OFFICE FOR HARMONIZATION
IN THE INTERNAL MARKET
(TRADE MARKS AND DESIGNS)

The economic cost of IPR infringement in the cosmetics and personal care sector: report of a pilot study

Quantification of infringement in Manufacture of perfumes and toilet preparations sector (NACE 20.42)

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Acknowledgements

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Executive Summary

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 IPR infringements.

In a study carried out in collaboration with the European Patent Office[1], the Office for Harmonization in the Internal Market (OHIM), acting through the Observatory, calculated that 39% of total economic activity in the EU is generated by IPR-intensive industries, and approximately 26% of all employment in the EU is provided directly by these industries, with a further 9% of jobs in the EU stemming from purchases of goods and services from other industries by IPR-intensive industries.

Perceptions and behaviours of European citizens regarding Intellectual Property and counterfeiting and piracy[2] 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 has now embarked on an effort 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 hidden from view. In order 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.

1 - "Intellectual Property Rights intensive industries: contribution to economic performance and employment in the European Union", September 2013

2 - European citizens and intellectual property: perception, awareness and bahaviour, November 2013

Several sectors whose products are known or thought to be subject of counterfeiting have been selected. This report presents the results of the first sectorial study, covering the cosmetics and personal care sector[3].

It is estimated that the legitimate industry loses approximately €4.7 billion of revenue annually due to the presence of counterfeit cosmetics (perfumes, beauty and make-up) and other personal care products such as sunburn protection creams, shampoos, toothpaste, shaving and deodorants products in the EU marketplace, corresponding to 7.8% of the sector's sales. This translates into employment losses of approximately 50,000 jobs.

If we add the knock-on effects on other industries and on government revenue, when both the direct and indirect effects are considered, counterfeiting in this sector causes approximately €9.5 billion of lost sales to industry, which in turns leads to employment losses of about 80,000 jobs and a loss of €1.7 billion in government revenue.

3 - The formal name of the sector is: NACE code 20.42 "Manufacture of perfumes and toilet preparations". NACE is the official classification of economic activity used by Eurostat, the statistical office of the EU.

01 - Introduction

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, 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 and programmes, targets for enforcement as they limited 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 methodological constraints, the Observatory developed a specific approach and piloted it in the cosmetics and personal care sector. This sector, officially labelled *Manufacture of Perfumes and Toilet Preparations* by Eurostat[4], covers various types of products, such as:

- perfumes and toilet water;
- beauty and make-up preparations;
- sunburn prevention and suntan preparations;
- manicure and pedicure preparations;
- shampoos, hair lacquers, waving and straightening preparations;
- dentifrices and preparations for oral hygiene, including denture fixative preparations;
- shaving preparations, including pre-shave and aftershave preparations;
- deodorants and bath salts;
- depilatories;
- manufacture of cosmetic soap.

The approach in this study aims to estimate the scale of the two major economic impacts of counterfeiting which are direct and indirect costs to industry and costs to government/society.

1) Direct costs to industry

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

4 - NACE code 20.42 from Eurostat

The methodology builds on an adaptation of a methodology developed for the European Commission[5] 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 sector, which can be derived from European statistical data on employment for the sector 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) Impact on public finances

Since the activity in question is illegal, it is likely that those engaged in manufacture and distribution of counterfeit goods do not pay taxes on the resulting revenues and incomes. Therefore, an additional impact of counterfeiting is the resulting losses of tax revenue by government, specifically income taxes and social contributions, corporate taxes, and indirect taxes such as excise taxes or VAT.

In order to approximate these costs, several relationships are estimated. 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 the sector are generated and compared with actual sales in each country, as reported in official statistics. The difference can then be explained by socio-economic factors such as evolution in household incomes, or demographic factors, for example the percentage of women aged 20-49 (since this group can be assumed to consume significant quantities of cosmetics). In addition, factors related to counterfeiting are relevant, such as behaviour of consumers[6], and the characteristics of a country's markets and its legal and

5 - RAND (2012) : Measuring IPR infringements in the internal market. Report prepared for the European Commission.

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

regulatory environments[7]. The difference between forecast and actual sales is analysed in order to extract the level of counterfeited consumption of the products.

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. As losses are incurred in the manufacturing, wholesale and retail trade sectors, data from Eurostat on employment in these sectors 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, there are also indirect impacts on other sectors 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 as well, essentially tax revenue such as VAT, 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 include losses in sectors that provide inputs to manufacture and distribution of legal products in the EU. Possible positive effects of inputs provided for production or distribution 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, or the fact that some portion of sales of counterfeit products happens through the legitimate sales channels. The net employment effect could therefore be smaller than the gross effect calculated here[8].

