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

The economic cost of IPR infringement in sports goods

Quantification of infringement in Manufacture of sports goods (NACE 32.30)

09 | 2015

www.oami.europa.eu

The Economic Cost of IPR Infringement in sports goods





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Acknowledgements

The authors would like to thank FESI (Federation of the European Sporting Goods Industry) for comments received during the preparation of this report. Members of the Economics & Statistics Working Group of the Observatory provided useful comments on the reports in this series and on the methodology used.

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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 their own 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.

Several sectors whose products are known or thought to be subject of counterfeiting have been selected. Previous studies have been carried out on cosmetics and personal care[3] and the clothing and footwear sectors. This third report presents the analysis of the sports goods sector[4]. The products of this sector include mainly sporting equipment such as golf clubs,

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 behavior, November 2013

3 - These reports can be accessed on the web page of the Observatory: https://oami.europa.eu/ohimportal/en/web/observatory/quantification-of-ipr-infringement

4 - The formal name of the sector is: NACE code 32.30 “Manufacture of sports goods”. NACE is the official classification of economic activity used by Eurostat, the statistical office of the EU.

tennis rackets and balls, skis etc. However, it does not include sports apparel (such as football jerseys or baseball caps) which can also be worn as normal clothing. Such apparel is included in the clothing and footwear sector.

It is estimated that the legitimate industry loses approximately €500 million of revenue annually due to the presence of counterfeit sports goods in the EU marketplace, corresponding to 6.5% of the sector's sales. This translates into employment losses of approximately 2,800 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 €850 million of lost sales to industry, which in turns leads to employment losses of about 5,800 jobs and a loss of €150 million in government revenue[5].

It is important to note that in contrast to the previous two reports, the impacts of counterfeiting for sports goods refers only to manufacturing and so does not include wholesale and retail trade[6]. For that reason, the absolute numbers in this report cannot be directly compared to those previously presented for cosmetics and personal care and for clothing and footwear.

5 - Possible positive effects of inputs provided for production of illicit goods and corresponding indirect effects and taxes are ignored in this study, due to lack of available data.

6 - The reason is that the data provided by Eurostat does not distinguish between retail sales of sports goods and retail sales of other goods related to sports (such as bicycles or boats) which are not part of this NACE code. It is therefore not possible to calculate the trade margins for sports goods.

1. 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 information 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 limit the possibilities to design more focused policies as well as evidence-based public awareness campaigns.

To help overcome these challenges while taking full account of methodological constraints, the Observatory developed a specific approach to be applied at sector level. This methodology has previously been applied to cosmetics and personal care and to the clothing and footwear sectors.

Now, a new sector is presented, officially labelled *Manufacture of sports goods* by Eurostat[7] that covers the manufacture of sporting and athletic goods, except apparel and footwear, and includes articles and equipment for sports, outdoor and indoor games, of any material such as:

- **hard, soft and inflatable balls**
- **rackets, bats and clubs**
- **skis, bindings and poles**
- **ski-boots**
- **sailboards and surfboards**
- **requisites for sport fishing, including landing nets**
- **requisites for hunting, mountain climbing etc.**
- **leather sports gloves and sports headgear**
- **basins for swimming and padding pools etc.**
- **ice skates, roller skates etc.**
- **bows and crossbows**
- **gymnasium, fitness centre or athletic equipment**

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.**

7 - NACE code 32.30 from Eurostat

1) Direct costs to industry

The costs to industry are mainly composed of lost sales due to counterfeiting. Estimation of the 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 loss of public fiscal revenue.

The methodology builds on an adaptation of a methodology developed for the European Commission[8] 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 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 Appendices A and B 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 GDP growth, or demographic factors such as population growth. In addition, factors related to counterfeiting are considered, such as the behaviour of consumers[9], and

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

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

the characteristics of a country's markets and its legal and regulatory environments. The difference between forecast and actual sales is analysed in order to extract the effect of consumption of counterfeit products on the sales of legitimate industry.

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, 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, reduced economic activity in the private sector has an impact on government revenue, including VAT, household income and corporate taxes and 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 of *legal* products in the EU. Possible positive effects of inputs provided for production of illicit goods that could be manufactured inside or outside the EU, are ignored in this study. In other words, the indirect effect calculated is a gross effect that does not take into account the long-term effect of sales displacement from legal to illegal producers. The net employment effect could therefore be smaller than the gross effect calculated here.

