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UNIVERSIDADE DO MINHO

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EEE fees and the WEEE system –

A model of efficiency and income in European countries

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Abstract

Countries have been adjusting their electrical and electronic equipment (EEE) fees since the European directive for the control of waste electrical and electronic equipment (WEEE) entered into force. Using a novel data set collected by the team, our results show that EEE fees are negatively adjusted to the country's income per capita, with a 0.6% decrease in the fee for 1% increase in GDP per capita (GDP*pc*) for Large Household Appliances, but a positive association of a 0.8% increase for the Cool and Freezing category. For collection rates, a positive association is shown for Lamps and a negative association for Small Household Appliances. We broadly consider the observed relations weaker than expected and rather heterogeneous, which may be the result of the current lack of binding European policy in this matter. Considering the final EEE consumer, who could be responsible for the payment of the fee, and the extended Producer Responsibility Organisation (PRO) that receives it, we propose that fee levels should reflect both the countries' income per capita of consumers and the collection rates from WEEE suppliers. We also advise, towards the implementation of better transparency, good practices that include public availability of data and background calculation of fees.

Keywords: Waste Electrical and Electronic Equipment (WEEE); Recycling; WEEE management; Electrical and Electronic Equipment (EEE) fees.

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1 Introduction

The regulation of waste electrical and electronic equipment treatment is one of the EU's concerns and which has led to the recent update of the regulatory policy. The latest Waste Electrical and Electronic Equipment (WEEE) Directive (2012/19/EU, 2012) further updated previous measures defined in 2002, promoting the protection of the environment and human health. This Directive 2012/19/EU aims to prevent or reduce adverse impacts arising from the production and management of such waste, decrease overall impacts and improve the efficient use of the resources in order to create a more sustainable development.

WEEE management systems in Europe are mainly the responsibility of EEE producers. They are responsible for the collection and treatment of equipment when they reach their end-of-life status, which is known as Extended Producer Responsibility (EPR). In order to better manage WEEE collection and further treatment, producers are usually organised in associations that fulfil this responsibility, named Producer Responsibility Organisations (PRO). According to a preliminary analysis of those WEEE management systems, information concerning the amount of EEE fees applied to each appliance in some countries is public, such as in Portugal, whereas in others it is not. We conjecture that differences in national WEEE legislation lead to some disparity in transparency across countries, and may increase unnecessary costs that make the European recycling system less efficient.

To address this issue, the European Commission carried out several studies that enable an international cross evaluation of EEE/WEEE registration models, calculation methods, recovery and reuse goals, percentage of collection and treatment costs, amongst others (Magalini et al., 2014; Sander et al., 2007; Seyring et al., 2015; Spasojevic and Swalens, 2016; Watkins et al., 2012). However, at the date of this paper, no previous studies were found on the applicable fees or EPR models practised in each country. Under these circumstances, the need for further information on the current EEE fee systems implemented in Europe becomes critical in order to properly evaluate leading actors towards the European WEEE collection target of 65 % of electronic equipment sold from 2019 onwards, or 85 % of electronic waste generated, as noted in Directive 2012/19/EU (2012).

The analysis presented herein aims to tackle this lack of knowledge, understand how the EEE fees are adjusted to each country's income per capita, and evaluate the efficiency of the WEEE management process across Europe.

Therefore, we considered variables that directly relate to fee levels, both on the consumer and producer sides. Regarding the role of consumers, income per capita should influence the amount and type of EEE purchased, whereas, regarding the PROs, the amount of WEEE collected and the recycling and valorisation rates achieved should reflect the efficiency of the WEEE collection systems, as well as of sorting and treatment processes. The methodology of this work thus includes the collection and analysis of information on EEE fees - considering their dimensions by category and by country - and, finally, on the association between the existing fees, the amount of equipment collected, and the GDP per capita (GDP*pc*).

The EPR concept was previously introduced by Lindhqvist and Lidgren (1990). This research takes into consideration financial incentives that may be applied in order to hold producers responsible for the full lifecycle of their products, including the end-of-life disposal costs. Published works on the subject have emerged in the last fifteen years focusing on the design of EEE/WEEE management systems and case studies of best practices. Widmer et al. (2005) present global perspectives on WEEE in line with the previous Directive (2002/96/EC, 2003), identifying problems in the WEEE management and analysing EPR as a new paradigm, while Sachs (2006) considers the practical problems of implementing EPR principles. Other authors on EPR analysis include Mayers (2007), who adopts a practical approach on the implications of the EPR design in Europe through a case study of Sony Computer Entertainment Europe; and Dubois (2012), who criticises the efficiency of the EPR system and proposes the creation of a complementary tax charged to producers. More recent studies include Kiddee et al. (2013), with the analysis of WEEE management approaches, concluding that EPR may prove to be good policy in solving the growing e-waste problems; and Wang et al. (2017), where they compare operating models for WEEE in Japan, Germany, Switzerland and China, taking into consideration the development directions of the EPR system. For other references of pertinent studies on EPR, Cahill et al. (2011) provide an extended review analysis comparing EPR implementation on packaging waste and WEEE in eleven EU countries.

WEEE handling issues are also relevant to understand the efficiency of the system. Several analyses of best practices on WEEE handling are available, although they do not take into consideration EEE fees. Comparisons have been made between Switzerland, Norway, Sweden and Denmark (Ongondo et al., 2011); Switzerland and India (Sinha-Khetriwal et al., 2005); Italy and Romania (Torretta et al., 2013); another study specifically analyses Romania (Ciocoiu et al., 2016); and a more recent analysis compares Europe and China on the emergence of PROs (Salhofer et al., 2016).

The above-mentioned studies support the intentions of European countries of promoting the best practices of collection, treatment and recycling of WEEE in order to increase efficiency of WEEE management systems, and reach European standards and targets for collection and treatment, considering valorisation and recycling rates. The EEE fee design is therefore of utmost importance to promote efficiency of WEEE management systems. Curiously, very few studies examine or compare EEE fees and costs of European obligations, most likely due to the difficulty in data collection. One author, Favot, stands out because he has comprehensively taken this issue into consideration, developing a study on statistical analysis of EEE prices (Favot and Marini, 2013), questioning the origin of PROs with a focus on costs (Favot, 2015), and analysing the evolution of the Italian EPR system (Favot et al., 2016), and the ratio of EPR compliance fees on sales revenues of EEE (Favot et al., 2017).

Cahill et al. (2011) further confirm that the current European EPR systems are in conflict with regard to the different opinions between local authorities, stakeholders and industry. No other relevant evidence exists on the analysis of EEE fees between EU countries, nor proposals for transversal improvement.

The resulting evidence on expected average fees per changes in income per capita and per levels of WEEE collection allows regulators and users to adjust their payments and create a more competitive, and less costly, WEEE management system.

