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THE ECONOMIC COST OF IPR INFRINGEMENT IN THE TYRES AND BATTERIES SECTORS

Quantification of infringement in the Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres (NACE 22.11) and Manufacture of batteries and accumulators (NACE 27.20)

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THE ECONOMIC COST OF IPR INFRINGEMENT IN THE TYRES AND BATTERIES SECTORS

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1. FOREWORD

The European Observatory on Infringements of Intellectual Property Rights (the Observatory) was created to improve the understanding of the role of intellectual property (IP) and of the negative consequences of intellectual property rights (IPR) infringements. It was transferred from the Commission to the EUIPO in 2012 by Regulation (EU) No 386/2012.

In a study carried out in collaboration with the European Patent Office[1] , the EUIPO, acting through the Observatory, estimated that approximately 42 % of total economic activity and 28 % of all employment in the EU is directly generated by IPR-intensive industries, with a further 10 % of jobs in the EU arising from purchases of goods and services from other industries by IPR-intensive industries.

Another study[2] compared the economic performance of European companies that own IPRs with those that do not, finding that IPR owners' revenue per employee is 28 % higher on average than for non-owners, with a particularly strong effect for small and medium-sized enterprises (SMEs). Although only 9 % of SMEs own registered IPRs, those that do have almost 32 % more revenue per employee than those that do not.

Perceptions and behaviours of European citizens regarding IP and counterfeiting and piracy[3] were also assessed as part of an EU-wide survey. This survey revealed that although citizens recognise the value of IP in principle, they also tend to justify infringements at an individual level in certain cases.

The Observatory is seeking to complete the picture by assessing the economic impact of counterfeiting and piracy.

This exercise is challenging from a methodological point of view, as it attempts to shed light on a phenomenon that by its very nature is not directly observable. To pave the way towards quantification of the scope, scale and impact of IPR infringements, as identified in its mandate, the Observatory has developed a step-by-step approach to evaluating the negative impact of counterfeiting and its consequences for legitimate businesses, governments and consumers, and ultimately for society as a whole.

Several IPR-intensive industries whose products are known or thought to be subject to counterfeiting have been selected. Previous studies have examined the following sectors: cosmetics and personal care; clothing, footwear and accessories; sports goods; toys and

1 - EUIPO/EPO, *Intellectual property rights intensive industries and economic performance in the European Union: industry-level analysis report*, 2nd ed., EUIPO, Alicante, 2016.

2 - OHIM, *Intellectual property rights and firm performance in Europe: an economic analysis: firm-level analysis report*, OHIM, Alicante, 2015.

3 - EUIPO, *European citizens and intellectual property: perception, awareness and behaviour*, 2nd ed., EUIPO, Alicante, 2017.

games; jewellery and watches; handbags and luggage; recorded music; spirits and wine; pharmaceuticals; pesticides; and smartphones.

The EUIPO and OECD joint report[4] on global trade in counterfeit products revealed the broad scope of industries affected by counterfeiting, ranging from luxury items to everyday goods, including products that can pose a threat to consumers' health and safety and to the environment. Car spare parts are among those products targeted by counterfeiters, covering any part and automotive component, such as piston rings, filters, seat belts, oils and lubricants, batteries, and tyres.

4 - EUIPO/OECD, Trade in counterfeit and pirated goods: mapping the economic impact, OECD Publishing, Paris, 2016.

This twelfth study, covering tyres and batteries, uses a similar methodology to that applied in previous sectorial studies. The EUIPO/EPO (2016) *IP Contribution study* showed that both industries are intensive in their use of trade marks, patents and designs.
TEXT

2. EXECUTIVE SUMMARY

2.1. Methodology and data

The methodology applied in this study (as in the other studies in this series) requires a long time series of sales data of a homogeneous product. When possible, official data from Eurostat have been used, defining each sector based on the NACE[5] classification. For car spare parts, only two NACE classes comply with those requirements: tyres and batteries.

The starting point of this analysis is the value of tyres and batteries sold in the EU based on Eurostat's Structural Business Survey (SBS) and international trade statistics. Predicted sales of each of the two products are generated and compared with actual sales in each EU Member State. The differences between predicted and actual sales are then analysed using statistical methods. These differences can be partly explained by **socio-economic factors**, such as GDP growth, currency exchange rates or the number of passenger cars per 1 000 inhabitants. In addition, **factors related to counterfeiting** are considered, such as behaviour of consumers[6] as reflected in the *IP Perception study*.

The methodology is explained in detail in Section 4.

5 - NACE (***N****omenclature statistique des* ***a****ctivités économiques dans la* ***C****ommunauté* ***E****uropéenne)* is the official classification of economic activity used by Eurostat, the statistical office of the EU.

6 - Results from the *IP perception study* published by the EUIPO in November 2013 are used, such as the propensity of EU citizens to intentionally buy counterfeit goods.

2.2. Main findings

It is estimated that **EUR 2.2 billion are lost annually by the legitimate industry due to the presence of counterfeit tyres in the EU marketplace and EUR 180 million are lost annually due to counterfeit batteries**, corresponding to **7.5 % and 1.8 % of the sectors' sales, respectively.**

The resulting estimates of the lost sales due to counterfeiting in the manufacture of tyre and battery sectors, for all Member States are shown in Table 1 in relative as well as absolute terms.

TABLE 1. LOST SALES DUE TO COUNTERFEITING OF TYRES AND BATTERIES BY COUNTRY (2010-2015)

	TYRES		BATTERIES	
	Lost sales (%)	Lost sales (million EUR)	Lost sales (%)	Lost sales (million EUR)
AUSTRIA	6.1	30	1.6	3
BELGIUM	15.6	96	4.0	3
BULGARIA	17.2	21	4.4	4
CYPRUS	17.1	7	4.4	1
CZECH REPUBLIC	7.3	106	1.9	3
GERMANY	4.2	261	1.1	31
DENMARK	6.1	13	1.6	1
ESTONIA	9.0	4	2.3	N/A
GREECE	17.4	39	4.5	5
SPAIN	17.6	445	4.6	32
FINLAND	3.1	17	0.8	1
FRANCE	7.6	411	2.0	27
CROATIA	9.2	9	2.4	N/A
HUNGARY	5.1	16	1.3	7
IRELAND	5.3	11	1.4	1
ITALY	5.9	256	1.5	18
LITHUANIA	19.2	15	5.0	1
LUXEMBOURG	10.1	2	2.6	N/A
LATVIA	17.8	11	4.6	1
MALTA	8.4	1	2.2	0
NETHERLANDS	4.2	12	1.1	3
POLAND	6.6	74	1.7	6
PORTUGAL	11.5	41	3.0	3
ROMANIA	15.4	76	4.0	3
SWEDEN	6.8	45	1.8	10
SLOVENIA	8.3	14	2.2	1
SLOVAKIA	5.1	14	1.3	1
UNITED KINGDOM	5.5	201	1.4	13
EU-28	**7.5**	**2 247**	**1.8**	**179**

The country least affected by counterfeiting of tyres and batteries in relative terms is Finland (3.1 % and 0.8 % respectively), while Lithuania is the country most affected (19.2 % and 5 % respectively). In absolute terms, the impact is greatest in Spain, with lost sales due to counterfeit tyres and batteries estimated at EUR 477 million, followed by France at EUR 438 million, Germany (EUR 292 million), Italy (EUR 274 million) and the United Kingdom (EUR 214 million). The five largest EU Member States account for EUR 1.7 billion lost due to counterfeiting, 70 % of total lost sales in the EU.