Similarly, while illicit activities do not generate the same levels of tax revenue as legal activities, to the extent that distribution and sales of counterfeits happen in the legitimate sales channels, some amount of direct and indirect taxes is levied on these products, 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.

The next section presents the main findings of the study.

7 - The World Bank index of regulatory quality is used in this study.

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

2. Impact of counterfeiting in the cosmetics and personal care sector

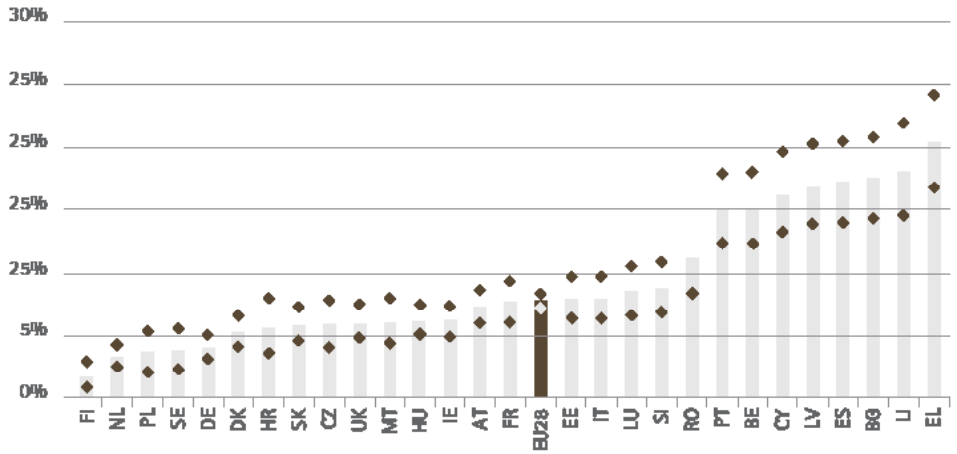
The starting point is to estimate the consumption of these products in each country. Based on official data on production, intra and extra EU trade and trade margins, it is estimated that the total consumption of the EU was €60 billion in 2011[9], or about €120 per capita.

Based on these data, 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:

- **per capita consumption of these products and the index of consumer prices of products for personal care** (socio-economic variables);
- **percentage of the population reporting having bought counterfeit products intentionally** in the IP Perception study and the growth rate of the **World Bank Index of Regulatory Quality**[10] (variables related to counterfeiting).

The resulting estimates of the lost sales due to counterfeiting for all Member States are shown in the figure below[11]. This is the direct impact of counterfeiting discussed above.

For each country, the bar indicates the impact of counterfeiting on the sector, expressed as a percentage of sales, while the diamonds indicate the 95% confidence interval of that estimate[12]. The figures represent an average for the 5 years 2007-2011.



9 - In 2011, EU production amounted to €32 billion. Net exports to third countries were €11 billion, leaving €21 billion (at factory prices) for consumption in the EU. Wholesale and retail trade margins totalled €39 billion, so that the amount finally spent by EU consumers was €60 billion.

10 - The World Bank Index of Regulatory Quality reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.

11 - A table with the underlying results by country is shown in Appendix C.

12 - 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 7.8%, with a 95% probability that the true percentage lies between 7.2% and 8.3%, as shown in the table in Appendix C.

For the EU as a whole[13], the estimated total counterfeiting effect amounts to 7.8% of consumption (€4.7 billion). This is a direct estimate of sales lost by legitimate industry in the EU each year due to counterfeiting in this sector, including losses in manufacture, wholesale and retail trade sectors.

Since the legitimate industry sells less than it would have sold in the absence of counterfeiting, it also employs fewer workers. As losses are incurred across the manufacturing, wholesale and retail trade sectors, data from Eurostat on employment in these sectors is used to estimate employment lost as a result of lost sales due to counterfeiting. Employment to sales ratios for the three sectors at EU level are used to estimate the corresponding employment lost in the legitimate cosmetics and personal care sector, resulting in a total of 51,561 jobs across the EU.

Detailed results of sales and employment lost by industry are shown in the table below:

	Sales lost (€ million)	Employment loss
Manufacturing	1,762	10,667
Wholesale trade	1,938	14,010
Retail trade	1,009	26,884
Total	**4,708**	**51,561**

About half of the jobs lost are in the retail trade, followed by wholesale trade and manufacturing. As mentioned above, this calculation does not take into account possible infiltration of counterfeit goods into the legitimate sales channel, which would mean that the net employment loss in wholesale and retail trade would be smaller than the gross loss shown here.