This article further presents the data collection process and preliminary analysis in Chapter 2, the model results in Chapter 3, and concludes in Chapter 4 with the final considerations.

2 Material and methodology

The availability of public information on EEE fees and collected quantities is highly limited, urgently requiring an in-depth data collection effort. Data collection was a challenging stage of this analysis due to confidentiality concerns from PROs. Lack of data impairs the analysis of the costs of WEEE management, which may be the result of lack of obligation to transparency. The EU Directive on WEEE management provides indications on categories and collective financing schemes, though not specifically encouraging the clear availability of data to the consumer. Therefore, the main contribution of this paper lies in the assembly of data which allows the analysis of EEE fees across ten European countries.

The WEEE Directive and the adopted 2017 WEEE Package mostly provide guidelines on quantity issues and collection targets. The financing of the costs of the system is up to the discretion of each country, taking into acccount the possibility of individual or collective financing by the producers but without an obligation to consider the visible EEE fees in most of the cases. Therefore, countries may consider cost information as confidential, or they simply do not voluntarily disclose such information.

Critical data for this work included WEEE quantities and EEE fees. A comprehensive bottom-up approach was used, starting with a detailed listing of entities, developed by searching in each EU country for PROs and other WEEE management organisations. A total of 82 entities from 25 countries was recorded, in which almost no public information was accessible. The following step involved personalised contacts, which unsurprisingly revealed confidentiality issues in disclosing information, mainly due to commercial strategy. To further ensure privacy in data treatment, WEEE Forum endorsed the present research, thus allowing an easier collection of information within their associates.

The WEEE Forum is a non-profit association of 34 WEEE PROs, or producer compliance schemes, mostly from Europe. It provides a platform for PROs to take on the challenge of properly managing WEEE in Europe by fostering ideas and sharing best practices while optimising environmental performance[1]. The contact with WEEE Forum PRO associates resulted in a better response rate, although participating entities could not be listed due to confidentiality agreement reasons. In the end, we were able to gather information from entities of ten European countries, specifically Austria, Belgium, Greece, France, Ireland, Italy, Netherlands, Norway, Poland and Portugal, corresponding to 36% of the WEEE Forum associates, and 36% of initially contacted countries.

The analysis undertaken for each country considered income level and waste collection rates, the two main variables that we propose that influence the charged fees. First, the income level is expected to be related to the established EEE fees, as a higher level of revenues per capita may lead to more EEE purchased, and thus more WEEE produced. Second, the amount of WEEE collected directly reflects waste collection and treatment costs.

To represent the income level we used GDP*pc* information, a typical measure of wealth per person. GDP*pc* is highly correlated to the fiscal revenues per capita of environmental taxes, and to a stringent index of environmental policies in European countries, which makes it a good proxy to represent the consumers' concerns and intentions when buying electronic equipment. Values were obtained from EUROSTAT (main GDP aggregates per capita, at constant prices (2010)).

Regarding the collection ratios of WEEE, rates are measured as the ratio between the waste collected and the products placed on the market, measured in tonnes. In Table 1 we present the values for the ten countries included in our analysis, also obtained from

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[1] More information on WEEE Forum available at http://www.weee-forum.org/.

EUROSTAT. Current methodology to calculate collection quantities is presented in the 2017 WEEE package. However, it does not apply retroactively to previous years, so we chose not to consider it.

Table 1 – Collection rates (total WEEE) by country, 2012-2014

Country	2012	2013	2014
Austria	48.9%	49.3%	47.0%
Belgium	35.3%	39.0%	38.6%
Greece	27.5%	30.7%	32.6%
France	29.4%	30.9%	33.6%
Ireland	48.5%	50.1%	48.1%
Italy	55.7%	51.6%	35.5%
Netherlands	38.1%	38.4%	44.3%
Norway	56.4%	58.1%	58.8%
Poland	36.4%	35.3%	27.6%
Portugal	37.3%	41.0%	49.6%

Source: EUROSTAT (WEEE by waste operations).

Considering WEEE characterisation, data on total WEEE collected and EEE fees was examined for each available PRO. On the selected categories, the WEEE 2012 Directive (REF) sets a total of ten types of products for reporting purposes. However, to harmonise our analysis and align the study with all participating countries and PROs, we reduced the study to five groups, as presented in Table 2. In the end, we requested information on fees per broad type of EEE, specifically Large Household Appliances (A), Cooling and Freezing (B), Small Household Appliances (C2), including information technologies, Lamps (D), and Screens (E), and the collected quantities.

Table 2 – WEEE categories mapping

Directive 2012/19/EU WEEE Categories	Considered categories		
	Name	Short	Code
Large household appliances (including cooling and freezing)	Large household appliances	LHA	A
	Cooling and freezing	CF	B
Small household appliances	Small household appliances	SHA	C2
IT and telecommunications equipment	Small household appliances	SHA	C2
Consumer equipment (including televisions and monitors)	Small household appliances	SHA	C2
	Televisions and monitors	SCR	E
Lighting equipment	Lighting equipment	LAM	D
Electrical and electronic tools	Small household appliances	SHA	C2
Toys, leisure and sports equipment	Small household appliances	SHA	C2
Medical devices	Large household appliances	LHA	A
Monitoring and control instruments	Large household appliances	LHA	A
Automatic dispensers	Large household appliances	LHA	A

Source: Own computations. Short stands for 'short names'.

Since PROs present differences in the units of account, the data has to therefore be normalised. In some cases, the fees are charged per product, whereas in others they are charged per weight. The recent WEEE Package provides further insight on the methodology for the calculation of the weight of EEE placed on the market, and a common methodology for the calculation of the total quantity of WEEE generated by weight in a Member State. However, it does not provide indication on individual product weight, which is required for the analysis of individual fees. For this work, we chose to follow the most common measurements amongst participants, and use a unit of euros per kilogram (€/kg), applying the necessary conversion values in order to have an average weight per product. The full conversion table is available in Annex I.

To summarise the collected information, while keeping a degree of confidentiality, we disclose information by country in Table 3 below.

Taking note of all initial limitations in data collection, we were able to build a database, listed in the previous tables, that allows a proper evaluation of the effect of collected quantities and GDP per capita in the applicable EEE fees in each country.

Table 3 – Average EEE fees by category and country, in €/kg

Category		AT	BE	EL	FR	IR	IT	NL	NO	PL	PT
A	LHA	0.014	0.012	0.125	0.064	0.033	0.055	0.023	0.065	0.022	0.049
B	CF	0.202	0.037	0.140	0.075	0.080	0.034	0.032	0.100	0.024	0.068
C2	SHA	0.150	0.392	0.178	0.167	0.067	0.493	0.073	0.060	0.022	0.090
D	LAM	0.818	0.641	0.000	-	0.200	0.170	1.827	0.060	0.358	0.335
E	SCR	0.137	0.084	0.254	1.871	0.060	3.545	0.049	0.100	0.022	0.124

Source: Own computations.