The resulting estimates of relative lost sales due to counterfeit tyres and batteries by country are shown in Figures 1 and 2. The bar indicates the impact of counterfeiting on the legitimate sector's sales, expressed as a percentage of sales, while the diamonds indicate the 95 % confidence interval of that estimate[7].

7 - The 95 % confidence interval is a statistical calculation that means that there is a 95% probability that the true figure lies between the lower and upper bounds of that interval. For example, for the EU as a whole, the estimated percentage of lost sales is 7.5 %, with a 95 % probability of the true percentage lying between 7 % and 8 %.

FIGURE 1. LOST SALES DUE TO COUNTERFEITING OF TYRES BY COUNTRY (2010-2015)

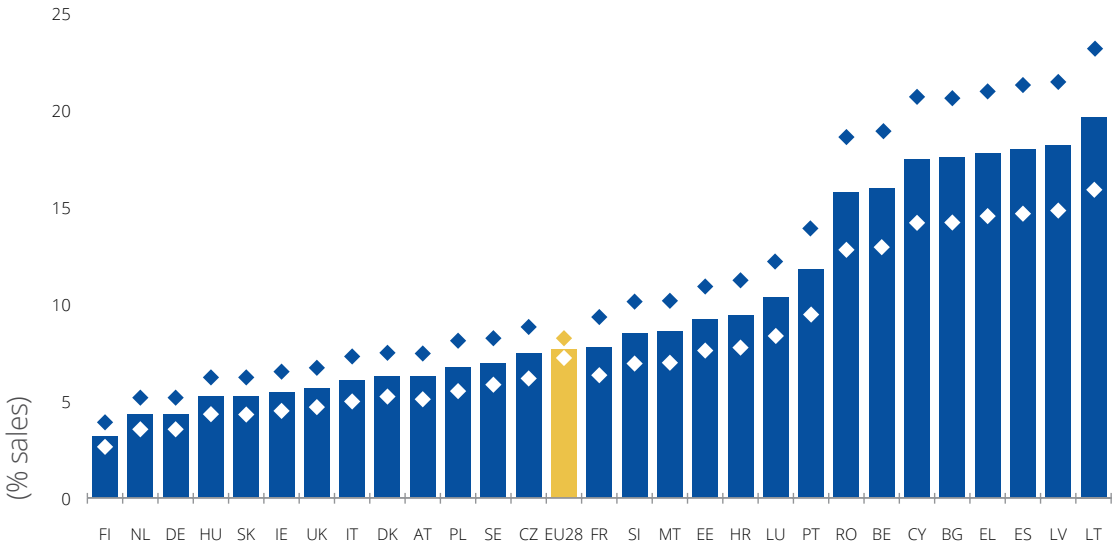
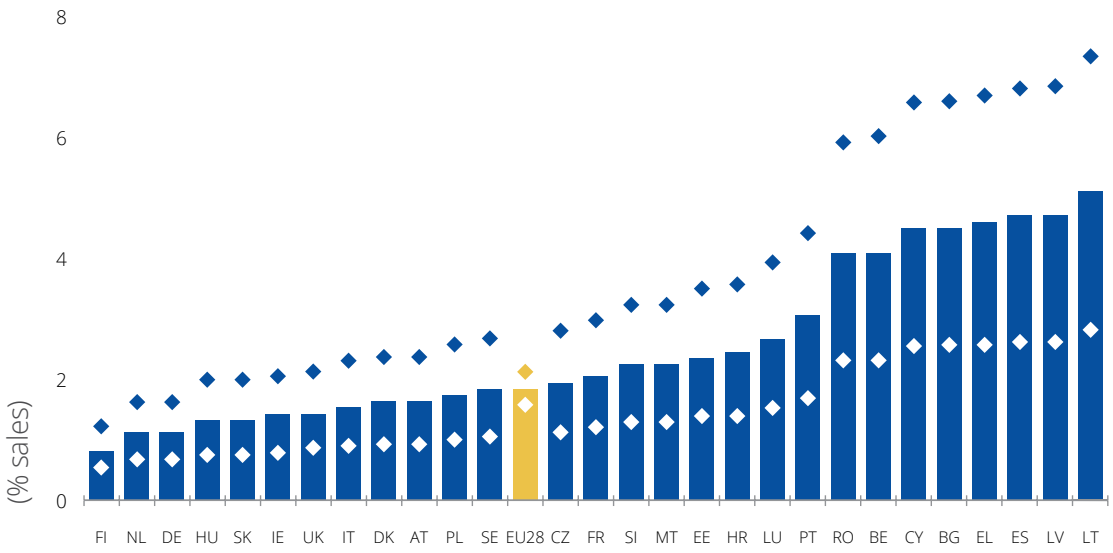


FIGURE 2. LOST SALES DUE TO COUNTERFEITING OF BATTERIES BY COUNTRY (2010-2015)



These lost sales translate into direct employment losses of 8 318 jobs[8].

If the knock-on effects on other industries are added, when both the direct and indirect effects are considered, counterfeiting in these two sectors causes approximately EUR 4.8 billion of lost sales to the EU economy, which in turns leads to employment losses of 22 283 jobs.

Finally, assuming that illicit producers do not declare their activities and the resulting revenues to the authorities, **the total loss of government revenue (household income taxes, social security contributions and corporate income taxes) can therefore be roughly estimated at EUR 340 million.**

8 - These figures do not take account of the effect of imports, since in those cases the associated employment impacts occur outside the EU. Nor does it include losses suffered by EU producers as a result of counterfeiting in non-EU markets. Estimated employment losses in the EU therefore relate to goods produced and consumed within the EU.

2.3 Non-economic impacts of counterfeit tyres and batteries

This report focuses on the economic consequences of counterfeit tyres and batteries. However, there are a number of other impacts in areas such as safety and environmental damage.

