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INTELLECTUAL PROPERTY OFFICE

THE ECONOMIC COST OF IPR INFRINGEMENT IN THE PESTICIDES SECTOR

Quantification of infringement in Manufacture of pesticides and other agrochemical products (NACE 20.20)

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EXECUTIVE SUMMARY

THE ECONOMIC COST OF IPR INFRINGEMENT IN THE PESTICIDES SECTOR

The European Observatory on infringements of Intellectual Property Rights (the Observatory) was created to improve the understanding of the role of Intellectual Property and of the negative consequences of Intellectual Property Rights (IPR) infringements.

In a study carried out in collaboration with the European Patent Office[1], the European Union Intellectual Property Office (EUIPO)[2], acting through the Observatory, has 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[3] compared economic performance of European companies that own IPRs with those that do not, finding that IPRs 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 Intellectual Property and counterfeiting and piracy[4] 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 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 in the European Union, as identified in its mandate, the Observatory has developed a step by step approach to evaluate the negative impact of counterfeiting and its consequences for legitimate businesses, governments and consumers, and ultimately 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 & personal care; clothing, footwear and accessories; sports goods; toys & games; jewellery & watches; handbags & luggage; recorded music; spirits & wine and medicines. This report presents the results of the tenth sectorial study, covering the production of pesticides[5].

1 - *Intellectual Property Rights intensive industries and economic performance in the European Union*, EUIPO/EPO, October 2016.

2 - Until 23 March 2016, the name of the Office was Office for Harmonization in the Internal Market (OHIM). The name was changed to EUIPO as part of the trade mark reform legislation which came into force on that date. In this report, the new name is used throughout, except for bibliographical references to reports published prior to the name change.

3 - *Intellectual Property Rights and firm performance in Europe: an economic analysis*, June 2015.

4 - *European citizens and intellectual property: perception, awareness and behaviour*, November 2013.

5 - The sector analysed here comprises the four digit NACE code: 20.20 'Manufacture of pesticides and other agrochemical products'. NACE is the official classification of economic activity used by Eurostat, the statistical office of the EU.

The EUIPO/EPO (2016) study revealed that this industry is intensive in the use of trade marks, patents and designs.

It is estimated that the legitimate industry loses approximately **EUR 1.3 billion** of revenue annually due to the presence of counterfeit pesticides in the EU marketplace, corresponding to **13.8 % of the sector's sales.**

These lost sales translate into direct employment losses of approximately 2 600 jobs. This figure does not take account of the effect of imports, since in those cases the associated employment impacts occur outside of 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.

If the knock-on effects on other industries and on government revenue are added, when both the direct and indirect effects are considered, counterfeiting in this sector causes approximately EUR 2.8 billion of lost sales to the EU economy, which in turns leads to employment losses of about 11 700 jobs and a loss of EUR 238 million in government revenues.

It is important to note that the impact of counterfeit pesticides refers only to the manufacturing industry and so does not include wholesale and retail trade due to absence of data. For that reason, the absolute numbers in this report cannot be directly compared to those previously presented for other sectors such as cosmetics, clothing and footwear, or medicines.

1. INTRODUCTION

THE ECONOMIC COST OF IPR INFRINGEMENT IN THE PESTICIDES SECTOR

A major problem which has hindered the effective enforcement of Intellectual Property Rights (IPR) in the EU is related to a lack of knowledge in relation to the precise scope, scale and impact of IPR infringements. 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 IP rights and in charge of establishing precise priorities, programmes and targets for enforcement, as they limit the possibilities to design 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 Cosmetics and Personal Care; Clothing, Footwear and Accessories; Sports Goods; Games and Toys; Jewellery and Watches; Handbags and Luggage; Recorded Music; Wine and Spirits; and Pharmaceutical sectors.

In the present report the Observatory focuses its attention on the *Manufacture of Pesticides and other Agrochemical products*. The products included in this sector, as defined by Eurostat, are:

- Manufacture of insecticides, rodenticides, fungicides, herbicides, acaricides, molluscicides, biocides;

- Manufacture of anti-sprouting products, plant growth regulators;

- Manufacture of disinfectants (for agricultural and other uses);

- Manufacture of other agrochemical products, n.e.c.

This class excludes:

- Manufacture of fertilisers and nitrogen compounds.

This study aims to estimate the scale of the two major economic impacts of counterfeiting which cover the direct and indirect costs to industry and the wider costs to government and society.

1) DIRECT COSTS TO 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[6] so that it can be used on a sectorial level rather than on a firm level which proved very difficult to apply in practice.

