords: Belgium; extended producer responsibility; green dot; packaging waste; Portugal; recycling.

1. Introduction

The focus of the European Union to improve Europe's resource efficiency has resulted in several, often ambitious, directives related to waste management (for an overview, see Cruz et al., in press). In particular the Packaging and Packaging Waste (PPW) Directive, which sets targets for recycling and recovery of packaging waste, has had an undeniable impact on local packaging waste management throughout the EU. Despite the fact that exact targets are determined by the PPW Directive, the member states still enjoy a considerable degree of freedom with respect to the practical organization and management strategies adopted. The subsequent heterogeneity in policy choices has prompted the very pertinent issue of the effectiveness and efficiency of the adopted management strategies. Although the optimal strategy depends on the local situation and is often driven by historic investments in waste collection and processing infrastructure, comparisons between countries can still generate useful insights.

Even though several authors have already analyzed the performance of the EU member states in terms of recycling and recovery rates (see, for example, Hage and Söderholm, 2008; Alwaeli, 2010 or Marques et al., 2012a), some issues deserve further consideration. In particular, the balance between the costs incurred by the (local) waste management operators and the financial support from the companies responsible for bringing the packaging material onto the market (i.e. the industry), has received little attention by scholars. A notable exception, however, can be found in Cruz et al., in press). By comparing the financial costs and benefits for Portugal, France, Romania, Germany and the UK, the authors were

able to identify key differences between the economic viability of the packaging recycling systems in these countries. For Belgium, however, such a comparison has not yet been reported.

Also in this scope, Bailey (2002) examined the economic benefits of environmental taxes and other market based mechanisms centered on studies of the PPW Directive. The importance of economic mechanisms for the success of the packaging waste management policy is quite clear. Moreover, the technology adopted in waste collection, transportation, sorting, treatment, disposal and recycling and the institutional arrangements in place are also crucial aspects with an impact on the viability of the 'recycling system' (Bohm et al., 2010). Although recycling waste from municipal systems may be economically efficient (Lavee, 2007), all these variables must be considered and the packaging waste must be managed through an integrated system (Alwaeli, 2010; e.g. sorting and recycling of some flows together with the incineration and/or landfilling of other flows). In a recent study, Massarutto et al. (2011) modeled several scenarios considering different source separation levels (SSL). By achieving higher SSL rates, the quality of materials collected is expected to be lower and, therefore, more waste going from sorting to treatment is produced. The need to consider waste management as an integrated process is emphasized by these authors. At a regional level, recycling and incineration with energy recovery are not mutually exclusive alternatives to minimize landfilling rates. Massarutto et al. (2011) also point out to a 50% SSL threshold (for Italy) above which no positive externalities outweigh the financial costs.

A thorough understanding of the drivers of the economic viability, both at the economic and strategic levels, could indeed generate relevant insight for the competent authorities to design an effective and efficient resource management strategy. Thus, this paper will scrutinize the Belgian system and compare it with the case of Portugal (previously addressed in Cruz et al., 2012). This case could reveal interesting insights for two main reasons. First, with a recycling rate of almost 80% for household and industrial packaging waste in 2010 (Eurostat, 2012), Belgium proves to have a highly effective system. Moreover, the high recycling rate is reflected in the general recycling target for packaging waste set by the Belgian authorities (this target of 80% is considerably more ambitious than the 60% goal put forward in the PPW Directive). However, the impact of this strategic policy choice on the economic viability of the recycling system has yet to be analyzed. Second, the financial consequences of the adopted management model in Belgium might trigger further discussion on the relevance of appropriate economic incentives and the general design of the recycling system. In particular, the impact of inter-municipal cooperation (IMC), the system of financial transfers, as well as the organization of separate collection of packaging waste might be of interest to both scholars as policy makers.

Before describing the general institutional framework, some issues deserve additional discussion. First, it is not our goal to compare the Belgian packaging waste recycling strategy with the strategy of all other EU member states. We rather opt to restrict our comparison to Portugal, a country for which the relevant data is readily available and which has the advantage of being used as a benchmark due to its comparability with the general structure of the packaging waste management system in Belgium. Second, the decision structure with respect to packaging waste for both Belgium and Portugal consists of a mix of decentralized and centralized competencies. Therefore, the focus will be at the level where the operational decisions are taken (i.e. the municipalities or multi-municipal companies). In other words,

this paper intends to compare the economic viability of packaging waste recycling in Belgium and Portugal from the perspective of the local authorities responsible for collecting and processing packaging waste. Third, the case of Portugal has already been extensively discussed in Cruz et al. (2012) and Cruz et al. (in press), which allows this paper to focus on the case of Belgium and use Portugal as a benchmark. Fourth and finally, although the PPW Directive covers both household and industrial packaging waste, this paper only analyses the economic viability of the household packaging waste strategy.

After this brief introduction, section 2 provides an overview of the institutional setting (rules and responsibilities) of the Belgian and Portuguese packaging waste recycling systems. Section 3 discusses the different selective collection types, governance models and financial mechanisms implemented by these two countries. The methodology adopted in this paper to compare and contrast the two systems is presented in section 4 whereas the results of this analysis are discussed in section 5. Finally, section 6 concludes the paper.

2. Institutional framework

Since 1993, the Belgian environmental and waste policies have been transferred to the regional governments (i.e. Brussels Capital region, the Walloon region and the Flemish region). Nevertheless, certain national policy competencies still have an explicit impact on regional waste management. In particular product standardization and product taxation - two national competencies – have intersecting areas with waste policy. In the Flemish region, waste management is ruled by the Regional Statute of 14 December 2011 (Belgian Gazette, 2012a). The practical implementation of the principles outlined in the Statute is further specified in a bundle of Flemish regulations called VLAREMA, which entered into force together with the statute. In the Walloon region, waste management is regulated by the Regional Statute of 27 June 1996 on waste and revised on 10 May 2012 (Belgian Gazette, 2012b), while the Brussels region approved a new ordinance on 14 July 2012 (Belgian Gazette, 2012c). Although in Belgium packaging waste management is a regional competence, a cooperation agreement concluded in 1996 between the three regions (i.e. Flanders, Wallonia and the Brussels-Capital region) harmonizes the packaging waste policy across the entire Belgian territory. The agreement transposes the EU Directive 94/62/EC (amended by the EU directive 2004/12/EC) into Belgian law.

Countries transposing the PPW Directives into national law, essentially introduce the so-called extended producer responsibility for packaging waste. This responsibility implies that companies which are responsible for bringing packaging material onto the local market are required to guarantee certain recovery and recycling targets for their packaging materials. In Belgium and Portugal (this country implemented the PPW Directive in 1997) companies may either develop their own system for taking back and processing their packaging waste or make an agreement with an officially accredited organization. In other words, the industry may delegate its packaging waste take-back responsibilities to an authorized third party (this applies to most EU countries). In Belgium, the private non-profit organization Fost Plus is the only endorsed company carrying out the take-back obligation for household packaging waste, while in Portugal the recycling system of household packaging waste is managed by

Sociedade Ponto Verde (SPV).[1] These are the so-called Green Dot companies. As for most companies it is economically inefficient (and/or physically or logistically impossible) to organize their own collection and separation programs, the vast majority opts for the second alternative.[2]

Although many practical details differ, the general structure of the packaging waste management system in Belgium and Portugal is similar. In particular, the organization of the material and financial flows are similar to a large extent (Figure 1 provides a general representation of this system). In both countries member companies pay a fee to the Green Dot company. The exact fee, however, is country specific (see Marques et al., 2012b and Marques et al., 2013 for a detailed description of these so-called Green Dot fees). As producers are likely to incorporate this cost in the price of the consumer goods, the households (more specifically, the consumers of the packaged products) are ultimately the ones that finance the Green Dot fee. The Green Dot company uses this revenue, among other ends to finance the collection and separation of packaging waste. Nevertheless, the Green Dot company is not responsible for the practical organization of those collection and separation activities, as legislation in both countries requires the municipalities to ensure the management of household waste. However, to exploit economies of scale when providing the waste related services, municipalities can engage in inter-municipal cooperation (IMC) with other, often neighboring, municipalities. Consequently, the municipalities or the multi-municipal organizations (henceforth called MMOs for simplicity) emerging from IMC receive a contribution from the Green Dot company for organizing the collection and sorting of packaging waste. Finally, any revenue generated via selling the recyclable (i.e. sorted) household packaging material, is also used to fund the activities of the Green Dot company.