Indirect impact

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

13 - The estimation was performed using with data from 20 member states due, since these countries account for 90% of total consumption of EU28, it is reasonable to apply the resulting coefficients also to the eight Member States for which data on the dependent variable was not available.

To assess this indirect impact, data from Eurostat[14] are used, showing how much the perfumes and toilet preparations sector buys in the EU from other sectors in order to produce what it delivers[15].

Since final consumption of perfumes and toilet preparations, as estimated in this report, includes wholesale and retail trade margins and not only the value of production, the final demand considered will be €4.7 billion, of which €1.8 billion is the value of production (NACE 20.42), €1.9 billion is wholesale trade margin and €1 billion is the retail trade margin[16].

With those assumptions, using European statistical data with the reference year 2009, **the requirements in the EU economy for the production of a final demand for perfumes and toilet preparations of €4.7 billion is a total of €9.5 billion**, assigned to the following industries (in € billion):

Chemical industry	2,3	Financial services	0.2
Wholesale trade	2,3	Security	0.2
Retail trade	1,1	Rental and leasing	0.1
Legal and accounting	0.3	Advertising	0.1
Electricity and gas	0.3	Construction	0.1
Warehousing	0.2	Other industries	2.1
Real estate	0.2	**TOTAL**	**9.5**

Thus, beyond the direct effects on the sectors involved in the production and distribution of perfumes and toilet preparations (€4.7 billion in annual sales), a further €4.8 billion is lost in other sectors of the economy due to counterfeiting. This is the indirect effect of counterfeiting[17].

Regarding employment, if we add losses in the supplier sectors to the direct employment loss in the cosmetic and personal care sector, the total employment loss resulting from counterfeiting of perfumes and toilet preparations is estimated at 78,959.

14 - Input-Output Tables (IOT) published by Eurostat provide the structure of input requirements for the production of a certain final demand considering also if the origin of these inputs is domestic or imported

15 - The input-output tables are provided by Eurostat on the NACE 2-digit level rather than the 4-digit level. This means that for calculating the impact of the sales reduction in sector NACE 20.42 it is necessary to use the structure of the chemical industry as a whole (NACE 20).

16 - The NACE codes for the relevant sectors are: 46.45 (Wholesale of perfumes and cosmetics) and 47.75 (Retail trade of cosmetics and toilet preparations in specialised stores).

17 - 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.

Finally, the reduced economic activity in the legitimate private sector has an impact on government revenues as well[18]. If we accept this assumption, the lost taxes that sales of perfumes and toilet preparations valued at €4.7 billion would have generated can be calculated, as well as the tax revenues corresponding to the total (direct + indirect) loss of € 9.5 billion calculated above.

The three main types of tax considered are[19]: Value Added Tax (VAT), taxes on household income, and taxes on the income or profits of companies.

1) The lost VAT is estimated on the basis of household consumption of direct lost sales in perfumes and toilet preparations sector (€4.7 billion)[20], accounting for €713 million.]

2) The lost household income tax, estimated on the basis of the share of wages generated by employment lost to total wages, considering direct and indirect effects on employment, amounts to €416 million.

3) The lost tax on corporate profits is estimated from the share of direct and indirect costs to industry and amounts to € 143 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 €463 million.

The total loss of government revenue (household income taxes and social security contributions, corporate income taxes and VAT) can be roughly estimated at €1.7 billion.

18 - 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.

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

20 - VAT generated by indirect effects is not estimated because inputs are intermediate uses that in general do not pay VAT.

3. Conclusions and perspectives

The first pilot study attempting to quantify for a specific sector, in this case the sector of cosmetics and personal care, the scale and impact of IPR infringements, has provided a significant estimate of the size of the problem of counterfeiting for legitimate businesses and society in terms of lost sales, leading to lost jobs and loss of public revenue. This study has put the methodology to the test and demonstrated the benefits from working in cooperation with stakeholders to take advantage of their knowledge of the market circumstances of the sector, while relying on harmonised European statistical data for the analysis.

This first sectorial study will be followed during the coming months by other similar studies covering a dozen of additional sectors, applying the same methodology and combining it with data and knowledge contributions from industry stakeholders from these sectors. These sectors include clothing, footwear and accessories; medicines; tobacco; luggage and handbags; alcoholic beverages covering beer, wine and spirits, as well as the sectors of games and toys, computers and automotive parts, watches and jewellery.

