The evolution of the Italian EPR system for the management of household Waste Electrical and Electronic Equipment (WEEE). Technical and economic performance in the spotlight

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ABSTRACT

In this paper we analyse the Italian collective system for the management of household Waste Electrical and Electronic Equipment (WEEE), and its evolution over time, following the European Directives on WEEE, which include the Extended Producer Responsibility (EPR). The analysis focuses on the technical and economic performance of WEEE compliance organisations (consortia), as they are the key players in the Italian EPR regime. Economic results have not usually been provided in previous studies, due to the lack of available data. This study overcomes this problem by accessing the financial statements for the years 2009–2014 of all consortia. The main conclusions of the study are: The Italian EPR system barely exceeded the technical target of the first WEEE Directive (4 kg per capita). Improvements are necessary to achieve the target set for 2019 by the Recast Directive. The economic performance of the Italian EPR regime improved significantly over time. The fees charged per tonne of WEEE collected decreased by almost 43% from 652 Euro per tonne in 2009 to 374 Euro per tonne in 2014, while the fees per tonne put on the market (POM) were 134 Euro in 2009 and 104 Euro in 2014. The results prove the theory which states that, competing consortia use the learning effects to reduce the contribution fees for producers rather than to increase the quantity collected. Municipalities remain the most important actor in WEEE collection operations. Consortia compensate municipalities with a reimbursement that ranges between 28 and 38 Euros per tonne collected. These repayments cover only partially their costs. Additional studies should investigate their role.

1. Introduction

In November 1996, a European Parliament Resolution asked the Commission to present a proposal for the management Waste from Electrical and Electronic Equipment (WEEE, also referred to as e-waste) that included the EPR principle. WEEE was considered one of the priority waste streams. The WEEE stream is characterised by a wide variety of waste products (from vending machines to mobile phones, from fridges to lamps), mixtures of materials (hazardous and valuable components) and increasing quantities. The last available study by the United Nation University (Baldé et al., 2015) estimated a worldwide production of almost 42 million metric tonnes in 2014. WEEE Directive 2002/96/EC, published in February 2003, required member states from 13 August 2005 to collect at least 4 kg per capita of WEEE from households and to ensure that ‘producers provide at least for the financing of the collection, treatment, recovery and environmentally sound disposal of WEEE from private households deposited at collection facilities’. Directive 2012/19/EU (Recast WEEE Directive) applied a collection target to all WEEE and based it on volumes placed on the market: by 2016, 45% of the average weight of EEE (Electrical and Electronic Equipment) placed on market in the past 3 years must be collected, 65% in 2019. EU legislation largely lets Member States to decide on allocation of financial and organisational responsibilities in EPR regimes. As a result, the costs of implementing WEEE legislation in Member States are distributed differently between the actors involved in the regime’s implementation, notably producers, retailers, municipalities and consumers. Several studies have analysed EPR implementations in Europe applied to WEEE or other stream of waste covered by EPR principle (EC, 2014; EEA, 2005; OECD, 2005; Remedial, 2012; Sagis, 2014; Sanz et al., 2015; Cruz et al., 2014; Ferreira et al., 2015; Cahill et al., 2010; Fredholm et al.,...
However, a comprehensive economic analysis of national WEEE management does not exist, largely due to a lack of data. This has important consequences for scholars and policy makers. A better understanding of the economics of national WEEE management would explain cause-effect mechanisms, allow to isolate those with the best technical and economic outcomes and thus contribute to appropriate policy proposals. This research aims to partially close this gap by providing an analysis of the EPR system in Italy with a focus on WEEE compliance organisations and the evolution of their technical and economic results. The solution adopted in Italy is a so-called ‘market model’ solution as defined by Savage and his colleagues (EC, 2006). Producers have created 16 competing compliance organisations, whose activities are co-ordinated by a national clearing house. In this model, compliance has been achieved at minimal cost, creating ‘financial stretch’. Innovation and learning effects are used to lower the contribution fees for producers rather than to increase the sorting results (Dubois, 2012 and EC, 2006). This paper comprises the following parts: after this introduction we present a brief discussion on the theoretical background and on the existing studies on EPR systems. Then, we present the evolution of the EPR system in Italy, the material and methods used in the study followed by the technical and economic performance of the EPR system. The main conclusions are that the EPR system has improved its economic performance and this is estimated with the economic results of the collective organisations. The consortia use their learning effects to improve the economic performance, while the technical performance is quite stable over time and does not exceed the targets set by the legal requirements. In fact, the technical performance demonstrates that the B2C WEEE regime barely reached the target of the first directive. The 2016 targets will be achieved as they apply also to non-household WEEE, which in Italy constitutes a far larger share of WEEE than in other countries. However, improvements are necessary in order to attain the 2019 targets. We also analyse the financial contributions that the collective organisations transfer to municipalities. Additional studies would be necessary to investigate the economics of WEEE collection operations performed by municipalities.

