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Reverse logistics strategic antinomies: the case of the automotive sector

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Abstract

Legislation plays a major role in the automobile manufacturing sector. The European legislation has a prominent international role in this respect. We examine the impact of the European Parliament, Council (2000) Directive 2000/53/EC on the EU automobile sector reverse logistics activities in the light of the Extended Producer Responsibility (EPR) principle. We argue that there is an antinomy in the application of the Directive that is supposed to support an EPR strategy. The antinomy is expressed by [1] the absence of the necessary capabilities of Producer Responsibility Organizations (PROs) to advance to higher reverse logistics activities like remanufacturing [2] an indefinite delay of the possibility for transformation of the current forward chain manufacturing model, [3] a stability in the strategic group formation of the European automobile manufacturing sector that prevents the further diffusion of manufacturing and remanufacturing capabilities within EU with profound positive economic impacts in favour of the industrialized countries with a strong automotive manufacturing sector and negative impacts to less industrialized countries. We also argue that the proper application of the EPR strategy is in favour of established EU manufacturers and can act as a barrier to entry for non-European firms.

Keywords: automotive sector, reverse logistics, strategy, legislation, EC Directive, EPR

1 INTRODUCTION

According to the European Council Directive 2000/53/EC (2000) for The End-of Life Vehicles (ELVs), reverse logistics is defined as "the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal". The Directive 2000/53/EC has been amended by a number of Commission Decisions (2002/525/EC, 2005/53/EC, 2005/438/EC, 2002/151/EC, 2003/138/EC, 2001/753/EC, 2005/293/EC) and then by the Directive 2008/33/EC of the European Parliament and of the Council. Critical issues in the EU ELV legislation is that manufacturers should achieve reusability and/or recyclability of at least 85% and if measured against the international standard ISO 22620 to achieve reusability and/or recoverability of new vehicles produced after 2008 of at least 95% by weight and that this goal should be reached by 2015. Producers are pushed by legislation to take the responsibility to manufacture new vehicles with a view to their recyclability. Other important issues are: [1] the use of lead, mercury, cadmium and hexavalent chromium are prohibited in materials and components in vehicles put on the market after 1st of July 2003, [2] the block exemption regulation that provides to independent repair businesses open access to information on parts and repair processes, [3] that newer vehicles' ecology should concentrate on CO2 emission reductions, [4] that preference of plastic materials that are recyclable, and [5] that member EU countries legislate collection – dismantling systems for ELV management that ensure that all vehicles are transferred to authorized treatment facilities, and the last holder of an ELV is able to dispose it free of charge.

While the Directive is based on the so called Extended Producer Responsibility Principle (EPR) that requires from the producers to accept the responsibility to apply the Directive most manufacturers do not seem to have the capability or the capacity to do that individually, mainly due to asymmetries in manufacturing and remanufacturing capabilities.

The aim of this paper is to identify possible asymmetries in manufacturing and remanufacturing capabilities between countries within the European Union. Moreover, there has been an effort to identify the key characteristics of the EU manufacturing automobile industry profiles and directions.

The remainder of this paper begins in section 2 with a brief presentation of literature background on reverse logistics in the automotive sector. Section 3 accommodates the analysis and the findings of this research, while the paper concludes in the Section 4 with arguments arising from this study, useful managerial insights and definition of future research challenges for the authors.

2 LITERATURE REVIEW AND INSIGHTS

In the last years reverse logistics has become a critical aspect in global competition, forcing companies to adopt certain policies and practices. The outcome is that the optimization of reverse logistics processes, by taking into consideration financial, environmental and regulatory issues, constitutes a rapidly evolving research field (Xanthopoulos et al., 2012, de Brito, 2004). Reverse logistics offer the appropriate contextual framework within which the examined problem can be tackled comprehensively. According to Rogers and Tibben-Lembke (1998) "reverse logistics is the process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal". The integrated supply chain model as developed by Thierry et al. (1995) includes both forward and reverse logistics operations and distinguishes three main areas, i.e. waste management, product recovery management and direct reuse. According to Rogers and Tibben-Lembke (1998) the possible reverse logistics activities for products are "return to supplier, resell, sell via outlet, salvage, recondition, refurbish, remanufacture, reclaim materials, recycle and landfill". Out of the corresponding reverse logistics activities remanufacturing has the higher relative impact on energy preservation (Steinhilper, 1998).

