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The Extended Producer Responsibility for Waste Oils

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ABSTRACT

Currently, lubricants producers, electrical, electronic producers, and cars producers share waste oil management responsibility. The extended producer responsibility (EPR) regime for WEEE was updated to incorporate the mandate of using economic incentives correctly regarding applying the hierarchy principle in WEEE management. Moreover, EPR on end on life vehicles (ELV) was updated to accomplish the hierarchy principle. This work aims to evaluate the scope of EPR for waste oils, for which other producer responsibility organizations (PROs) have responsibility. The method consists in estimating first the cointegrating equation for the variables lubricating oil production (LP) and oil price (FRP) using Dynamic Least Squares Estimator (DOLS) for the period 2007-2020. Subsequently, the cointegrating equation between the variables LP and electric domestic appliances with oils (AWO) and LP and vehicles production (VP) are estimated using DOLS. The main results show that the variables LP and FRP are cointegrated. Besides, the elasticity of the LP variable up to FRP was negative at 0.45. In contrast, variables LP and AWO, neither LP nor VP, are not cointegrated. That context suggested that EPR for waste oils should be considered to join other economic incentives.

Keywords: Extended Producer Responsibility, Waste Oils, WEEE, ELV
JEL Classifications: H21, H23, Q53

1. INTRODUCTION

Extended producer responsibility (EPR) in Europe is regulated by Directive 2008/98/EC and the EPR regimes for specific waste flows, such as those for waste electrical and electronic equipment (WEEE), end-of-life vehicles (ELV), tires or batteries, and accumulators[1]. That Directive defined EPR as a set of measures that include accepting returned products and the waste that remains after using those products and the subsequent management of the waste and financial responsibility for such activities. EPR also includes organizational responsibility and contributes to waste prevention and the reusability and recyclability of products. Producers of products subject to EPR can fulfill that mandate individually or collectively, for which producers set producer responsibility organizations (PROs).

The Directive (EU) 2018/849 amending Directives 2000/53/EC, on ELV, and Directive 2012/19/EU, on WEEE, to improve the management of waste in the EU, and thereby to contribute to the protection, preservation and improving the quality of the environment and to the prudent and rational utilization of natural resources. Besides, Directive 2018/849 aims for EU members to set the necessary measures for the correct application of the waste hierarchy[2]. Regarding making the transition towards a circular economy, the Directive considered the feasibility of setting targets for specific materials contained in the relevant waste streams.

In Spain, Royal Decree 679/2006 on waste oils, establishing EPR in managing waste oils[3]. From 2007, the Integrated Management

1 Directive (EU) 2018/851 of the European Parliament and the Council of May 30, 2018, modified the Waste Directive 2008/98/EC. Law 22/2011, July 28, on Waste and Contaminated Soils transposed Directive 2008/98/EC.

2 Directive 2008/98/CE, on waste, set the following waste hierarchy (Article 4): (a) prevention; (b) preparing for reuse; (c) recycling; (d) other recovery energy recovery; and (e) disposal.

3 Royal Decree 679/2006 set the ecological objectives of collecting 95% of the waste oils generated and valorizing 100% of the waste oils recovered in 2006, and regenerating 55% and 65% of the recovered oils in 2007 and

System of Waste Oil (IMS), namely SIGAUS, functioned, by which the lubricant oil producers finance the management of waste oils through their contribution to SIGAUS of 0.06 euros per kilogram of the industrial oil put on the market. Since 2015, lubricants producers and electrical and electronic producers (EEE) share waste oil management responsibility[4]. Those WEEE that contain oils –mainly temperature exchange appliances- like fridges, refrigerators, or air conditioning- get 22% in 2021. Moreover, oils producers and cars producers, share responsibility for oils since 2017.

The EPR regime for WEEE established by Royal Decree 110/2015 was updated to incorporate directive (EU) 2018/849 through Royal Decree 27/2021 regarding using economic incentives to apply the hierarchy principle in WEEE management correctly. Also, the scope of application of Royal Decree 110/2015 is extended to all EEE and allows modulating objectives for categories, uses, or types of EEEs. The EEE producers will fulfill the obligations about the design and placing on the market directly, while PROs will fulfill the organization and financing. EEE producers must guarantee no double financing with the EPR regime for used batteries and oils contained in WEEE. In turn, EEE producers can reach agreements with PROs for batteries and accumulators to organize this waste management.