In parallel, the Observatory has embarked on a joint study with the Organization for Cooperation and Development (OECD) to estimate the value of counterfeit goods in international trade, and on studies of infringements in the music, film and e-book industries, in this case with the support of the Joint Research Centre of the European Commission.

Taken together, these studies complement each other and will provide a complete and objective picture of the impact of IPR infringements in Europe, in order to help policy makers develop effective enforcement policies.

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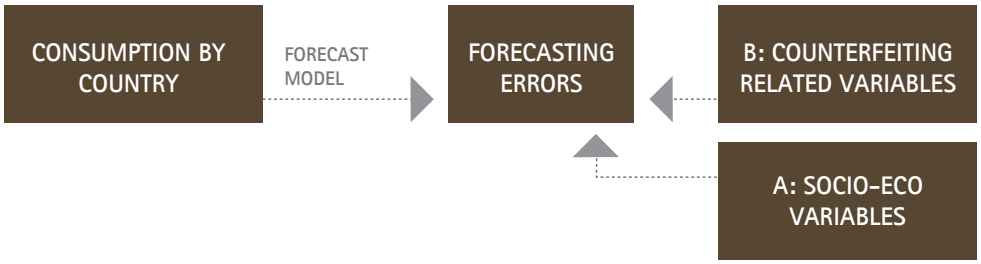
Appendix A: The first-stage forecasting model

Overview

The methodology used in the study is depicted in the following figure and explained in detail in this Appendix and in Appendix B.



The first stage in the model for quantification of infringement requires building models that produce forecasts 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.

Once the forecast has been generated, the forecasting error is the difference between the prediction and the actual consumption, expressed as a share of actual consumption in order to avoid the effect of differences in the magnitude of consumption across countries and years:

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

where Y_{it} is consumption in country i and year t (measured in EUR) and $\hat{Y}_{it}$ is the forecast of Yit obtained using information until t-1.

The relative error q^*_{it} measures to what extent the forecasting model has estimated a higher than actual value as a share of actual consumption. It is thus positive if the model over-forecasted consumption and negative in case of under-forecasting.

The forecasting errors are not interesting in and of themselves. The purpose of this study is not to produce a "good" forecast but rather to generate a set of relative forecasting errors which can then be analysed in the second stage. Forecasts were estimated based on univariate models and using an automatic procedure, which ensures that they are comparable and not polluted by a priori knowledge of factors influencing changes in demand.

Obtaining forecasts using ARIMA models

Various methods for obtaining forecasts exist. The so-called Box-Jenkins approach has been in widespread use since the early 1970s. It involves estimating models that only need past values of a variable to forecast future values of the same variable. These models are called univariate Autoregressive Integrated Moving Average (ARIMA) models (or univariate Box-Jenkins models) and have become very popular due to their simplicity and easy interpretation. They often deliver better forecast performance than econometric models.

In order to obtain the simplest possible forecast, comparable across all Member States, univariate ARIMA models are applied. These models only use the past values of each variable to predict future consumption. In effect, an ARIMA model is simply an extrapolation of trends, albeit one that uses an advanced extrapolation method.

An ARIMA model can be expressed as follows:

$$Y_{it} = f(Y_{it-1} + Y_{it-2} + \cdots + Y_{it-k}) + u_{it}$$

Where Y_{it} represents sales of a product in country i and year t. The model explains the value in year t as a function f of values in the preceding k years. But since the value of sales in a year cannot be determined exactly based on past values, an error term, denoted u_{it}, remains.

Such univariate models explain what would happen next year 'ceteris paribus', that is, assuming that factors which influence sales have not changed or are not expected to change. Therefore, these models include the effects of counterfeiting on product sales to the extent such effects persist over time.

Once the function f has been estimated, and assuming that factors that influence Y have not changed, the forecast for a future year t+j can be obtained by applying the estimated equation:

$$\hat{Y}_{it+j} = f(\hat{Y}_{it+j-1} + \hat{Y}_{it+j-2} + \cdots + \hat{Y}_{it+j-k})$$

In summary, the ARIMA forecast provides the expected sales for year t+j if underlying trends do not change, including the influence of counterfeiting.

For the estimation of the ARIMA models in this study, the TRAMO software was used. This software was developed by Banco de España and is widely used in many official institutions[18].