In the automobile sector, ELV waste flow is a major environmental concern because of its rapidly increasing amount and special composition of hazardous substances (Simić & Dimitrijević, 2010). In that direction, the European Parliament Council (2000) 2000/53/EC Directive legislates critical issues in the European Union (EU) End-of Life Vehicle (ELV) legislation and is based on the so called Extended Producer Responsibility (EPR) principle that is holding producers responsible for the recovery management of their products at the end of their life. Under the Directive, member EU countries legislated collection – dismantling and shredding facilities for ELV management acting as PROs for the vehicle manufacturers.

According to Reinhardt (2005) the application of the EU Directive is not standardized across the EU countries and result in non-standard practices. He also states that the automotive industry prefers that higher level of reuse is being determined by market and is against the application of quotas. The impact of the EC Directive to manufacturing and remanufacturing activities has drawn increased global research attention (Yu, Welford & Hills, 2006). Thierry et al. (2005) identified the antinomy of legislation that cannot be enforced on a global scale while trade is global. According to Golinska and Kawa (2011) the European manufactures are closing the supply loop mainly due to the legislative requirements. Carter and Ellram (1998) introduced a hierarchy framework in environmental management giving special attention to the potential contribution of the resource reduction environmental legislation strategies, while Wu and Dunn (1998) added the contribution of resource substitution strategies. Subramoniam et al. (2009) argue that legislation can act as a driver or as a barrier for remanufacturing and address the absence of strategic analyses in the area. Zuidwijk and Krikke (2008) investigated the impact of EU Directives on reverse logistics and found little evidence to support this. Sakkas and Manios (2003) reviewed a number of strategic issues related to the cost benefit analysis of reverse logistics activities as legislated in Greece.

3 RESEARCH METHODOLOGY AND FINDINGS

The first step of the analysis includes the data collection of manufacturing plants, vehicle production, remanufacturing units, and ELV recycling and reuse in the 27 EU countries. A cross-tabulation of the above data and statistical analysis with the use of SPSS 20.0 have been employed as a commonly used mapping and visualization analysis tool in order to identify possible asymmetries in manufacturing and remanufacturing capabilities between countries. The selected data is presented in Table 1. The data regarding the manufacturing plants and vehicle production figures have been mined manually from the ACEA (European Automobile Manufacturer's Association) (2012) reports, the remanufacturing figures have been mined manually from the APRA (Automotive Parts Remanufacturing Association) search engine on the website (www.apra.org/directory) and the recycling and reuse quantities have been retrieved from Eurostat (2013) data on end-of-life vehicles: reuse, recycling and recovery.

Taking under consideration that none of the remanufacturing plants in Table 1 is operated or owned by automotive manufacturers, we argue that automotive manufacturers still favour the forward logistics business model that maximizes their profits based on economy of scale and capital investment.

Taking under consideration that dismantling facilities acting as PROs for the last few years have not advanced to higher reverse logistics activities and that also none of them has an invested interest in remanufacturing, the EPR principle remains de facto unattended by manufacturers, justified exactly by the Directive that has been legislated for its reinforcement.

Table 1: Manufacturing plants, vehicle production, remanufacturing plants and ELV recycling and reuse per country (EU27)

A/A	Country	Manufacturing plants	Production year 2011 (number of cars)	Remanufacturing plants	Recycling and Reuse year 2010 (tones)
1	Austria	6	152.505	NA	57.255
2	Belgium	8	562.386	7	156.973
3	Bulgaria	1	NA	1	66.136
4	Cyprus	0	0	NA	9.543
5	Czech Republic	11	1.199.834	1	108.790
6	Denmark	0	0	7	94.947
7	Estonia	0	0	NA	5.937
8	Finland	2	2.540	1	98.139
9	France	36	2.294.889	11	1.223.990
10	Germany	46	6.311.103	27	492.907
11	Greece	0	0	1	77.867
12	Hungary	5	202.800	3	12.803
13	Ireland	0	0	1	130.216
14	Italy	23	790.348	10	1.031.369
15	Latvia	0	0	1	8.270
16	Lithuania	0	0	1	20.159
17	Luxemburg	0	0	NA	5.173
18	Malta	0	0	NA	185
19	Netherlands	9	73.151	10	193.533
20	Poland	14	837.132	8	193.226
21	Portugal	6	192.242	NA	79.736
22	Romania	3	335.232	1	131.136
23	Slovakia	3	639.763	1	24.216
24	Slovenia	1	174.119	1	4.698
25	Spain	15	2.353.682	3	666.723
26	Sweden	14	189.969	2	175.085
27	UK	30	1.463.999	5	933.315

From the cross-tabulation in Table 1 we can identify the following cases:

1. Denmark has no production plants but has proportionally one of the largest remanufacturing capabilities (number of remanufacturing plants) in EU27.