[Insert Figure 1 here]

3. Comparing packaging waste management models

3.1 Scope of the comparison

Since it is our goal to compare the economic viability of the packaging waste recycling strategies adopted in Belgium and Portugal, this section will elaborate on the practical and organizational differences between both countries. Keeping in mind that the aim is to analyze the economic viability from the perspective of the local authorities responsible for collecting and processing urban waste, the focus will be on those elements which may have an impact on the cost structure of the municipalities and/or inter-municipal organizations. In particular, we will zoom in on the differences between 1) the collection

[1] Note that SPV is currently also licensed to manage trade and industrial packaging waste In Portugal. In Belgium Val-I-Pac is the counterpart for industrial packaging waste.

[2] In Belgium only 250 companies fulfilled the take-back obligation themselves (IVCIE, 2012) while 5,235 companies outsourced their take-back obligation to Fost Plus by 2010 (Fost Plus, 2011). In Portugal about 10,008 contracts were signed with packers by the end of 2010 (Marques et al., 2011).

system, 2) IMC and outsourcing decisions and 3) the financial mechanisms. Some key figures linked to the latter three elements are included in Table 1.

[Insert Table 1 here]

Both countries show a wide range in terms of population and area coverage per MMO, irrespectively of their demographic situations. In Belgium, almost all MMOs are located in urban areas; however, for example, there is one MMO (in a rural area) that only covers about 34 thousand inhabitants and the largest urban MMO operates for more than 1 million inhabitants. In Portugal, the range is even larger (14,806 – 1,554,066 inhabitants). Moreover, around 50% of the Portuguese population (including the Islands of Madeira and Açores) is served by rural MMOs.

3.2 Collection system

In Belgium and Portugal the level of service of packaging waste collection sometimes differs between the MMOs. For instance, the number of collection rounds or the number of pick-up points, influences the ease of recycling for the residents, but also has an important impact on the cost structure of the MMOs. The Green Dot company in Belgium, therefore, only reimburses the costs of a pre-determined "standard" level of service. This includes separate collection at the source of glass, paper and cardboard and the so-called PMD fraction (i.e. plastic bottles and flasks, metals and drinks cartons). Note that the standard level of service consists of curbside collection of PMD (twice a month) and paper and cardboard (once a month) (IVCIE, 2008), and a system of evenly distributed bottle banks throughout the territory of the MMO for the collection of glass.[3] Next to curbside collection of PMD and paper and cardboard and the network of bottle banks, most Belgian municipalities also collect packaging waste via municipal recycling or drop-off centers. It is important to mention that the standard level of service can be considered as a minimum. Some MMOs opt to provide additional services such as supplementary collection rounds of PMD or even curbside collection of glass.

In Portugal, selective collection of packaging waste is mainly organized via drop-off containers and drop-off centers. The density of the drop-off points is higher compared to Belgium, as about 32,614 drop-off containers and 201 drop-off centers (see Marques et al., 2011) are available throughout Portugal. Curbside collection of packaging waste is less common, although some pilot projects are currently in effect. However, the total amount of packaging waste collected via curbside collection remains relatively low (about 4,4 % of separate collection). Although the level of service in terms of collection frequency and collection method might influence the costs of the MMOs in both Belgium and Portugal, it remains

[3] The standard level of service for glass includes a site with bottle banks per 700 or 400 residents depending on the population density (IVCIE, 2008). According to Fost Plus about 8,920 sites with one or more bottle banks were available in the Belgian territory.

difficult to assess a priori which country has higher total collection cost per ton. On the one hand, the collection frequency included in the standard level of service in Belgium (i.e. twice a month of PMD and once a month for paper and cardboard) is considerably lower than the collection frequency at the drop off centers in Portugal (i.e. between once and three times a week). On the other hand, with over 4.6 million households in Belgium in 2009, the density of pickup points for packaging waste collection is higher in Belgium when compared to Portugal (curbside collection is more strongly embedded in the Belgian system). Nevertheless, as argued in Rogge and De Jaeger (2013) debate on the impact of the density of pick-up points on the cost per ton collected is still on-going, as reductions in driving time between pickup points might be offset by constraints caused by congestion.

3.3 Inter-municipal cooperation

Clearly, IMC can have an important impact on the economic viability of packaging waste recycling. As argued by Hulst and van Montfort (2011) rising production scales are often the driver for local governments to engage in cooperative arrangements for service delivery. This could also hold for the local authorities responsible for collecting and processing packaging waste (i.e. the municipalities in Belgium and Portugal), which might generate considerable benefits of scale by cooperating via IMC. Note that both in Belgium and in Portugal several alternative cooperation systems are available. As it is not our goal to provide the reader with an in depth analysis of the legal basis and institutional arrangements that shape IMC for the provision of packaging waste services, we only briefly discuss some key characteristics of IMC in these countries before comparing public-private partnerships and contracting out decisions between Belgium and Portugal.[4] Given the aim of our paper, this focus is driven by the relative abundance of studies addressing the impact of contracting out public services on the cost structure and the emphasis of public choice and property rights theory on the importance of ownership (Bel and Fageda, 2009, Simões et al. 2012 or Simões and Marques, 2012). Nonetheless, at this point it is interesting to note that Bel and Warner (2008) found no systematic link between privatization and cost savings when reviewing the econometric literature on the production of waste related services. In addition the authors argue that due to the absence of competition in such markets, ownership often makes little difference on the costs borne by municipalities/ratepayers. Therefore, it remains difficult to assess a priori the impact of differences in the management models of IMC between both countries.

IMC in Belgium is not regulated in the cooperation agreement. Each of the three Belgian regions is still responsible for devising its own policy regarding local administrations and IMC (for more details Marques et al., 2012c). The regional differences with respect to IMC are evident in the geographic concentration across regions. For instance, the Walloon region has recently sought to establish more synergies between the existing MMOs by reducing their number and raising their scale efficiency (Wayenberg and De Rynck, 2013). The map of Belgium in Figure 2 indeed reveals that IMC is more dispersed in the Flemish region than in the Walloon Region. In the Flemish region 304 (out of the 308) municipalities organize collection and separation of packaging waste via 20 MMOs, while in the Walloon region all 262

[4] Interested readers can find a more detailed description of IMC in Marques et al. (2011) for Portugal, and Marques et al. 2012c for Belgium.

municipalities rely on only 7 MMOs for organizing this service. In the Brussels-Capital region a single public enterprise responsible for collecting and treating household waste serves all 19 municipalities. Note, however, that differences in the geographic concentrations might also be driven by non-political factors such as population density or even historic investments in infrastructure.

Similar to Belgium, municipalities in Portugal have the possibility of relying on multi-municipal systems for waste treatment, disposal and, very often, selective collection. In Portugal, the waste sector can be clearly divided in two separate segments (see Marques et al., 2011). The 'retail' segment comprises the services between the waste collection and the transfer station, while the 'wholesale' segment is responsible for storing, transportation, sorting, treatment and disposal of urban waste. However, the 'wholesale' companies are, in most cases, responsible for the selective collection of waste (including collection of packaging waste). The majority of the wholesale companies in charge of selective collection are owned by the central state (via a sub-holding company) and the covered municipalities. Nevertheless, other forms of MMOs exist, namely (and important in the context of this paper) there are a small number of wholesale MMOs which consist of public-private partnerships (one concession and five mixed companies out of a total of 24 MMOs in mainland Portugal).

In Belgium public-private ownership in the context of IMC differs somewhat between the regions. In Flanders most MMOs responsible for packaging waste collection and separation rely on the so called 'Service Associations' and 'Mandated Associations', a cooperation structure which only allows participation of municipalities or other MMOs. In the Walloon region most MMOs providing waste related services also associate with the respective province (in Belgium the Flemish and Walloon regions are further subdivided into a total of ten provinces) and associations with private partners are usually an exception.

Finally, in both Belgium and Portugal MMOs can decide to contract out certain waste related services. In Belgium about half of the MMOs outsource collection of packaging waste to a third party. Figure 2a displays the geographic dispersal of contracting collection of PMD. As contracting out collection activities of glass and paper and cardboard is, with a few exceptions, similar to the situation of PMD, the map for glass and paper and cardboard is not included in this paper. For separation activities the situation is different. As shown in Figure 2b only three MMOs organize separation activities themselves.