2. Theoretical background

Several studies have aimed at evaluating the EPR systems. Some of this research has a theoretical approach. This is the case of the studies by Dubois (2012, 2016), Palmer and Walls (1997), Walls (2006) Massarutto (2014). Economic theory studied EPR mechanisms extensively (Dubois, 2012). However, the implementation of the EPR principle need to be carefully considered (Wiesmeth and Häckl, 2011). First, it is necessary to define the goals within an EPR policy and, in the next step, the appropriate instruments have to be selected (Wiesmeth and Häckl, 2011). The WEEE Directive imposed collection targets as well as recovery and recycling targets. Dubois (2012) points out that static targets, do not provide incentive for additional sorting. In fact compliance organisations work on the producers’ interests. Therefore, competing consortia will use the learning effect to reduce the contribution fees paid by their members (i.e. the producers) rather than increase the sorting results. The same view is shared by Savage and colleagues (EC, 2006) where they report that ‘market model’ creates ‘financial stretch’ in order to comply to the minimal cost, without providing incentives for environmental or behavioural improvement beyond that stipulated by the legislation. On the other hand, ‘national collective system’ (monopoly) has invariably exceeded the collection and recovery targets set by the government, and provided ‘environmental stretch’ by investing in consumers’ behaviour change (EC, 2006). Therefore, the first research question is to study if the WEEE system in Italy, which presents static collection targets and is organised as a ‘market model’, presents reduced contribution fees paid by the consortia members and stable collection rates as expected from the theory.

The second research question is the assessment of the Italian ERP system, or in other terms, to quantify the technical and economic results of the national system. The following studies present evaluation tools in order to perform such assessments. The OECD study (2005) defines three categories of cost and environmental benefits: operation costs, environmental benefits and side effects. Widmer et al. (2005) provide five broad parameters to consider when a WEEE management system is designed or characterised. These are: legal regulation; system coverage; system financing; producer responsibility and ensuring compliance (usually by setting targets for collection or recycling). Periodically updated country reports by policy research firm Sagis, co-authors of this study, analyse national WEEE legislation, corresponding compliance activities and their environmental results and project their economic costs. Fredholm et al. (2008) present a framework developed to compare environmental and economic performance of recycling systems. Remedial’s study (Remedia, 2012), analysed the Italian ERP system for the household sector in 2011. It studied the flows of WEEE as well as the economic results of the ERP regime. The European Commission study of 2014 (EC, 2014) assesses the performance of the European ERP systems for WEEE, and for other types of waste covered by the ERP principle, by distinguishing the technical performance and the economic performance. Cruz et al. (2014) describe and examine five European ERP schemes established for packaging waste with focus on local authorities and industry.

We adopt the methodology reported in the European study (EC, 2014) because it provides comprehensive and practical indicators to assess the ERP system. The technical performance of the WEEE system is evaluated by some indicators such as the collection and/or recycling rates as well as by the total quantity POM and WEEE collected. The economic performance is defined as “how costly it was to implement the ERP principle” and the cost effectiveness is represented by the total fees of the system, the fees per EEE POM, the fees per EEE collected and the fees per inhabitant per year. As member states need to report EEE and WEEE volumes to the European Commission, systems for the collection of ‘technical’ (or environmental) data are in place and such data is usually available. However, there is little transparency as regards the economic performance of the ERP WEEE regimes for a number of reasons. A monopolistic compliance organisation may not wish to disclose full financial information, as this may compromise its negotiating position vis-à-vis recyclers. Where compliance organisations compete, their costs information may be considered a trade secret (EC, 2014; Sagis, 2014). Last but not least, the WEEE management costs of several actors (notably municipalities and distributors) are difficult to isolate. For these reasons, no conclusive studies exist about the total costs of WEEE regimes and their economic performance. The European study approximates the costs of the system by the amount of fees paid by the producers to ERP compliance organisations. This computation is a good approximation of the cost of the system because the compliance organisations play a central role in aggregating funds from producers in view of channelling them towards other actors to reach the environmental objectives of the legislation. The limitation is that the fees might cover only partially the costs of the national system. Other actors, such the local authorities, can play a role in the national system and they might be only partially compensated by the ERP compliance organisations i.e. the consortia. Therefore, the studies of the national systems should include considerations on the cost coverage of the ERP system i.e. which types of costs are covered by the ERP and in which proportions (EC, 2014).
3. The adoption of WEEE Directive in Italy