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

2. Impact of counterfeiting in the sports goods sector

The starting point is the estimation of consumption of these products by country. Based on official data on production and intra and extra EU trade, it is estimated that the total consumption of sports goods in the EU was €7.5 billion in 2012[10]. The sector employs approximately 43,000 workers in the EU.

Information on wholesale and retail trade of sports goods cannot be obtained from official statistics, so estimation of consumption for these products is at factory prices and thus does not include the value of trade margins paid to distributors and retailers.

In 2012, across the EU a total of 4,271 enterprises were engaged in the manufacture of sports goods. Of this total 86% of companies were categorised as SMEs, with 76% of such enterprises employing less than 10 persons.

Italy is the primary producer of sports goods, accounting for more than 20% of total EU production (€1.2 billion). Germany and France are also important producers. Collectively these three countries account for 55% of total EU production.

Based on country level consumption data the difference between forecast sales and actual sales has been estimated (appendix A), and analysed using statistical methods (appendix B), relating the sales shortfall to factors (called *variables* in economic parlance) such as:

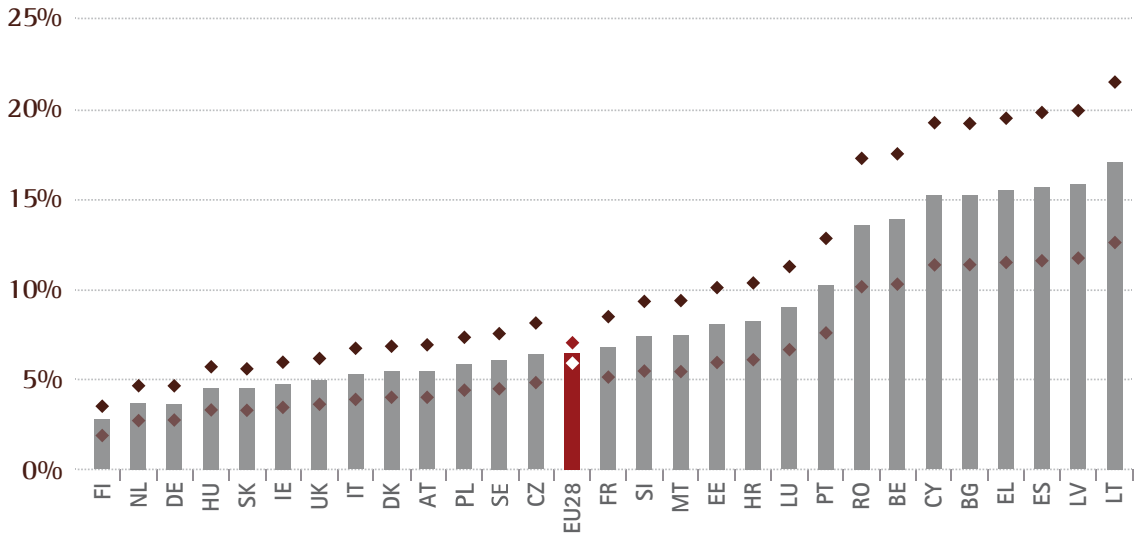
- **GDP growth** (socio-economic variable); and
- **Percentage of the population reporting having bought counterfeit products intentionally** in the IP Perception study (variable related to counterfeiting).

The resulting estimates of lost sales due to counterfeiting for all Member States are shown in the figure below. This is the **direct impact** of counterfeiting discussed above. For this sector, however, due to the availability of limited information and in contrast to other estimations previously presented, consideration is only given to the effects on manufacturers and not those enterprises involved in wholesale and retail.

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[11]. The figures represent an average for the 6 years 2007-2012.

10 - In 2012, EU production amounted to €5.4 billion. Net imports from third countries were two billion euros, leaving nearly €7.5 billion (at factory prices) for consumption in the EU.

11 - 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 6.5%, with a 95% probability that the true percentage lies between 6% and 7.1%.