Counterfeit tyres or batteries often appear to be authentic as it is very difficult to distinguish a legitimate from a fake by checking the outer appearance. Consumers can therefore inadvertently purchase products that are substandard and unsafe, since testing and quality processes are often non-existent in counterfeit products, putting drivers and other road users at risk.

A study on accident conditions related to tyre usage[9] demonstrated that having a tread depth of 1.6 mm or more reduces grip accident probability on wet or snowy roads by 84 % and tyre blowout failure accident probability is reduced by 86 %, compared with tyres with less than 1.6 mm tread depth. Tests carried out by the industry showed fake tyres with 1.4 mm tread depth and regrooved tyres (doctored to look new despite actually being older tyres with little or none of the original tread left) result in clear safety risks for users.

Manufacturers of car batteries must follow strict specifications to meet consumers' expectations for performance and safety. Products are designed to prevent electrolyte leakage (which is potentially harmful not only to the circuitry in devices but also to body tissues). In addition, a single-use vent designed into the seal of the battery releases internal pressure within the battery during conditions of abuse in order to prevent an explosion. These safety features are sometimes absent from counterfeit batteries, putting the user at risk.

In addition to the user safety aspect, counterfeit tyres and batteries can also cause damage to the environment, as the materials used to manufacture counterfeit parts may fail to meet safety standards and do not always comply with environmental protection standards and the EU Circular Economy Action Plan[10], which includes measures covering production to waste management, including recycling and reuse.

Tyres are an example of a product where the circular economy starts at the design stage, extends to use, collection of used products and continues with reuse and recycling. The European Tyre & Rubber Manufacturers' Association (ETRMA) reports[11] a 96 % treatment rate of tyres (e.g. reuse of materials or other types of recycling).

Many of the components of batteries can also be recycled, avoiding the release of hazardous substances into the environment and providing valuable materials. Directive 2006/66/EC of The European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators (Batteries Directive)[12] prohibits the

9 - CHOI, E-H., *Tire-Related Factors in the Pre-Crash Phase* (Report No DOT HS 811 617), National Highway Traffic Safety Administration, Washington DC, 2012 .

10 - https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/towards-circular-economy_en

11 - http://www.etrma.org/uploads/Modules/Documentsmanager/elt-report-v9a---final.pdf

12 - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX-:02006L0066-20131230&rid=1, OJ L 266, 26.9.2006, p. 1.

marketing of batteries containing some hazardous substances and fixes targets for collection and recycling, assigning responsibility for waste management of batteries to producers. It is unknown to what extent producers of counterfeit batteries comply with these regulations.

While quantification of the non-economic impacts outlined in this sub-section is beyond the scope of this report, they are clearly of significant societal importance and must be kept in mind when considering the phenomenon of counterfeit tyres and batteries.

3. THE ECONOMIC IMPACT OF COUNTERFEITING ON THE MANUFACTURE OF TYRES AND BATTERIES SECTORS

A major problem that has hindered the effective enforcement of IPRs in the EU is related to a lack of knowledge of the precise scope, scale and impact of IPR infringement. Many attempts to quantify the scale of counterfeiting and its consequences for businesses, consumers and society as a whole have suffered from the absence of a consensual and consistent methodology for collecting and analysing data on counterfeiting and piracy across various sectors. Different approaches have been used, such as surveys, mystery shopping or monitoring of online activities, making it all the more difficult to aggregate results for the whole economy. The very nature of the phenomenon under investigation makes it extremely challenging to quantify reliably, as obtaining comprehensive data for a hidden and secretive activity is by necessity difficult.

These challenges have in turn hindered the tasks of those involved in enforcing IPRs and in charge of establishing precise priorities, programmes and targets for enforcement, as they limit the possibilities of designing more focused policies as well as evidence-based public awareness campaigns.

To help overcome these challenges while taking fully into account the methodological constraints, the Observatory developed a specific approach that has so far been applied to the following sectors: cosmetics and personal care; clothing, footwear and accessories; sports goods; toys and games; jewellery and watches; handbags and luggage; recorded music; spirits and wine; pharmaceuticals; pesticides, and smartphones.

In the present report, the Observatory focuses its attention on two sectors officially labelled by Eurostat as *Manufacture of rubber tyres and tubes, retreading and rebuilding of rubber tyres and Manufacture of batteries and accumulators*[13]. The products included in these sectors, as defined by Eurostat, are listed below.

13 - NACE codes 22.11 and 27.20, respectively.

Manufacture of tyres includes:

- manufacture of rubber tyres for vehicles, equipment, mobile machinery, aircraft, toys, furniture and other uses;
- manufacture of inner tubes for tyres;
- manufacture of interchangeable tyre treads, tyre flaps, 'camelback' strips for retreading tyres, etc.;
- tyre rebuilding and retreading.

Tyre and tube repair, fitting or replacement is not included in NACE 22.11, and neither is the manufacture of tube repair materials.

Manufacture of non-rechargeable and rechargeable batteries includes:

- manufacture of primary cells and primary batteries;
- manufacture of electric accumulators including separators, containers and covers;
- manufacture of lead acid, NiCad, NiMH, lithium, dry cell and wet cell batteries.

This study aims to estimate the economic impacts of counterfeiting on these two sectors, including the direct and indirect costs to industry and the wider costs to government and society.

3.1 The EU market for tyres and batteries

Based on official data from Eurostat, EU production of tyres amounted to EUR 28 billion and net imports from non-EU countries were worth EUR 1 billion in 2015, leaving EUR 29 billion (at producer prices) for sale in the internal market. In the same year, there were about 120 000 people employed in the manufacture of tyres across the EU.

The production of batteries in the EU in 2015 is estimated at EUR 10 billion, and total consumption reached EUR 12.5 billion once the EUR 2.5 billion of net imports were added. This industry employed 28 200 people in the EU in the same year.

The products previously analysed in this series were mainly consumed by private households, with the exception of medicines and pesticides, which are purchased by households and by health service providers or farmers, respectively. Smartphones are also bought by consumers

and by companies to be used by their employees. In the case of tyres and batteries, their final use is difficult to determine, since many passenger cars are used for private as well as business purposes (e.g. taxis or vehicles used by companies in their activities). However, vehicles such as buses, lorries or aircraft are capital goods used in the transportation sector.

No data on the final use of tyres is available in Eurostat but PRODCOM statistics provide the detail of production of tyres for different types of vehicles. Production of new rubber tyres for buses or lorries represents 24 % of the value of production of tyres in the EU in 2014, but only 10 % of volume, reflecting the high value of those goods compared with passenger car tyres. The manufacture of batteries includes all types of batteries, whether used for automobiles, telephones or other electronic devices, with car batteries representing about three quarters of the total value of batteries produced in the EU.