The Italian system started to operate in November 2007 with the Ministry decrees that established the national clearinghouse and other national organisations, while the financial responsibility was passed on to producers from September 2007. Only by the end of 2008 all municipalities had registered in the national clearinghouse and thus included compliance organisations’ WEEE take back activities, and were eligible for compensation. Therefore, this study starts from 2009, the first full operational year of the WEEE regime. The compliance organisations (also called producer responsibility organisations PROs, consortia or collective systems) manage the transport, treatment and recycling of WEEE on the national territory. They must set up and finance the national clearing house named “Coordination Centre for WEEE” (CdCRAEE). It was created in order to regulate and coordinate the activities of the consortia and guarantee uniform and homogeneous conditions among them (Degree Law 151/2005). The national clearing house receives information on the quantities of EEE put on the market by the members of the consortia. Based on these quantities and other parameters, it assigns annually each municipal collection point to one or more consortia (Favot, 2015). This depends on whether the PRO treats all five groups of WEEE (as defined by the Italian legislation) or not. In this last case, another collective system has the duty to collect the other groups of WEEE. Consequently, the analysis has to be performed at a national level, while regional or local investigations are not possible.

There are currently 16 compliance organisations operating in Italy, while there were 15 of them in 2005. Their role is central in the management of B2C WEEE. Between 2009 and 2014, the five largest consortia managed over 78% of all B2C WEEE, and the two largest compliance organisations managed 52%. The four smallest consortia, excluded from the computation, covered less than 0.50% of the market up to 2013. In 2014 one of these four consortia increased its market share (reaching 3.25%). Nevertheless, we kept it out of the analysis because it handles mainly batteries and accumulators, and its financial statements do not allow isolating its WEEE business. This exclusion does not significantly impact the results of this analysis.

In Italy, most of the compliance organisations have the legal form of consortia though legislative decree n. 151/2005 did not impose this. Most compliance organisations were initiated and controlled by producer. Legislative decree 49/2014, which transposed the Recast Directive, required compliance organisations to adopt the legal form of a consortium and have a not-for-profit objective. Retailers, transporters, collection companies, treatment companies, etc., may, in accordance with producers, be shareholders. In August 2014, Law 116/2014 required each WEEE compliance organisation to have a minimum share of 3% of EEE placed on the market in one or more of the five WEEE collection groups. This requirement was expected to consolidate the market as one third of the 16 of compliance organisations were under this threshold in 2014 (Sagis, 2014).