For the EU as a whole , the estimated total counterfeiting effect amounts to 6.5% of consumption (€500 million). This is a direct estimate of sales lost by legitimate industry in the EU each year due to counterfeiting in this sector.

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 sectorial employment-to-sales ratios is used to estimate employment lost in the legitimate sports goods sector as a result of lost sales due to counterfeiting. The result is an estimated total loss of 2,800 jobs across the EU.

12 - The estimation was performed using data from 23 Member States, as these countries account for 95% of the total consumption of the EU28. It is reasonable to apply the resulting coefficients to the remaining five Member States for which data on the dependent variable was not available.

Country-level results and associated 95% confidence intervals, expressed as a percentage of sales as well as the value of lost sales in millions Euro, are shown in the table below:

	Lower 95%	Average	Upper 95%	Lost sales (million Euro)
AUSTRIA	4.1	5.5	6.9	31
BELGIUM	10.3	13.9	17.5	6
BULGARIA	11.4	15.3	19.3	4
CYPRUS	11.3	15.3	19.2	2
CZECH REPUBLIC	4.8	6.5	8.2	4
GERMANY	2.8	3.7	4.7	44
DENMARK	4.0	5.5	6.9	6
ESTONIA	6.0	8.1	10.1	2
GREECE	11.5	15.5	19.5	12
SPAIN	11.7	15.7	19.8	76
FINLAND	2.0	2.8	3.5	6
FRANCE	5.1	6.8	8.6	82
CROATIA	6.1	8.2	10.3	3
HUNGARY	3.4	4.5	5.7	5
IRELAND	3.5	4.7	5.9	4
ITALY	3.9	5.3	6.7	53
LITHUANIA	12.7	17.1	21.5	1
LUXEMBOURG	6.7	9.0	11.3	1
LATVIA	11.8	15.9	20.0	2
MALTA	5.5	7.5	9.4	0
NETHERLANDS	2.8	3.7	4.7	11
POLAND	4.4	5.9	7.4	11
PORTUGAL	7.6	10.2	12.8	14
ROMANIA	10.2	13.7	17.2	42
SWEDEN	4.5	6.1	7.7	16
SLOVENIA	5.5	7.4	9.3	3
SLOVAKIA	3.4	4.5	5.7	1
UNITED KINGDOM	3.6	4.9	6.2	50
EU-28	**6.0**	**6.5**	**7.1**	**492**

The biggest absolute impacts are found in France and Spain. These two countries account for one third of total EU lost sales due to counterfeiting.

Employment losses arising from lost sales (2,800 jobs), relate to countries where the products are manufactured, not where they are sold. The table below shows the nine countries with the highest employment losses, accounting for more than 80% of the EU total job loss:

Country	Employment	%
ROMANIA	416	28.2
ITALY	393	6.6
UNITED KINGDOM	373	6.5
CZECH REPUBLIC	318	10.0
GERMANY	304	5.0
FRANCE	285	5.8
AUSTRIA	171	4.8
BULGARIA	166	14.6
NETHERLANDS	143	14.5
EU-28	**2,796**	**6.5**

As a proportion of overall employment in the sports goods manufacturing sector, the highest employment losses occur in Romania, Bulgaria and the Netherlands.

Indirect impact

In addition to the direct loss of sales in sports goods, 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, causing sales declines and corresponding employment effects in other sectors.

To assess this indirect impact, data from Eurostat[13] are used to illustrate how much this sector buys in the EU from other sectors in order to produce what it delivers[14].

Final demand for sports goods, as estimated in this report, includes imported goods and not only the value of EU production. Analysis of these import figures reveals that on balance the EU is a net importer of sports goods from countries outside of the EU. Employment effects arising from these imports occur outside of the EU and therefore are not included in our calculations. Consequently, of the total lost sales figure of €492 million, only the value of domestic production (€368 million) is used to generate indirect impacts[15].

Using the Input-Output data, the estimated total direct and indirect output required to support the final demand **of €492 million totals €854 million**.

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

14 - The input-output tables are provided by Eurostat on the NACE 2 class level (2-digits) or aggregations of classes rather than the 4-digit level. This means that for calculating the impact of the sales reduction in sector NACE 32.30 it is necessary to use the structure of *'Furniture and other manufactured goods'* (NACE 31-32).