Variations in a sector's sales are analysed using statistical techniques which allow the researcher to relate them to economic and social factors and thereby estimate the amount of sales lost by rights holders due to counterfeiting.

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 sectors in question.

2) INDIRECT EFFECTS OF COUNTERFEITING

In addition to the direct loss of sales in the identified sector, 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 sales declines and corresponding employment effects in other sectors.

3) IMPACTS ON PUBLIC FINANCES

Since the activity in question is illegal, it is likely that those engaged in manufacture of counterfeit goods do not pay taxes on the resulting revenues and incomes. Therefore, an additional impact

6 - RAND (2012), *Measuring IPR infringements in the internal market.* 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 sector-level data which can be obtained from public sources.

of counterfeiting is the resulting losses of tax revenue by government, specifically income taxes and social contributions or corporate taxes.

In order to quantify these costs, several relationships are estimated using statistical techniques. The methodology is fully explained in the Appendices and is briefly outlined below.

Step 1: Estimation of lost sales due to counterfeiting

Predicted sales of relevant sectors are generated and compared with actual sales in each country, as reported in official statistics. The difference can then be partly explained by socio-economic factors such as GDP growth or per capita income. In addition, factors related to counterfeiting are considered, such as behaviour of consumers, and the characteristics of a country's markets and its legal and regulatory environments[7]. The difference between forecast and actual sales is analysed in order to extract the effect of counterfeit consumption on legitimate sales.

Step 2: Translation of lost sales into lost jobs and lost public revenue

Since the legitimate industry sells less than it would have sold in the absence of counterfeiting, it also employs fewer workers. Data from Eurostat on employment in this sector is used to estimate the employment lost related to the reduction of legitimate business as a result of lost sales due to counterfeiting.

In addition to the direct loss of sales in the sector being analysed, there are also indirect impacts elsewhere in the economy, as this sector will also buy fewer goods and services from its suppliers, causing sales declines and corresponding employment effects in other sectors.

Furthermore, the reduced economic activity in the private sector has an impact on government revenue, essentially tax revenue such as household income tax and tax on company profits, but also social security contributions.

It should be noted that 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[8].

7 - Perception of corruption by citizens from Eurobarometer and the Worldwide Governance Indicator of Government Effectiveness from the World Bank are used in this study.

8 - On the other hand, this report only estimates the effect on sales of the pesticides sector within the EU marketplace. So, to the extent that counterfeit products in non-EU markets displace exports of legitimate EU producers, there is a further employment loss in the EU which is not captured here.

Similarly, while illicit activities do not generate the same levels of tax revenue as legal activities, to the extent that sales of counterfeits happen 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.

This study, as is the case with the previous sectorial studies, focuses on the economic impact of the presence of counterfeit pesticides in the EU marketplace. However, due to the special nature of these products, it is important to point out the potential consequences for health and the environment associated with fake pesticides. Before these products can be authorised for use in the EU, they must undergo and pass a range of stringent tests and assessments to comply with the high safety standards set under EU legislation. These tests and assessments look for, among other factors, effects on the environment (incl. plants, birds, mammals, pollinators and other beneficial insects) and human health. Obviously, the counterfeit pesticides have not undergone such testing, and can thus endanger the health of both the farmers who are the direct users of the products (and are thus very directly exposed), and of consumers. Besides the human suffering they entail, these effects also have economic consequences for society and notably on the health care systems of EU Member States. Such economic consequences can unfortunately not be taken into account in the present study due to the difficulty of quantifying them, but they should be kept in mind when considering the phenomenon of counterfeit pesticides.

The next section presents the main findings of the study.

2. IMPACT OF COUNTERFEITING IN THE PESTICIDES INDUSTRY

THE ECONOMIC COST OF IPR INFRINGEMENT IN THE PESTICIDES SECTOR

The starting point of this analysis is the estimation of consumption of pesticides by Member State based on official data from Eurostat on production and intra- and extra-EU trade. Information on wholesale and retail trade of pesticides cannot be obtained from official statistics, so the estimation of consumption of pesticides analysed in this report is stated at producer prices and thus does not include the trade margins paid to distributors and retailers.

THE PESTICIDES INDUSTRY IN THE EU

During 2014, EU production of pesticides amounted to EUR 12 billion and net exports to third countries were worth EUR 3 billion leaving EUR 9 billion (at producer prices) for consumption in the internal market.

In the same year, there were about 25 300 people employed in the pesticides manufacturing industry across the EU.

In previous sectorial studies the different products analysed were directly consumed by private households (with the exception of medicines which are purchased by households and by health care providers). However, in the case of pesticides, the main use of pesticides is intermediate consumption[9].