Royal Decree 265/2021, of April 13, on ELV, was approved, which aims to strengthen the waste hierarchy principle, forcing the adoption of measures to ensure the practical application of the order of priorities[5]. Moreover, it ensures the homogeneous management of authorized treatment centers (ATCs). The components and materials provided as standard or in the first assembly of the automobile are subject to the extended responsibility of the automobile producer, and expanded flow responsibility regimes will not apply to them (waste oils, tires, batteries, and accumulators) to avoid double regulation and financing[6].

Both WEEE and ELV are currently sectors applying economic incentives. Tax on hydrocarbons set a tax rate for lubricants equal to industrial fuel; however, those products are not taxed[7]. Law 16/2013 of October 29 includes a tax on HFC's consumption, PFC, and SF_6 gases[8]. Tax on HFC's emissions is mainly related to temperature exchange appliances and refrigeration systems in vehicles. In 2020, there were subsidies to buy cars, but sales of cars delivered to the ATCs for removal and destruction decreased, and the number of arranged ATCs (SIGRAUTO, 2021). In 2020, the number of oils for which car producers have responsibility decreased by 25%, and those for which EEE producers have responsibility increased by 12% (SIGAUS, 2021a). Meanwhile, responsibility for lubricant producers increased up to 6.53%.

This work aims to evaluate the scope of EPR for waste oils, for which other producer responsibility organizations (PROs) have responsibility. Previously, the study was considered for all EEE for 2007-2019 (Arner, 2020). This study updates for 2007-2020 by considering only EEE, which contains oils. New regulation for WEEE justifies taken account, particularly that category of EEE. Subsequently, other economic literature about competition in the market and innovation and differentiation is shown. The methodology consists in estimating the cointegrating equations between the variables lubricating oil production (LP) and EEE, which contain oils (AWO), and between variables LP and vehicles production (VP), using Dynamic Least Squares Estimator (DOLS), for the period 2007-2020. The main results show that the variables SIG and FRP were cointegrated. Besides, the elasticity of the LP variable up to FRP was negative at 0.45. In contrast, variables LP and AWO, neither LP nor VP, were not cointegrated.

The paper organizes as follows. The following section presents environmental taxation in Spain. Section 3 reviews economic literature. Section 4 refers to methods. Section 5 and 6 contain the results and conclusions, respectively.

2. ENVIRONMENTAL TAXATION

According to Law 38/1992, on Excise, Tax on hydrocarbons is levied on hydrocarbons (petrol, diesel, natural gas, fuel oil, biofuels) used as petrol or as fuel. However, there is no tax on hydrocarbons for purposes other than petrol, fuel, or fuel used in the hydrocarbon manufacturing process. Moreover, they have not taxed hydrocarbons in regular commercial vehicles or special containers tanks. The tax rate for lubricants equals industrial fuel; however, products are not taxed, neither new product nor remanufactured, only gasoline, automotive gas oil, and automotive and heating reduced price is levied (Table 1). In 2013, Law 16/2013 of October 29 also taxed natural gas and biofuels, but in 2018, the tax on natural gas, gas oil, and fuel oil was disappeared to produce electric power.

In 2007, SIGAUS functioning supposed oil derivates prices were similar, not from 1993 when taxation was eliminated (Arner, 2018a). Recently, since 2015 base oil price decreased under 600€/ton, oils producers shared responsibility for oils with producers of oils affected by Royal Decree 110/2015, on WEEE, and producers of oils affected by Royal Decree 265/2021, on ELV (Figure 1). Undoubtedly, it supposed SIGAUS responsibility for waste oils was modified. However, since 2019, the base oil price decreased again under the price of 600€/ton. Moreover, meanwhile between 2016 and 2018, waste oil PRO reduced the average cost

2008, respectively.

4 Royal Decree 110/2015, on WEEE and Royal Decree 20/2017 on ELVs, supposed to transfer responsibility for managing waste oil in WEEE and ELV from the lubricant manufacturer to manufacturers of EEE and vehicles, respectively.

5 It derogated Royal Decree 20/2017 of January 20.

6 Royal Decree, 731/2020 of August 4, modifies Royal Decree 1619/2005, of December 30, established conditions that second use tires and treated tires must comply for marketing. Since 2010, the automotive sector signed the Voluntary Agreement of the automation sector for the collection of used car batteries, constituting 99.69% of the total Spanish market for lead-acid automotive batteries, whether they are replacement batteries or batteries placed on the market incorporated into the vehicles at the time of sale. Royal Decree, 731/2020 of August 4, modifies Royal Decree 1619/2005, of December 30, established conditions that second use tires and treated tires must comply for marketing.