15 - On the other hand, this report only estimates the effect on sales of the sports goods 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.

Thus, beyond the direct effects on the manufacture of sports goods (€492 million in annual sales), a further €361 million is lost in other sectors of the economy due to counterfeiting. This is the indirect effect of counterfeiting .

Turning to employment, if we add losses in the supplier sectors to the direct employment loss in the manufacture of sports goods sector, the total employment loss resulting from counterfeiting is estimated at 5,772.

Finally, the reduced economic activity in the legitimate private sector has an impact on government revenues as well . If we accept this assumption, the lost taxes that sales of sports goods valued at €492 million would have generated can be calculated, as well as the tax revenues corresponding to the total (direct + indirect) loss of € 854 million calculated above.

The three main types of tax considered are : 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 direct lost sales in the manufacture of sports goods (€492 million) , accounting for €70 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 €34 million.**

3) **The lost tax on corporate profits is estimated from the share of direct and indirect costs to industry and amounts to €11 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 can be used to calculate lost contributions as a consequence of counterfeiting. These lost social security contributions amount to €35 million..

> **The total loss of government revenue (household income taxes and social security contributions, corporate income taxes and VAT) can be roughly estimated at €150 million.**

16 - 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 could be less than estimated, since those illicit producers might source some of their inputs from EU producers.

17 - 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.

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

19 - 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 three studies attempting to quantify the scale and impact of IPR infringements in cosmetics and personal care, clothing and footwear, and now sports goods have provided coherent estimates 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. These studies have used a common methodology and demonstrated the benefits from working in cooperation with stakeholders to take advantage of their knowledge of market conditions, while relying on harmonised European statistical data for the analysis.

These sectorial studies 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 sectors include medicines; tobacco; alcoholic beverages covering beer, wine and spirits; games and toys; jewellery and watches; handbags and luggage; computers; and other sectors, depending on availability of data.

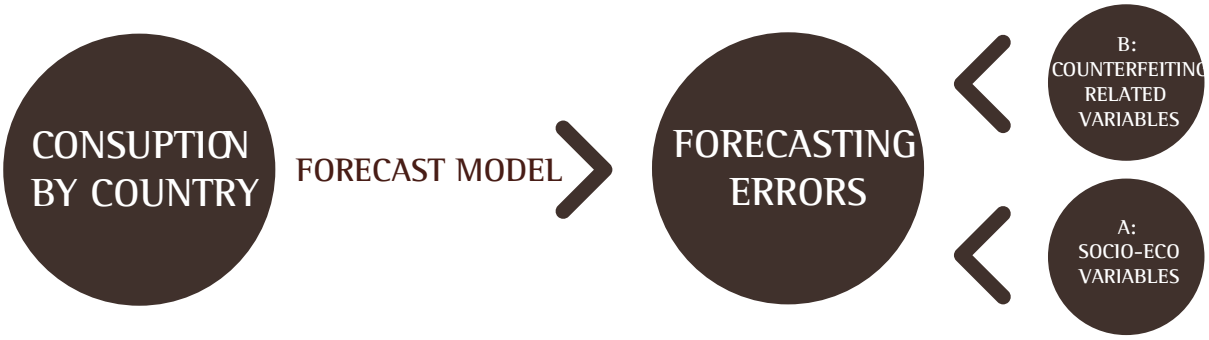
In parallel, the Observatory has embarked on a joint study with the Organization for Cooperation and Development (OECD) to estimate the value of counterfeit goods in international trade, and on studies of infringements in the music, film and e-book industries, in this case with the support of the Joint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

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 of the modelling process requires the construction of forecasts of product sales for Member States. Production of such forecasts is dependent upon the availability of a sufficiently long time series of data to enable the underlying data generating process to be identified.

Once the forecast has been generated, 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. For instance:

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

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 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 than the actual value (as a share of consumption) versus the actual level of consumption observed from Eurostat data..

The forecasting 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 forecasting 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.

Obtaining forecasts using ARIMA models

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 popular due to their simplicity and easy interpretation. They often deliver better forecast performance than econometric models.

ARIMA models are simply a projection of trends, albeit ones that use 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 by uit, remains.