The biggest producer of pesticides in the EU is Germany (EUR 4 billion), followed by France (EUR 3.5 billion). These two countries are also the major exporters with a trade balance of EUR 1.7 billion in the case of Germany and EUR 1.5 billion in France (including exports to other EU Member States), and total net exports of 28 EU countries to third countries of EUR 2.6 billion.

The EU pesticides industry consists of more than 600 enterprises, with an average of 36 workers per firm. Of these companies, nearly 400 are SMEs, half of which half are micro enterprises (less than 10 workers). The SMEs account for one third of total employment in the sector and generate 38 % of its total turnover.

These statistics underline the importance of smaller companies in the manufacture of pesticides across the EU.

9 - The value of sales by each sector to businesses in other sectors (intermediate consumption) and to final users (final consumption or exports) is contained in Input Output Tables at 2 digit level of NACE. Division 20 includes a wide variety of chemical products so one cannot conclude from it which is the share of pesticides sold to intermediate and final users. However, the Economic Accounts for Agriculture (EAA) indicate that intermediate consumption in agriculture is valued at EUR 11 billion at purchaser prices.

Case 1: a seizure in Hamburg

In the early 2015, a single container with 5 000 kg of Thiamethoxam (TMX) in 25 kg drums, with an estimated value of EUR 590 000, was identified by Hamburg Plant Protection Authorities en route from Shanghai. Once it had arrived in Hamburg, it was detained by the authorities before it could reach its intended destination in Hungary. The packing was not only unsafe but also designed to make access difficult. Analysis confirms that the product did contain the active substance, thiametoxam. The shipment was confiscated and then destroyed.

(Source: case provided by the ECPA).

Case 2: Operation Silver Axe

In late 2015, Europol supported the massive 12-day international operation Silver Axe, during which 350 inspections of containers were carried out at major ports and airports in seven countries. As a result, law enforcement agencies from Belgium, France, Germany, Italy, Slovenia, Spain and the Netherlands discovered 190 tonnes of illegal or counterfeit pesticides.

One hundred cases of infringements were detected, which led to the initiation of further investigations by the authorities. The infringements included counterfeit pesticides (e.g. IPR infringements/non-genuine products), illicit pesticides (e.g. unknown products potentially containing unauthorised chemicals) or false declarations (e.g. transporting dangerous goods).

Operation Silver Axe focused on the sale and placing on the market (imports) of counterfeit pesticides, including infringements of intellectual property rights such as trade marks, patents and copyright, as well as targeting the illegal trade of pesticides.

Throughout the operation, which started on 16 November and ended on 27 November 2015, Europol's experts exchanged and analysed data among participating countries, and liaised with rights holders from the private sector, including CropLife International, the European Crop Protection Association (ECPA) and the European Crop Care Association (ECCA).

Pesticides are one of the most regulated products in the world today, and can only be traded and used in the EU if the products are proven safe and authorised.

Operation Silver Axe was organised in line with the EU Action Plan on the enforcement of intellectual property rights, and was financially supported with an EU granted budget.

Source: Europol press release, accessed at:
https://www.europol.europa.eu/newsroom/news/huge-seizures-of-190-tonnes-of-counterfeit-pesticides

Direct impact

Based on country-level consumption data of pesticides at producer prices, the difference between forecast sales and actual sales has been estimated for each country (Appendix A), and analysed using statistical methods (Appendix B), relating the sales shortfall to factors (called *variables* in economic parlance) such as:

Differences between expected and actual sales in both formats are independently analysed using statistical methods (described fully in Appendix B), relating the sales shortfall to factors (called variables in economic parlance) such as:

- Growth rates of **Utilised Agricultural Area and the exchange rate of the Euro vs. other currencies** (socio-economic variables);

- The percentage of the population thinking that the problem of **corruption is widespread** as reflected in the Eurobarometer on corruption[10] and the **World Bank Index of Government Effectiveness**[11] growth rate (variables 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 be partly explained by economic or social factors (including both cyclical factors such as recessions and structural ones such as per capita income), and partly by the consumers'[12] propensity to infringe IP rights (sometimes unwittingly), as evidenced by responses to surveys such as the 2013 IP Perception Study by the EUIPO, similar questions from Eurobarometer surveys, and indices related to corruption and quality of governance published by organisations such as the World Bank. The specific variables 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.

The resulting estimates of the lost sales due to counterfeiting in the pesticides sector, for all Member States, are shown in the figure below. This is the direct impact of counterfeiting discussed above, although as noted before, for this sector only the impact on the manufacturers is included, as opposed to wider considerations incorporating the wholesale and retail trade sectors.