4. Material and methods

Our research is focused on a single case-study: the implementation of the EPR system for household electrical and electronic waste in Italy. It has been argued that “case studies can be conducted and written with many different motives, including the simple presentation of individual cases, or the desire to arrive at broad generalizations, based on case study evidence” (Yin, 2005). Following the previous studies, we are more inclined to fulfill the former objective rather than the latter. In other words, we are interested in presenting the Italian approach to WEEE rather than to develop a theory at European level. In order to provide a comprehensive analysis, we analyse both the technical and economic performance of the Italian EPR system, applying the methods presented in the European Commission study (EC, 2014). In this study the technical performance is defined as “to what extent did the EPR implementation foster the capture of a substantial share of the waste arising and the achievement of the recycling targets” (EC, 2014). More precisely the technical performance of the WEEE systems is assessed by five parameters: EEE put on the market; WEEE arising; WEEE collected; recycling rate and recovery rate. When available, the data is split in B2C and B2B sector. Additionally, the first three parameters related to the household data are also presented as quantity per inhabitant. In our analysis of the Italian system, we used and elaborated the data disclosed by the national clearing house and Eurostat. Even if the study is focused on the household sector, we also shed some light on the technical performance of the business sector because it presents an anomaly in terms of quantities put on the market versus quantities collected. Moreover, the recycling and recovery rates are only available for the combination of the two systems (B2B plus B2C). Last but not least, in the recast WEEE Directive the B2B sector is included in the calculation of the targets. Therefore, the last computation includes recycling and recovery rates as well as the collection rate (WEEE collected/WEEE put on the market) of the household and business sectors. The information is provided by the national clearing house (CdCRAEE) and by Eurostat. The population data is provided by the National Statistics Institution (ISTAT). The economic performance refers to how costly it is to implement the EPR principle (EC, 2014). As reported before, information on costs is usually only available to the members of the schemes (EC, 2012), and PROs do not commonly provide economic data for reasons of confidentiality. This is especially true for compliance organisations for WEEE (EC, 2014; Sagis, 2014). This lack of data does not allow for a comparison of the systems at European level, and above all, it prevents the understanding of the crucial factors that could improve them. The European study approximates the costs of the system by the amount of fees paid by the producers to the consortia. The cost effectiveness is assessed by four parameters: total fees, fees per EEE put on the market in tonnes, fee per EEE collected in tonnes and fees per inhabitant per year. Therefore, following these instructions, we have assessed and analysed the balance sheets of all the collective systems operating in Italy from 2009 to 2014. This was possible due to the Italian civil code obliging Italian companies (such as the collective systems) to publish their financial statements within 30 days of their approval. Analysis of the balance sheets allow a broad assessment of the economic structure of the Italian compliance organisations over time, which has never been investigated before. As reported earlier, we analysed the largest 12 consortia that were operational between 2009 and 2014. The data used as the total fees is the “total value of production” of all consortia as presented in their balance sheets. In this study we also analysed separately the contributions that collective systems granted to the municipalities and their variations over time. This data only account for what the compliance organisations paid to the municipalities based on a special agreement between the national clearing house (CdCRAEE) and the organisation of the Italian municipalities (ANCI). These compensations do not necessarily reflect the full cost incurred by the local authorities.

5. Results

5.1. Technical performance

In this section we present the technical performance of the Italian WEEE regime for the household, followed by the business sectors and the combination of the two. This split is relevant as it...
provides some important considerations on the Italian WEEE regime. The calculations are based on CdCRAEE data, ISTAT data (the national statistical institution) and Eurostat data. In Table 1, we present the household data. There is no data available on the WEEE generated while the recycling and recovery rates are only available for the combination of the two sectors.

The first important figure analysed, is the drop in household EEE put on the market between 2011 and 2012, which fell by more than 12%. According to the national clearinghouse’s annual report, this is mostly due to the economic slowdown that reduced the quantities of EEE sold (CdCRAEE, 2012). Moreover, during the same period, the quantity of B2C WEEE collected was reduced by more than 8%, most likely because consumers, hit by the crisis, kept their old equipment. Another reason that could explain the drop of POM between 2011 and 2012 can be found in the so-called television “digital switch-over” (Sustainable Development Foundation, 2014). By law this was due by the end of 2008, but was eventually completed by the middle of 2012. According to the Open Society Foundation report (2011), the use in Italy of the digital television increased by 63% between 2007 and 2010 reaching 76.4% of the population in 2010. This change of technology forced the replacement of analogue televisions with digital televisions. Therefore, this switch effect had a significant impact on the quantity of TVs sold up to 2011, with volumes eventually diminishing in 2012 (CdCRAEE, 2012). These two factors explain the variation of quantities put on the market between 2011 and 2012. The second important figure to analyse is the quantity of WEEE collected per capita. The Italian systems had struggled to achieve the 4 kg per capita collection target of the first WEEE Directive. Nominal collection of household WEEE peaked at 4.38 kg per capita in 2011 and declined to 3.81 kg in 2014. Despite the decline of nominal volumes, the collection rate for household EEE has remained largely constant in the last four years (ranging between 29% and almost 31%) as EEE POM volumes also declined by over 11% between 2011 and 2014. In the second table we present the results of the WEEE regime for the business sector. The data source is Eurostat and CdCRAEE, with Eurostat data available up to year 2013.