These univariate models forecast what is likely to happen next year 'ceteris paribus', that is, assuming that the factors influencing sales do not change or are not expected to change. These models therefore include the effects of counterfeiting on product sales to the extent that such effects persist though 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 assuming underlying trends do not change, including the influence of counterfeiting.

The first step in producing these forecasts is to use all available time series data to interpolate missing observations. Next, sequential forecasts are produced for year t (t= 2007, 2008, 2009, 2010, 2011 and 2012), re-estimating models at each data point. This procedure yields estimated forecast errors for six years (2007 to 2012) for each of the 23 countries for which complete data was available.

These forecast errors are subsequently analysed and decomposed through an econometric model which represents the second stage of the modelling process. It should be noted that the one-period-ahead forecast errors estimated with ARIMA models follow a white noise process that is stationary and thus uncorrelated in time. The errors consequently have zero mean and a constant and finite variance.

The relative forecasting errors, expressed as a share of actual consumption, for the 23 countries are shown below:

RELATIVE ERRORS (%)	2007	2008	2009	2010	2011	2012
AUSTRIA	16.0	15.2	19.1	-4.5	-15.2	1.1
BELGIUM	-9.5	NA	NA	38.7	NA	7.4
CYPRUS	-18.9	-16.7	46.7	43.0	-23.0	19.0
CZECH REPUBLIC	NA	-29.1	NA	-23.1	NA	NA
GERMANY	6.6	-1.7	-1.0	-6.7	-6.0	-19.8
DENMARK	NA	-22.7	2.4	-28.2	14.0	15.7
SPAIN	2.7	23.6	33.4	7.5	21.2	6.5
FINLAND	26.3	17.5	1.5	-20.4	6.2	12.0
FRANCE	9.2	41.3	4.8	-24.4	-10.3	8.8
CROATIA	14.5	-6.8	56.5	73.2	15.0	-1.1
HUNGARY	-35.3	-48.8	30.2	17.7	11.0	32.1
IRELAND	12.3	-0.3	47.7	2.0	-6.5	8.2
ITALY	-7.1	52.7	57.7	17.6	28.7	1.5
LITHUANIA	NA	33.7	96.6	NA	-58.6	39.5
LATVIA	-3.9	37.5	34.4	NA	-5.6	NA
MALTA	-12.8	17.4	-9.2	-1.1	-6.3	-20.4
NETHERLANDS	-11.1	-17.0	19.0	-38.9	-2.1	NA
POLAND	-1.1	-22.2	30.8	-9.9	15.2	11.4
PORTUGAL	-8.1	-4.7	15.3	-30.6	-43.0	-16.1
SWEDEN	-10.9	13.9	2.0	-11.0	-17.8	-3.0
SLOVENIA	20.7	-9.6	17.3	-49.1	13.3	14.8
SLOVAKIA	-25.6	NA	NA	1.1	-7.2	6.9
UNITED KINGDOM	23.0	26.9	35.8	-14.4	11.8	-11.3

The overall forecast error over the six years is small, at 5%, although there is significant variation across time and among countries.

Appendix B: The second-stage econometric model

Specification of the model

Counterfeiting might be one of a number of factors impacting on the level of legal sales of sports goods, but there are other economic factors which can explain the differential, such as variables related to the economic capacity of households, or consumer demographics (e.g. population growth) or any other driver of consumption expenditure.

Having accounted for the influence of economic variables on the sales differential, we look to assess the extent to which counterfeiting variables, or relevant proxies, can explain the propensity to purchase fake sports goods. 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 us to specify a 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. ε_{it} is the remaining error.

Variables considered explanatory, but not related 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. Population growth;
5. Average age of population;
6. Several variables from the Eurobarometer on *'Sports and physical activity'* such as percentage of population that are members of sport clubs and health and fitness centres or the frequency of playing sports.

Variables considered to be related to counterfeiting[20] (and thus candidates for inclusion in the matrix Zit in the equation above) include:

1. Population at risk of poverty or social exclusion as a share of total population;
2. Distribution of income by quartiles (share of income going to the lowest quartile and ratio of income going to fourth and first quartiles);
3. Gini coefficient (a measure of income inequality);

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

4. Several variables selected from the Observatory IP Perception study[21] 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);

Variables 1 to 4 in the list are considered to be consumer related drivers of demand for counterfeiting. The population at risk of poverty, the share and concentration of income in quartiles of the household income distribution, along with the Gini coefficient, are all variables that describe degrees of income inequality.