[Insert Figure 2 here]

In Portugal contracting out is mainly confined to refuse collection (undifferentiated flow). In fact, municipalities are responsible for urban waste 'retail' services but lately they have been contracting out these services to a greater extent (Cruz et al. 2013). As mentioned above, selective collection is mostly carried out by the 'wholesale' (regional) companies. These operators also perform the sorting of the selectively collected waste themselves. The most representative type of management model is the multimunicipal company, which consists of partnerships between a public company owned by the central state (Empresa Geral de Fomento - EGF) and the covered municipalities. EGF owns 51% of the

shares in these companies while the municipalities hold the remainder (see EIMPack, 2011a). There are 12 multimunicipal concessionaries in operation. Alternatively, local governments also created intermunicipal companies (100% municipally-owned or resulting from institutionalized public-private partnerships – mixed companies) for the delivery of these services. There are eight intermunicipal companies delivering 'wholesale' waste services in Portugal. Finally, there are four associations of municipalities (direct public management), two intermunicipal services (direct public management) and one private concessionaire operating in this segment. To refer to the waste management systems we will use the term "municipal systems and local authorities" (SMAUT in the Portuguese acronym) irrespective of the institutional arrangements. Figure 3 presents the different management models for the selective collection and sorting of household packaging waste in Portugal.

[Insert Figure 3 here]

3.4 Financial support for the MMOs

As outlined in section 2 the Green Dot companies in Belgium and Portugal finance the MMOs for the selective collection and separation of packaging waste. Nevertheless, the design of the compensation scheme differs considerably between both countries. The compensation paid by the Portuguese Green Dot company is calculated based on a variable fee per ton. A key characteristic of this system is that the level of the fee per ton depends on a certain per capita rate of packaging waste sorting (see Cruz et al., 2012). By raising the level of the fee per ton if certain thresholds are met, financial incentives to increase efficiency are well rooted in the Portuguese compensation system.

In Belgium the scheme is primarily designed to allow for a reimbursement of the full cost incurred by MMOs for providing a pre-defined standard level of service. In order to reach this goal, four alternative scenarios are used:

1) Since many MMOs outsource their packaging waste related services to a third party (see section 3.2), the Green Dot company can reimburse the MMO according to the costs per material reported on the outsourcing contract.
2) Alternatively, the Green Dot company and the MMO can agree on a so called reference cost. This cost is paid by packaging material and consists of a variable part (40% of the reference cost depends on the amount collected) and a fixed part (60% depends on the number of residents). Note that the resulting reference cost should correspond to the average cost of the first scenario. If the MMO can provide proof for a different cost structure, the Green Dot company can decide to use an alternative proportion of the fixed and variable components of the reference cost.
3) In case the MMO decides not to outsource its collection and separation services of packaging waste, the level of the reimbursement can be determined by mutual agreement between the Green Dot company and the MMO.

4) If a utility decides to complement the standard level of service with additional collection rounds, the Green Dot company reimburses the full cost for the "standard" level of service per flow of packaging waste, while additional quantities are reimbursed with a special contribution. For the plastic and metal, the contribution corresponds to 50% (at least) of the "standard" cost per ton and per material. For the other type of materials, the "standard" cost per ton is fixed at €160.

Besides the financial supports described above, the Green Dot companies in Belgium and Portugal pay also a number of complementary fees. In Belgium such additional compensations include, amongst others, fees for communication and information campaigns (€0.25 per resident), a bonus for low PMD residue after sorting and compensations for monitoring the outsourcing contracts. In Portugal the additional fees are limited to a report fee for packaging waste that is not recovered or recycled via the selective collection chain and an information and motivation fee for trade and industrial packaging waste sent for recycling.

The differences between Belgium and Portugal with respect to the main focus of the compensation scheme can have a considerable impact on the economic viability of the packaging waste strategies for the municipalities and MMOs. In Belgium, providing the standard level of service almost automatically implies that the financial cost is entirely covered by the contributions made by the Green Dot company. In Portugal, on the other hand, the cost structure of the MMOs, the amount of packaging waste collected and the potential avoided costs will be crucial determinants of the economic viability of the system.

4. Economic analysis methodology

The present paper comprises an economic analysis[5] of the packaging waste recycling in Belgium and in Portugal based on costs and revenues (adopting strictly financial and economic perspectives). For the cost measurement, the following were considered: a) operational and maintenance expenses (taking into account the cost associated with selective collection and sorting); b) the depreciation of assets (allocated to the selective collection and sorting facilities); and c) the return on capital employed (debt and equity), concerning the investment allocated to selective collection and sorting facilities. Regarding the (financial) benefits quantification, the following were taken into account: a) the financial support for local authorities (FSLA, that is, the values paid by the Green Dot company); b) other revenues (which are attained from direct transactions with recyclers); and c) subsidies to investment (that is, the ones allocated to selective collection and sorting assets). Moreover, as an economic benefit, the savings that derive from the diversion of waste from refuse collection and other treatment activities (e.g. landfilling, mechanical-biological treatment – MBT – or incineration) were considered. The economic and financial analysis of recycling of packaging waste comprises the measurement of the costs and benefits referred to, and also identified in Figure 4, for the 27 SMAUTs and the 37 Belgium MMOs in charge of the

[5] However, in this paper, the economic analysis only takes into account the money that local authorities save by diverting the packaging waste from the refuse collection circuits and final disposal. Environmental or social impacts are not considered.

selective collection and sorting, covering the entire Belgium and Portuguese population. Our analysis concerns the management of the household flow and reports to the year of 2010. The trade and industry flow does not involve selective collection and sorting operations (the packaging waste is sorted at the source and collected by specialized waste management operators that receive the information and motivation fee). Figure 4 shows the diverse components identified that constitute the cost-benefit analysis of the recycling system in Portugal and Belgium.

[Insert Figure 4 here]

As already mentioned, in this paper the costs and revenues are accounted for adopting the perspective of the local authorities responsible for collecting and processing municipal solid waste (i.e. the municipalities or the MMOs). The methodology used is based on an economic and financial model which establishes a balance between costs and benefits related to the activities of selective collection and sorting carried out by the MMOs.

On the costs side, the costs of operation and maintenance (taking into account the cost associated with service provision), depreciations of fixed assets and return on capital employed (debt and equity) were considered in the financing of fixed assets allocated to the activities referred to above. Note that for Belgium the operational costs only include the costs for a standard level of service. Some MMOs opt to provide additional services such as supplementary collection rounds of PMD or curbside collection of glass. As mentioned in the previous chapter these costs are only partly reimbursed by Fost Plus via the additional fees. Unfortunately, the full costs for the additional services are not available. Therefore the operational costs used in this calculation might not always reflect the full operational costs of all MMOs. Nevertheless the decision to provide additional facilities for the residents – a decision which is always taken at the local level – is linked to the level of service and not to the general functioning of the system. Given the goal of this study (an analysis of the economic viability of the systems), considering the full cost of the additional services is less relevant for the general conclusion (since local authorities are not required to undertake these costs and increasing the level of service beyond the legal obligations is at their discretion).

Regarding the collection of data for the 37 MMOs in charge of collection and treatment of household waste in Belgium and the 27 SMAUTs in Portugal, some of the required variables were obtained from the annual activity reports for the year 2010 while others were calculated. The majority of the information used was obtained directly (through surveys) from the MMOs. However, in particular circumstances, it was necessary to use the information from their annual account reports.

The financial support, the other revenues (e.g. the revenue from selling non-packaging paper that is discarded in drop-off containers is included in this component) and the subsidies to the investment were mainly declared in the survey sent to the MMOs. The subsidies are accounted annually and adjusted in the same proportion as the depreciation of the subsidized assets. The “other benefits”, obtained from

the diversion of the waste from landfill, were calculated considering the costs of refuse collection and the other types of waste treatment, being calculated separately and according to equations (1) and (2). Note that the savings from the diversion of packaging waste of refuse collection circuits and other treatment are not financial benefits (i.e. they do not represent revenue). However, considering these avoided costs is quite relevant for local authorities.

Costs avoided with refuse collection (€/year)	=	Quantity of waste selectively collected (ton/year)	×	Unit cost of refuse collection (€/ton)		(1)
Costs avoided with waste treatment (€/year)	=	Quantity of waste recovered (ton/year)	×	Unit cost of treatment and disposal (€/ton)		(2)

For this calculation, the values of Tables 2 and 3 for the variables presented below were used, for Belgium and Portugal respectively.

[Insert Table 2 here]

[Insert Table 3 here]

The quantity of packaging waste of each material collected through selective collection is not equal to the quantity of packaging waste recycled, providing evidence of the efficiency of sorting. The residues of the sorting process are usually sent to landfills, so this cost is not avoided for a small percentage of the packaging waste selectively collected (note that for plastics this percentage is not irrelevant).