For each country, the bars indicate the impact of counterfeiting on the legitimate sector's sales, expressed as a percentage of sales revenue at producer prices, while the diamonds indicate the 95 % confidence interval of that estimate[13]. The figures represent an annual average for the six years 2009-2014.

10 - According to WCO (2012), 'the predominance of the informal economy 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 as an explanatory variable for counterfeiting.

11 - The World Bank Index of Government Effectiveness captures perceptions of the quality of public services, the quality of civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

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

13 - The 95 % confidence interval is a statistical calculation which 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 13.8 %, with a 95 % probability that the true percentage lies between 12.5 % and 15.2 %.
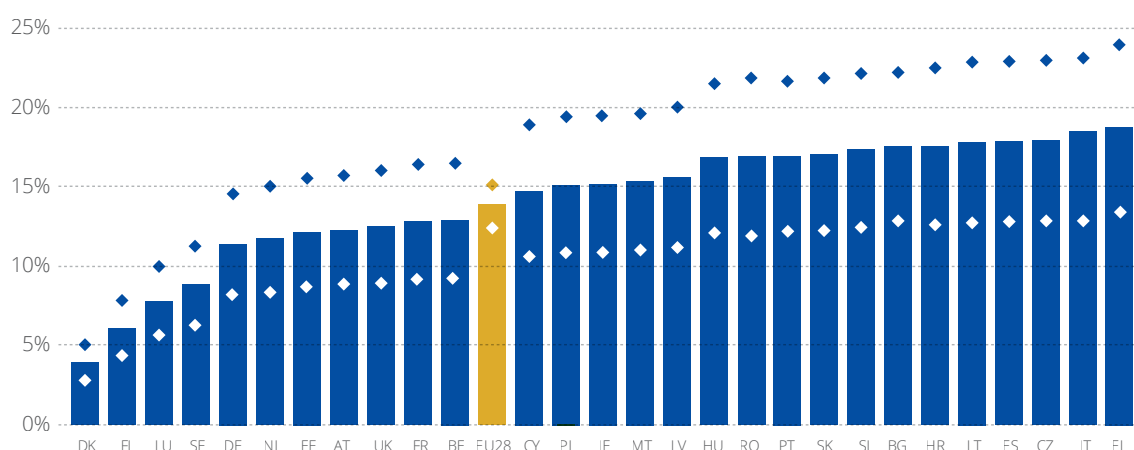
For the EU as a whole[14], the estimated total counterfeiting effect amounts to 13.8 % of sales or EUR 1.3 billion. This is a direct estimate of sales lost by legitimate manufacturers of pesticides in the EU each year due to counterfeiting.

Country-level estimates of lost sales expressed both as a percentage of total sales and in Euro, are shown in the table below.

	Lower 95%	Average	Upper 95%	Lost sales (million EUR)
AUSTRIA	8.8	12.2	15.7	19
BELGIUM	9.2	12.9	16.5	45
BULGARIA	12.8	17.5	22.2	13
CYPRUS	10.7	14.8	19.0	3
CZECH REPUBLIC	12.9	17.9	23.0	36
GERMANY	8.2	11.4	14.6	299
DENMARK	2.9	4.0	5.1	3
ESTONIA	8.7	12.2	15.6	3
GREECE	13.5	18.7	24.0	41
SPAIN	12.8	17.9	22.9	94
FINLAND	4.4	6.1	7.8	3
FRANCE	9.2	12.8	16.4	240
CROATIA	12.6	17.6	22.5	13
HUNGARY	12.1	16.8	21.5	23
IRELAND	10.9	15.2	19.5	15
ITALY	12.9	18.1	23.2	185
LITHUANIA	12.7	17.8	22.9	12
LUXEMBOURG	5.6	7.8	10.0	1
LATVIA	11.2	15.6	20.1	7
MALTA	11.0	15.3	19.6	0
NETHERLANDS	8.4	11.7	15.1	19
POLAND	10.8	15.1	19.4	78
PORTUGAL	12.2	16.9	21.7	25
ROMANIA	11.9	16.9	21.9	36
SWEDEN	6.3	8.8	11.3	7
SLOVENIA	12.5	17.3	22.2	5
SLOVAKIA	12.3	17.1	21.9	12
UNITED KINGDOM	9.0	12.5	16.0	76
EU-28	12.5	13.8	15.2	1 313

The biggest absolute impacts of counterfeiting are observed in Germany (EUR 300 million) and France (EUR 240 million), although both countries have relative effects of lost sales due to counterfeiting in pesticides below the EU average (11.4 % and 12.8 % respectively). Italy has relative lost sales above the EU average at 18.1 %, with an absolute impact of nearly EUR 200 million. The relative effect of counterfeit pesticides in Spain is nearly 18 % but the absolute impact is half that of Italy. Finally, in the United Kingdom, the relative effect of counterfeiting in lost sales is below the EU average (12.5 %) and total lost sales are EUR 76 million. The direct effect of counterfeit pesticides on sales is below 10 % only in four Member States: Denmark, Finland, Luxembourg and Sweden.