7 Law 38/1992, of December 28, 1992, on Excise.

8 Law 16/2013 of October 29 set down specific environmental tax measures and adopted other tax and financial measures.

Table 1: Tax on hydrocarbons

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019p	2020p
Eurosuper-95										
Price with taxes	131.9	142.5	143.0	138.4	123.1	115.2	121.6	129.1	130.1	118.7
Price without taxes	67.57	73.90	71.62	67.64	55.16	48.69	53.95	60.15	55.30	45.81
VAT	20.12	22.76	24.83	24.03	21.37	20.01	21.11	22.41	22.58	20.60
Other Indirect taxes	44.23	45.88	46.64	46.80	46.59	46.58	46.57	46.56	55.22	52.28
State rate	40.26	40.23	40.21	40.22	40.23	40.25	40.25	40.25	40.24	40.25
Special Rate (1)	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	7.18	7.23
Regional Tax (1)	1.57	3.25	4.03	4.18	3.96	3.93	3.92	3.92	4.80	4.80
Automotive gas oil										
Price with taxes	126.7	136.5	135.8	130.2	111.4	101.6	110.0	120.4	121.6	107.7
Price without taxes	72.41	78.25	75.29	70.41	55.16	47.07	53.97	62.58	57.81	46.34
VAT	19.33	21.80	23.57	22.61	19.35	17.64	19.09	20.90	21.10	18.71
Other Indirect taxes	34.98	36.46	36.96	37.24	36.97	36.95	36.94	36.94	42.68	42.74
State rate	30.70	30.70	30.70	30.70	30.70	30.70	30.70	30.70	30.70	30.70
Special Rate (1)	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	7.18	7.24
Regional Tax (1)	1.88	3.36	3.86	4.14	3.87	3.85	3.84	3.85	4.80	4.80
Automotive gas oil and heating reduced tax										
Price with taxes	96.15	106.20	102.14	95.83	73.16	62.82	74.11	84.25	85.75	64.52
Price without taxes	72.81	80.55	75.66	70.50	51.77	43.23	52.56	60.93	59.99	42.45
VAT	14.67	16.96	17.73	16.63	12.70	10.90	12.86	14.62	14.88	11.20
Other Indirect taxes	8.67	8.69	8.76	8.69	8.69	8.69	8.69	8.70	10.87	10.87
State rate	7.87	7.87	7.87	7.87	7.87	7.87	7.87	7.87	7.87	7.87
Special Rate (1)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	1.80	1.80
Regional Tax (1)	0.20	0.22	0.28	0.22	0.22	0.22	0.22	0.23	1.20	1.20
Tax Income	9152	8370	9949	9857	10257	10527	10797	10990	12353	10253
Brent price €	80.63	87.44	82.51	74.49	47.01	39.17	48.08	60.10	57.92	36.34

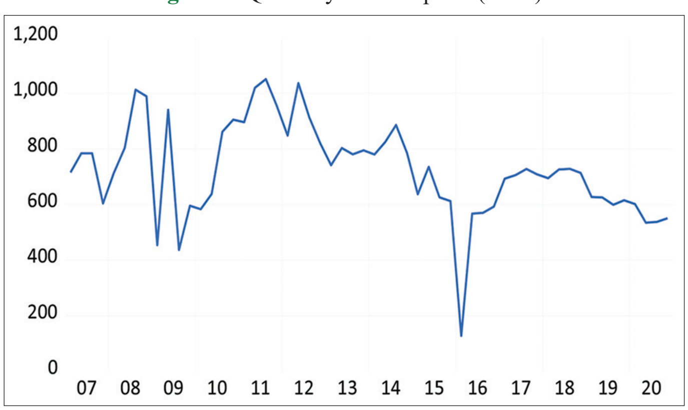
(1) Up to 2012, Especial Tax on retails sales of certain hydrocarbons

(2) From 2013, Regional fee of the Tax on Hidrocarbons. It was derogated from 1/1/2019.

(p) Provisional estimation

Source. AEAT (2021)

Figure 1: Quarterly base oil price (€/ton)



Source: ICEX (2021)

of managing from 142 €/ton to 81.66 €/ton, because of different measures increasing efficiency were set, from 2019 it increased up to 101 €/t and in 2020 up to 111.20 €/ton (SIGAUS, 2021a).