On the costs side, the operational costs of selective collection and sorting and the depreciation of the assets allocated to these activities were obtained from the survey results and from the annual accounts of the MMOs. The return on capital employed regarding the investments made on selective collection and sorting equipment and infrastructure was calculated through equations (3) and (4). The values of the variables are presented in Table 4.

Return on capital employed (€/year)	=	(Depreciation - subsidies) (€)	×	Useful life of the assets (-)	×	WACC[6] (%)		(3)

$$\text{WACC (\%)} = \text{Cost of equity} \times \frac{\text{Equity}}{(1 - \text{corporate tax})} + \text{Cost of debt} \times \text{Debt} \quad (4)$$

[6] WACC – Weighted Average Cost of Capital

[Insert Table 4 here]

5. Economic analysis of Recycling

The methodology used to carry out the economic analysis of recycling services comprises the balance between the economic and financial costs and benefits of selective collection and sorting activities, carried out by the Belgian MMOs and the Portuguese SMAUTs, whose results are graphically shown in Figure 5. This analysis was developed considering the quantity (in tons) of waste collected. MMOs benefited 286€ per ton of packaging waste collected in 2010, considering the avoided costs. In a strictly financial perspective (not taking into account the avoided costs), the benefits represented 126€ per ton. Since financial benefits cover the costs of the service (in fact, the cost coverage is around 90% from a financial perspective). Hence, the current Belgian recycling system is financially sustainable and has no public money directly involved. However, considering the (significant) avoided costs seems to be quite relevant. Indeed, this could be an incentive for local authorities to go beyond the "standard requirements" in terms of selective collection. Diverting more packaging waste from the undifferentiated flow may significantly reduce the costs with urban waste management for the municipalities.

Conversely, in Portugal there is public money involved. On average, the SMAUTs benefit 260€ per ton of packaging waste collected. Adopting a strictly financial perspective, the benefits are significantly reduced to the value of 158 € per ton of waste collected. Regarding the cost perspective, selective collection and sorting of packaging waste represent 204€ per ton collected for the SMAUTs. Note that the unit costs and benefits were weighted by the tons sorted by each SMAUT. As can easily be observed in Figure 5, currently the cost coverage is around 128% considering an economic perspective but only 77% if the cost savings due to recycling are not taken into account. The question about the fairness of financial transfers has to be raised. If an economic approach was followed, the FSLA should be globally reduced around 43%, but if the policy was to make the industry 100% accountable for its packaging waste, that is excluding other benefits and subsidies from analysis and exempting local authorities from any financial responsibility (like in the German Dual System, MS2 and Perchards, 2009), the FSLA should increase by 35%.

Note that the operational costs in Belgium seem relatively small in comparison to the operational costs for Portugal. One of the reasons is the difference in collection frequency. The standard level of service in Belgium includes curbside collection twice a month of PMD and once a month for paper and cardboard (IVCIE, 2008), while, for instance, in Portugal this service is provided 1 to 3 times per week. Indeed, the climate has clearly an important impact on the cost structure of local authorities regarding waste management. Such lower frequencies in Portugal would not be admissible because the warmer weather would cause unacceptable odor nuisance.

[Insert Figure 5 here]

Figure 6 shows the operational costs of the recycling service per packaging waste flow in Belgium and Portugal. Not surprisingly the recycling system costs (selective collection and sorting activities) depend on the material flow considered, since it has different characteristics. In Belgium, the lower service cost of the glass waste (in comparison with other packaging waste materials, mainly the PMD flow) can be justified by its high weight and density which significantly reduce the collection cost. PMD, on the other hand, has a relatively low density (a full collection truck contains approximately 3 tons of PMD). In Belgium PMD is collected every two weeks at the curbside, which explains the relative high service cost for this packaging flow. Finally, paper and cardboard is also collected at the curbside, but only once a month, while the density is considerably higher than the PMD flow (a full collection truck contains approximately 9 tons of paper and cardboard).

In Portugal, there are also several characteristics distinguishing the different (costs) flows in the recycling of packaging waste. The glass waste selectively collected from drop-off containers is not sorted and its high density provides a lower collection frequency (when compared to other materials), which significantly reduces the operational costs. The high costs of the PMD flow reveal the difficulty for the SMAUTs to invest on the plastic and metals flow. In fact, in this particular flow, sorting remains with high operational cost and low efficiency when compared with the other flows, increasing the weight and relevance of these costs in the SMAUTs' cost structures (see Figure 6).

[Insert Figure 6 here]

The costs of the service were separated into costs of selective collection and costs of packaging waste sorting. The results are presented in Figure 7 both for Belgium and Portugal. It is concluded that the global cost of selective collection in Belgium is 96€ per ton of packaging waste collected and the cost of sorting is 179€ per ton effectively sent for sorting. Note that in Belgium the PMD flow is the only waste flow which is sorted after collection (paper/cardboard and glass waste are stored and/or sent directly to recycling). In fact, sorting corresponds to about 46% of the total cost of the "preparation for recycling" service. In Portugal, we can observe that the global cost of sorting is 101€ per ton sorted (plastic/metal and paper/cardboard, since the glass waste is sent for the sorting stations but it is not effectively sorted) and the global cost of selective collection is 133€ per ton collected. These results further support the highest cost for the plastic and metal flows. It is interesting to note that the lower costs of the service in Belgium are mainly due to the savings attained with the lower collection frequencies. In fact, the unit cost of sorting is higher in Belgium than in Portugal (which is expected, since the cost of living is higher in this county – i.e. staff costs, etc.).

[Insert Figure 7 here]

The economic and financial model was also analyzed according to the population density of the MMOs and SMAUTs. The results are shown in Figures 8 and 9.[7] In Belgium, the recycling system is financially sustainable for all levels since cost coverage is assured by Fost Plus. However, the operational costs are slightly higher for MMOs with lower population densities. This tendency is not observed for the Portuguese SMAUTs (in fact, it seems that the best balance between costs and benefits is achieved by the SMAUTs under 250 inhabitants per km^2). In Belgium the operational costs are, on average, lower than in Portugal. In addition to the collection frequency issue, these results can also be explained by the geography of both countries; in Portugal there is even a substantial difference between the North and South, with many more mountains and hills in the North and then in the South. Indeed, the SMAUTs with higher operational costs are located in the North characterized by a dispersed population placed in mountains. Conversely, the SMAUTs with lower operational costs are located in the Centre (which provide evidence of contrasting characteristics).

[Insert Figure 8 here]

[Insert Figure 9 here]

Figures 10 and 11 illustrate the cost recovery (the ratio between all benefits and all costs) of the MMOs in Belgium and Portugal, respectively. We observe that in Belgium the costs recovery is not always above the 100% (i.e. the costs are not covered by the benefits). As we observe higher operational costs by urban MMOs, in Portugal the cost recovery is also higher for the rural ones. This circumstance might be related to the need for complex technology (and higher investments) of the urban SMAUTs considering the highest volume of packaging waste dealt with. In addition, this situation can also be instigated by other questions related to the "congestion phenomenon", which is more relevant in densely populated areas.

[Insert Figure 10 here]

[Insert Figure 11 here]

Finally, Table 5 presents the average unit operational costs (per collected ton) of the recycling system for public and private (including PPP arrangements) waste management operators. Apparently, private

[7] The weighted average is based on the tonnes collected.

models seem to report lower operational costs (except for sorting facilities in Belgium). Nevertheless, the observations are not sufficient to generate statistically significant results.

[Insert Table 5 here]

6. Conclusions

The recycling of packaging waste has been a matter of great concern among the European member states in the last decade. In Belgium, the implementation of the European Directive 94/62/EC on PPW has been quite successful in terms of recycling rates and in the application of the extended producer responsibility principle. In Portugal, all annual packaging waste recycling targets have also been met recently. Fost Plus in Belgium and SPV in Portugal are the Green Dot companies that manage the packaging waste recycling system of the household packaging waste flow. The success of the systems should be recognized not only by their effectiveness in terms of target achievement, but also by their financial-economic sustainability.

This research investigates the viability of the recycling system of packaging waste in Belgium and Portugal, by means of an economic and financial analysis focused on the household flow. It innovates by comparing two countries with similar institutional frameworks/arrangements but different targets, service delivery models, collection methods and financing mechanisms; it also innovates in terms of methodology by including two components that are traditionally left out of these assessments: the return on capital employed (debt and equity) regarding the financing of the assets allocated to the recycling process and the avoided cost of refuse collection and the other types of waste treatment (such as landfill, incineration or MBT).