2.1 The European disparities

Although an initial analysis of average fees by country may present what seems to be just random values throughout Europe, a more detailed analysis is provided in Figure 1, where outliers were removed from the sample (three values from categories E and D). This approach was replicated for specific categories in Figure 2, Figure 3 and Figure 4. The study focused on the years 2013-2016 including all countries, except Greece, Norway and Poland, in which an average was calculated for 2013-2015; Ireland, with values only from 2016; and Italy, referring to the 2009-2010 average, due to lack of information for the main period considered. From all data collection, we came to understand that in each country the variation in fees over the years is very low. Thus, despite the assumptions and different years considered, Figure 1 - Figure 4 suitably show the average fees by country and category.

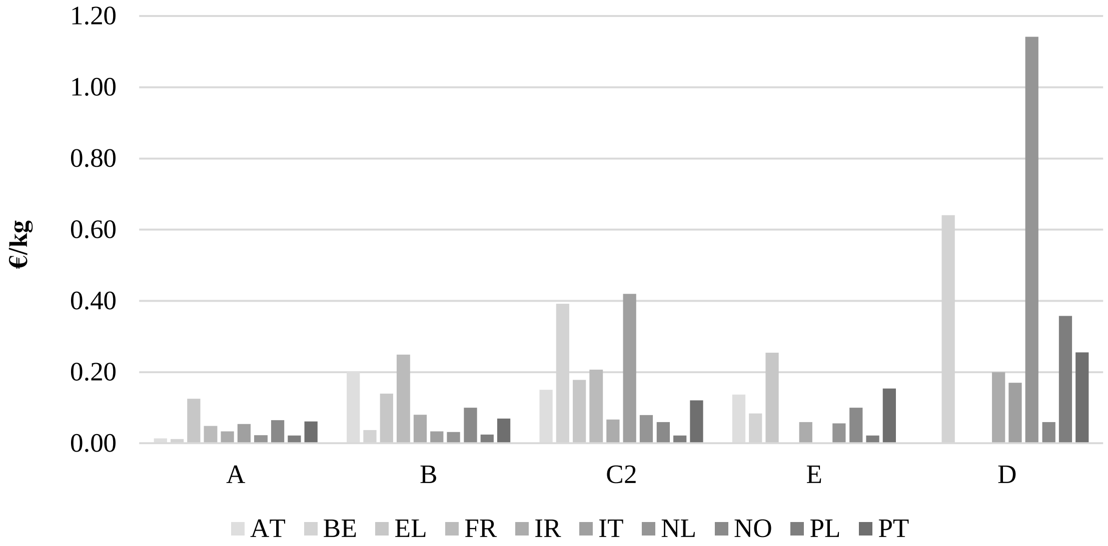

Figure 1 – Average fees by category and country

Category A initially stands out with the lowest fee per kg, whereas categories C2 and D, namely Small Household Appliances and Lamps, show higher fee values per kg.

Taking a closer look at categories A, B and C2, in Figure 2, we see Large Household Appliances (A) standing out as the category with the lowest values, from the minimum value of 0.012 €/kg (in Belgium) to 0.13 €/kg (in Greece). This result may be due to the fact that it has been rather easy for countries to combine the fee for new equipment with the decommissioning of older machines, in the case of equipment with a long life span. In Figure 3, Cooling and Freezing (B) and Screens (E) show slightly similar values, varying from 0.02 €/kg to 0.25 €/kg. Category C2 (Small Household Appliances) has higher values, reaching 0.39 €/kg (Belgium) and 0.42 €/kg (Italy), which may be due to the large scope of this dimension, which includes several types of equipment with higher collection and treatment costs. Also, it is a category where products are lighter, and thus the fee per equipment is lower in total, even if it shows a higher €/kg value.