As reported in Table 2, the business sector provides a small amount of EEE put on the market compared to the B2C sector. This is even more evident if we compare, in the business sector, the quantity put on the market against the quantity collected. This discrepancy is quite remarkable as the quantity collected is between two and eight times higher than the quantity sold. The time lapse between selling EEE and the collection of WEEE cannot justify these results. According to Peagam et al. (2013), very little business-to-business WEEE is reported as collected in Europe. Italy reported to Eurostat that around 5 kg per capita of WEEE are collected from sources other than households: the highest among EU countries (average 0.6 kg in 2012). This can be explained by two reasons: first the extraordinary high collection volume of B2B WEEE most likely comes from household WEEE, which should instead flow through the compliance organisations and the national clearing house; second the Government’s methodology for accounting for these flows should be reviewed (Sagis, 2014).

A key measure of the technical performance of an EPR regime as formulated in the recast WEEE Directive is the collection rate, which is expressed as the ratio of WEEE collected and EEE put on the market (POM). To smooth out annual variations, WEEE Directive 2012/19/EU prescribes that the average POM of the preceding three years is used. The target from 2016 is 45% which needs to be increased gradually in order to reach 65% by 2019. For lack of data, we calculate the collection rate based on POM in the same year only. We also provide the recycling and recovery rates as presented in the Eurostat database.

In Table 3 we provide the combined data for B2B and B2C sectors. The 2016 collection targets of 45% of the quantity of EEE POM have already been reached, as reported in Table 3. In fact, the new WEEE Directive the computation includes B2C and B2B. On the other hand, the 2019 collection targets are ambitious as they increase the collection rate to 65% of volumes POM (or 85% on WEEE generated). The recycling/reuse rates of the WEEE regime in Italy always exceed 80%. In the remaining part of the paper, we deal only with the household WEEE regime, which has more relevance to the WEEE system.

### 5.2. Economic performance

The compliance organisations were set up to manage household WEEE. The consortia outsource most of their operations, stipulating contracts for the logistic and treatment activities, which are their core business. Only one consortium deals internally with

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**Table 1** Technical performance of the WEEE regime in Italy for the household sector.

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>B2C EEE POM tonnes</td>
<td>935,881</td>
<td>956,786</td>
<td>894,782</td>
<td>781,623</td>
<td>760,320</td>
<td>794,897</td>
</tr>
<tr>
<td>B2C EEE POM kg/inh.</td>
<td>15.51</td>
<td>15.78</td>
<td>15.07</td>
<td>13.10</td>
<td>12.51</td>
<td>13.07</td>
</tr>
<tr>
<td>B2C WEEE collected tonnes</td>
<td>193,042</td>
<td>245,351</td>
<td>260,090</td>
<td>237,966</td>
<td>225,931</td>
<td>231,717</td>
</tr>
<tr>
<td>B2C WEEE collected kg/inh.*</td>
<td>3.20</td>
<td>4.05</td>
<td>4.38</td>
<td>3.99</td>
<td>3.72</td>
<td>3.81</td>
</tr>
</tbody>
</table>

Source:

* CdCRAEE data or its elaboration.
* CdCRAEE data for quantities and ISTAT data for the population.

**Table 2** Technical performance of the WEEE regime in Italy for the business sector.

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>B2B EEE POM kg/inh.</td>
<td>0.63</td>
<td>2.65</td>
<td>1.67</td>
<td>1.86</td>
<td>1.42</td>
</tr>
<tr>
<td>B2B WEEE collected tonnes</td>
<td>304,250</td>
<td>328,829</td>
<td>295,251</td>
<td>277,706</td>
<td>227,918</td>
</tr>
<tr>
<td>B2B WEEE collected kg/inh.*</td>
<td>5.04</td>
<td>5.42</td>
<td>4.97</td>
<td>4.65</td>
<td>3.75</td>
</tr>
</tbody>
</table>

Source:

* Elaboration of Eurostat data and CdCRAEE data.
* Eurostat data for quantities and ISTAT data for the population.