The variables considered for inclusion in the Z matrix from the IP Perception survey 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 considered it acceptable to buy counterfeit products in certain circumstances.

Corruption related variables considered for use in the Z matrix from the Eurobarometer survey include[22]; 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. The Tolerance Index to Corruption is a measure covering the percentage of the population that declares that corruption in public administration or public service is acceptable was considered.

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

The Corruption Perception Index (CPI 2012) 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 2010 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.

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

22 - In WCO (2012) it is stated that: '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 explanatory for counterfeiting.

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 proxies of the perceived risk when buying or selling counterfeit goods, a driver of counterfeit trade according to WIPO (2010) study. These indices have a high negative correlation with poverty indicators and with the variables from the IP Perception study and Eurobarometer.

Finally, variables 8 to 10 reflect characteristics of markets in each country that might be related to counterfeiting.

Modelling Considerations

Altogether, 74 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 simple single variable specification, through to multivariate representations. Variables were only added and retained if they improved results. Variables not related to counterfeiting were tested first.

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 two or more explanatory variables with a high correlation are included in the model, the coefficients estimated for these variables could be mistakenly considered insignificant (small t-statistics), although they exhibit a high combined significance for the model (using the F-test). In such circumstances, estimated coefficients might change drastically when a variable is added or deleted.

For example, there are positive correlations between variables from the IP Perception study and Eurobarometer and variables related to sales via the internet and sales in markets. Likewise, there is a strong negative correlation between the Corruption Perception and IPR indices. The various income inequality measures (cited by WIPO in 2010 as having a relationship with the purchase of fake goods) are strongly correlated with one another.
When significant correlation between explanatory variables is identified, as in the case of the income inequality measures, only one of these variables is included in the model to avoid this problem.

Counterfeiting variables considered for use in the Z matrix from the IP Perception study and Eurobarometer survey are used on a cross-sectional basis, as the results are not directly comparable (differing methodologies) across survey years. The same survey value is used therefore in each country for the six years included in the model so that the variable operates in a similar way to country fixed-effects (time invariance), although allowing for variation across countries.

Once the most appropriate explanatory variables in the X matrix are identified, the subsequent residuals represent the share of the relative forecast errors left unexplained by the variables not related to counterfeiting.

A matrix of explanatory variables relating to counterfeiting (Z matrix) and including residuals

from the first regression is then analysed in a similar way. The optimal model, containing variables in both X and Z matrices, was then selected on the basis of the statistical significance of the variables, interpretation of coefficients and tests on the resulting residuals. Estimation of the value of lost sales due to counterfeiting is carried out using this model.

Heteroscedasticity

Having defined the model and acknowledged potential estimation issues (multicollinearity) we begin testing the specified model. Our first observation is that there is correlation between the residuals of the specified model and the variations in the sales differential, the dependent variable.

This relationship indicates a potential problem of heteroscedasticity, which implies that the variance of the estimated residuals is not stable, thus violating homoscedasticity, one of the key assumptions behind the statistical validity of Ordinary Least Squares (OLS).

A number of tests and solutions to the issue of heteroscedasticity were investigated. Some of these considerations are discussed below.

Applying a White test to the residuals of the first OLS regressions revealed that the hypothesis of homoscedasticity could be rejected at the 99% confidence level.

Heteroscedasticity can be corrected (at least partially) via the construction of a consistent estimator which can be obtained via the application of the Weighted Least Squares (WLS) method. This approach requires assumptions about the pattern of residuals. A number of different alternatives were tested.

Heteroscedasticity might also arise as a measurement error of the dependent variable when it is estimated in auxiliary analysis and some observations are more accurate than others.

In our 2nd stage model, the dependent variable is the forecasting error provided by the univariate ARIMA models. This is an example of an Estimated Dependent Variable (EDV) model. In the first stage of the estimation process, we not only have the estimated forecast errors, but also a measure of their accuracy, namely the Standard Error (SE) of the forecast.