TRAMO provides an automatic procedure, which tests for log and level specification, interpolates missing observations and performs automatic model identification and outlier detection. The main criteria used in

21 - http://www.bde.es/bde/es/secciones/servicios/Profesionales/Programas_estadi/Programas_estad_d9fa7f3710fd821.html

the automatic model identification are: out-of-sample forecasts test, Bayesian Information Criteria (BIC) and minimum Mean Squared Error (MSE) of forecasting errors with special consideration of parsimonious and balanced models (orders of total AR and MA). The models are estimated by exact maximum likelihood (ML).

This method was used to generate the stage 1 forecasts in this report. First, the complete time period 1995-2011 was used to interpolate missing data. Then, forecasts were estimated for year t (t= 2007, 2008, 2009, 2010 and 2011) using the time span until t-1 so that one-period-ahead forecasts for 5 years were obtained. A sequential updated forecasting run was carried out, re-estimating models with each additional data point. This yielded estimated forecasting errors for five years (2007 to 2011) for each of 20 countries. These forecasting errors are quite volatile, mainly because consumption is also very volatile, with annual variation ranging between +50% and -30%.

The forecasting errors, defined as the differences between forecast and actual values of Y_{it}, were used in the second stage of the demand model. It must be underlined that the one-period-ahead forecasting 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 relative forecasting errors, expressed as a share of actual consumption, for the 20 countries are shown below

RELATIVE ERRORS %	2007	2008	2009	2010	2011
AUSTRIA	0.2	3.1	-0.4	1.5	-1.1
BELGIUM	-11.1	24.0	-23.2	0.4	-2.9
CYPRUS	4.5	-6.9	11.5	5.9	9.4
GERMANY	2.8	-16.9	12.4	-7.3	5.4
DENMARK	1.	17.1	-2.8	2.9	23.2
GREECE	-10.9	-10.2	-8.3	0.8	-14.0
SPAIN	4.1	11.4	10.3	9.7	-0.1
FINLAND	NA	-0.7	-4.3	-1.3	2.2
FRANCE	-10.0	NA	1.5	-3.6	-1.9
HUNGARY	-27.3	8.3	11.8	-4.6	-12.8
ITALY	-4.4	-2.1	-3.1	-17.3	0.8
LITHUANIA	-23.0	-30.9	27.9	18.2	39.3
LUXEMBURG	NA	NA	-34.5	-8.5	-28.7
POLAND	-8.9	6.2	33.3	-33.0	19.4
PORTUGAL	-11.8	5.1	-3.1	34.1	5.0
ROMANIA	NA	20.3	13.4	-4.2	8.0
SWEDEN	-36.5	-8.0	19.9	-116	-5.8
SLOVENIA	-23.8	-10.0	-6.8	9.6	2.2
SLOVAKIA	3.0	32.0	6.1	37.8	19.5
UNITED KINGDOM	4.4	6.8	4.3	-7.3	-10.6

Thus, while the overall forecasting error over the five years was small, at 0.2%, there was significant variation across time and among countries.

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Appendix B: The second-stage econometric model

Specification of the model

The residuals from the first stage forecasting model are analysed in the second stage by estimating a "demand" model. This is not a model of demand in the traditional sense of the word, as it includes elements of both demand and supply of the goods in question; rather, it can be thought of as a model describing the quantity transacted in the relevant market. Nonetheless, for ease of expression, the term "demand model" is used in this report.

The demand model can be written as:

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

where X_{it} is a matrix of explanatory variables unrelated to counterfeiting and Z_{it} a matrix of variables related to counterfeiting. $\boldsymbol{\varepsilon_{it}}$ is the remaining error.

Variables considered explanatory, but not related to counterfeiting, could include:

1. Per capita consumption of perfumes and toilet preparations;
2. Gross Disposable Income (GDI) of the household sector: per capita income and growth;
3. Prices: Harmonized Index of Consumer prices (ICP) for articles for personal care (COICOP 1212-1213);
4. Women 25-49 years: % of total population;
5. GDP per capita and GDP growth;
6. Population growth;
7. Exchange rate of Euro vs. other EU currencies.

Some of these variables could be indirectly related to counterfeiting, such as economic growth. Nevertheless, only variables clearly related to propensity of consumers to buy counterfeit goods (as reflected in the literature) are included in the second group of variables.

Some of these variables are correlated with each other. High correlation coefficients between explanatory variables (referred to as multicollinearity) present a common problem in econometric analysis. If two or more explanatory variables with high correlation are included in the model, the coefficients estimated for these variables could be mistakenly considered insignificant (small t-statistics) with high overall significance of the model (using the F-test). Also, the estimated regression coefficients might change drastically when a variable is added or deleted.