Law 16/2013 of October 29 set a tax on HFC's consumption, PFC, and SF_6 gases (GHG) contained WEEE (Table 2). Tax on GHG was established in 3 years. From the end of 2019, the tax rate decreased 25%. However, income from Tax on GHG has decreased every year since 2014. Currently, Tax on GHG is under revision to facilitate taxation and determine that taxpayers must be producers, importers who perform intra-EU purchases, or waste managers because they are less and easier to control tax income.

Tax on GHG belongs to environmental taxation established in Spain in 2013, joining direct Tax on power production, Tax on used combustible nuclear and waste production, and Tax on used combustible nuclear and waste storage (Table 3). Tax on power production is the essential tax of environmental taxation. In 2016 decreased significantly due to decreased price of the power production market; consequently, it shows substantial variations. In 2019, normative changes eliminated taxation in 2018 last quarterly and 2019 first quarterly[9].

The European Commission adopted the European Green Deal on December 11, 2019, aiming to transform the EU into a modern, resource-efficient, and competitive economy with no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use[10]. It includes increasing the EU climate ambition towards 50-55% GHG emission reductions for 2030. That transformation requires effective carbon pricing and the removal of fossil fuel subsidies. Well-designed taxes play a direct role by sending the right price signals and providing the right incentives for sustainable practices of producers, users, and consumers. These concern important sectors, such as aviation and maritime transport, that are currently fully exempt from energy taxation, while land transport bears an essential burden of energy taxation. The Energy

9 Royal Decree-Law 15/2018, on urgent energy transition measures and consumer protection.

10 European Commission (2021): Proposal for a Council Directive: Restructuring the Union framework for taxing energy products and electricity (recast). COM (2021) 563 final. Brussels 14.7.2021.

Table 2: Tax on HFC's consumption, PFC, and SF_6 gases

Año	Tax rate application (%)	Net income	% variation
2014	33	30.566	-
2015	66	98.946	223.71
2016	66	94.726	–4.3
2017	100	119.988	26.7
2018	100	109.630	–8.6
2019	100	80.802	–26.3
2020	100	67.282	–16.7

Source: AEAT, (2021)

Table 3: Environmental taxation

Time	2016	2017	2018	2019p	2020p
Total Income	1574	1807	1872	1019	1441
Tax on power production	1285	1510	1586	717	1146
Tax on used combustible nuclear and waste production	284	287	277	292	286
Tax on used combustible nuclear and waste storage	6	9	9	10	9
Tax on GHG	95	120	110	81	67

Source: AEAT (2021)

Taxation Directive 2003/96, now under revision, lays down the EU rules for the taxation of energy products used as motor fuel or heating fuel and electricity, being lubricants not taxed. However, since its adoption in 2003, energy markets and technologies in the EU have experienced significant developments. Mainly, lubricants are around 92% synthetic or semi-synthetic oils.

3. REVIEW OF ECONOMIC LITERATURE

This review is about those topics that can answer the scope of EPR as new products, take-back targets, industry structure, and design for recycling.

3.1. New Products, Take-back Targets, Industry Structure

The scope of the products, which are the aim of EPR regulations, determines the extent of EPR. Products can be new products introduced in the market or remanufactured products. Habitually, EPR is with product collection and recycling targets that producers must accomplish individually or collectively. According to Mazahir et al. (2019), the new Directive of WEEE restricted the scope of Directive on WEEE only to new products introduced in the market for the 1st time or new products. As a result, they assume that remanufactured products are exempt from collection recycling obligations. Moreover, the showed that cannot be a simple best environmental policy suitable for all products. Consequently, the right set of products suitable for one of the policy options can be established. They also evaluated the implications for introducing a separate target for the product reuse and category-based targets or product-specific targets. For Nakamura et al. (2012), the recycling of some more minor metals, gallium, and titanium, contained in both WEEE and ELV, requires, in the long term, both nationally and internationally, the development of new value chains the recycling, which also determines the extend of EPR.

Esenduran et al. (2016) found that e-waste take-back legislation with collection targets increases remanufacturing levels when the remanufactured products are exempt from collection requirements. However, their analysis using an LCA-based approach reveals that a higher remanufacturing level induced by legislation does not always result in superior environmental outcomes. Otherwise, if there is a collection target on remanufactured products, too, then take-back legislation may cause a decrease in remanufacturing. Besides, the recycling ratios could be arbitrary in the electronics equipment sector and respond to interest groups.