The main manufacturers of tyres and batteries in the EU are Germany, France, Italy and Spain. The major importer of both products is the United Kingdom, with a negative trade balance of EUR 2.5 billion followed by Germany (EUR 1.7 billion). The Czech Republic and Poland have a trade surplus in both tyres and batteries.

3.2 Direct economic impact of counterfeit tyres and batteries on legitimate industry

The costs to industry consist mainly of lost sales due to counterfeiting. Estimation of lost sales is therefore a necessary first step, both because it constitutes a major economic consequence in itself and because it drives other consequences, for example, the loss of public fiscal revenue.

The methodology builds on an adaptation of a methodology developed for the European Commission[14] by RAND Europe. It is fully described in Section 4 below.

Based on country-level value of sales of tyres and batteries at producer prices, as reported by Eurostat, the difference between forecast and actual sales has been estimated for each country, and analysed using statistical methods, relating the sales shortfall to factors (called variables in economic parlance) such as:

- GDP growth rates, the exchange rate of the euro versus other currencies, the number of passenger cars per 1 000 inhabitants and the percentage of the population using cars (socio-economic variables) and;
- the percentage of the population reporting having bought counterfeit products intentionally in the 2013 *IP Perception study*[15] (variable related to counterfeiting).

The rationale behind the selection of explanatory variables lies in the idea that differences between predicted and actual sales in a given country can partly be explained by economic

14 - RAND Europe, *Measuring IPR infringements in the internal market: development of a new approach to estimating the impact of infringement on sales*, Rand, Santa Monica, 2012. Report prepared for the European Commission. RAND proposed to analyse ex post the forecast errors on the level of individual companies, using company-specific explanatory variables. However, attempts at implementing the methodology in this manner were not successful, mainly due to the fact that most companies are not able or willing to provide the required data on past budgeted and actual sales revenues. Therefore, the methodology has been modified to allow its use on historical sector-level data, which can be obtained from public sources.

15 - Available at: https://euipo.europa.eu/ohimportal/en/web/observatory/ip_perception

or social factors (including both cyclical factors such as recessions and structural ones such as the stock of cars per inhabitant), and partly by consumers'16 propensity to infringe IP rights (sometimes unwittingly), as evidenced by responses to surveys such as the *IP Perception Study*[17].

The relative effect of counterfeiting in each country, expressed as a percentage of legitimate sales, is estimated based on the value of the estimated coefficient of the IP Perception variable for each product (tyres and batteries), as explained in Section 4.2. The economic consequences of fake tyres and batteries sold in the EU are then estimated combining these relative impacts with total sales reported by Eurostat for each Member State.

For the EU as a whole[18], the estimated total effect of counterfeit tyres amounts to 7.5 % of sales or EUR 2.2 billion and the effect of counterfeiting of batteries is estimated to be 1.8 % of total sales or EUR 179 million. It is important to highlight the fact that this direct effect of counterfeiting is not the value of fake goods sold in the EU; rather, it estimates how much higher sales of the legitimate industry would be if counterfeits were not present in the marketplace. Furthermore, only sales inside the EU are considered here, so that to the extent that counterfeit products in non-EU markets displace exports of legitimate EU producers, there is a further loss for EU firms not captured here.

Country-level estimates of lost sales and associated confidence intervals expressed both as a percentage of sales and in EUR, are shown in Tables 3 and 4 below.

16 - The term 'consumers' applies to both individuals and companies in this report.

17 - A list of factors affecting demand for and consumption of counterfeit goods is available in OECD (2008).

18 - The estimation of the model for tyres was performed using data from 24 Member States, while 20 Member States are included in the model for batteries. In both cases, the Member States included account for about 90 % of total sales in the EU-28. It is therefore reasonable to apply the resulting coefficients to the remaining Member States for which data on the dependent variable is not available.

TABLE 3. DIRECT LOST SALES DUE TO COUNTERFEITING OF TYRES IN EU COUNTRIES. RELATIVE AND ABSOLUTE LOSSES AND CONFIDENCE INTERVALS

TYRES	Lower 95 %	Lost sales (%)	Upper 95 %	Lost sales (million EUR)
AUSTRIA	5.0	6.1	7.3	30
BELGIUM	12.7	15.6	18.5	96
BULGARIA	14.0	17.2	20.4	21
CYPRUS	13.9	17.1	20.3	7
CZECH REPUBLIC	5.9	7.3	8.6	106
GERMANY	3.4	4.2	5.0	261
DENMARK	5.0	6.1	7.3	13
ESTONIA	7.4	9.0	10.7	4
GREECE	14.2	17.4	20.6	39
SPAIN	14.4	17.6	20.9	445
FINLAND	2.5	3.1	3.7	17
FRANCE	6.2	7.6	9.1	411
CROATIA	7.5	9.2	10.9	9
HUNGARY	4.1	5.1	6.0	16
IRELAND	4.3	5.3	6.3	11
ITALY	4.8	5.9	7.1	256
LITHUANIA	15.6	19.2	22.7	15
LUXEMBOURG	8.2	10.1	11.9	2
LATVIA	14.5	17.8	21.1	11
MALTA	6.8	8.4	9.9	1
NETHERLANDS	3.4	4.2	5.0	12
POLAND	5.4	6.6	7.8	74
PORTUGAL	9.3	11.5	13.6	41
ROMANIA	12.5	15.4	18.2	76
SWEDEN	5.6	6.8	8.1	45
SLOVENIA	6.8	8.3	9.9	14
SLOVAKIA	4.1	5.1	6.0	14
UNITED KINGDOM	4.5	5.5	6.5	201
EU-28	**7.0**	**7.5**	**8.0**	**2 247**

TABLE 4. DIRECT LOST SALES DUE TO COUNTERFEITING OF BATTERIES IN EU COUNTRIES. RELATIVE AND ABSOLUTE LOSSES AND CONFIDENCE INTERVALS