2. Belgium, Netherlands, Poland and Czech Republic host relatively high manufacturing and have developed comparatively very high remanufacturing capabilities.

3. The originator countries of OE manufacturers like Germany, Spain and Sweden have comparatively low remanufacturing capabilities. Specifically, in the case of Germany the rate of ELV recycling and reuse is significantly lower than the production rate.

4. From the rest of the countries that host manufacturing plants, only Italy has developed satisfactory remanufacturing capability.

5. Most other countries are underdeveloped in this respect.

We can see that some economically weaker countries have not developed reverse logistics capabilities that would be in favour of their own economic sustainability interest (e.g. Bulgaria, Estonia, Portugal, Rumania, Slovakia, and Slovenia). This also holds for countries with large markets that can support the demand for remanufacturing products and are hosting considerable manufacturing capabilities (Austria, Spain, and UK). Greece is amongst those countries that have developed some remanufacturing capability despite the fact that it is one of the 3 countries; the other two are Denmark and Luxemburg, with no vehicle manufacturing plants.

Moreover, in order to come up with more reliable conclusions a statistical analysis (with the use of SPSS 20.0) was performed. Spearman's rho and Mann-Whitney tests were employed.

In a first step was examined the correlation between production and ELV recycling and reuse quantities. Spearman's coefficient (0.707) is significant at the 0.01 level, whereas the coefficient's positive sign indicates that the larger the production capability of a country is increases the number of recycled cars. In addition, the correlation between the number of remanufacturing plants and ELV recycling and reuse quantities is also significant (rho=0.716, p=0.000).

Then, it was examined the difference in the quantities of recycled and reused cars between producer and non-producer countries within the EU. The coefficient U took the value 25.0, which corresponds to a high significance (p=0.003), whereas the mean rank (Table 2) confirmed that a larger number of cars is recycled in producers countries.

Table 2: Mann-Whitney test for the variables X and Y

Ranks

	Producer Country	N	Mean Rank	Sum of Ranks
Recycling_Reuse	yes	18	17,11	308,00
	no	9	7,78	70,00
	Total	27		

Test Statistics[a]

	Recycling_Reuse
Mann-Whitney U	25,000
Wilcoxon W	70,000
Z	-2,880
Asymp. Sig. (2-tailed)	,004
Exact Sig. [2*(1-tailed Sig.)]	,003[b]

a. Grouping Variable: Producer_Country

b. Not corrected for ties.

However, when limiting the analysis in 9 countries (Belgium, Czech Republic, France, Germany, Italy, Poland, Slovakia, Spain and UK) with produce higher than the European average (approximately 500,000 cars), the correlation between the size of production and the recycling numbers is non significant (rho=0.467, p=0.205), despite the fact that outnumber the small producers (<500,000 cars) in some of the other measurements, as it is presented in Table 3.

Table 3: Data for Producer and Non-Producer Countries

	Producer Countries (<500.000)			Producer Countries (>500.000)			Non Producer Countries		
	Mean	**N**	**Std. Deviation**	**Mean**	**N**	**Std. Deviation**	**Mean**	**N**	**Std. Deviation**
Manufacturing Plants	6,83	9	4,35	18,90	9	14,50	,27	9	,646
Production Quantities	164131	9	47886,12	1678836,80	9	1770050,702	230,90	9	765,83
Recycling and Reusing Quantities	87185	9	80404,46	496264,50	9	440862,52	46961,09	9	47337,87

Especially in producer countries with capacity above the 1.000.000 cars (Czech Republic, France, Germany, Spain and UK) the same test gives a very small Spearman's value (rho=0.1, p=0.873) confirming that in these countries the recycling is not related with the volume of production. Furthermore, although the correlation between recycling and remanufacturing plants is significant (rho=0.716; p=0.000) in the top five countries there is not significance (rho=0.400; p=0.505), despite the fact that the number of remanufacturing plants is higher (mean value: 9.4 vs. 3.29 in the other European countries).