Another potential source of heteroscedasticity in panel data models is groupwise heteroscedasticity: observations are grouped into groups (countries in our example) and the variance may differ considerably across groups/countries. In this case, the assumption of homoscedasticity may hold within each country but not between them. We might test for groupwise heteroscedasticity using White's test (which involves regressing the squared least squares residuals on country dummy variables or including a constant if we exclude one country variable). Applying White's test for groupwise heteroscedasticity allowed us to clearly reject homoscedasticity at a 99% confidence level. Residual plots by country also suggested the presence of groupwise heteroscedasticity.

Consequently, two-stage least squares (2SLS) was used instead of OLS to estimate the model. As a final check, the residuals of 2SLS method were analysed to check compliance with the usual assumptions of regression models. The tests included: the White test and residuals plots for heteroscedasticity; correlations among explanatory variables and coefficients and tolerance analysis and Variance Inflation Factor (VIF) for multicollinearity; and the Jarque-Vera test for normality of residuals. These tests indicated that the residuals complied with the assumptions [23]with exception of normality.

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	-0.0147	0.0286	-0.5129	-0.0713	0.0420
GDP growth	-0.0190	0.0035	-5.3894 ***	-0.0259	-0.0120
Exchange Euro growth	1.4322	0.3069	4.6665 ***	0.8245	2.0399
IP Perception Study: buy counterfeit intentionally	1.9644	0.6331	3.1025 ***	0.7107	3.2181

R square = 42.8%
F statistic = 22.2 ***

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

This model explains more than 40% of the total variance of the stage 1 residuals using three explanatory 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. As indicated, all estimated coefficients are significant at the 99% confidence level[24].

Two of the model´s explanatory variables are economic in nature, namely **GDP growth** and **the exchange rate of the Euro vs other currencies.** The negative coefficient on GDP growth

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

24 -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.

implies that countries with higher growth, tend to have smaller forecast errors, whilst there is a positive relationship between the Euro exchange rate and forecast errors, implying that as the Euro appreciates, so does the capacity for counterfeiting outside the Euro zone.

The third variable is related to counterfeiting, and covers the percentage of the population recognising that they have bought fake products intentionally, as described in the IP Perception study. This variable is time invariant and its coefficient has a positive sign, meaning that the higher the percentage of population declaring having bought fakes is positively related to counterfeiting.

The main objective of the modelling process is to estimate the coefficients for variables related to counterfeiting. Therefore, the stability of these coefficients across a number of specifications is a desired result. A range of variables were tested across a number of different methods (specifically, OLS and 2SLS method under different variance residual assumptions). The table below shows the value of the coefficients of the IP Perception variable in each of the models estimated, with the first model being the one presented above:

	IP Perception: buy counter-feit intentionally
1	1.9644
2	1.7891
3	1.7364
4	1.9870
5	1.7892

As can be seen from the table, the coefficient of the variable related to counterfeiting remains stable even when explanatory variables are added or different methods of estimation are used. 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 coefficient estimated in the model to the value of the variable related to infringement:

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

Where C_i^* represents the sales lost due to counterfeiting in country i (expressed as the fraction of the sector's actual sales) and Z_i is the percentage of people declaring intentional purchase of counterfeit goods in the IP Perception study[25] in each country. The β is the estimated coefficient from the table at the beginning of this section.

Taking Finland as an example, the percentage of the population declaring having bought counterfeit goods is 1.4% as reflected in the IP Perception study. Then the counterfeiting effect for Finland is calculated as:

$$1.9644*0.014 = 0.0275, \text{ or } 2.75\%$$

This is a direct estimate of lost sales of sports goods in Finland due to counterfeiting. Put another way, in the absence of counterfeiting and all else being equal, sales of the legitimate sector in the Finnish market would be 2.75% higher than they actually are.

In a similar manner, the counterfeiting effect can be calculated for all 28 EU Member States, applying the values of the explanatory variables to the coefficient estimated in the model above. While the estimation was performed using data from 23 member states, as these countries account for 95% of total consumption of EU28, it is reasonable to apply the resulting coefficients to the five Member States for which data on the dependent variable was not available.

25 - It should be noted that the value of Zi is the same for all t since the variable is time-invariant

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