According to Atasu et al. (2009), although the collective system may come with a cost advantage, it seems that free-rider avoidance is most important from the manufacturer's perspective. Moreover, the targets must adjust to the industry's cost, environmental impact, and competition level differences. Also, Toyasaki et al. (2011) show that when the recycling industry comprises firms with different technologies and operational efficiencies, it is essential a nonprofit organization in the monopolistic scheme to allocate WEEE based on recycling fees that enhance the competition among the recyclers, however failure to do so will result in a free-rider problem.

Atasu et al. (2013) differentiated two take-back product systems: first, State-operated systems, where manufacturers or consumers finance take-back through recovery fees (State-operated systems or tax model). Second, manufacturer-operated systems where the State imposes specific take-back objectives on manufacturers (producer take-back mandate based or rate model). Consistent with them, social welfare is better under the tax model, reinforced by increased competition. Meanwhile, manufactures and consumers preferred the rate model.

3.2. Design for Recycling

EPR mandates producers to be financially responsible for product end-of-life costs, which motivates producers to improve the recyclability of their products to reduce these costs. Providing such design incentives is explicitly stated as an important goal in EPR-based legislation (Gui et al., 2015). The tradeoff between design for recycling and recycling cost results because, in a collective system, producers make design decisions independently, but then their products are processed collectively, and the resulting total recycling cost allocate among them. Consistent with that study, managing the design-stability tradeoff requires looking into how available processing technologies interact with product design improvement in reducing recycling costs and the capacity mix of these technologies.

Atasu and Subramanian (2012) point out that while an individual recycling system (IRS) provides a reduction in recovery costs, because of the recycling design incentives it introduces, a collective recycling system (CRS) achieves greater efficiency in the operating costs. However, it depends significantly on competition in the markets and recovery costs. Consistent with Plambeck and Wang (2009), the recyclability design occurs when manufacturers bear the specific end-of-life cost. Regarding different e-waste, regulations found that a fee-upon-sale type of e-waste regulation (Advanced Recovery Fee), collective EPR with current-sales-based cost allocation and restrictions for hazardous products) decreased the quantity of electronic production and disposal by reducing the frequency of new product introduction. Meanwhile, a fee upon disposal (individual EPR system) motivates manufacturers to design for recyclability, but it fails to reduce the frequency of new products introduction in competitive products categories.

Efficiency evaluation of EPR on waste oil previously constituted a recycled material standard (RMS), and that policy was more efficient than a subsidy (Arner et al. 2006, 2021). However, different PROs involved in managing waste oil from 2015 (SIGAUS, WEEE, ELV) modified that result (Arner, 2018b). From the perspective of waste oil management, competition between PROs supposed that the RMS is not previously defined; the result is undetermined (Sigman, 1995). However, if considered market oil, a more differentiated oil demand of synthetic and semi-synthetic oils is not compatible with EMR. Otherwise, according to the II Prevention Business Plan, 2018-2021 (SIGAUS, 2018), new oils incorporate eco-design standards to lengthen the useful life of industrial oils, using synthetic base oils or Low SAPs additives improve oils characteristics for easier waste oils management and decrease dangerousness of waste oil.

4. DATA AND METHODS

4.1. The Order of Integration of the Variables

The definition of the variables used in the model is shown in Table 4.

The order of integration of variables AWO, FRP, LP, and VP is evaluated using the statistic Augmented-Dickey Fuller (ADF) and the Akaike information criterion (AIC). Ho is the existence of a unit root in all cases. The main conclusions are using variables in second differences for all the variables (Table 5). According to the results, Ho is accepted for all the variables; therefore, all the variables are not stationary. Subsequently, cointegration relationships between these variables are estimated[11].

4.2. Estimating Cointegration Equations for LP and FRP Variables

Subsequently, are estimates of the cointegration equation for WOR and FRP, using DOLS. Meanwhile, the number of delays and advances is chosen using the Akaike information AIC. Data are quarterly for the period 2007-2020.

11 According to Engle and Granger (1987), examining if a group of variables is cointegrated is interesting about the relationship is stable in the long run.

The proposed cointegrating equation for the variables LP and FRP is:

$$LP = f(FRP) \quad (1)$$

The expected sign of the coefficient of the FRP variable will be positive in Equation 1.