Therefore, when two explanatory variables are highly correlated, only one of these variables should be included in the model in order to avoid this problem.

For instance, per capita consumption of perfumes and toilet preparations, per capita Gross Disposable Income (GDI) of the household sector and per capita GDP are highly correlated with each other. During model devel-

opment, all three variables were tested, but no model should include more than one of them.

Variables considered related to counterfeiting[22] (and thus candidates for inclusion in the matrix Z_{it} in the equation above) include:

1. Population at risk of poverty or social exclusion: share of total population;
2. Distribution of income by quartiles (share going to the lowest quartile);
3. Gini coefficient (a measure of income inequality);
4. Several variables selected from the Observatory IP Perception study[23] and from Eurobarometer;
5. Corruption Perceptions Index, CPI (level and growth);
6. Intellectual Property Right Index;
7. Worldwide Governance Indicators (World Bank): Government effectiveness, regulatory quality, rule of law and control of corruption;
8. World Bank International Tourism Index;
9. Sales in stalls and markets (from survey to trade enterprises);
10. Internet purchasers (% of population and growth);
11. Share of imports of NACE 2042 products from countries with high rates of seizures of perfumes and cosmetics (China, United Arab Emirates, Hong Kong, Turkey) and their growth rate.

Variables 1 to 4 in the list are considered to be drivers of demand for counterfeiting related to consumer characteristics.

Population at risk of poverty, income of the first quartile and the Gini coefficient are all variables that describe the degree of inequality of the household income distribution. As summarised in WIPO (2010), some studies find that a high degree of income inequality appears to cause a greater demand for fake goods. Only one of these variables was included in each model in order to avoid multicollinearity.

Variables selected from the IP Perception study and Eurobarometer are related to a single year (2007, 2009, 2011 or 2013) because the methodology of the studies is so different that they cannot be combined to obtain a variable that varies across time. Therefore, the same value is used in each country for the five years included in the model so that it is a variable similar to country-fixed effects (time invariant effects) but with significant range of variation across countries.

The variables considered from these surveys were: % of population that has bought counterfeit products intentionally and % of population that consider it acceptable to buy counterfeit products in some situations.

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

23 - Available at: https://oami.europa.eu/ohimportal/en/web/observatory/ip_perception.

The correlations between explanatory variables from the IP Perception study and Eurobarometer are significant, and these variables are also correlated with variables related to sales via Internet and sales in markets.

Variables 5 to 7 are considered to be drivers of counterfeiting related to institutional characteristics of each country.

The Corruption Perception Index is published by Transparency International and measures how corrupt public sectors are seen to be by the public in each country. The level of this index and the change in the index from year to year are considered as potential explanatory variables related to counterfeiting.

The Intellectual Property (IP) Rights Index used is published by Property Rights Alliance and measures the strength of protection accorded to IP. The index included in this study is related to year 2010, and the same value is used in each country for the five years included in the model as a time invariant variable.

There is a high negative correlation between Corruption Perception and IPR Indexes.

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 strong regulatory quality (for the second index) to -2.5, representing weak regulation. These indicators could reflect the perceived risk when buying or selling counterfeit goods that is considered an explanatory variable in WIPO (2010). These indexes have a very high negative correlation with the poverty indicators and with the variables from the IP Perception study and Eurobarometer.

Finally, variables 8 to 11 reflect characteristics of markets for perfumes and toilet preparations that might be related to counterfeiting.

The international tourism index (number of arrivals) has a high correlation with the survey variables related to counterfeiting.

Altogether, 65 different explanatory variables were tested and also different econometric techniques were applied in order to select a model with robust econometric results and a clear interpretation. Different models were estimated starting from a simplified model with a single explanatory variable and moving to more complex models by adding variables but only if they improved the results. Variables not related to counterfeiting were checked first: different specifications were tried, taking into account the correlation matrix of dependent and explanatory variables to avoid multicollinearity. Once the most appropriate explanatory variables in X_{it} matrix had been decided, residuals of this preliminary model represent the share of the relative forecasting errors left unexplained by the variables not related to counterfeiting. A correlation matrix of explanatory variables related to counterfeiting (Z_{it} matrix) and also including residuals from the first regression were then analysed in the same way. Only a few models including variables in both X and Z matrices were selected, and as a final step, residuals were analysed in order to check compliance with the usual assumptions for regression models. Finally, one model was selected based on residuals tests and significance and clear interpretation of coefficients. Estimation of the value of lost sales due to counterfeiting was carried out using this model.