BATTERIES	Lower 95 %	Lost sales (%)	Upper 95 %	Lost sales (million EUR)
AUSTRIA	0.9	1.6	2.3	3
BELGIUM	2.2	4.0	5.8	3
BULGARIA	2.5	4.4	6.4	4
CYPRUS	2.4	4.4	6.4	1
CZECH REP.	1.0	1.9	2.7	3
GERMANY	0.6	1.1	1.6	31
DENMARK	0.9	1.6	2.3	1
ESTONIA	1.3	2.3	3.4	NA
GREECE	2.5	4.5	6.5	5
SPAIN	2.5	4.6	6.6	32
FINLAND	0.4	0.8	1.2	1
FRANCE	1.1	2.0	2.9	27
CROATIA	1.3	2.4	3.4	NA
HUNGARY	0.7	1.3	1.9	7
IRELAND	0.8	1.4	2.0	1
ITALY	0.9	1.5	2.2	18
LITHUANIA	2.7	5.0	7.2	1
LUXEMBOURG	1.4	2.6	3.8	NA
LATVIA	2.5	4.6	6.6	1
MALTA	1.2	2.2	3.1	0
NETHERLANDS	0.6	1.1	1.6	3
POLAND	0.9	1.7	2.5	6
PORTUGAL	1.6	3.0	4.3	3
ROMANIA	2.2	4.0	5.7	3
SWEDEN	1.0	1.8	2.6	10
SLOVENIA	1.2	2.2	3.1	1
SLOVAKIA	0.7	1.3	1.9	1
UNITED KINGDOM	0.8	1.4	2.1	13
EU-28	**1.5**	**1.8**	**2.0**	**179**

Since the legitimate businesses sell less than they would have sold in the absence of counterfeiting, they also employ fewer workers. Thus, loss of sales also leads to loss of employment in the affected sectors, which can be derived from European statistical data on employment for the NACE 22.11 and 27.20 classes, considering only lost sales of domestically produced goods. For the EU as a whole, total employment lost in the tyres sector is estimated at 7 955 jobs while 363 jobs are lost in the batteries sector.

Direct employment impacts are calculated at country level by estimating lost sales by that country's sector across the entire EU market. For example, the direct sales lost by the French industry as a result of counterfeit tyres are estimated by adding sales lost in France to sales of French tyres lost in other EU countries. The latter total is calculated based on the different counterfeiting rates prevailing within each Member State.

TABLE 5. DIRECT LOSSES DUE TO COUNTERFEITING OF TYRES IN SELECTED EU MEMBER STATES

TYRES	Direct effects			
	Sales		Employment	
	million EUR	%	persons	%
SPAIN	445	17.6 %	1 014	9.2 %
FRANCE	411	6.8 %	1 673	6.1 %
GERMANY	261	4.2 %	1 340	5.5 %
ITALY	256	5.9 %	651	5.7 %
UNITED KINGDOM	201	5.5 %	415	6.5 %
CZECH REPUBLIC	106	7.3 %	401	5.1 %
ROMANIA	76	15.4 %	492	6.6 %
POLAND	74	6.6 %	641	5.7 %
EU-28	**2 247**	**7.5 %**	**7 955**	**6.5 %**

French and German loses in employment in the legitimate tyres sector are explained not only by the lost sales of tyres in the national market but also by lower exports to other EU countries.

The country with the highest employment losses in the batteries industry due to counterfeiting is Germany, followed by France and Poland.

3.3 Indirect effects on the EU economy

In addition to the direct loss of sales in the two sectors identified, there are also impacts on other sectors of the EU economy. These indirect effects are a result of the fact that the different sectors of the economy buy goods and services from each other for use in their production processes. If one sector's sales are reduced because of counterfeiting, then this sector will also buy fewer goods and services from its suppliers, causing declines in sales and corresponding employment losses in other sectors.

To assess this indirect impact, data from Eurostat[19] are used, showing how much the manufacture of tyres and batteries industries buy from other sectors in the EU in order to produce what they deliver[20].

Final demand, as estimated in this report, includes imported goods (about EUR 500 million of imported tyres and EUR 70 million of imported batteries) and not only the value of EU production. Employment and indirect effects arising from these imports occur outside the EU and are therefore not included in the calculations. Consequently, only the value of domestic production (EUR 1.8 billion of tyres and EUR 108 million of batteries) is used to calculate indirect impacts[21].

The total direct and indirect effect in the EU of lost sales due to counterfeiting of tyres, as an annual average for the period 2010-2015, amounts to EUR 4.5 billion, while EUR 306 million are lost due to the sale of fake batteries in the EU.

Turning to employment, if losses in the supplier sectors are added to the direct employment losses in each industry, the total employment loss resulting from counterfeit tyres is estimated at 21 066 jobs, while employment losses due to counterfeit batteries amount to 1 217 jobs.

Total effects (direct and indirect) at country level are presented for tyres in Table 6 for the Member States with the highest total impacts.

19 - Input-Output Tables (IOT) published by Eurostat provide the structure of input requirements for the production of a certain final demand, acknowledging whether the origin of these inputs is either domestic or imported. The IOT used in this report refer to 2014 and are based on the new European System of Accounts (ESA) 2010 methodology.

20 - The IOT are provided by Eurostat at division level (2-digit NACE level) instead of class level (4-digit level). This means that for calculating the impact of the sales reduction in the 22.11 NACE class, it is necessary to use the structure of 'Rubber and plastic products' (NACE 22) and for calculating the impact on sales of the 27.20 NACE class, the structure of 'Manufacture of electrical equipment' (NACE 27) division is used.

21 - However, this report only estimates the effect on sales within the EU marketplace. Therefore, as noted above, to the extent that counterfeit products in non-EU markets displace exports of legitimate EU companies, there is a further employment loss in the EU that is not captured here.

TABLE 6. TOTAL LOSSES DUE TO COUNTERFEITING OF TYRES IN SELECTED EU MEMBER STATES

TYRES	Total effects	
	Sales	Employment
	million EUR	persons
SPAIN	556	3 199
FRANCE	521	3 086
GERMANY	478	2 650
ITALY	390	1 859
UNITED KINGDOM	233	1 312
POLAND	201	2 317
EU-28	**4 520**	**21 066**

In the case of batteries, the country with the highest impact is Germany, where total lost sales and employment due to counterfeit batteries are estimated at EUR 48 million and 237 jobs lost. The second most affected Member State is Poland with EUR 25 million and 214 jobs lost due to the sale of fake batteries in the EU.

Since the activity in question is illegal, it is likely that those engaged in manufacturing counterfeit goods do not pay taxes on the resulting revenues and incomes[22]. Therefore, an additional impact of counterfeiting is the resulting loss of government revenue, estimated at EUR 320 million lost due to counterfeiting of tyres and EUR 19 million lost due to counterfeit batteries sold in the EU.

In calculating these losses, two main types of taxes have been considered[23]: taxes on household income and taxes on the income or profits of companies. In this report, VAT losses are not considered because cars and their parts are subject to different VAT rates depending on whether they are used by companies or individuals. To take those different uses of cars into account when calculating VAT losses would require many assumptions at Member State level, and it was therefore decided to omit VAT from the calculations.