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the treatment phase, using its facilities. The central consortia activities are all accounted for together under ‘service costs’, and their quantification is reported in the balance sheet. Nevertheless, the balance sheets do not provide specific information on the composition of this category of costs. We managed to obtain specific details only for three consortia, because we accessed an additional document named “informative note”. From this document we found out that ‘service costs’ include: logistic costs, transport and treatment costs, efficiency bonuses to municipalities, contribution to the coordination centre, communication expenses, travel expenses, software licenses, rents etc. The predominant costs within the service category are logistics and treatment costs. Their incidence varies a lot between the systems. In the three cases reported above, the logistics and treatment costs contribute to between 58% and 76% of total service costs and between 48% and 66% of total production costs. These results are compatible with Remedia’s conclusions (Remedia, 2012) which estimates the treatment and logistic costs at 57% of the total costs of the consortia for the year 2011. On average the production costs per tonne collected decreased from 2009 to 2013, increasing slightly in 2014. In 2011 the total production costs were 494 EUR per tonne collected. This is in line with Remedia’s results for the same year, which reached almost 450 euro per tonne collected (Remedia, 2012). The percentage of the decrease, based on the previous year, ranges from –3.50% (2011 over 2010) to –17.22% (2012 over 2011). The increased efficiency is even more evident if we compare the costs between the first and the last year of the dataset. The decrease of the production costs per tonne collected between 2009 and 2014 is almost 26%, which is more than 1/4. This increased efficiency can be explained by cost pressures put on the suppliers (collectors, transporters, treatment facilities and municipalities), as well as the start-up costs that are gradually absorbed after the first years of operation. Another important cost included in the ‘service costs’ is the contribution that the compliance organisations pay out to the municipalities. The analysis of this cost is important in order to estimate the cost coverage of the EPR system. Neither the balance sheets nor the ‘informative notes’ of the consortia present such information. Therefore we utilized the data provided by the national clearing house (CdCRAEE). There are two types of compensations paid to the municipalities: funds for the quantities of WEEE collected and infrastructural funds. CdCRAEE and ANCI (the organisation representing the Italian councils) have formulated an agreement stipulating the compensation, with the last agreement signed in February 2015. It includes several requirements that collection operations must include in order to be eligible for compensation. Such conditions for the collection compensation are: to be registered in the CdCRAEEE portal, to keep the collection centre open for at least 6 hours per week and to reach the minimum threshold of quantity collected per WEEE category per trip. The infrastructural funds are granted to the establishment of new collection points (50%) and to the improvement of existing ones (50%). These compensations vary between 41 EUR tonne (2010) to 53 EUR tonne per tonne collected and compensated (2012). On the other hand, if we consider all the tonnages collected by the local authorities and the total compensation received (including infrastructural funds), compensation varies between 23 and 38 EUR tonne as reported in Table 4.

The analysis of the compensations granted to the municipalities is important data in estimating the cost coverage of the EPR system. However, there is very limited research available on the cost and benefits undertaken by the local authorities in Italy for WEEE. The only available data is provided by Remedia (2012) for 2011, and by the National Institute for Environment Protection (ISPRA). The ISPRA annual reports show the average cost borne by the municipalities per tonne of WEEE separately collected. The methodology is not disclosed and the reports only declare that the costs include collection and transport costs minus the revenues. We can assume that the costs included are only operational costs as defined by Cruz et al. (2014). The institute samples annually about a thousand municipalities, covering between 11% and 16% of the population, and around the same percentage of household WEEE collected nationwide. The average net cost, estimated by ISPRA, was EUR 300.3 in 2010, EUR 268.3 in 2011, EUR 294.5 in 2012, EUR 261.6 in 2013 and 232 EUR in 2014 (ISPRA, 2010–2014). If the ISPRA data is confirmed at a national level, the coverage of the costs of municipalities for separated collection granted by the consortia, varies between 8% (in 2010) and 17% (in 2014). Even if the data and the methodology adopted are not exhaustive, the results show that the costs borne by the municipalities are not fully covered by the clearing house. The same data (the total compensation granted to the municipalities) can be read from the compliance systems’ perspective. These compensations account for 4.30% in 2009 to 10.67% in 2014 of the total fees borne by the consortia.

In Table 5, we present the indicators of economic performance adopted in the European study (EC, 2014). The indicators are: the

| Table 3 |
|------------------|------------------|------------------|------------------|------------------|------------------|
| **Year** | **2009** | **2010** | **2011** | **2012** | **2013** |
| **Waste collected (tonne)** | 521,113 | 582,482 | 544,577 | 497,378 | 437,090 |
| **Collection rate** | 54% | 52% | 55% | 56% | 52% |
| **Recycling and reuse rate** | 87% | 86% | 93% | 80% | 88% |
| **Recovery rate** | 92% | 90% | 94% | 81% | 89% |

Source: Eurostat data or its elaboration.