All the above show a profound asymmetry in both manufacturing and remanufacturing capabilities across the EU27 countries. The asymmetry in manufacturing can be explained by a number of forward chain based factors related to economies of scale. The asymmetry in remanufacturing is not justifiable under an EU strategy based on the EPR principle and can only be remedied with a change in the legislation that would enforce the cooperation of PROs and manufacturers in organized advanced reverse logistics activities. We argue that such policies not only will decrease asymmetries in capabilities between countries and will increase employment opportunities in countries with small manufacturing base, but the business model will be in favor of EU manufacturers as well because these structures cannot be developed as effectively by non-European manufacturers. This becomes evident from the information provided in Table 4 that shows the domination of certain European manufacturers and the relatively small penetration of non-European manufacturers in EU countries. In order to identify the characteristics of the manufacturing automobile industry profiles and directions, a strategic group analysis methodology has been employed. Strategic group analysis of competitive strategies in an international context has been carried by Bogner, Thomas and McGee (1996) who investigated the entry paths and competitive positions of European pharmaceutical firms in the U.S. market based on their strategic assets and competencies. Hatten and Hatten, (1987) assessed the consequences of a collective movement by many firms into similar competitive postures or to verify similarities of strategic direction across an industry. Strategic group analysis has also been applied in order to reveal whether there is a strong group manufacturing identity (Peteraf & Shanley, 1997). Environmental legislation in EU provides a common framework of beliefs, values and related research activities that help in the development of similar identities in several international sectors.

Porter (1980) and McGee and Thomas (1986) suggested that the two categories of dimensions for strategic group analysis are the scope of activities and the resource commitment. Under the scope of activities category fall the dimensions of product diversity, geographical coverage, number of segments served and number of distribution channels used. Under the resource commitment category fall the dimensions extent of branding, marketing effort, extent of vertical integration, product or service quality, technological leadership, and size of the organization.

The data in Table 4 have been mined manually from the ACEA reports (2012) and include information on Geographic Distribution (number of producer countries), Product Types (number of products types: Passenger Cars, Light Carriage Vans, Carriage Vans and Buses), Engine Plants (number of engine plants), Vehicle Plants (number of vehicle assembly plants), Mixed Plants (number of engine and vehicle assembly plants) and Vehicle Sales (within EU) for the European and non-European automobile manufacturers.

Table 4. Information for European and non-European Automobile Manufacturers

Host Country	Manufacturer	Geographic Distribution	Product Types	Engine Plants	Vehicle Plants	Mixed Plants	Vehicle Sales (within EU) year 2012 (in thousands)	Scope of Activities (*10)	Resource Commitment (*1.000)
Germany	DAIMLER AG	10	4	5	22	2	800,7	4	23,2
	BMW GROUP	5	2	2	9	1	811,1	1	9,7
	VOLKSWAGEN AG	15	4	4	33	8	3.276	6	147,4
	PORSCHE	3	2	1	2	0	45,3	0,6	0,1
Italy	FIAT S.p.A.	6	4	4	13	2	986,5	2,4	18,7
	IVECO	6	3	3	14	0	49,4	1,8	0,8
France	PSA PEUGEOT CITROEN	9	3	3	18	0	1.784,9	2,7	37,5
	RENAULT SA	8	3	3	13	3	1.300,3	2,4	24,7
Sweden	VOLVO GROUP & VOLVO CAR CORPORATION	6	4	4	18	0	245,6	2,4	5,4
UK	JAGUAR LAND ROVER	1	1	1	3	0	141	0,1	0,6
	ASTON MARTIN	1	1	0	1	0	1,8	0,1	0,0
NON-EU with produ-ction plants in EU	TOYOTA MOTOR EUROPE	9	2	3	10	0	576,3	1,8	7,5
	FORD OF EUROPE	7	3	6	5	4	1.112,9	2,1	16,7
	HYUNDAI MOTOR EUROPE	5	4	0	11	1	432,5	2	5,2
	GENERAL MOTORS EUROPE	8	2	4	5	2	1.084,9	1,6	11,9

The Scope of Activities measure is characterized [a] by the number of production types and [b] by geographical production coverage represented by the number of countries where manufacturing takes place. These proxies represent product diversity and geographical coverage respectively. The number of distribution channels is not taken under consideration since the market is saturated by distribution channels and outlets that are in close vicinity to the customers and additionally under the EPR principle this characteristic seems to have no significant effect in the development of the remanufacturing industry.

The Resource Commitment Measure is characterized [a] by the number of engine production plants [b] by the number of vehicle assembly plants, [c] by the number of mixed plants owned by the manufacturer and [d] by the number of vehicle sales. These proxies represent the characteristics of vertical integration, technological leadership, quality (partially) and size. Characteristics like extent of branding, marketing effort and quality (partially) can be proxied partially by vehicle sales.