1) Lost household income tax, estimated on the basis of the share of wages corresponding to lost employment to total wages, considering direct and indirect effects on employment, amounts to EUR 96 million due to counterfeiting of tyres and EUR 6 million due to counterfeit batteries.

22 - According to WIPO (2010) and the OECD (2008), most of the empirical work assumes that counterfeiting occurs in informal markets that usually do not generate tax revenues.

23 - National Account tax aggregates are published by Eurostat and provide information on total payments of income taxes to all levels of government.

2) The lost tax on corporate profits is estimated from the share of direct and indirect costs to industry in total output and amounts to EUR 40 million for counterfeiting of tyres and EUR 3 million due to counterfeiting of batteries.

In addition, social security contributions linked to the direct and indirect employment losses are also estimated. Social security contribution data by industry are available in Eurostat, so that social security contributions per employee in each industry can be used to calculate lost contributions as a consequence of counterfeiting. These lost social security contributions amount to EUR 184 million for counterfeit tyres and EUR 11 million due to counterfeit batteries.

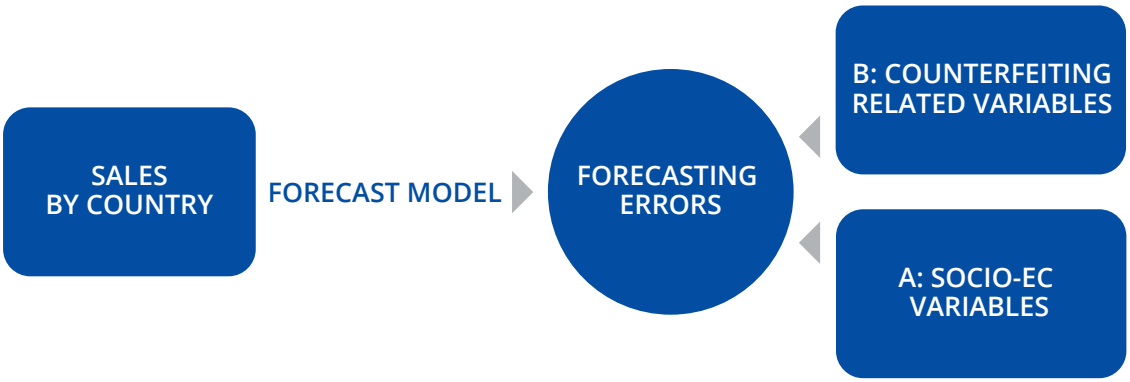
The total loss of government revenue (household income taxes, social security contributions and corporate income taxes) can be roughly estimated at EUR 320 million due to counterfeiting of tyres and EUR 19 million due to counterfeit batteries.

The indirect effect of sales lost due to counterfeiting only includes losses in sectors that provide inputs to the manufacture of legal products in the EU. Possible effects of inputs provided for production of illicit goods that could be manufactured inside or outside the EU, are ignored in this study. In other words, the indirect effect calculated is a gross effect that does not take into account the long-term effect of sales displacement from legal to illegal producers. The net employment effect could therefore be smaller than the gross effect calculated here.

Similarly, while illicit activities do not generate the same levels of tax revenue as legal activities, to the extent that sales of counterfeits occur in the legitimate sales channels, some direct and indirect taxes are paid, and so the net reduction in government revenue may be smaller than the gross effect calculated here. Unfortunately, data currently available do not allow for calculation of these net effects with any degree of accuracy.

4. METHODOLOGY

The methodology used for the estimation of the economic effects of counterfeiting is depicted in the following figure.



4.1 The first stage forecasting model

The first stage is comprised of a forecasting model of sales of products in each country. Assuming that a reasonably long time series of sales by country is available, a model is created that explains the trend of this time series and predicts the value of sales in subsequent years.

The simplest available comparable forecasts, across all Member States, are produced via the use of ARIMA modelling. These models use only the past values of sales to produce a forecast of future sales. The forecast error, that is, the difference between the ARIMA forecast and observed sales, represents an estimate of the expected lost sales, notwithstanding adjustments for the impact of socio-economic factors.

The forecast error is the difference between predicted and actual consumption and for the purposes of comparability is expressed as a proportion of actual sales, as shown in the following equation:

$$q^{*}_{it} = \frac{\hat{Y}_{it} - Y_{it}}{Y_{it}}$$

where Y_{it} is sales in country i and year t (measured in EUR) and $\hat{Y}_{it}$ is the forecast of Y_{it} obtained from the univariate ARIMA model using sales expenditure information up to and including the period t-1.

The relative error q^*_{it} measures the extent to which the forecasting model has predicted a higher or lower value (as a share of actual sales) versus the actual level of sales obtained from the Eurostat data.

Step-wise forecast errors for the six years from 2010 to 2015 are constructed for Member States for which sufficient data is available. The one-period-ahead forecast errors estimated with ARIMA models follow a white noise process that is stationary and thus uncorrelated in time with zero mean and constant and finite variance.

The forecast errors are presented in Table 7. It is evident that these errors exhibit a large degree of variability. However, the forecast errors are not interesting in themselves. The purpose of this study is not to produce a 'good' forecast, but rather to generate a set of relative errors that can then be quantitatively analysed to construct estimates of the impact of counterfeiting. Forecasts are produced using univariate models and using an automatic procedure, which ensures that they are comparable and 'unpolluted' by a priori knowledge of factors influencing changes in demand.

TABLE 7. TYRES SALES RELATIVE FORECAST ERRORS (2010-2015)