Finally, the cointegrating equation for estimation, with L being the logarithmic notation of the variables, is as follows:

$$LLP_t = \beta_1 + \beta_2 LFRP_t + \beta_3 @trend + u_{1t} \quad (2)$$

where u_{1t} constitutes a white noise error term.

Table 6 shows estimates. Although the model explanatory capacity (R^2) was not very high, it is satisfactory enough. Moreover, the individual significance of β_1, β_2, and β_3 was accepted, although the sign of β_2 is the opposite to expected. In turn, there was a cointegrating equation for LLP and LFRP variables. Subsequently, other characteristics of the error term are shown[12]. In Equation 2, under the Jarque-Bera statistic, the null hypothesis that the residues are distributed by a multivariate normal distribution was accepted at the significance level of 5%. However, according to the statistic Q, there is autocorrelation at the significance level of 5% since level 1. According to the Engle-Granger tau-statistic and z-statistic test, including, in this case, autocorrelation in the error term, the Ho hypothesis was rejected, that the variables are not cointegrated, at the significance level of 5%, using AIC. Subsequently, cointegrating equations estimated were appropriate from estimation, although there was autocorrelation in the error term. Moreover, the stochastic structure of variables was consistent enough.

4.3. Estimating Cointegration Equations for LP, AWO, and VP

The proposed cointegration function is for the variables LP and AWO, and also LP and VP, considering responsibility for waste oil in WEEE and ELV was transferred from lubricating oil producer to appliances producers and vehicle producers as follows:

$$LP = f(AWO) \quad (3)$$

$$LP = f(VP) \quad (4)$$

12 Other characteristics of the error term were analyzed according to Novales (2010).

Table 4: Variable's definition*

Variable	Definition	Unit measure	Source
AWO	Manufacture of electric domestic appliances	Production volume index, base 100=2015, seasonally and calendar adjusted data.	Database - Eurostat (europa.eu)
FRP	Base oil price	€/ton	DataComex - ICEX (comercio.es)
LP	Lubricating oil from associated producers in SIGAUS	tons	https://www.sigaus.es/en/publicaciones
VP	Manufacture of motor vehicles	Production volume index, base 100=2015, seasonally and calendar adjusted data.	Database - Eurostat (europa.eu)

*Regarding AWO is referred to as WEEE, which contains oils, it is impossible to use quarterly data more precisely for that category

Moreover, the expected sign of the AWO and VP variable coefficient is positive in Equations 3 and 4.

Finally, the cointegrating equations for estimation, with L being the logarithmic notation of the variables, were as follows:

$$LLP_t = \beta_4+\beta_5 \, LAWO_t+u_{2t} \quad (5)$$

$$LLP_t = \beta_6 LVP_t+u_{3t} \quad (6)$$

where u_{2t} and u_{3t} constitute a white noise error term.

Table 7 shows estimates. Results concerning the model explanatory capacity (R^2) were satisfactory enough in Equations 5 and 6. Moreover, the individual significance of all the coefficients in equations 5 and 6 was accepted. Regarding other characteristics of the error term, under the Jarque-Bera statistic, the null hypothesis that the residues are distributed by a multivariate normal distribution was accepted at the significance level of 5% in Equations 5 and 6. However, according to the statistic Q, at the significance level of 5%, there is no autocorrelation in equation 5, but there is autocorrelation in equation 6 up to level 5. Finally, according to the Engle-Granger tau-statistic and z-statistic test, the Ho hypothesis was accepted, that the variables are not cointegrated, at the significance level of 5%, using AIC. Consequently, in this case, the stochastic structure of variables was not consistent enough.

Table 5: Augmented-Dickey Fuller t-statistical AIC information criterion (second differences)

Variables	Critical values		t-statistics	P-value
AWO	1% level	–3.5713	–5.8558	0.0000
	5% level	–2.9224		
	10% level	–2.5992		
FRP	1% level	–3.5924	–3.6145	0.0094
	5% level	–2.9314		
	10% level	–2.6039		
LP	1% level	–3.5713	–6.7032	0.0000
	5% level	–2.9224		
	10% level	–2.5992		
VP	1% level	–3.5713	–7.0490	0.0000
	5% level	–2.9224		
	10% level	–2.5992		