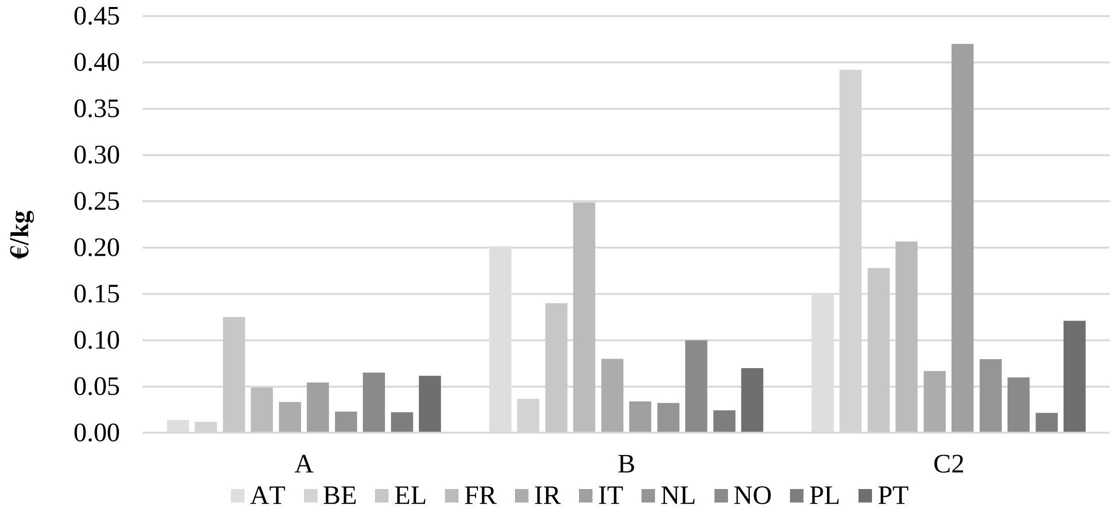

Figure 2 – Average fees by country, categories A, B and C2

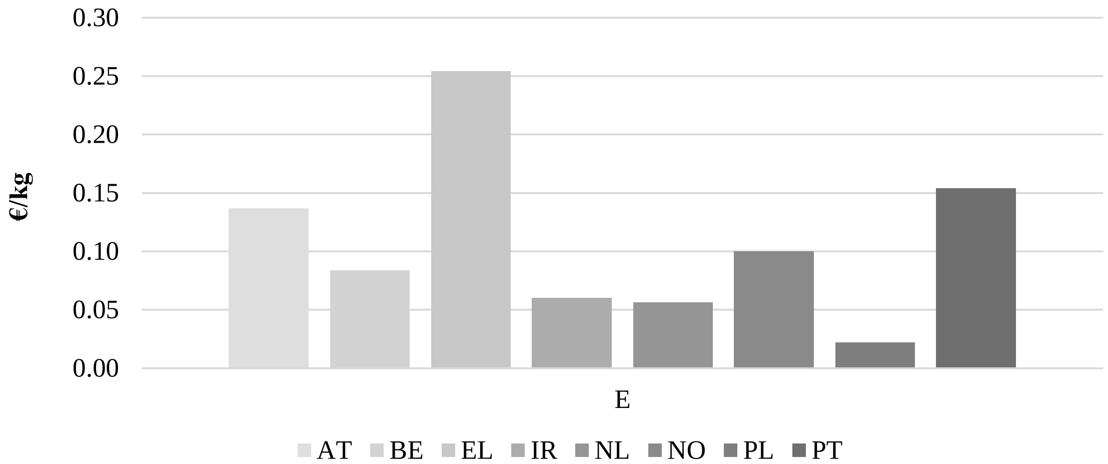

Figure 3 – Average fees by country, category E

Finally, in Figure 4, Category D (Lamps), as we will see throughout this analysis, shows the highest values when compared with other categories. It reflects the lowest absolute values of the fees, which proportionally to the equipment weight reaches negligible values per equipment. The Netherlands stands out with the highest fee, reaching 1.1417 €/kg, and Greece with the lowest fee, in contrast with its position in previous Category E. In Category (D), there is also high variations in fees amongst countries, most probably due to high collection and treatment costs.

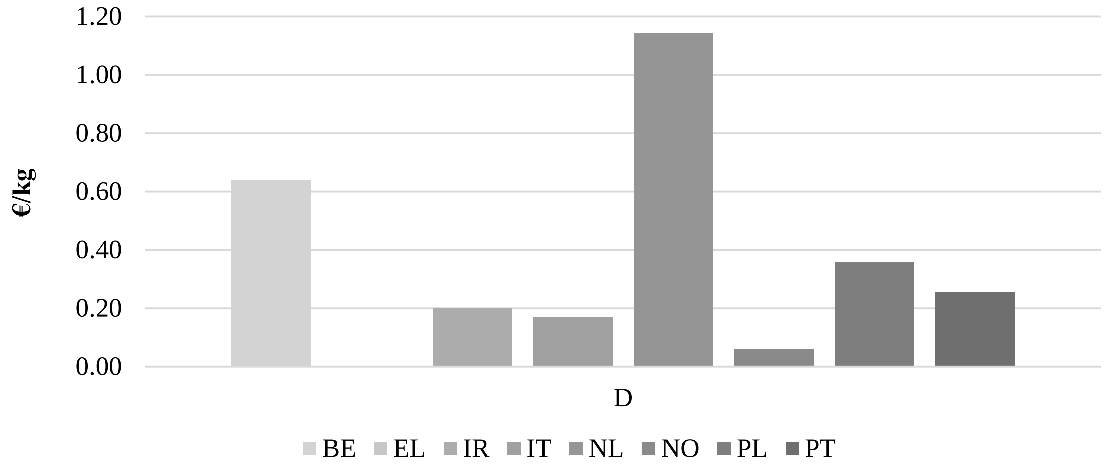

Figure 4 – Average fees by country, category D

Considering a temporal perspective, in Figure 5, the average fees within all categories, during the years 2013-2016, in each country are almost all within the range of 0.1 €/kg and 0.25 €/kg, except in the Netherlands in 2013, and in France. The reason why France shows higher values, between 0.63 €/kg and 1.05 €/kg, is due to an outlier linked to their fees on Screens, which reaches 3.73 €/kg. When excluding this category, France displays values aligned with the rest of the countries, with a growing trend as in the Netherlands. Conversely, Austria, Belgium, Poland and Portugal show decreasing values over time, which may relate to a better performance of the system.

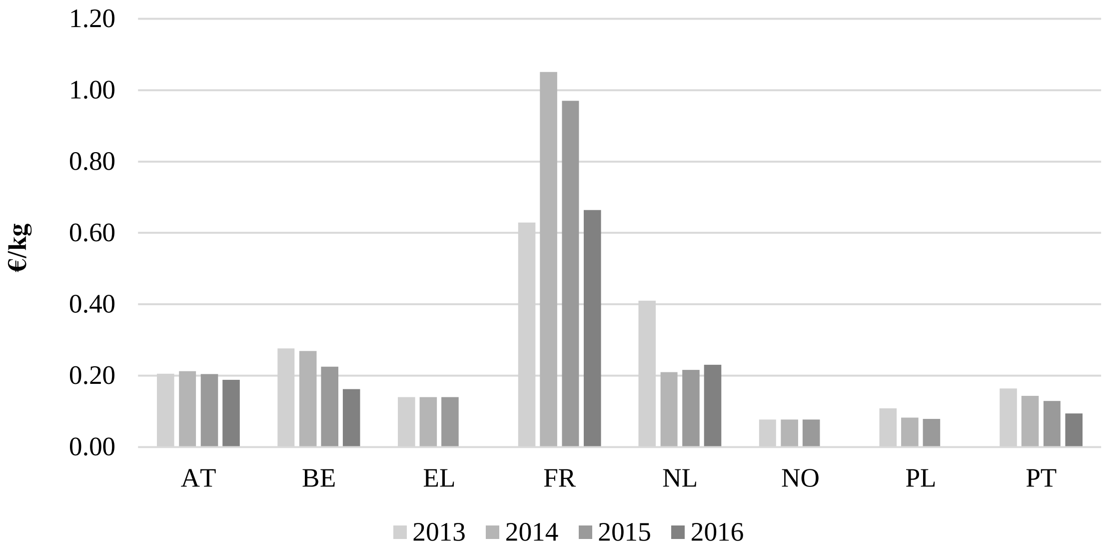

Figure 5 – Fees by country, category average, 2013-2016

More visibly, in Figure 6 we depict the average fee in 2015 in the analysed countries, 2017 for Ireland and 2009 for Italy. As already mentioned, the variation in years is not significant. Therefore, the map presents a geographical representation of the average EEE fee. We can see that central Europe has slightly higher fees, whereas peripheral countries have lower fees, except for Portugal. However, we did not find any indication that this space relation may be more than just a coincidence. Ranking the countries from the lowest average fee per kg to the highest, we start with Norway with 0.077 €/kg, and finish off with Belgium with 0.225 €/kg.