Since the legitimate industry sells less than it would have sold in the absence of counterfeiting, it also employs fewer workers[15]. Data from Eurostat on sectorial employment-to-sales ratios are used to estimate the corresponding employment lost in the legitimate pesticides industry due to counterfeiting, resulting in a total of 2 600 lost jobs across the EU

Direct employment impacts are calculated at the country level by estimating lost sales by that country's sector across the entire EU market. For example, the direct sales lost by the German industry as a result of counterfeit pesticides are estimated by adding sales lost in Germany to sales of German pesticides lost in other EU countries. The latter total is calculated from the differing counterfeiting rates prevalent within each Member State.

German and French loses in employment in the legitimate pesticides industry are estimated at 500 jobs in each country, Italian industry loses about 270 jobs and in the United Kingdom, Spain and Poland the losses amount to about 200 jobs in each country.

Indirect impact

In addition to the direct loss of sales in the pesticides industry, there are also impacts on other sectors of the EU economy, as a sector suffering lost sales due to counterfeiting will also buy fewer goods and services from its suppliers, causing sales declines and corresponding employment effects in other sectors.

To assess this indirect impact, data from Eurostat[16] are used, showing how much the pesticides industry buys from other sectors in the EU in order to produce what it delivers [17].

Final demand for pesticides, as estimated in this report, includes imported goods (about EUR 180 million) and not only the value of EU production (even though on balance the EU is a net exporter of pesticides). Employment and indirect effects arising from these imports occur outside the EU and therefore are not included in the calculations. Consequently, of the total lost sales figure of EUR 1.3 billion, only the value of domestic production (EUR 1.1 billion) is used to calculate indirect impacts[18].

The total direct and indirect effect in the EU of lost sales due to counterfeiting, as an annual average for the period 2009-2014, amounts to EUR 2.8 billion

Thus, beyond the direct effects on the pesticides industry (EUR 1.3 billion in annual sales), an additional EUR 1.5 billion are lost in other sectors of the economy due to counterfeiting. This is the indirect effect of counterfeiting [19].

Turning to employment, if losses in the supplier sectors are added to the direct employment loss in the pesticides industry, the total employment loss resulting from counterfeiting is estimated at 11 700.

Total effects (direct plus indirect) are calculated at country level based on ESA 2010 harmonised IOT published by Eurostat and presented in the table below for the five Member States with the biggest total impacts.

Total effects

	Sales (million EUR)	Employment(persons)
GERMANY	694	2 902
FRANCE	548	2 295
ITALY	233	826
SPAIN	157	723
UNITED KINGDOM*	128	496
EU-28	2 827	11 686

*Based on ESA 1995 harmonised Input-Output Tables

The direct and indirect (and hence the total) effects on sales and employment reflect the structure and volume of production in each Member State, in particular the use of domestic inputs as well as different employment ratios.

18 - On the other hand, this report only estimates the effect on sales of pesticides within the EU marketplace. So, 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 which is not captured here.

19 - As mentioned in Section 1, this calculation assumes that the counterfeit products are produced outside the EU. If they are (partly) produced inside the EU, then the indirect impact would be less than shown in the table since those illicit producers would presumably source some of their inputs from EU producers.

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

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

Finally, the reduced economic activity in the legitimate private sector has an impact on government revenues[20] as well. Assuming that illicit producers do not declare their activities and the resulting revenues to the authorities, the lost taxes that sales of pesticides valued at EUR 1.3 billion would have generated can be calculated, as well as the tax revenues corresponding to the total (direct + indirect) loss of EUR 2.8 billion calculated above.

Two types of taxes have been considered[21]: taxes on household income and taxes on the income or profits of companies. In this report, VAT losses are not considered because pesticides are sold mainly to as intermediate products to the agriculture sector, and the VAT initially charged is later refunded.

1) The lost household income tax, estimated on the basis of the share of wages corresponding to lost employment in total wages, considering direct and indirect effects on employment, amounts to EUR 77 million.

2) The lost tax on corporate profits is estimated from the share of direct and indirect costs in industry and amounts to EUR 26 million.