Estimation using Weighted Least Squares

When analysing the results obtained from the different model specifications tested, it became evident that the model residuals are correlated with the forecasting errors (the dependent variable), indicating of the possible presence of heteroscedasticity. A stable residual variance is one of the conditions for the correct estimation of the model using the most common regression method, Ordinary Least Squares (OLS). For this reason, an alternative estimation method, Weighted Least Squares (WLS) was used to generate the results shown in Section 2 .

One of the conditions that an econometric model must comply with is the stability of the variance of errors. This is referred to as *homoscedasticity*. Once a model is estimated, if the errors do not have a common variance, then *heteroscedasticity* is present. This is a problem that must be corrected. Otherwise, the estimators will be inefficient and the confidence intervals invalid.

In many cases heteroscedasticity is due to important variables omitted from the model. If that is the case, then in principle the problem can be corrected by correctly specifying the model to include all relevant variables. In the case of the models in this report, many specifications were estimated with different explanatory variables, but the variable set was restricted by the requirement of using homogeneous and official information for all countries. Therefore, if heteroscedasticity was caused by omitted variables, it could not be easily solved.

It is common to see heterocedasticity in regressions explaining economic behaviour when the variance of the residuals depends on regressors or on the dependent variable.

Another cause for heteroscedasticity can be the measurement error in the dependent variable when it is estimated in an auxiliary analysis and some observations are more accurate than others.

In the demand model used for estimating the impact of counterfeiting, the dependent variable is the forecasting error provided by univariate ARIMA models. This is an example of Estimated Dependent Variable (EDV) models. In the first stage, not only the forecasting errors have been estimated, but also a measure of their accuracy--the Standard Errors (SE) of the forecasts.

In general, EDV regression models are the second stage in a two-stage estimation process. Statistical tests can be used to determine whether heteroscedasticity is present[24]. If this is the case, then a consistent estimator can be obtained by dividing the OLS estimate by a measure of the variability of forecasting errors, a special case of WLS estimation.

The WLS estimation requires a measure of variance of the residuals. In this study, the standard error (SE) of the stage 1 forecasts was used for this purpose.

24 - Heteroscedasticity was tested based on White and Breusch-Pagan tests. A Feasible Generalized Least Squares (FGLS) method was also tested but rejected.

This way, the varying reliability of the forecasts is taken into account, and each observation in the demand model is inversely weighted by the SE of the forecasting error (which is the dependent variable in the stage 2 regression).

The estimation by WLS is carried out by applying OLS to the model transformed by dividing all variables (dependent and explanatory) by the estimate of the SE of the residuals from the first-stage ARIMA model.

The original model is:

$$Y_i = \beta_1 + \beta_2 * X_i + u_i$$

This model is then transformed as follows:

$$\frac{Y_i}{\sigma_i} = \beta_1 * \frac{1}{\sigma_i} + \beta_2 * \frac{X_i}{\sigma_i} + \frac{u_i}{\sigma_i}$$

where σ denotes the SE of the residuals. This equation is then estimated using OLS. It should be noted that this model does not have an intercept term and therefore includes an additional variable, the inverse of the SE of forecasting models, which is denoted 'constant' in the next table.

Residuals of final model estimated by WLS were analysed to check compliance with the usual assumptions of regression models. The tests included: the White test for heteroscedasticity; correlations among explanatory variables and coefficients and tolerance analysis for multicollinearity; and the Durbin-Watson test for auto-correlation of residuals. All tests indicated that the residuals complied with the assumptions[25].

Model results

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

Variable	Coefficient	Standard Error	t Statistic	95% Confidence interval	
				Lower	Upper
Constant	0.0718	0.0412	1.7405 *	-0.0102	0.1537
Per capita consumption	-0.0010	0.0002	-4.1792 ***	-0.0014	-0.0005
IP Perception study: buy counterfeit intentionally	2.0609	0.4474	4.6064 ***	1.1720	2.9497
WB Index Regulatory Quality (growth)	-0.4452	0.1548	-2.8753 ***	-0.7528	-0.1376

R square = 49%
F statistic = 17.5 ***

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

25 - All results of diagnostic tests are available on request.

This model explains 49% of total variance of the stage 1 residuals using four explanatory variables. For each variable, the first column shows the estimated coefficient of that variable; the second column shows the standard error, while the third column indicates whether the estimated coefficient is statistically significant at the 90%, 95% or 99% confidence levels[26].