Adopting an economic or (strictly) financial approach leads to distinct conclusions (diverging between a balanced or unbalanced recycling system). Despite the possible discussion about the “avoided cost”, the savings (regarding the other waste treatment facilities; in particular, the landfill) with the waste recycled and diverted from the other waste treatment facilities are undeniable. The costs of refuse collection and waste treatment are quite expressive and in countries with more limited land resources these costs can be even higher (Cruz et al., 2012).

Indeed, in Portugal the recycling system fairness depends on the approach. The services of selective collection and sorting of packaging waste represent on average 204€ per ton collected for the SMAUTs. Adopting a strictly financial perspective, the benefits are 158 € per ton of waste collected. The Green Dot company (i.e. the industry) in Portugal is bearing only a part of the financial costs of the recycling system (around 77%). Nevertheless, adopting an economic analysis the benefits outweigh the costs to the value of 260 € per ton of waste collected, with a cost coverage of 128%. In the case of Belgium, the argument about the avoided costs in the economic-financial balance may be different, since the financial benefits cover practically all the costs of the packaging waste service. In fact, about 90% of the total costs of the

service are covered by the financial benefits, since Fost Plus only finances the costs related to the "standard" level of service. At this level, the service cost is around 140€ per ton of packaging waste collected and the financial benefits sum 126€ per ton. However, it is noteworthy that the avoided costs (costs with refuse collection and other waste treatments) are around 160€ per ton of packaging waste collected, being higher than the costs of selective collection and sorting. These figures may contribute significantly for the high recycling rates attained by this country. On the contrary, in Portugal, the avoided costs are 103€ per ton of packaging waste collected, which is lower than the recycling costs. Therefore, the SMAUTs could increase the gate fees of incineration and, in particular, landfilling in order to raise the quantities of packaging waste sent for recycling.

The analysis made according to the population density showed that the packaging waste recycling system is financially sustainable for all levels in Belgium. In Portugal the same analysis reveals that SMAUTs with lower population density present the highest balance between benefits and costs with recycling services. These results may be somewhat counterintuitive (larger distances between collection points seem to imply higher collection costs). However, it might be the case that congestion effects and technological constraints are increasing costs in urban areas.

This study shows that, from the waste management operators' standpoint, the recycling system in Belgium is sustainable. Moreover, the current system succeeds in achieving (and overcoming) the European targets for the recycling and recovery of packaging waste. Portugal has also achieved the Directive targets, with a recent important investment in infrastructures related to urban waste management. When comparing the operational costs with Belgium, one should bear in mind some important characteristics that distinguish both countries: the heterogeneity of the landscape and population density; the climate that prevents a waste collection with a lower frequency and the maturity of the packaging waste recycling system.

It is noteworthy to emphasize that the pay-as-you-throw (PAYT) scheme implemented in Belgium represents one of the most relevant features for the success of the recycling system in this country. Since citizens have to pay for the collection of municipal solid waste (undifferentiated waste flow) based on the amount they throw away, there is a true financial incentive for users to separate packaging waste. In Portugal, households pay for waste services based on water consumption (in their water bill). In this regard, since the domestic expenses are not based on waste production, there are no incentives for households to change their habits (and increase source separation levels). Indeed, Portugal could invest more in citizens' awareness and create incentives to increase participation in the recycling system (which is crucial for the success of recycling).

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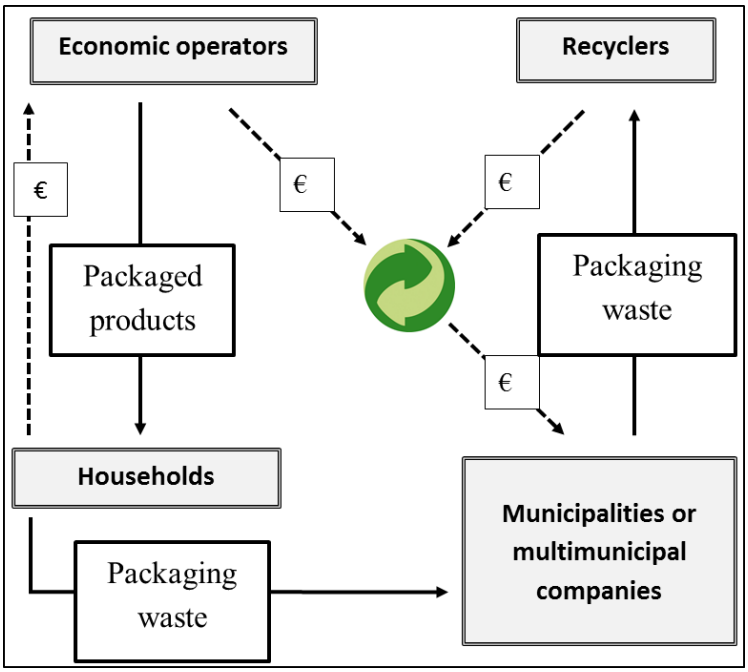

Figure 1 – General framework of household packaging waste management in Belgium and Portugal