In addition, social security contributions linked to the direct and indirect employment losses are also estimated. Social security contributions 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 135 million.

The total loss of government revenue (household income taxes, social security contributions and corporate income taxes) can therefore be roughly estimated at EUR 238 million.

3. CONCLUSIONS AND PERSPECTIVES

THE ECONOMIC COST OF IPR INFRINGEMENT IN THE PESTICIDES SECTOR

The studies aiming to quantify the scale and impact of IPR infringements in cosmetics and perfumes, clothing and footwear, sports goods, toys and games, jewellery and watches, handbags and luggage, recorded music, spirits and wine, pharmaceuticals and now pesticides have provided coherent estimates of the size of the problem of counterfeiting for legitimate businesses and for society in terms of lost sales, leading 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 harmonised European statistical data for the analysis.

The ten sectorial studies published to date will be followed in the coming months by other similar studies covering additional sectors, applying the same methodology and combining it with knowledge from industry stakeholders. These studies include smartphones and other sectors, depending on availability of data.

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 objective picture of the impact of counterfeit goods in Europe, in order to help policy makers develop effective enforcement policies.

APPENDIX A: THE FIRST STAGE FORECASTING MODEL

THE ECONOMIC COST OF IPR INFRINGEMENT IN THE PESTICIDES SECTOR

The methodology used for the estimation of the economic effects of counterfeiting is depicted in the following figure and explained in detail in this Appendix and in Appendix B.
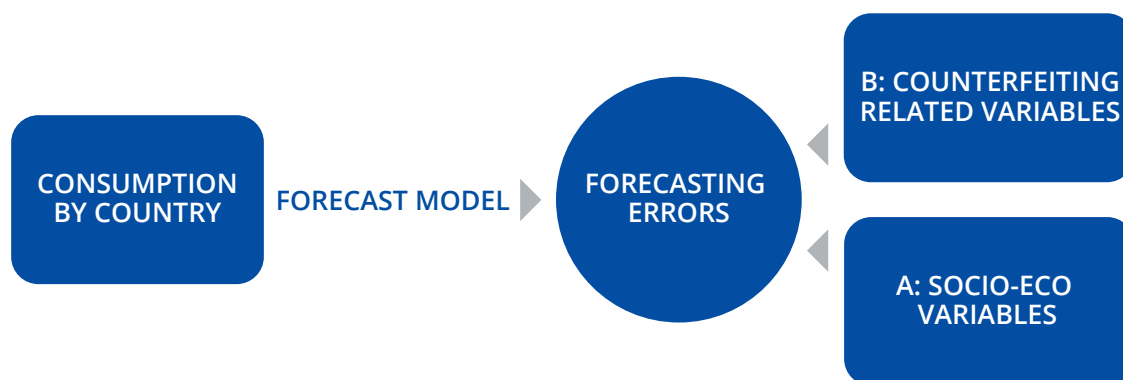
The first stage is comprised of a forecasting model of sales of products in each country. Assuming that a reasonably long time series of sales by country is available, a model is created that explains the trend of this time series and predicts the value of sales in subsequent years.

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 consumption to produce a forecast of future consumption. 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 consumption, as shown in the following equation:

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

where Y_{it} is consumption in country i and year t (measured in EUR) and $\hat{Y}_{it}$ is the forecast of Y_{it} obtained from the univariate model using consumption 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 consumption) versus the actual level of consumption observed from the Eurostat data.

Step-wise forecast errors for the six years from 2009 to 2014 are constructed for Member States for which sufficient data is available, a total of 24 countries. It must be underlined that 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 the table below. 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 which can then be quantitatively analysed to construct estimates 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.