| Table 4 |
|------------------|------------------|------------------|------------------|------------------|------------------|
| **Compensation to the municipalities.** |
| **Compensation to municipalities** | **2009** | **2010** | **2011** | **2012** | **2013** |
| **Total tonnes collected** | 193,042 | 245,350 | 260,090 | 237,965 | 225,931 |
| **Total tonnes compensated** | 80,026 | 130,646 | 130,839 | 102,475 | 138,599 |
| **Collection compensation (EUR)** | 3,424,989 | 5,466,779 | 6,614,768 | 5,441,303 | 7,263,961 |
| **EUR/tonne compensated** | 42.80 | 41.84 | 50.56 | 53.10 | 52.41 |
| **Fund for infrastructure (EUR)** | 1,164,000 | 1,064,000 | 1,106,459 | 8,427,961 | 8,896,995 |
| **Total support (EUR)** | 5,424,989 | 5,841,779 | 6,993,565 | 6,095,499 | 8,427,961 |
| **EUR/tonne collected** | 28.10 | 23.81 | 26.89 | 25.62 | 37.30 |

Source: CdCRAEE data.
Economic performance indicators of the Italian EPR system: 2009–2014. The collection rate 6.4 kg per capita. In Italy in the same year the 2010 was equal to 28% (quantity collected/ quantity POM), with of the fees per tonne collected in Italy, when compared with the EUR 160 in Ireland, while in Italy, they equalled EUR 539 per tonne of WEEE collected in 2010 were EUR 384 in France and fees per tonne of EEE POM and the fees paid per inhabitant annu-

On average, the collective systems charged their members between EUR 652.57 per tonne of WEEE collected (2009) to EUR 366.90 (2013), with a stable decrease ranging from between 5% and 19% (discounting an increase between 2013 and 2014 of about 1.95% when the average value equalled EUR 374.05). Competition has played a significant role in reducing these fees. If we consider the fees per tonne put on the market, they increased from 2009 up to 2011, reaching EUR 148.52 per tonne in 2011 and thereafter decreased falling to EUR 104.88 per tonne in 2014. These results are in line with the findings of the European study (EC, 2014) that evaluated the economic performance in France and Ireland in 2010 (as there is currently no information available for other countries for the reasons explained before). France is considered a country similar to Italy in terms of the WEEE system (CdCRAEE, 2016). In France, the total fees for household WEEE equated to EUR 181 million (EUR 2.8 per inhabitant per year) and in Ireland, EUR 6.5 million (EUR 1.4 per inhabitant per year). In the same year, in Italy producers contributed with more than EUR 131 million, equating to EUR 2.17 per inhabitant per year. The fees per tonne of EEE put on the market were EUR 132 in France and EUR 68 in Ireland, while in Italy the fees per tonne lingered at EUR 137. Therefore, the fees per tonne of EEE POM and the fees paid per inhabitant annually are in line with the results of the French system. The fees per tonne of WEEE collected in 2010 were EUR 384 in France and EUR 160 in Ireland, while in Italy, they equalled EUR 539 per tonne of WEEE collected (40% higher than the French fees). The contrast of the fees per tonne collected in Italy, when compared with the French system, can be explained by the lower performance of the Italian collection system. In fact, the return rate in France in 2010 was equal to 28% (quantity collected/ quantity POM), with the collection rate 6.4 kg per capita. In Italy in the same year the return rate reached 25.64%, with a collection rate of 4.05 kg per capita. Again, this can be partially explained by significant volumes of B2C WEEE being treated outside of the CdCRAEE system.