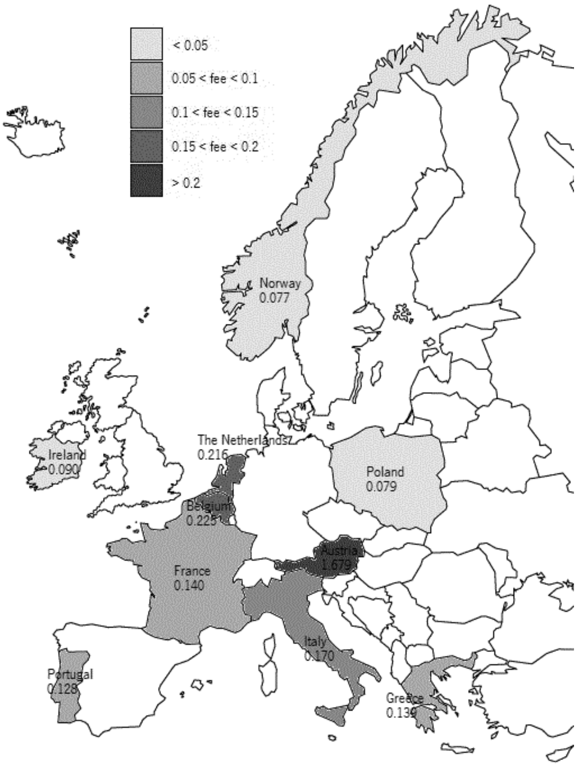

Figure 6 – Average fees (€/kg) by country, 2015

2.2 Descriptive analyses of the WEEE categories

In this section, we consider the average EEE fees across Europe, by category and year. We observed values of similar magnitudes for Large Household Appliances (A), Cooling and Freezing (B) and Small Household Appliances (C2). Screens (E) and Lamps (D) typically have higher fees per kg. Curiously, when looking at values by country, averaging the years (Figure 1), we see similar values between Cooling and Freezing and Screens. This means that the overall European results do not correspond to the sum of the individual analysis of each country. Taking this information into account, and noting the critical lack of information on the subject, we will briefly describe in the following figures the average fee of all countries during the years 2013-2016 only for reporting purposes.

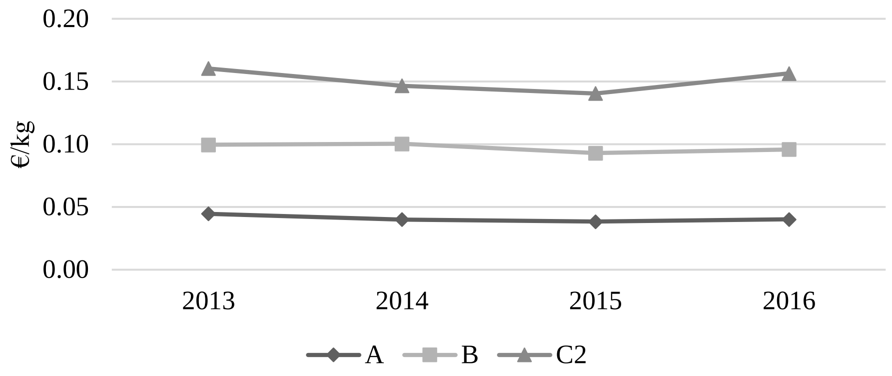

Figure 7 – EU average fees, 2013-2016, categories A, B and C2

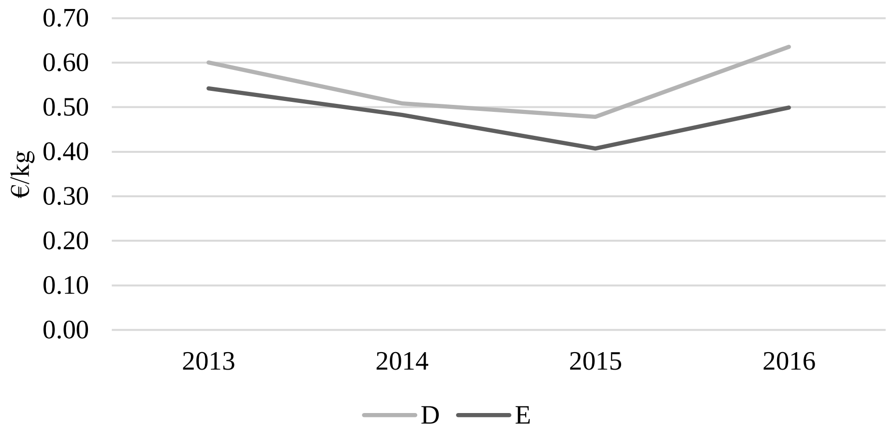

Figure 8 – EU average fees, 2013-2016, categories D and E

In Figure 7, all three categories, Large and Small Household Appliances (A, C2), and Cooling and Freezing (B), have very stable values over the years. This result may be due to the experience European countries hold in dealing with these household appliances, to a high level of consumer awareness, and to the unavailability to keep older equipment. We found values of almost 0.05 €/kg for Large Household Appliances, around 0.10 €/kg for Cooling and Freezing, and an average 0.15 €/kg for Small Household Appliances.

As aforementioned, Lamps (D) have higher fees, although in Figure 8 we noted that Screens (E) show a similar trend and magnitude. The values of the Lamps (D) may be justified by their low weight, meaning that the fee per equipment may be relatively small, thus allowing a higher fee per kg. However, similar reasoning cannot be applied to Screens (E). In the previous section, according to the detailed analysis by country, we observed that Screens have similar values to Cooling and Freezing, which seems a more reasonable conclusion. As the average EU values are not in line with the individual analysis of each country, we will discard this conclusion.

2.3 Model of fees, national income and WEEE collection rate

To analyse the relation between EEE fees, countries' income per capita and amount of WEEE collected, used as a proxy for efficiency, we developed a multiple regression model to explain the value of a variable based on the value of other two or more variables. Typically, these models also allow us to determine the overall fit of the model and the relative contribution of each of the predictors to the total variance explained.

In this project, the goal is to understand if each fee (in each category) is affected by two main identified aspects. On the one hand, the consumer features, which we measure by the country's wealth per capita using the GDP*pc*; and, on the other hand, the supply scheme, evaluated by the WEEE collected rates. In detail, the logarithm of the fee is used as the dependent variable ($Log\ Fee$), measured in euro cents per kilogramme. As independent variables, we included the logarithm of the GDP per capita ($Log\ GDPpc$), measured in euros (constant prices; 2010 reference year), and the *collection rates* (CR), measured as the ratio between the waste collected and the products placed on the market, both measured in tonnes, by country and WEEE category. This variable is included in the model with one-year lag, assuming that fees are adjusted according to collection rates observed in the previous year. Since the dependent variable is in logarithmic form, the coefficients β_1 and β_2 can be interpreted as elasticities. *Dummy variables* were also included (YD) for each of the years considered to control macroeconomic shocks that could similarly have affected all countries (2013 is the base year).

The equation of the regression model is as follows:

$$Log\ Fee_{c,t}^{i} = \beta_1\ Log\ GDPpc_{c,t} + \beta_2\ CR_{c,t-1}^{i} + \beta_3\ YD_{2014} + \beta_4\ YD_{2015} + e_t^{i}$$

$$i = \{A, B, C2, E, D\}, \qquad c = \{countries\}, \qquad t = \{2013, 2014, 2015\}$$

Outliers were dropped from estimations using the index DFITS proposed by Welsch and Kuh (1977), and the cut-off point of 2√(k/n) suggested by Besley et al. (2005).