Table 6: Estimates equation 2

Dependent variable: LLP (3, 10)			
Variable	**Coefficient**	**t-statistic**	**P-value**
LFRP	–0.4506	–3.618270	0,0013
C	14.2840	16.77254	0.0000
@Trend	–0.0039	–2.7930	0.0099
R^2=0.6779			
R^2 adjusted=0.4117			
Jarque-Bera test		**Statistical**	**P-value**
		0.0882	0.9568
Box-Pierce/Ljung-Box		**Statistics/Delay**	**P-value**
Q estadístico		10.345/1	0.01
		Statistical	**P-value**
Engle-Granger tau-statistic (AIC)		–2.3057	0.6406
Engle-Granger z-statistic (AIC)		–14.26067	0.3393

Numbers in parentheses are the number of advances and delays, respectively

5. RESULTS DISCUSSION

The coefficient β_2 of –0.4506 constituted the elasticity of LLP to LFRP in Equation 2. Because LP is exclusive as PRO for waste oil, the negative sign can be justified by other destinations of oils, like vehicles and EEE exports. Subsequently, although elasticity is less than 1, the variable base oil price negatively impacts the lubricants oil that the IMS manages. Moreover, those variables are cointegrated. Consequently, that relationship is steady in time. In addition, using DOLS, β_2 was a long-term elasticity, with delays and advantages equal to 3 and 10.

According to Table 7, variables LLP and LAWO are not cointegrated; neither LLP nor LVP are cointegrated variables. Besides, the coefficient β_5 of 0,4594 constitutes the elasticity of LLP to LAWO in Equation 5, which is like the elasticity of LLP to LFRP in Equation 2. Table 8 also shows that elasticity was higher than 1 if all EEE were considered. Moreover, the coefficient β_6 of 2.4258 constituted the elasticity of LLP to LVP in Equation 6. Subsequently, because variables have no steady relationship,

Table 7: Estimates equation 5 and 6

Dependent variable: LLP (10, 9)			
Variable	**Coefficient**	**t-statistic**	**P-value**
LAWO	0.4594	4.765318	0.0003
C	8.9906	20.5244	0.0000
R^2=0.7914			
R^2 adjusted=0.4786			
Jarque-Bera test		**Statistical**	**P-value**
		0.5797	1.0900
Box-Pierce/Ljung-Box		**Statistics/Delay**	**P-value**
Statistical Q		1.3079/1	0.253
		Statistical	**P-value**
Engle-Granger t statistics (AIC)		–4.6527	0.0022
Engle-Granger *z* statistics (AIC)		–44.9253	0.0000

Dependent variable: LLP (10, 9)			
Variable	**Coefficient**	**t-statistic**	**P-value**
LVP	2.4258	814.9821	0.0000
R^2=0.8216			
R^2 adjusted=0.5339			
Jarque-Bera test		**Statistical**	**P-value**
		0.6710	0.71
Box-Pierce/Ljung-Box		**Statistics/Delay**	**P-value**
Q estadístico		10.335/5	0.066
		Statistical	**P-value**
Engle-Granger tau-statistic (AIC)		–6.1949	0.0000
Engle-Granger z-statistic (AIC)		–44.8879	0.0000

Table 8: The elasticity of LLP to LEEE and LAWO

Time	The elasticity of LLP to LEEE/LAWO
2007–2019	2.4156 (LEEE)
2007–2020	0.4594 (LAWO)

results did not justify enough transferring responsibility for oils from oils to manufacturers of EEE and vehicles producers about oils in WEEE and ELV. Moreover, EEE or vehicles exports constitute an alternative way to recycle those oils that oils producers are not responsible. It justifies that the relationship between base oil price and oils managed by IMS is negative, and that relationship is positive between LP and AWO, also LP and VP, although those variables were not cointegrated.

That context comes up with other economic incentives joined EPR playing their role to get environmental objectives; otherwise, the extent of EPR has been redefined. The new Directive on WEEE set targets for reuse, not only recovery and recycling targets. Moreover, targets for different categories of WEEE are set. Setting new targets or differentiated about which products, new or remanufactured, producers must bear responsibility constitutes allow mark off EPR. Transferring responsibility for oils from oils producer to EEE and car producers supposed SIGAUS responsibility for waste oils was modified, but it is opposite to get an excellent design for recycling. Besides, the setting which type of oils, new or remanufactured, should be targeted entirely modifies EPR extend.