6. Discussion and conclusions

In this paper we present the Italian system for the management of household WEEE, with focus on the compliance organisations and their technical and economic performance. The regime includes multiple actors: producers, compliance organisations, a national clearinghouse (CdCRAEE), retailers, municipalities, logistics operators, treatment facilities and consumers, portraying a complex chain of exchanges, from the production and selling phase of electric and electronic equipment (EEE) to the management of WEEE (waste EEE). In Italy, the main actors are the collective systems (also referred to as compliance organisations or producer responsibility organisation). In this paper we analyse these competing consortia that are mostly created by the producers to deal with the legally imposed obligations and targets under the WEEE Directive. Several sources report that there is a lack of data and transparency regarding the economic implementation of the EPR systems in Europe especially for WEEE. The last European study conducted by the European Commission (2014), provides economic information only for two countries, France and Ireland, and it refers to the year 2011. We adopted the methodology used in this last research to assess the Italian EPR system. The technical performance is evaluated by the performance indicators (quantities of products put on the market, quantity of waste collected, recycling and recovery rates). The data is provided by the national clearinghouse and Eurostat. The quantity of EEE put on the market show a relevant drop between 2011 and 2012, mostly due to the economic slowdown and to the end of television ‘digital switch-over’ effect (that caused the replacement of old TV sets). The collection rate of 4 kg per inhabitant per year has been achieved or nearly achieved in the 5 years of the study, by the household sector. However, the new collection targets set by the WEEE Recast Directive impose pressure on the system to increase the quantities collected. It stands out from the analysis that the business sector has an extraordinary collection volume that most likely hides households WEEE treated outside the clearinghouse system, with the economic performance being based on confidential data that are not usually disclosed. Nevertheless, we have analysed the profit and loss data of all collective systems in Italy, allowing for the undertaking of a study of the Italian B2C WEEE compliance systems that has never been conducted before. One important conclusion is that the average production costs decreased from EUR 590 per tonne in 2009 to EUR 379 per tonne in 2014, a decrease of more than 35%. The decrease of these costs is mainly due to competition, learning effects, specialisation and start-up costs that are gradually absorbed. Secondly, the fees per tonne collected (charged by the compliance organisations to the producers) decreased from EUR 652 in 2009 to EUR 374 in 2014 (a decrease of more than 42%). The fees per inhabitant ranged between EUR 1.36 per year (2013) and EUR 2.24 euro (2011). These results are coherent with the theory described by Dubois (2012) and Savage and colleagues (EC, 2006). They report that ‘market model’ (i.e. a model where producers create competing PROs) leads to ‘financial stretch’. This means that compliance organisations use their learning effects to reduce the contribution fees for producers rather than to increase the sorting results. In fact, in Italy between 2009 and 2014 the collection rates remained quite stable while the fees per tonne collected decreased quite steadily. Additionally, we have partially analysed the cost coverage of the EPR Italian system. The collective systems cover the full costs of WEEE delivered to a specific collection point, while the costs of collection – being borne by the municipalities – are only partially reimbursed. Moreover, we calculated the compensation paid to the municipalities based on the data provided by the national clearinghouse, with reimbursements ranging between EUR 25 and EUR 38 per tonne collected. These contributions are far less than the actual costs borne by the municipalities for the collection phase, which is estimated by Remedie at EUR 242 per tonne collected in 2011 (Remedia, 2012), and between EUR 300 tonne (in 2010) and EUR 232 (in 2014) by the national Institute for the Environmental Protection (ISPRA, 2011–2014). Additional research, on the cost coverage of the system, is necessary. The main limitations of this study reflect, above all, the limitation of the methodology used in the European study (EC, 2014). First of all,
the economic performance is approximated by the producers’ fees because there is a lack of data on costs. The limitation is that the fees in many cases are not directly linked to the costs e.g. partial cost coverage (EC, 2014). In our case study, the cost coverage of the Italian ERP system for household WEEE cannot be precisely defined, even if we provide some information on the costs borne by the municipalities and the compensations received from the compliance systems. Second, costs and performance are influenced by external factors namely population density, historical development of the system, value of secondary materials, citizens’ awareness, and existence of other waste policy instruments (EC, 2014). Therefore, potential comparisons with other national systems (even with the French one) are not so straightforward. Third, the technical performance such as the quantities POM, collected and recycled, could be calculated in diverse ways, leading to incoherent data. This is the case, for example, of the quantity of EEE put on the market in Italy. In the last annual report by the national clearing house (CdCRAEE, 2016), the EEE POM declared by the consortia is lower than the quantity declared by the producers via the EEE registry by more than 10%. Therefore, the main recommendation for policy makers is to promote transparency. Lack of data on technical performance and above all economic performance does not allow the full comprehension of the EPR system, the cause-effect mechanisms and the potential trigger points to improve such schemes. Second, the “black box” of PROs need to be opened up by control and monitoring actions as the compliance schemes are the key player not only in the WEEE Italian system. Last, the collection target, set by the first WEEE Directive, was too low for consolidated markets and perhaps too high for new systems. These targets have been modified by the recast Directive partially overcoming these problems. Nevertheless, EPR should not be limited to the application of collection and recycling targets. According to Thomas Lindhqvist (2000), Extended Producer Responsibility (EPR) is implemented through administrative, economic and informative policy instruments. Therefore, policy makers could improve the EPR implementation by improving and introducing new instruments.

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