The idea is to perceive the signal and magnitude in which the variations in GDP*pc* and the collection rate affect the charged EEE fees, in order to understand how countries are attributing a value to their WEEE treatment. The analysis of EEE fees across Europe and amount of WEEE collected is valuable evidence, and will be reported in Chapter 4.

3 Results and discussion

In this section, we formulate the idea that each fee (in each category) is affected by two aspects. On the one hand, the consumer features, which we measure by the country's wealth per capita using the GDP*pc*, and, on the other hand, the supply scheme capacity, evaluated by the WEEE collection rates. Building on the previous straightforward analysis of the variables, presented in sections 2.1 and 2.2, the model goes one step further and calculates the direction and quantity of the correlation. The goal is to understand if the consumers' wealth and the WEEE collected positively affect the EEE fees, and by how much. We developed an independent model for each category to better perceive differences between equipment.

From the multiple regression model presented in section 2.3, we obtained four relevant outcomes, visible in Table 4.

Table 4 – Estimation results: association between fees, GDP*pc* and collection rates

	A (LHA)	B (CF)	C2 (SHA)	E (SCR)	D (LAM)
Log(GDP*pc*)	-0.596*	0.772*	0.170	-0.262	-0.627
	(0.317)	(0.369)	(0.347)	(0.398)	(0.622)
Collection rates	0.009	-0.027	-0.032*	0.001	0.039***
	(0.026)	(0.016)	(0.015)	(0.018)	(0.014)
Observations	27	29	29	26	22
R-square	0.153	0.154	0.157	0.028	0.357

Notes: robust standard errors in parentheses. Significance levels: ***, 1%; **, 5%; *, 10%. The dependent variable is *log(fee)*. All models include a constant and year dummies.

The association between WEEE collection rates and EEE fees is heterogeneous. It is negative and statistically significant for the Small Household Appliances category, which may indicate economies of scale associated with a greater amount of WEEE collected. There is also a positive, and statistically significant, association between fees and collection rates for the category Lamps (one percentage point increase in the collection rate of Lamps is associated with a 0.04% increase in fees), which may be due to, on the one hand, the amount of hazardous or non-valuable materials in their composition that increases treatment costs and, on the other hand, the low weight of lamps that increases the collection costs.

In the following graphs, we show the partial-regression plots, or added-variable plots, which are useful in identifying influential points. Figure 9 and Figure 10 show $Log\ Fee$

by $Log\ GDPpc$ after both $Log\ Fee$ and $Log\ GDPpc$ have been adjusted for all other predictors in the model (collection rates and time dummies), for each WEEE category, where statistically significant coefficients were found. Figure 11 and Figure 12 show $Log\ Fee$ by $Collection\ Rate$ after both variables have been adjusted for all other independent variables. Again, we only present the graphs where the slopes of the regression lines are statistically significant.

For **Large Households Appliances** (A), Figure 9 shows a clear negative association between $Log\ Fee$ and $Log\ GDPpc$. 1% increase in GDP*pc* is associated with a 0.6% decrease in fees. This relationship is statistically significant. Countries with smaller GDP*pc* tend to exhibit higher fees for similar collection rates, except Poland. PROs in Austria and Belgium charge smaller EEE fees than the average of countries with similar income per capita and collection rates. The opposite applies to Norway.

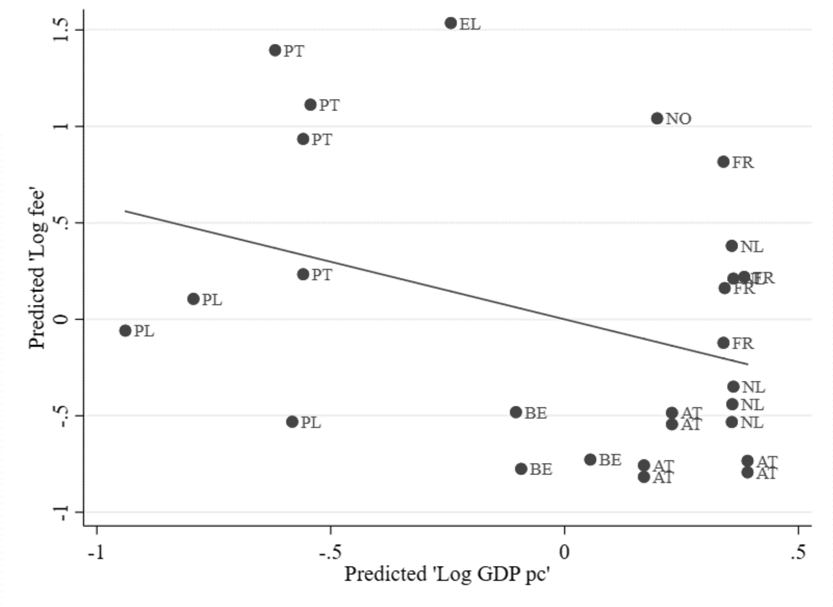

Figure 9 – Large Household Appliances: added-variable plot for Log(GDP*pc*)

For the **Cooling and Freezing** category (B), 1% increase in GDP*pc* is associated with a 0.77% increase in fees. This relationship is statistically significant. Fees charged in

Poland, Belgium and Netherlands tend to be lower than the ones predicted by the model. The opposite is true for Austria and Greece. Fees charged in Portugal, Norway and France are close to the values predicted by the model.

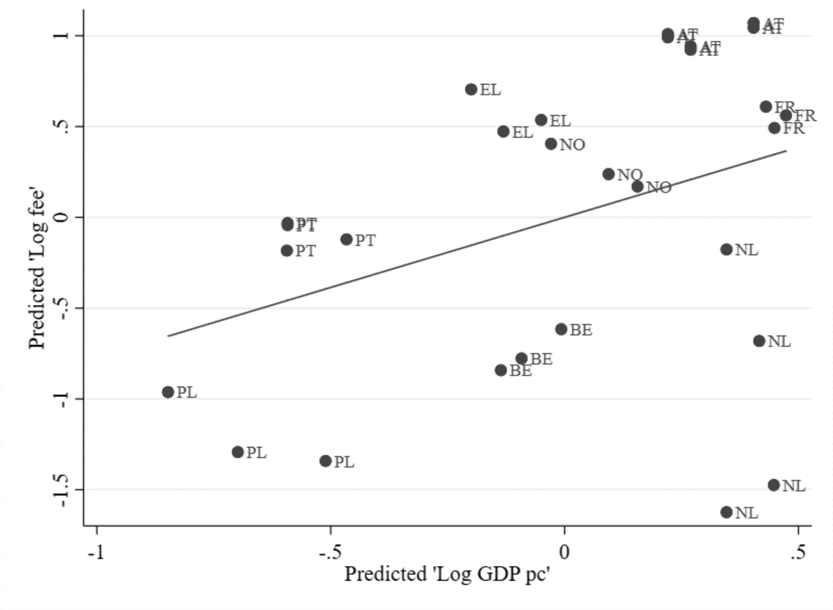

Figure 10 – Cooling and Freezing - added-variable plot for Log(GDP*pc*)

Fees for categories C2, E and D did not present any statistically significant relations with the GDP*pc*.