The Scope of Activities and the Resource Commitment dimensions that are used for the identification of the strategic groups for countries and manufacturers can be either quantified as combinations of additions and/or multiplications of their measurable characteristics or as vectors of the relevant characteristics i.e. sequenced numbers in brackets separated by commas. The vector for Scope of Activities is (Geographic Distribution, Product Types) and for Resource Commitment (Engine Plants, Vehicle Plants, Mixed Plants, Vehicle Sales within EU). As an example, the vectors for Volkswagen AG are Scope of Activities (15, 4) and the Resource Commitment (4, 33, 8, 3.276).

Quantifiable measures could be taken by the multiplication of the figures in each vector in case of non-zero values. Specifically, Scope of Activities = Geographic Distribution * Product Types, while Resource Commitment = (Engine Plants + Vehicle Plants + Mixed Plants) * Vehicle Sales within EU. The Volkswagen AG example Scope of Activities=15*4=60 and Resource Commitment = (4+33+8)* 3.276=147.420.

From the data presented in Table 4, we can identify the manufacturers with the highest rankings for Scope of Activities and the Resource Commitment measures, which are:

1. For the Scope of Activities Dimension: Volkswagen AG (60), Daimler AG (40), PSA Peugeot Citroen (27), Fiat S.p.A. (24) and Renault SA (24).

2. For Resource Commitment Dimension: Volkswagen AG (147.420), PSA Peugeot Citroen (37.500), Renault SA (24.700), Daimler AG (23.200), and Fiat S.p.A. (18.700).

From the values of dimensions listed Table 4 we can identify the following strategic groups in the European automobile supply chain:

1. The 1st Group is consisted from Volkswagen AG (60, 147.400) and PSA Peugeot Citroen (27, 37.500). The manufacturer Volkswagen AG is leader in both dimensions within EU.

2. The 2nd group is consisted from Daimler AG (40, 23.200), Fiat S.p.A. (24, 18.700) and Renault SA (24, 24.700). The manufacturers in this strategic group have developed highly in both dimensions.

3. The 3nd group is consisted from Iveco (1.8, 0.8), Porsche (0.6, 0.1) and Jaguar (0.1, 0.6). The manufacturers in this strategic group are less developed but more specialized.

Germany is the host country for Volkswagen AG and Daimler AG, France is the host country for PSA Peugeot Citroen and Renault SA, and Italy for Fiat S.p.A. From the above, it can be easily concluded the domination of European manufacturers in the automobile sector. The non-European manufacturers show relatively small penetration in EU automobile market. For example, Ford of Europe is in the 7th place in the Scope of Activities dimension and in the 6th place in the Resource Commitment Dimension, while Hyundai Motor Europe is in the 8th and 11th places respectively.

4 CONCLUSIONS

The current automobile manufacturing business model is based on short term efficiency that depends on the established automated manufacturing processes rather than long term effectiveness processes that are mostly related to man-powered systems requiring special knowledge and expertise. The legislated by the 2000/53/EC Directive assignment of the EPR principle application to PROs does not lead to advanced reverse logistics activities like remanufacturing and proves an antinomy in the application of the legislation of PROs that do not serve the EPR strategy and preserve the existing asymmetries in the manufacturing capabilities between EU countries and manufacturers.

The application of the Directive’s EPR principle requires the application of practices and the development of reverse supply networks that are difficult to be developed for non-European manufacturers with small manufacturing network in EU that means that such a development can become a strong barrier to entry for other manufacturers that do not have the capacity to develop such an operations network in the EU market.

The strategic group analysis has shown that the European automobile industry is dominated by strong European OEMs with relatively small participation from non-European OEMs (Ford and GM from USA and Toyota from Japan). Germany dominates the industry but there are several big European players as well and there exists a wide distribution of assembly plants all over Europe.

The comparison of production levels, and manufacturing and remanufacturing distribution in Europe indicates that some economically weaker countries seem to fell for the short term interests of manufacturers rather than developing national reverse logistics strategies that would be in favour of their economic sustainability interest. It seems that increased import taxes can make a big difference in developing sustainable reverse logistics operations. Such an example is Denmark that has the higher taxes in Europe for automobiles and has so achieved by large the best development in remanufacturing operations. The application of the Directive on higher levels of reuse will give more possibilities for less developed areas to invest in labour intensive sustainable reverse logistics operations that will have a positive impact on both energy preservation and advanced skill job creation.

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