In addition, SIGAUS collects waste oils in areas with difficulty in Spain as countryside, mountain areas, or villages with less than one thousand inhabitants (SIGAUS, 2021b). Although it is according to Law 22/2011 of July 28 on waste which mandates to oils producer collection, for all country, of used oils generated by oils in the market, it similarly the provision of a universal service that a nonprofit entity must accomplish. It is added to the collective producer responsibility system's free-rider problem. SIGAUS took responsibility from PRO functioning for free riders, oils from unidentified producers. Consequently, different market failures justify the Government establishing other economic incentives to join with EPR. Alternatively, according to Law 22/2011, producers may benefit from a public collection entity or undertaking and may conclude agreements with other extended responsibility systems to coordinate management organization.

According to the economic literature on market instruments to reduce the amount of waste to be disposed of concluding that an SDR or combination of a product tax and a recycling subsidy is the most efficient policy (Dinan, 1993; Fullerton and Kinnaman, 1995; Sigman, 1995; Palmer and Walls, 1997, 1999; Fullerton and Volverton, 2000). Moreover, the SDR is consistent with EPR programs under perfect competition (Palmer and Walls, 1999). Besides, Walls (2006) sowed that a recycled material standard (EMR) is consistent with EPR. Otherwise, the product is relevant in the markets where EPR is established (cars, household appliances), and the quality of the product affects waste management costs (Fleckinger and Glachant, 2010). An efficient design can move to product price; thus, it constitutes an incentive for efficient design (Eichner and Pethig, 2001)[13]. However, the EPR organization management supposes EPR causes welfare losses because it does not consider imperfection due to producers' market power (Runkel, 2003). Consistent with Calcott and Walls (2002), if the market is not perfectly competitive, a deposit-refund system (DRS) join with a landfill tax, promotes enough design that guarantees recycling. According to Tsai et al. (2013) even if the market is imperfectly competitive, the SDR is consistent with EPR.

13 Green design is a process in which environmental attributes become product design aims (Fullerton and Wu, 1998).

6. CONCLUSION

In Europe, EPR is by Directive 2008/98/CE, which reaches organizational and financial responsibility for returned and management of products and waste and for waste prevention and recyclability of the products. That policy was established when the waste problem reached great importance and, simultaneously, public funds were restricted. That policy is based on the producer taking fundamental decisions about their product, like design, materials, and marketing, determining product impact regarding waste management. The producer responsibility principle and EPR transfer initial public responsibility, about collection and management of waste, to the producers of the products that generate waste. It supposes that a competitive market will promote efficient waste management.

Besides, EPR generates incentives for design for recycling by which product differentiation has been promoted, depending on IRS or CRS are established. Meanwhile, financial and organization belong to PROs, design for recycling is the producer's responsibility. It supposes an imperfection due to producers' market power. Mainly, EPR served for enough competitive products like EEE or cars, in which innovation and differentiation are significant, besides EEE or cars sectors directly bear economics recession. Also, CRS must bear the free-rider problem. Finally, PROs must provide a universal service for that producer's product. Consequently, taken account different market imperfections and economics ask about the extent of EPR is necessary and economic incentives like tax or subsidies join with EPR.

From 2015, oils producers share responsibility for oils with EEE producers and from 2017 with vehicles producers. It is supposed to limit the extent of oil producer responsibility. This work shows that the transfer of responsibility from oils producers to EEE or car producers is not justified enough because the relationship between those variables is not stable in time. Moreover, the variables LP and FRP are cointegrated; the elasticity of the LP variable up to FRP was at –0.45. Because LP is exclusively referred to as PRO for waste oil, the negative sign can be justified by other destinations of oils, like oils exports. In contrast, variables LP and AWO, neither LP nor VP, are cointegrated. However, limiting the extend of EPR is opposite to a more excellent design for recycling. Those results were not very high in the explanatory capacity of the model; also, there was autocorrelation in the error term. Getting better results for that estimation is future work.

In sum, different market failures are revealed about the free-rider problem and EPR providing incentives for recycling. That context suggests that economic incentives joined with EPR, like taxes or subsidies, must serve to reach ecological objectives of waste oils. Tax on hydrocarbons could act as a subsidy for remanufactured products if new products are taxed in the oil sector. Although lubricants are not levied, environmental taxation is for all energy products. Currently, Directive 2003/96 is under revision by effective carbon pricing and the removal of fossil fuel subsidies belonging to the European Green Deal. Moreover, producers may benefit from a public collection entity or undertaking and conclude agreements with other extended responsibility systems to coordinate waste management.

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