Two of the explanatory variables are economic in nature: **per capita consumption of perfumes and toilet preparations,** and the **index of consumer prices of products for personal care.** The first variable has a negative coefficient, meaning that in countries with a higher per capita consumption, forecast errors tend to be smaller; the level of prices has the opposite effect. Between them, these two variables explain 32% of the total variance of the stage 1 forecasting errors.

The other two variables are related to counterfeiting: the **percentage of the population reporting having bought counterfeit products intentionally** in the IP Perception study and the growth rate of the **World Bank Index of Regulatory Quality.** The World Bank Index of Regulatory Quality reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.

The IP Perception study variable coefficient has a positive sign, while the World Bank Index growth has a negative impact on the dependent variable. These two variables explain 17% of the variance of the stage 1 forecasting errors.

The main objective of the model is the estimation of coefficients for variables related to counterfeiting. Therefore, the stability of these coefficients, depending on different specifications of the model, was checked by estimating eight alternative models including the two variables mentioned and different explanatory variables not related to counterfeiting. Other variables considered in these eight models are: exchange rate between euro and other national currencies, per capita Gross Disposable Income of the household sector, per capita GDP and GDP growth. The table shows the value of coefficients for the IP Perception and World Bank index variables in each of the models estimated, with the first model being the one presented above:

Model	IP perception	WB Index
1	**2.0609**	**-0.4452**
2	2.1227	-0.4446
3	2.1012	
4		-0.4676
5	1.8044	-0.4121
6	2.0203	-0.4260
7	2.2824	-0.4452
8	2.3119	-0.4445
9	2.0565	-0.4780

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.

As can be seen from the table, the two coefficients of interest remain stable even as the economic variables are changed. Such stability is a good indication that the model is correctly specified.

Using the model results to estimate loss of sales due to counterfeiting

The effect of counterfeiting on the sector's sales can now be obtained by applying the coefficients estimated in the first model to the value of the two variables considered related to infringement:

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

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_{1it} and Z_{2it} are the values of the two variables related to counterfeiting in that country and year, and the β's are the estimated coefficients from the table at the beginning of this section.

Taking Finland as an example, in the IP Perception study, 1.4% of the Finnish respondents declared having bought a counterfeit product during the past year; and the growth rate of the World Bank index as an average in years 2007-2011 is 2.57%. Then, the counterfeiting effect for Finland is calculated as:

$$2.0609*0.014 - 0.4452*0.0257 = 0.0174, \text{ or } 1.74\%$$

This is a direct estimate of lost sales of perfumes and toilet preparations in Finland due to counterfeiting. Put another way, in the absence of counterfeiting and all else being equal, sales of the sector in the Finnish market would be 1.74% higher than they actually are.

In a similar manner, the counterfeiting effect can be calculated for all 28 EU Member States, applying their values of the explanatory variables to the coefficients estimated in the model above. While the estimation was performed using with data from 20 member states, since these countries account for 90% of total consumption of EU28, it is reasonable to apply the resulting coefficients also to the eight Member States for which data on the dependent variable was not available.

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Appendix C: Results at country level

	LOWER 95%	AVERAGE	UPPER 95%
AUSTRIA	5.9	7.2	8.
BELGIUM	12.3	15.1	17.9
BULGARIA	14.2	17.5	20.7
CYPRUS	3.0	16.2	19.4
CZECH REP.	4.0	5.8	7.7
GERMANY	3.0	3.9	4.9
DENMARK	4.1	5.2	6.4
ESTONIA	6.2	7.9	9.5
GREECE	16.7	20.3	23.9
SPAIN	13.9	17.1	20.3
FINLAND	0.7	1.7	2.8
FRANCE	5.9	7.6	9.3
CROATIA	3.4	5.6	7.8
HUNGARY	5.0	3.1	7.2
IRELAND	5.0	6.2	7.4
ITALY	5.2	7.9	9.5
LITHUANIA	14.5	18.1	21.7
LUXEMBOURG	6.6	8.5	10.4
LATVIA	13.8	16.9	20.1
MALTA	4.2	6.0	7.9
NETHERLANDS	2.3	3.2	4.1
POLAND	1.9	3.6	5.3
PORTUGAL	12.2	15.0	17.8
ROMANIA	8.2	11.1	14.1
SWEDEN	2.1	3.7	5.4
SLOVAKIA	6.7	8.7	10.7
SLOVENIA	4.5	5.8	7.1
UNITED KINGDOM	4.7	6.0	7.3
EU28	**7.2**	**7.8**	**8.3**

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Quantification of infringement in Manufacture of perfumes and toilet preparations sector (NACE 20.42)