RELATIVE ERRORS (%)	2010	2011	2012	2013	2014	2015
AUSTRIA	– 8.8	– 24.9	1.2	– 0.5	2.4	8.2
BULGARIA	– 32.1	1.3	5.7	13.4	– 14.8	– 9.1
CYPRUS	2.0	10.4	– 0.2	24.6	23.4	– 8.5
GERMANY	– 25.4	– 9.8	– 1.9	– 2.8	– 8.3	2.3
DENMARK	– 23.5	– 8.2	19.9	– 17.3	– 5.1	– 8.2
ESTONIA	– 53.9	– 0.6	– 14.7	21.9	– 10.4	8.2
GREECE	18.1	– 6.2	– 2.4	– 24.6	16.0	N/A
SPAIN	– 22.2	– 9.2	7.5	– 1.5	6.3	– 6.6
FINLAND	N/A	– 33.4	– 12.4	7.4	– 40.2	N/A
FRANCE	– 6.5	– 20.2	– 6.1	2.2	2.7	– 1.0
HUNGARY	– 27.6	– 48.7	– 3.9	4.8	– 33.6	– 17.7
IRELAND	– 10.0	– 14.6	– 17.0	– 7.2	– 11.6	– 4.4
ITALY	11.0	– 26.0	13.2	11.2	20.2	15.6
LITHUANIA	N/A	– 40.0	42.8	– 3.4	8.1	8.2
LATVIA	16.1	– 34.8	– 7.5	8.0	– 4.7	15.9
MALTA	– 8.4	– 22.5	– 5.2	– 34.8	– 26.2	– 6.5
NETHERLANDS	– 14.9	– 43.2	11.5	N/A	N/A	N/A
POLAND	– 45.8	– 30.3	15.6	– 2.7	– 1.1	2.9
PORTUGAL	– 19.5	– 7.0	33.1	– 6.8	16.7	8.0
ROMANIA	– 49.2	– 41.3	7.5	– 2.3	– 4.3	– 18.7
SWEDEN	– 31.3	– 30.9	– 17.7	– 6.6	– 5.1	N/A
SLOVENIA	4.6	N/A	N/A	– 8.9	– 11.3	N/A
SLOVAKIA	3.3	– 42.7	– 28.9	N/A	– 51.0	– 38.7
UNITED KINGDOM	7.1	– 21.1	– 1.7	3.3	2.8	– 9.7

TABLE 8. BATTERIES SALES RELATIVE FORECAST ERRORS (2010-2015)

RELATIVE ERRORS (%)	2010	2011	2012	2013	2014	2015
AUSTRIA	– 37.1	– 38.0	– 27.7	12.3	– 47.7	24.5
BULGARIA	– 50.9	– 9.4	– 25.6	9.8	– 14.9	– 19.4
CYPRUS	– 39.2	– 5.2	12.1	31.0	– 7.2	2.8
CZECH REPUBLIC	– 21.9	N/A	– 36.4	0.2	43.9	19.7
GERMANY	– 11.3	– 24.1	– 14.4	11.3	– 4.8	– 35.4
DENMARK	– 31.5	– 25.2	– 9.5	– 1.7	– 8.8	– 24.2
GREECE	– 8.1	12.6	24.8	9.9	– 10.9	N/A
SPAIN	– 11.2	– 6.6	– 7.2	13.6	– 17.3	– 15.6
FINLAND	– 14.4	– 14.3	20.3	22.4	11.9	4.0
FRANCE	– 34.0	1.0	– 6.3	– 16.4	– 13.9	– 5.1
CROATIA	– 16.6	– 7.1	10.6	4.1	– 12.8	0.3
HUNGARY	– 40.7	N/A	N/A	N/A	N/A	N/A
IRELAND	27.6	8.9	13.7	5.7	– 12.0	– 3.8
ITALY	– 29.1	– 21.8	– 6.5	– 6.0	– 3.5	– 13.3
LITHUANIA	– 13.4	– 37.1	– 15.9	13.6	– 34.9	2.2
LATVIA	– 47.3	10.7	– 4.0	30.8	2.3	– 5.6
MALTA	– 2.6	– 24.1	17.5	– 30.8	– 15.3	– 49.6
POLAND	– 11.2	– 46.2	– 7.2	– 34.0	– 39.2	– 27.9
SLOVENIA	– 28.2	94.5	N/A	N/A	N/A	N/A
SLOVAKIA	– 32.4	7.3	12.9	N/A	N/A	N/A
UNITED KINGDOM	7.5	– 0.6	5.0	– 7.5	– 4.5	– 25.3

The second part of the estimation process seeks to determine to what extent these forecast errors can be explained by economic variables and by variables related to counterfeiting.

4.2 The second stage econometric model

Counterfeiting may be one of a number of factors impacting on the level of legal sales of tyres and batteries, but there are, as outlined earlier, a series of other economic factors that can explain the differential, such as variables related to the economic capacity of households (e.g. GDP growth or the euro exchange rate) or any other driver of expenditure on such items (e.g. the number of cars or percentage of the population using cars as their usual mode of transport).

Having accounted for the influence of socio-economic variables on the sales differential, an attempt is made to assess the extent to which counterfeiting variables, or relevant proxies, can explain the propensity to purchase counterfeit tyres or batteries. These variables might include measures of consumer and market characteristics, as well as the evolution of a country's legal environment.

Combining the economic and counterfeiting variables allows an econometric model to be specified, whose aim is to explain the aggregated differential between expected and real sales (i.e. the forecast errors from stage 1). The model is specified in the following format:

$$q_i^* = \partial * X_i + \beta * Z_i + \varepsilon_i \quad (3)$$

where X_i is a matrix of explanatory variables unrelated to counterfeiting and Z_i a matrix of variables related to counterfeiting. Finally, ε_i is the remaining error. A separate model was specified for each of the two sectors: tyres and batteries.

Socio-economic variables considered to have explanatory power, and unrelated to counterfeiting, include:

1. GDP per capita and GDP growth;
2. euro exchange rate versus local currencies (for those Member States that do not use the euro);
3. Measures of the use of cars, such as the percentage of people using a car as their usual mode of transport (Eurobarometer) or the number of registered passenger cars per 1 000 inhabitants (Eurostat).

Variables thought to be **related to counterfeiting** include:

1. several variables selected from the Observatory's *IP Perception study*[24] and from Eurobarometer (including counterfeiting and corruption-related variables);
2. corruption perception index (CPI);
3. IPR index;
4. worldwide governance indicators (World Bank) covering government effectiveness, regulatory quality, rule of law and control of corruption (level and growth).

24 - Available at: https://euipo.europa.eu/ohimportal/en/web/observatory/ip_perception

25 - In WCO (2012) it is stated that: 'The predominance of the informal is then associated with corruption and the degree of regulation...'. So, to the extent that counterfeiting is part of the informal economy, a measure of corruption could be considered explanatory for counterfeiting.

Variables from the *IP Perception study* and Eurobarometer are considered to be consumer-related drivers of demand for counterfeiting. The variables considered for inclusion in the Z matrix from the *IP Perception study* and the Eurobarometer include: the percentage of the population that has bought counterfeit products intentionally or been misled into the purchase of counterfeit products; and the percentage of the population that considers, in certain circumstances, buying counterfeit products to be acceptable. Some variables from the Eurobarometer survey[25] related to perception of corruption have also been considered for inclusion in the Z matrix.

However, variables 2 to 4 are considered to be drivers of counterfeiting related to institutional characteristics of each country: The CPI is published by Transparency International and measures how corrupt public sectors are seen to be by the public in each country; the IPR Index is published by the Property Rights Alliance and it measures the strength of protection accorded to IP; and the Worldwide Governance Indicators are published by the World Bank and reflect the perception of government effectiveness, regulatory quality, rule of law and corruption.