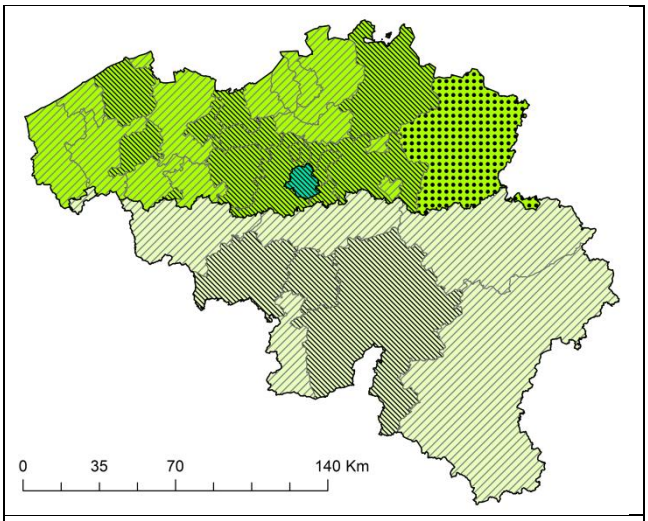

Figure 2a: Contracting out PMD curbside collection

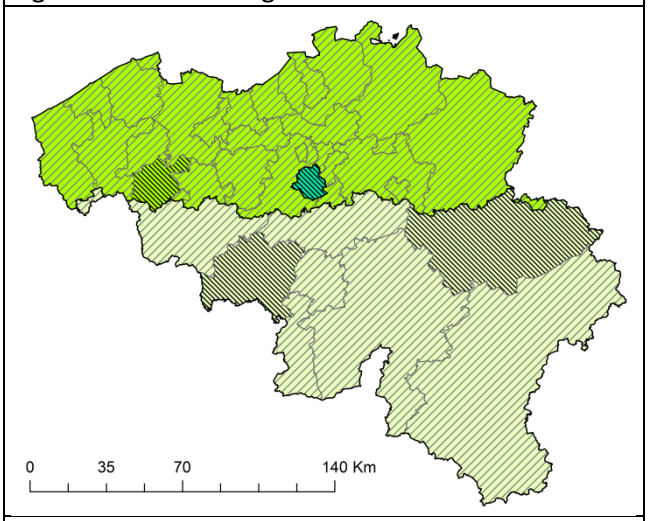

Figure 2b: Contracting out PMD separation

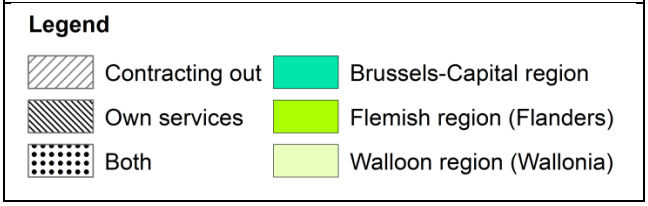

Figure 2 – Contracting out of PMD collection and separation

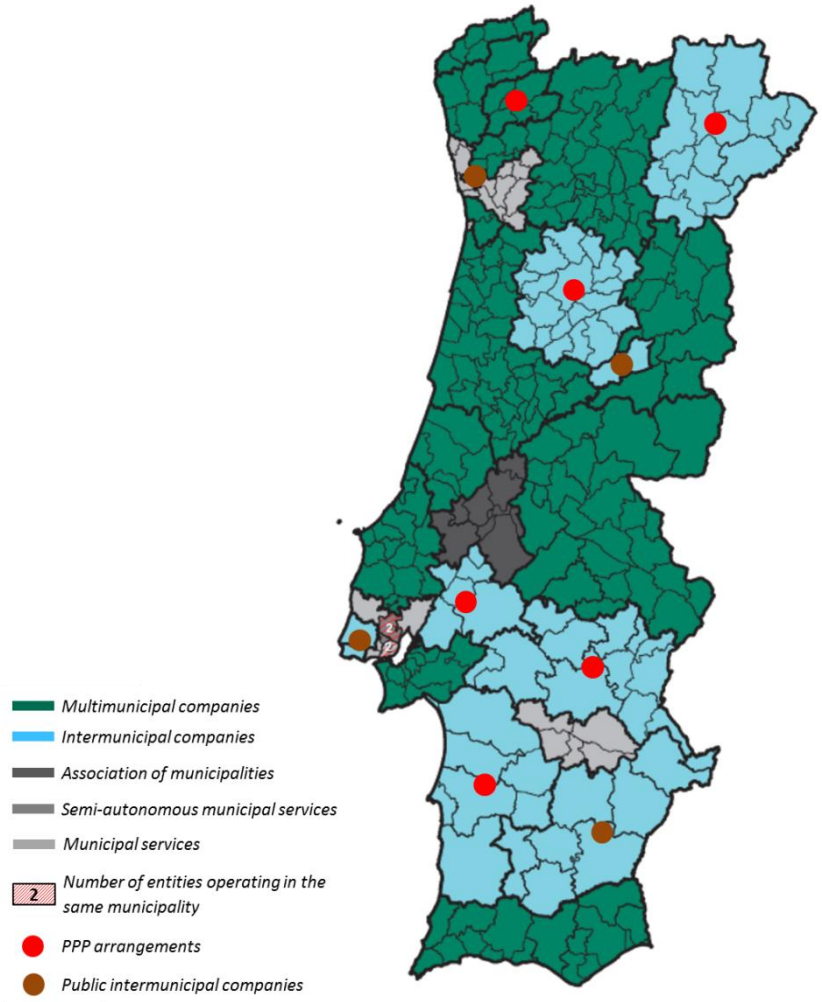

Figure 3 – Management models for the selective collection in Portugal for the year 2010

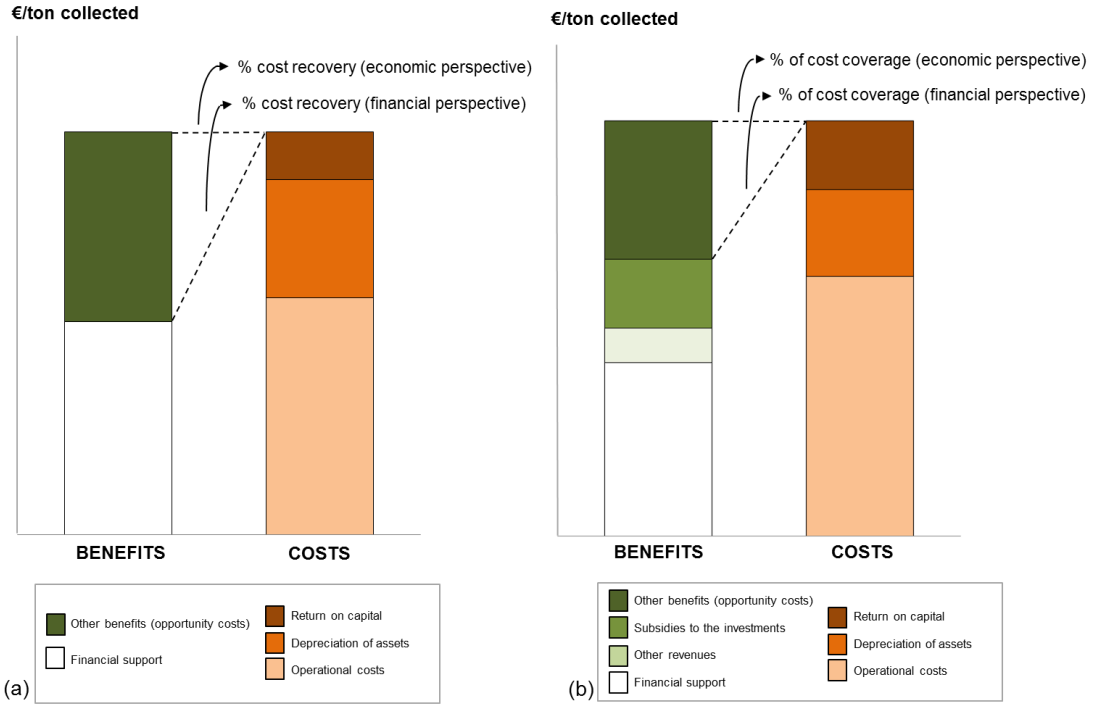

Figure 4 – The benefits and costs of recycling in (a) Belgium and in (b) Portugal

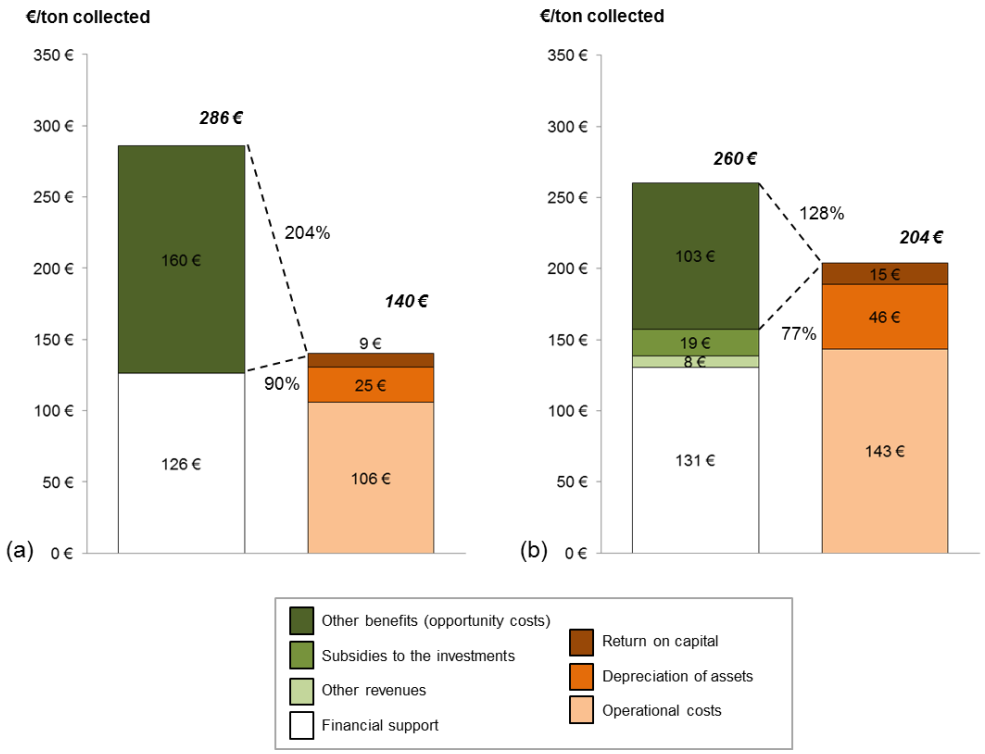

Figure 5 – Service cost recovery considering the tonnes of packaging waste collected in 2010 for (a) Belgium and (b) Portugal

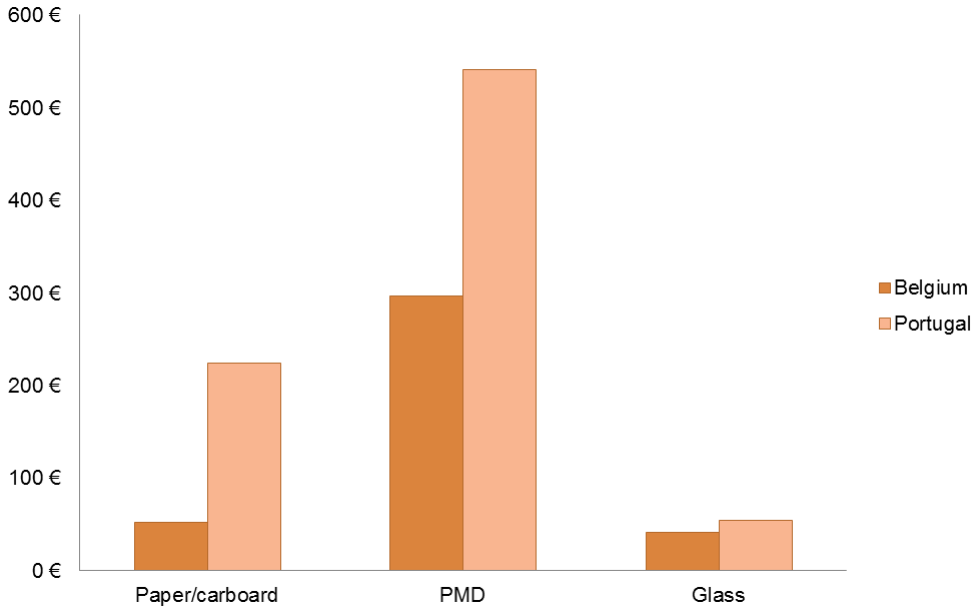

Figure 6 – Operational costs per tonne of packaging waste flow (for Belgium and Portugal)