Looking at WEEE collection rates, on **Small Household Appliances** (C2)**,** countries with higher collection rates tend to observe minor fees, apart from differences in income per capita, as shown in Figure 11. This negative correlation with fees suggests that economies of scale may be associated with a greater amount of WEEE collected. In this case, one percentage point increase in collection rates is associated with a 0.03% decrease in fees.

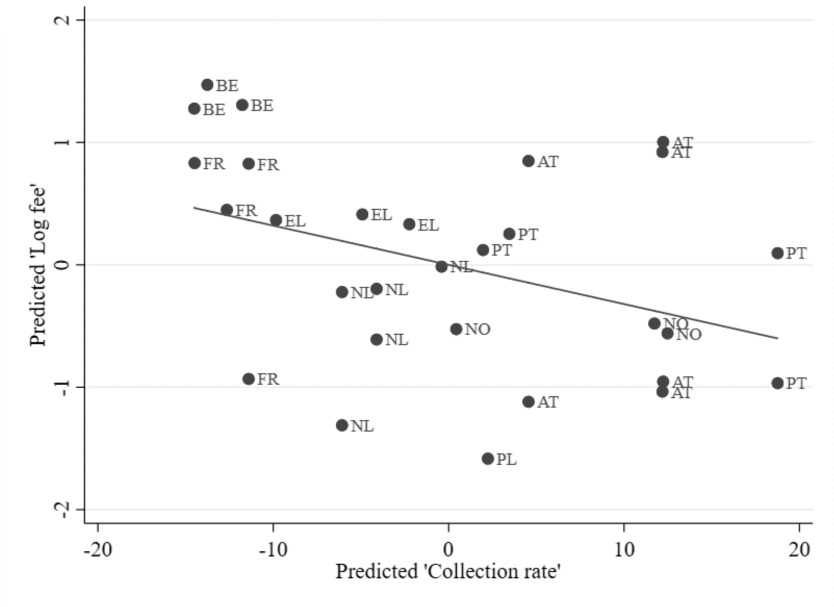

Figure 11 – Small Household Appliances - added-variable plot for Collection Rate

Countries with higher collection rates of **Lamps** (D) are likely to observe larger fees for this category. This positive association may be the result of higher unit collection costs as the collection rates increase, implying further investments in the collection systems.

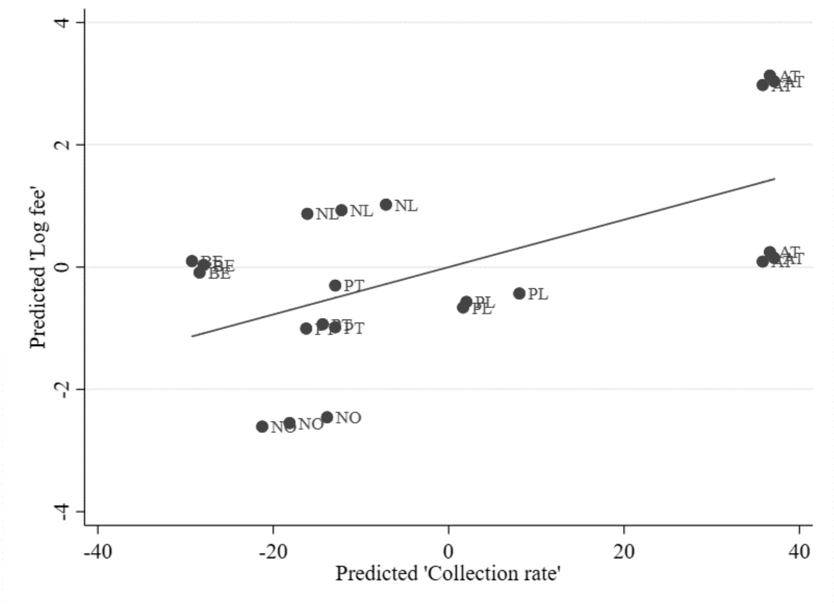

Figure 12 – Lamps - added-variable plot for Collection Rate

4 Conclusions and final policy remarks

We looked at the fees applied in EU countries to EEE in order to explore correlations between fee levels, and the main proxies for the demand of EEE, and the supply of WEEE treatment. Specifically, we analysed correlations between charged EEE fees, income levels, using the GDP*pc*, and WEEE collection rates.

Severe lack of data was verified in the beginning that impaired the analysis of the costs of WEEE management, and that may be the result of lack of obligation to transparency. The EU Directive on WEEE management provides indications on categories and collective financing schemes, though not specifically encouraging the clear availability of data to the consumer. Considering that data collection was a challenging stage of this analysis, this paper's main contribution thus lies in the assembly of information, enabling the analysis of EEE fees across ten European countries.

An initial analysis of the data showed a slightly growing trend in the fee values in France and in the Netherlands, and a decreasing trend in Austria, Belgium, Poland and Portugal. However, we may consider values within countries to be stable over the years, particularly because the time span we considered is yet too small. Considering different categories and countries, we found that France has unusually high values due to a very high fee value on Screens, followed by Austria, the Netherlands and Belgium, with fees between 0.25 €/kg and 1€/kg. Lower average values belong to Portugal, Poland, Greece and Norway, typically between 0.05 €/kg and 0.15 €/kg. On WEEE categories, Large Household Appliances show the lowest fees amongst most countries, followed by Cooling and Freezing, and Small Household Appliances, depending on the country, though all below 0.20 €/kg. We consider this to be due to the experience European countries hold in dealing with these appliances and to the fact that LHA and SHA have lower hazardous components that lead to lower treatment costs. In the case of Cooling and Freezing, the reason may lie in a higher consumer awareness and unavailability to keep older equipment. Lamps show the highest fee values, which is consistent with the high treatment costs, the high marginal collection effort, and the small absolute value due to its lightweight.

Overall, estimates of the regression model show statistically significant correlations particularly between the GDP per capita and collection rates, and the EEE fee levels, which guide the analysis of the data we collected.