The rationale behind these variables is that in countries where the population exhibits a high degree of acceptance of counterfeit products and where governance and the rule of law are perceived to be weak, there is a higher likelihood of consumption of an illicit product than in countries with good governance, a strong rule of law and low corruption.

Altogether, 45 different explanatory variables were tested and different econometric techniques were applied in order to select a model with robust econometric results and a clear interpretation. The specific variables related to counterfeiting selected for inclusion in the analysis vary slightly from sector to sector, but inclusion of a variable from each of the two groups has been a common feature of all previous sectorial studies in this series.

Some of the variables considered in the modelling process are correlated with each other. High correlation coefficients between explanatory variables (referred to as multicollinearity) are a

common problem in econometric analysis. If correlated explanatory variables are included in the model, the estimated coefficients for these variables could be mistakenly considered as insignificant (low t-statistics), although they possess a high overall significance for the model as measured by the F-test. This situation can pose problems when trying to interpret the meaning and significance of parameter estimates and when testing the significance of other variables in the model specification. Therefore, only those variables with the greatest explanatory power are included in the models in order to avoid the multicollinearity problem.

The final models were estimated using random-effect panel models and robust clustered estimation with country as the group variable for the tyres model and generalised least squares (GLS) estimation with the standard error (SE) of ARIMA residuals as weights for the batteries' model. Diagnostic tests including a variation inflation factor (VIF), Ramsey and Breusch-Pagan tests, residual plots and Akaike and Bayesian information criteria were also used to select the preferred model[26].

Analysis of influential[27] observations was also conducted, including analysis of studentised residuals, leverage, Cook's distance and DFBETA statistics to assess the specific impact of individual observations on the regression coefficient of the counterfeiting-related variable. As a result of this analysis the observation of Lithuania in 2012 has been discarded from the final model estimated for tyres and the observations of the Czech Republic in 2014 and Slovenia in 2011 for the batteries model.

The results of the final models are shown in Tables 9 and 10.

26 - All results of the diagnostic tests are available on request.v

27 - An observation is considered influential if removing the observation substantially changes the coefficients estimated.

TABLE 9. TYRES SALES ECONOMETRIC MODEL RESULTS

Tyres explanatory variables	Coefficient	Standard error	t Statistic	95 % Confidence interval	
				Lower	Upper
Constant	– 0.4460	0.0964	– 4.63 ***	– 0.6350	– 0.2570
GDP growth	– 0.0063	0.0060	– 1.05	– 0.0180	– 0.0055
Euro exchange rate growth	1.5937	0.8566	1.86*	– 0.0851	3.2725
Passenger cars per 1000 inhabitants (level)	0.0006	0.0002	3.17 ***	0.0002	0.0010
IP Perception: buy fakes intentionally	2.2030	0.5108	4.31 ***	1.2019	3.2041

R-square Between = 48.09 %
Wald Chi-2 statistic = 32.16 ***

* significant at 90 % confidence level
** significant at 95 % confidence level
*** significant at 99 % confidence level.

TABLE 10. BATTERIES SALES ECONOMETRIC MODEL RESULTS

Batteries explanatory variables	Coefficient	Standard Error	t Statistic	95 % Confidence interval	
				Lower	Upper
Constant	– 0.0809	0.0474	– 1.71 *	– 0.1737	0.0120
Use of cars (EB)	0.0159	0.0695	0.23	– 0.1204	0.1522
Passenger cars per 1 000 inhabitants (growth)	– 2.4320	0.3649	– 6.66 ***	– 3.1472	– 1.7168
IP Perception: buy fakes intentionally	0.5693	0.3176	1.79*	– 0.0532	1.1917

R-square = 7.93 %
Wald Chi-2 statistic = 50.41 ***

* significant at 90 % confidence level
** significant at 95 % confidence level
*** significant at 99 % confidence level

The econometric models explain 48 % of total variance of the stage 1 forecast errors of tyres sales and 8 % of variance of batteries sales. The model uses a combination of three economic variables for the tyre model and two for batteries and the same counterfeiting-related variable in both models. For each variable, the first column shows the estimated coefficient, the second column shows the standard error, while the third column indicates the statistical significance of the parameter estimates.

The explanatory variable related to counterfeiting in both models is **the percentage of people admitting to having bought fake products intentionally**, as described in the IP perception study. This variable is time invariant and its coefficient has a positive sign, meaning that the higher the percentage of respondents who recognise having bought fakes in a particular country, the greater the forecast errors[28].

28 - Alternative models have been estimated using different explanatory variables and methods of estimation. The coefficient of the *IP Perception* variable in different models is always significant with at least 90 % of confidence level providing a good indication of its stability.

Based on the coefficients estimated for the counterfeiting-related variable presented above, the impact of counterfeiting is estimated via the following relationship:

$$F_i^* = \hat{\beta} * Z_i$$

where F^*_i represents the sales lost due to counterfeiting in country i (expressed as the fraction of the sector's actual sales) and Z_i is the value of the *IP Perception* variable in that country. $\hat{\beta}$ is the estimated coefficient from the respective model, with value 2.2030 for tyres and 0.5693 for batteries. The counterfeiting impact is calculated for all 28 EU Member States by applying these coefficients to the values of the explanatory variables.

5. CONCLUSIONS AND PERSPECTIVES

THE ECONOMIC COST OF IPR INFRINGEMENT IN THE TYRES AND BATTERIES SECTORS

The studies aiming to quantify the scale and impact of IPR infringements in cosmetics and personal care; clothing, footwear and accessories; sports goods; toys and games; jewellery and watches; handbags and luggage; recorded music; spirits and wine; pharmaceuticals; pesticides; smartphones and now tyres and batteries have provided coherent estimates of the size of the problem of counterfeiting for legitimate businesses and for society in terms of lost sales, which lead to lost jobs and loss of public revenue. These studies have used a common methodology and demonstrated the benefits of working in cooperation with stakeholders to take advantage of their knowledge of market conditions, while relying on official, harmonised data sources for the analysis.

In parallel, the Observatory has carried out a joint study with the Organization for Economic Cooperation and Development (OECD) to estimate the value of counterfeit and pirated goods in international trade. That study, published in April 2016, estimated the value of international trade of counterfeit goods in 2013 at EUR 338 billion (USD 461 billion) globally, corresponding to 2.5 % of world trade. The corresponding figures for the EU were EUR 85 billion (USD 116 billion), representing 5 % of the EU's imports from the rest of the world.

Taken together, these studies complement each other and provide a complete and as objective as possible picture of the impact of IPR infringement in Europe and beyond, in order to help policymakers develop effective enforcement policies.

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