	2009	2010	2011	2012	2013	2014
AUSTRIA	– 29.7	– 24.0	– 5.9	NA	– 33.1	1.6
BULGARIA	0.9	– 4.7	– 30.1	– 34.4	– 6.2	– 17.7
CYPRUS	– 19.4	– 12.4	4.1	– 7.5	– 5.3	16.0
GERMANY	– 9.2	14.4	– 13.6	– 30.8	– 9.2	– 2.0
DENMARK	NA	– 40.8	– 31.0	– 31.4	36.7	– 13.3
ESTONIA	24.0	34.2	16.4	1.9	– 2.5	15.8
GREECE	19.8	– 11.4	– 22.8	9.5	– 11.5	– 10.1
SPAIN	0.8	– 1.9	– 5.8	33.7	5.3	– 0.1
FINLAND	– 5.7	11.2	– 3.8	– 6.3	– 15.2	2.3
FRANCE	– 9.6	2.9	– 16.1	– 4.2	– 6.5	– 3.7
CROATIA	– 6.7	7.8	12.8	0.9	33.9	NA
HUNGARY	13.7	12.3	8.1	6.9	– 24.0	– 3.7
IRELAND	NA	NA	NA	– 2.5	NA	NA
ITALY	– 13.1	10.6	– 4.3	– 9.7	23.0	17.4
LITHUANIA	– 22.5	– 21.2	– 20.7	– 35.7	20.6	2.9
LATVIA	6.9	– 15.0	– 24.1	– 41.9	47.7	– 1.3
MALTA	– 8.8	– 25.3	– 29.3	– 32.8	– 21.4	34.8
NETHERLANDS	NA	NA	NA	3.4	NA	NA
POLAND	4.6	– 8.3	– 25.6	– 19.5	– 14.5	– 12.2
PORTUGAL	26.6	4.5	7.6	– 1.2	– 1.2	4.0
ROMANIA	– 17.4	– 32.3	50.5	– 20.8	18.9	– 22.8
SWEDEN	12.7	– 9.9	– 11.2	– 24.6	– 25.6	– 0.4
SLOVAKIA	– 23.0	26.4	– 5.3	– 9.0	NA	NA
UNITED KINGDOM	NA	26.3	– 21.5	– 28.2	– 18.6	– 55.4

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.

APPENDIX B: THE SECOND STAGE ECONOMETRIC MODEL

THE ECONOMIC COST OF IPR INFRINGEMENT IN THE PESTICIDE INDUSTRY

Counterfeiting might be one of a number of factors impacting on the level of legal sales of pesticides, but there are, as outlined earlier, a series of other economic factors which can explain the differential, such as variables related to the economic capacity of households, or consumers[22] (e.g. agricultural area growth) or any other driver of consumption expenditure.

Having accounted for the influence of 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 pesticides. 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 for the specification of an econometric model whose aim is to explain the aggregate differential (forecast errors) between expected and real sales. The model is specified in the following format:

$$q_{it}^{*} = \alpha * X_{it} + \beta * Z_{it} + \varepsilon_{it}$$

where X_{it} is a matrix of explanatory variables unrelated to counterfeiting and Z_{it} a matrix of variables related to counterfeiting. Finally, ε_{it} is the remaining error.

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

1. Gross Disposable Income (GDI) of the household sector: per capita income and growth;
2. GDP per capita and GDP growth;
3. Exchange rate of Euro vs. other EU currencies;
4. Volume Indicator of Value Added in Agriculture (growth rate);
5. Share of Value Added and Output in Agriculture;
6. Utilised Agricultural Area, growth rate (from crop statistics, Eurostat).

The second term of the equation, Zit, contains the matrix of variables thought to be **related to counterfeiting**[23]. These variables 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 (level and growth);

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

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

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

3. Intellectual Property Right Index;
4. Worldwide Governance Indicators (World Bank) covering Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption (level and growth).

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.

Corruption related variables considered for inclusion in the Z matrix from the Eurobarometer survey include[24]: the percentage of the population declaring that corruption is widespread, that it is in the business culture, that it is a major problem and the percentage of the population that believed corruption had increased over the last three years. From the Tolerance Index to Corruption, the measure covering the percentage of the population that declares that corruption in public administration or public service is acceptable, was considered.

Variables 2 to 4 are considered to be drivers of counterfeiting related to institutional characteristics of each country.

The Corruption Perception Index (CPI) is published by Transparency International and measures how corrupt public sectors are seen to be by the public in each country. In this study the updated index is used as a time invariant variable with reference year 2012.

The Intellectual Property (IP) Rights Index used is published by Property Rights Alliance and measures the strength of protection accorded to IP. The 2012 index is used in this study and the same value is used for each country across the six years studied as a time invariant variable.

The Worldwide Governance Indicators reflect the perception of government effectiveness, regulatory quality, rule of law and corruption. They are published annually and range from 2.5 for favourable aspects of governance to – 2.5 for poor. These indicators are considered as potential proxies for the perceived risk of buying or selling counterfeit goods. These indices have a high negative correlation with the variables from the IP Perception study and Eurobarometer.

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 rule of law are

perceived to be weak there is a higher likelihood of consumption of a product to be illicit than in countries with good governance, strong rule of law and low corruption.

Altogether, 50 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.

Some of the variables considered in the modelling process are clearly correlated with each other. High correlation coefficients between explanatory variables (referred to as multicollinearity) present 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 (small t-statistics), although possessing 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.

For instance, per capita GDI of the household sector and per capita GDP are highly correlated. Therefore only those variables with the greatest explanatory power are included in the model in order to avoid the problems described above.