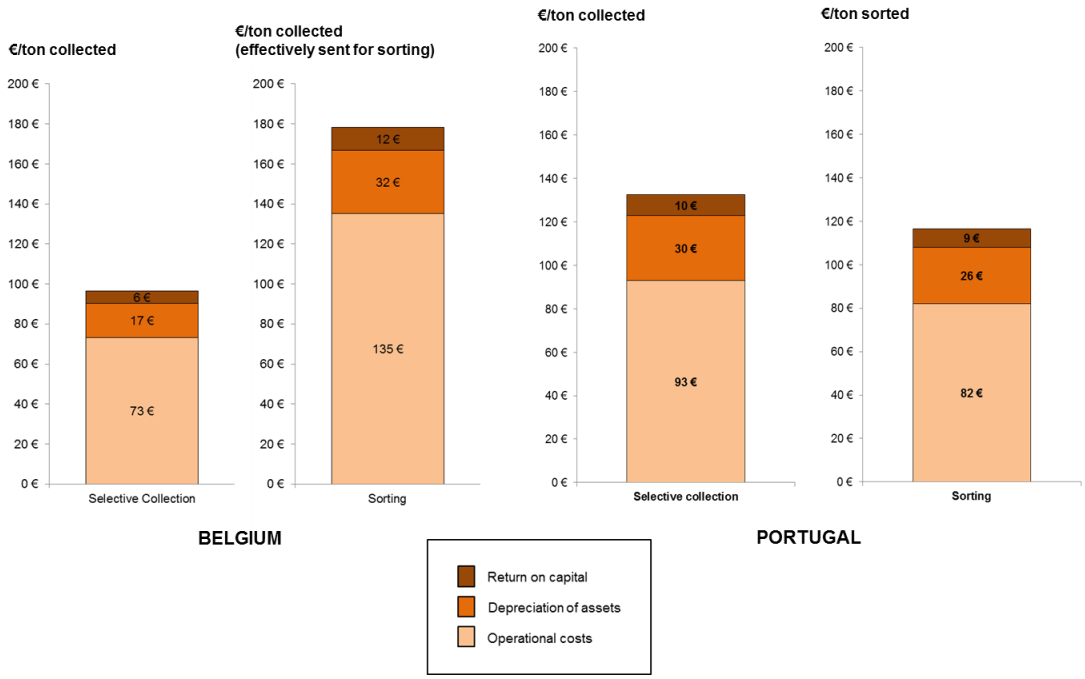

Figure 7 – Cost of selective collection and sorting activities

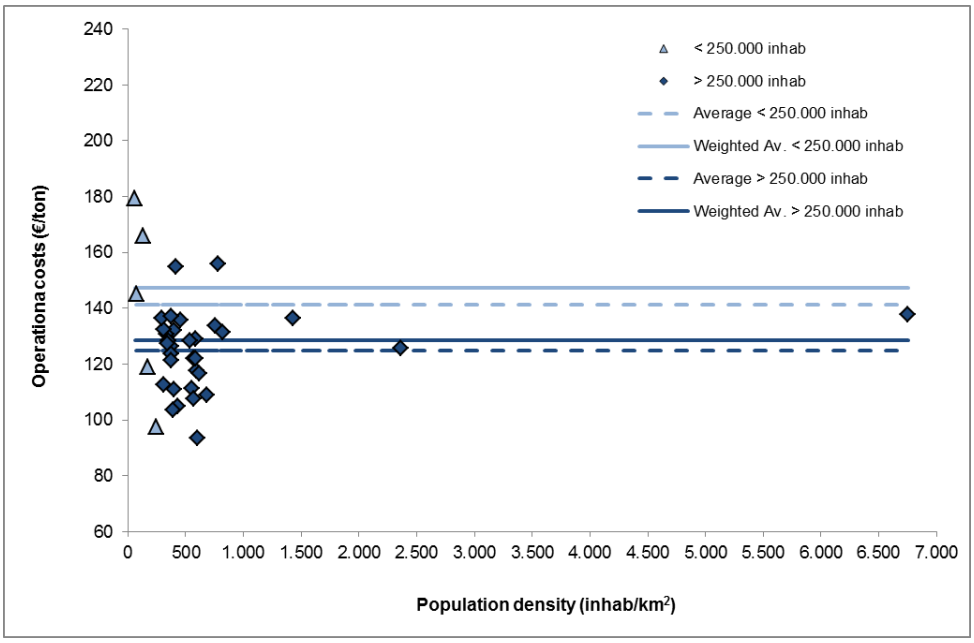

Figure 8 – Operational costs of MMOs per population density (Belgium)

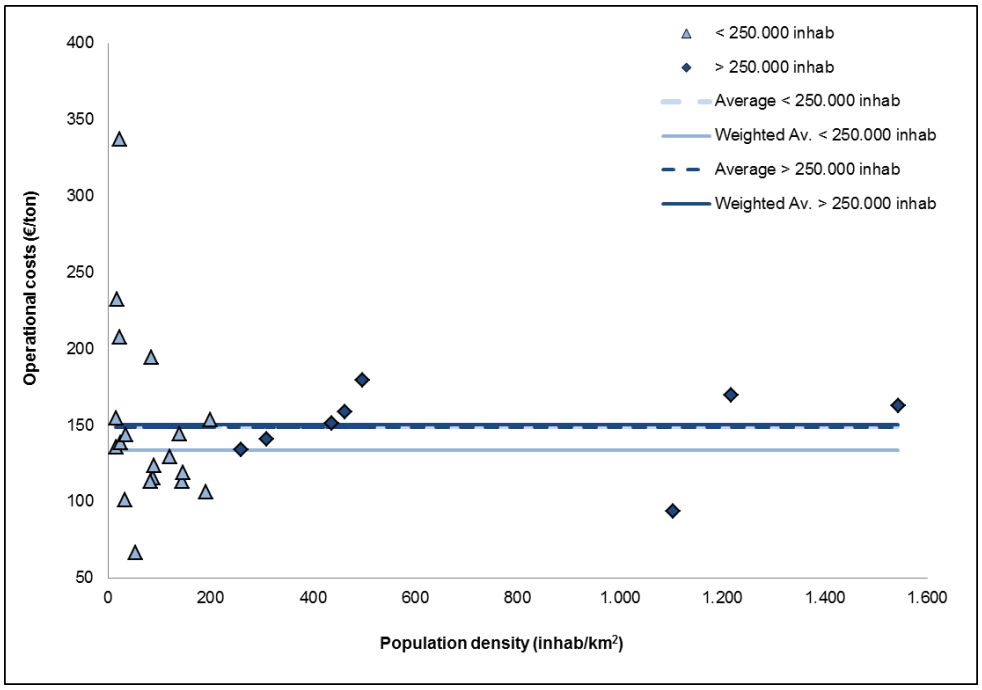

Figure 9 – Operational costs of SMAUTs per population density (Portugal)