We found that statistically significant relations with fees are largely dependent on the WEEE category, and are weaker and more heterogeneous than expected. It is worth mentioning the negative association between GDP*pc* and fees for Large Household Appliances (1% increase in GDP*pc* associated with a 0.6% decrease in the fees), and the positive association between GDP*pc* and the fees for Cool and Freezing (1% increase in GDP*pc* associated with a 0.77% increase in the Cool and Freezing fees). With regard to collection rates, we found a 0.03% decrease in Small Household Appliances fees for one percentage point increase in collection rates. Curiously, the opposite occurs with Lamps, where one percentage point increase in collection rates results in 0.04% increase in Lamps fees.

No other statistically significant relations were found. It is possible to justify significant signals, coherent within each country, though it seems there is a certain degree of randomness in the applicable fees across countries, showing a lack of binding European policy in this matter.

In this context, we consider that future good practices must include public availability of data, and information on the background calculation of the fees, even if it only covers previous years. This is currently not a common practice and creates transaction costs and learning difficulties that could be avoided. Our analysis adds significant value to research on the subject of EEE and waste collection, as we have set up a unique effort to systematise previously inaccessible information on EEE fees and develop an initial methodology for assessing the adequacy of fees to the specificities of the countries.

Further developments should consist of a scope expansion to other countries and to a larger time interval, as well as the enforcement of a close examination on the type of WEEE management market that may be influencing competition.

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6 Annex I – Equipment unit conversion

Electrical and Electronic Equipment	Tonnes	Number of units	Kg/unit
Total	94203.34	23816726	
1.1.1 Large Cooling Devices ≤ 150kg	17824.66	291107	61.23
1.1.2 Large Cooling Devices > 150kg	1197.66	4710	254.28
1.2 Large household appliances	24722.64	425350	58.12
1.3 Cooking or Food Processing Equipment > 20kg	4982.00	136092	36.61
1.1.A) Air Conditioners and Dehumidifiers ≤ 40kg	4052.95	224305	18.07
1.2.A) Air Conditioning Appliances]40-100kg]	1812.21	31202	58.08
1.3.A) Air Conditioning Appliances]100-500kg]	1193.51	5685	209.94
1.4.A) Air Conditioners > 500kg	766.24	408	1878.05
1.5.1A) Devices of Electric Heating Exhaust and Condition ≤ 10Kg	1392.77	337789	4.12
1.5.2A) Devices of Electric Heating Exhaust and Condition]10-150kg]	4781.04	142439	33.57
1.5.3A) Devices of Electric Heating Exhaust and Condition > 150kg	822.98	1380	596.36
2.1.1 Small Equipment for domestic use ≤ 0.2kg	32.07	370145	0.09
2.1.2 Small Equipment for domestic use > 0.2kg	10173.41	2419758	4.20
2.2 Cleaning Devices	1119.39	224910	4.98
3.1. Desktops. Servers and Main Frames (without monitor)	259.94	41375	6.28
3.2 Portable computers	354.86	237748	1.49
3.3.1 CRT / LCD / TFT / Plasma monitors ≤ 29 "	377.75	92074	4.10
3.3.2 CRT / LCD / TFT / Plasma monitors]29-42 "]	78.05	12693	6.15
3.3.3 CRT / LCD / TFT / Plasma Monitors > 42 "	60.69	3019	20.10
3.4.1 Photocopiers / Printers / All-in-ones / Plotters / Faxes / Scanners ≤ 60 Kg	1105.09	210792	5.24
3.4.2 Photocopiers / Printers / All-in-Ones / Plotters / Faxes / Scanners > 60kg	852.30	6941	122.792
3.5. Cell Phones / PDAs / Pocket / Laptop Calculators	215.59	1405307	0.15
3.6 Calculators with printer / bead printers / cash registers / POS	123.36	64037	1.93
3.7 Telephone Stations, Cordless and Desk Phones	87.09	244526	0.36
3.8.1 Other Equipment ≤ 1kg	312.79	1214263	0.26
3.8.2 Other Equipment]1-15kg]	378.90	141417	2.68

3.8.3 Other Equipment]15-50kg]	195.70	7112	27.52
3.8.4 Other Equipment > 50kg	237.23	1318	180.00
4.1.1 Televisions/CRT/LCD/TFT/Plasmas and Surveillance Monitors ≤ 29 "	101.16	23899	4.23
4.1.2 Televisions/CRT/LCD/TFT/Plasmas and Surveillance Monitors]29"-42"]	1503.99	155550	9.67
4.1.3. Television / CRT / LCD / TFT / Plasmas and Surveillance Monitors > 42 "	1439.90	86396	16.67
4.2.1 Receiving, Recording, Playback Audio Video / Video Vigilance and Photographic Material <= 1kg	140.74	270882	0.52
4.2.2 Receiving, Recording, Playback Video / Video Recorder > 1kg	363.17	89226	4.07
4.3 Video Projectors / Overhead Projectors	53.29	29598	1.80
4.4 Small equipment audio / video / photography	72.49	362491	0.20
4.5 Musical Instruments	86.02	14894	5.78
4.6.1 Other Equipment ≤ 1kg	60.87	228391	0.27
4.6.2 Other Equipment]1-15kg]	250.26	98807	2.53
4.6.3 Other Equipment > 15kg	44.25	767	57.69
4.7 Photovoltaic panels	207.51	10893	19.05
5.1.1 Fluorescent and Discharge Lamps	666.69	5897902	0.11
5.1.2 LED Lamps	869.25	4368982	0.20
5.2.1 Fixtures ≤ 1kg	461.76	1040325	0.44
5.2.2 Fixtures]1-6kg]	1937.50	783536	2.47
5.2.3 Fixtures > 6kg	770.93	74531	10.34
5.3 Other lighting equipment	283.64	553622	0.51
6.1 Electrical and Electronic Tools ≤ 1kg	42.34	90975	0.47
6.2 Electrical and Electronic Tools]1-10kg]	1452.24	460287	3.16
6.3 Electrical and Electronic Tools]10-20kg]	404.28	28904	13.99
6.4 Power and Electronic Tools > 20kg	1133.12	19931	56.85
7.1 Toys and Sports and Leisure Equipment ≤ 5kg	97.60	251497	0.39
7.2 Toys and Leisure and Sports Equipment > 5kg	25.09	1323	18.97
8.1 Medical Devices ≤ 20kg	73.51	44849	1.64
8.2 Medical Devices]20-100kg]	69.47	1668	41.65
8.3 Medical Devices > 100kg	372.22	783	475.38
9.1 Monitoring and Control Instruments	1135.60	525553	2.16
10.1 Automatic Dispensers without Heating and Cooling ≤ 60kg	11.04	562	19.64
10.2 Automatic Dispensers without Heating and Cooling > 60kg	320.87	883	363.38
10.3 Automatic Distributors with Heating and Cooling ≤ 60kg	5.33	197	27.06

10.4 Automatic Distributors with Heating and Cooling > 60kg	234.38	720	325.52

Source: Amb3E computations.

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