Different methods have been applied and the preferred model is estimated using Weighted Least Squares (WLS) with the Standard Errors of forecast errors from ARIMA models used as weights. This method solves problems of heteroscedasticity as stability of variance of estimated residuals is a requirement for an acceptable accuracy in the coefficients estimation.

Finally, residuals were analysed to check compliance with the usual assumptions of regression models[26].

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

Model results

The results of the final estimated model are shown in the table below.

Variable	Coefficient	Robust Standard Error	t Statistic	95% Confidence interval	
				Lower	Upper
Constant	– 0.2149	0.0529	– 4.07 ***	– 0.3424	– 0.1056
Utilised Agricultural area growth	– 0.0068	0.0041	– 1.68*	– 0.0152	0.0016
Euro exchange rate growth	0.7421	0.4513	1.64	– 0.1915	1.6758
EB: Corruption is widespread	0.1887	0.6647	2.84 ***	0.0512	0.3262
WB Index: Government Effectiveness (growth)	– 0.0229	0.0110	– 2.09 **	– 0.0455	– 0.0002

R-square between = 8 %
Wald Chi-2 statistic = 4.15 **

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

27 - If, for example, an estimated coefficient is significant at the 95 % confidence level, then one can say that the probability that the *true* coefficient is zero and the *estimated* value was obtained solely by chance is 5 %. The 't-statistic' shown in the third column is simply the estimated coefficient divided by its standard error. The last two columns show the 95 % confidence interval for the coefficient; in other words, the true coefficient lies in the interval between the lower and upper bounds with a 95 % probability.

The econometric model explains 8 % of total variance of the stage 1 forecast errors. The model uses a combination of two economic variables and two counterfeiting-related variables. 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[27].

The explanatory variables, not related to counterfeiting are **Utilised Agricultural Area growth** with a negative coefficient meaning that higher growth of agricultural area are associated with smaller forecasting errors; and the **Euro exchange rate** with a positive coefficient, implying that as the euro appreciates, so does the capacity for counterfeiting outside the Euro zone.

The remaining two variables relate to counterfeiting and include one variable from the 2013 Eurobarometer about Corruption and one of the Worldwide Governance Indicators from the World Bank. The variable from Eurobarometer is the **percentage of the population believing that the problem of corruption is widespread** and it is a time-invariant variable with a positive coefficient, implying that a higher percentage of the population thinking that corruption is widespread, has a positive relationship with forecasting errors estimated in the first stage.

The **Government Effectiveness Index** published by the World Bank captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence

from political pressures, the quality of policy formulations and implementations, and the credibility of the government's commitment to such policies. The coefficient estimated for this variable is negative, so that a higher growth rate of the index in a particular country corresponds to improving quality of regulation and is related to smaller forecast errors.

As the main objective of the model is to estimate the coefficients of the counterfeiting-related variables, the characteristics of these coefficients should be investigated. Several models have been estimated, adding different explanatory variables, using different econometric techniques and also based on sales at consumer prices. The resulting estimated coefficients for the counterfeiting-related variables are presented in the following table, providing a good indication of its stability.

	Eurobarometer Corruption	WB Government Effectiveness
1 (chosen model)	0.1887	– 0.0229
2	0.1550	–
3	0.1559	– 0.0131
4	0.1719	–
Average 2-4	0.1679	– 0.0180

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

$$C_{it}^* = \widehat{\beta_1} * Z_{1_i} + \widehat{\beta_2} * Z_{2_{it}}$$

Where C_{it}^* represents the sales lost due to counterfeiting in country i in year t (expressed as the fraction of the sector's actual sales), Z_{1_i} is the value of the Eurobarometer variable, and $Z_{2_{it}}$ is the value of the World Bank Index growth rate in that country and year[28]. The β's are the estimated coefficients from the table at the beginning of this section.

The counterfeiting effect is calculated for all 28 EU Member States, applying the coefficients estimated in the model above to the values of the explanatory variables.

Interpretation of this specification is made on the following basis: for a country where 20 % of the population believe that corruption is widespread and the average growth rate of Government Effectiveness index in 2009-2014 is – 5 %, the effect of counterfeiting on legitimate sales of pesticides is a sales decrease of 3.9 % (0.1887*0.20 – 0.0229*(– 0.05) = 0.0389).

28 - It should be noted that in this case, the value of Z_{1i} is the same for all t since the variable is time-invariant during the period covered by this study.

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THE ECONOMIC COST OF IPR INFRINGEMENT IN THE PESTICIDES SECTOR

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