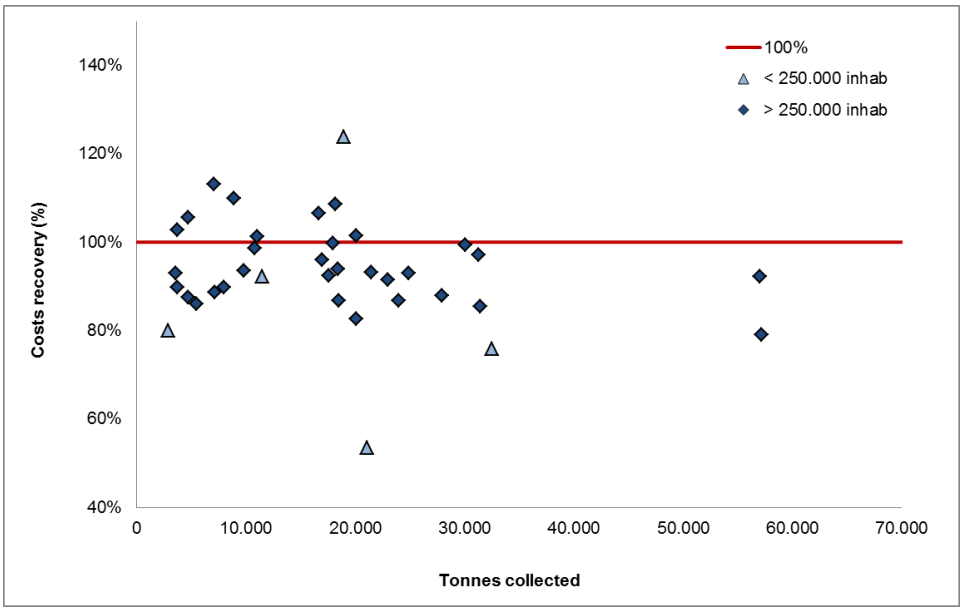

Figure 10 – Costs recovery by MMOs per ton collected (Belgium)

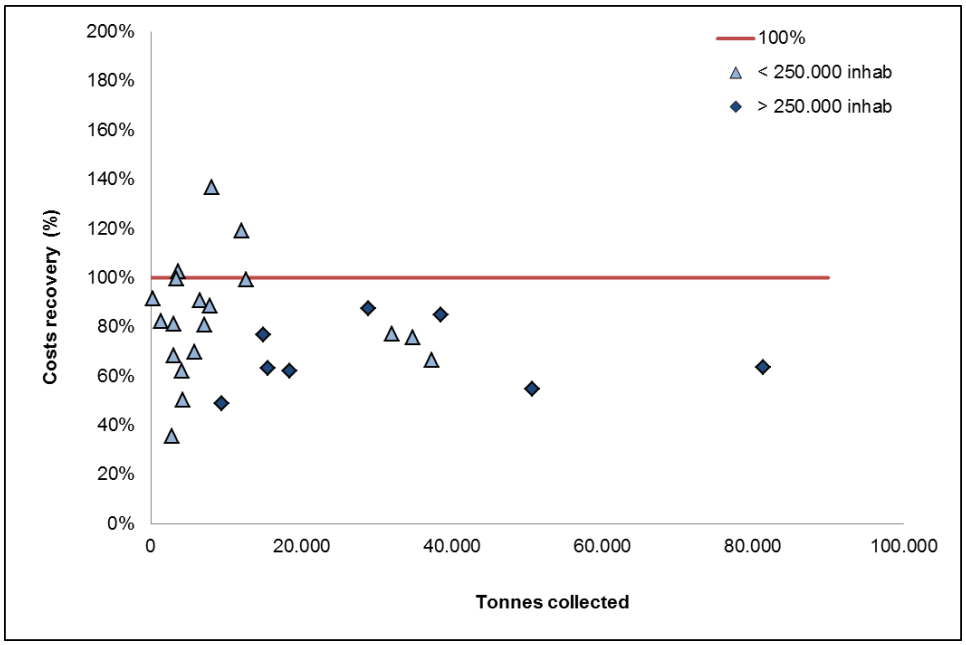

Figure 11 – Costs recovery by the SMAUTs per ton collected (Portugal)

Table 1 – Comparison of the packaging waste sector between Belgium and Portugal for the year 2010 (Sources: authors own elaboration; Fost Plus, 2011; Adams, 2011; Pinckaers, 2012).

	Belgium	**Portugal**
General statistics		
Population	10,839,905	10,637,713
Surface [km²]	30,530	92,090
Pop. density [pop/km²]	360	116
Number of municipalities	589	308
Municipal and multimunicipal organizations (MMOs)		
Population per MMO	292,970	391,887
	(231,266)	(379,889)
Surface per MMO [km²]	825	3,388
	(1,084)	(3,055)
Pop. density per MMO [pop/km²]	688	272
	(1,098)	(396)
Kg/cap separately collected via the green dot system		
Packaging waste total [kg per capita]	113.16	37.99
	(20.04)	(14.01)
Paper/cardboard [kg per capita]	68.67	15.74
	(13.51)	(19.65)
PMD (Plastic/metal/drink carton) [kg per capita]	15.00	6.94
	(1.83)	(8.37)
Glass [kg per capita]	29.49	14.31
	(7.00)	(15.48)
National recycling targets[a]		
Paper/cardboard	60%	60%
Glass	60%	60%
Plastics	30%	22,5%
Metals	50%	50%
Global recycling	80%	55-80%
Financial transfers (from the Green Dot Agencies) including complementary fee[b]		
Collection paper/cardboard [€ per capita]	1.11	1.48[c]
Collection and sorting PMD [€ per capita]	5.54	3.19[c]
Collection glass [€ per capita]	1.49	0.64[c]

Legend: standard deviation (if available) between brackets

[a] Ratio between the quantities of packaging waste recycled and produced. For Portugal, the national targets were the same defined in the PPW Directive

[b] In Portugal, SPV pays complementary fees for packaging waste that is recovered or recycled through the 'traditional' refuse collection chain (e.g. via MBT or incineration)

[c] Estimates based on surveys

Table 2 – Variables and values used in the methodology for the Belgium case

Value		Observation	Source
Unit costs of refuse collection	60 €/ton	This value is based on the costs reported by MMOs to OVAM. OVAM[a] used the costs for 2005 to estimate the value for 2010. This value was weighted by the waste collected.	OVAM (2008)
Unit cost of other waste treatment (mainly incineration)	100,83 €/ton	Incineration: 104,55€/t Environmental tax incineration: 7,43€/t Landfilling: 50€/t Environmental tax landfilling: 42€/t This value was weighted by the different streams selectively collected.	OVAM (2011)
Sorting efficiency: Glass Paper/cardboard PMD	 100% 100% 84,1%	These values are based on the figures reported by Fost Plus and IVCIE[b] and are averages for Belgium as a whole. Regional differences might still exist.	Official statistics: Fost Plus (2011) IVCIE (2011)

[a]OVAM is the Flemish Public Waste Agency

b IVCIE is the Interregional Packaging Commission (the competent authority for the certification of packaging waste management companies such as Fost Plus)

Table 3 – Variables and values used in the methodology for the Portuguese case

Value		Observation	Source
Unit costs of refuse collection (€/ton)	49,0	This value was taken from a survey sent to 308 operators (corresponding to the number of Portuguese municipalities), from which 196 have answered (corresponding to about 80% of the Portuguese population). This value was weighted by the waste collected.	Survey
Unit cost of other treatment (€/ton)	53,9	This value was obtained considering the 27 SMAUT (covering the entire Portuguese population) for the wholesale sector. In this regard, we exclude from the operational costs the costs with selective collection and sorting. This value was weighted by the waste selectively collected.	Annual account report
Sorting efficiency		This assumption was taken from the answers obtained from the SMAUT surveyed. This value was weighted by the waste selectively collected.	Survey
Glass (%)	95%		
Paper/cardboard (%)	93%		
Others (%)	63%		

Table 4 – Variables used to measure the return on capital employed

Value		Observation
Useful life of the assets (years)	9,6	This value was achieved considering the assets and their depreciation. This value was weighted by the waste selectively collected.
Cost of equity (%)	6,0	This value takes into account a non-risk (of 3%) and a risk premium (of 3%, related to the German Treasury Bonds).
Equity in the capital structure (%)	19,0	This value was defined considering the weight that equity has on the capital structure of the SMAUT (i.e. in relation to the passive). This value was weighted by the waste selectively collected.
Corporate tax (%)	34,0 (Belgium) 20,3 (Portugal)	This value was calculated according to the (national) tax paid by the companies and the level of "rurality", since there are some exceptions (reductions of taxes). This value was weighted by the waste selectively collected.
Cost of debt (%)	4,6	This value was achieved considering the interests paid for the SMAUT loans. This value was weighted by the waste selectively collected.

Table 5 – Unit operational costs per management model (public or private)

Waste activity	Public management		Private management	
	Belgium	**Portugal**	**Belgium**	**Portugal**
Selective collection	100,62 €/ton	126,73 €/ton	81,57 €/ton	106,86 €/ton
Sorting	165,68 €/ton	97,22 €/ton	167,09 €/ton	79,43 €/ton