Annex A. Methodological notes

A.1. The data

Precise quantification and measurement of the losses to Italian consumers, retail and wholesale industry and government attributable to counterfeit products smuggled into Italy and to infringements of Italian residents' IPR in global trade can prove elusive. This is because the clandestine and illicit nature of counterfeiting means the available data is likely to fall far short of what is needed for robust analysis and policy making (Box A.1). Put differently, the point of departure for any quantitative analysis in the area of counterfeit trade is to establish the sort of statistical data available for analysing the issue.

Box A.1. Data limitations

It is important to highlight that the data on counterfeiting and piracy are scarce and incomplete. Even though some progress in data collection has been observed over recent years, the quality of available statistics on counterfeiting and piracy still needs significant improvement. Consequently, there are three things that should be kept in mind when developing and applying a methodological framework to quantify the effects of counterfeit trade.

1. The framework developed here does not claim to quantify all the impacts of counterfeit and pirated trade on the Italian economy. It looks at areas where quantification was possible, while identifying areas of work needed to better understand how counterfeit and pirated trade affects economies and societies overall.
2. In areas where quantification was possible, the framework relies on a set of methodological assumptions. For transparency purposes, all are clearly spelt out in the text.
3. The framework leaves scope for further methodological amendments subject to future data improvements, for example more precise gauging of consumers' substitution rates between fake and genuine goods.

This report required three types of data, each discussed in the sections that follow:

- seizures data of IP-infringing products from customs and police forces (IPERICO and OECD/EUIPO (2016) on global customs seizures)
- import statistics
- other data – including on consumer behaviour regarding counterfeit products – and other background micro- and macroeconomic data.

Data on seizures of counterfeit products smuggled in Italy

The best information available on counterfeit product smuggling in Italy comes from the IPERICO database (see Box A.2). Information regarding infringements of Italian residents' IPR in global trade are extracted from the database on customs seizures of IP infringing products worldwide presented in the OECD/EUIPO (2016) report.

Box A.2. The IPERICO database

The IPERICO (Intellectual Property – Elaborated Report of the Investigation on Counterfeiting) database gathers information on seizures made by the Italian police forces that work to combat counterfeiting under the guidance of the Ministry of Economic Development, Directorate-General for the Fight against Counterfeiting – Italian Patent and Trademark Office (DGLC-UIBM), with the support of a pool of experts of the Guardia di Finanza, the Agenzia delle Dogane (Customs), and the Criminal Analysis Service of the Home Office.

The original dataset relies on data entries collected and processed by customs and police officers, and as with any other administrative data, they needed careful consideration before use in this quantitative analysis. In particular, harmonisation of the customs agency and tax police databases has led to the creation of a unique database, which merges data produced by both organisations. A set of limitations related to the creation of this unique dataset, including product classification levels and valuations, were carefully addressed by the DGLC-UIBM; these are summarised in their latest reports.

As a result, the database contains a wealth of information about IPR-infringing goods smuggled into Italy and can be used for detailed quantitative and qualitative analysis. In most cases it reports general information, such as the date of seizure, the region where the goods were seized, the provenance economy in the case of customs seizures and the product category, as well as more detailed descriptions, such as the name of the legitimate brand owner, the number of seized products and their estimated value.

Source: http://www.uibm.gov.it/iperico

It should be highlighted that the information contained in the IPERICO and the OECD/EUIPO (2016) databases refers to anti-counterfeiting activities and not to the phenomenon of counterfeiting itself. They may not therefore be considered a direct measurement of the phenomenon with a certifiable statistical value.

It follows that the first step in both analysis developed below consists in gauging the actual value of counterfeit products smuggled into Italy (Step 1) and the actual value of infringements of Italian brands and patents in global trade (Step 7) as carefully as possible. This is done on the basis of the strength and limitations of the IPERICO and the OECD/EUIPO (2016) databases, and the GTRIC methodology developed in OECD/EUIPO (2016).

Import statistics

Italian import statistics used in this report are based on the United Nations (UN) Comtrade database UN Trade Statistics (2018). With 171 reporting economies and 247 partner economies, the database is considered the most comprehensive trade database available. Import statistics are compiled from the records filed with Italian customs authorities. This is particularly important for this report, as all data related to trade and used in the statistical exercise (imports and data on customs seizures of infringing products) originate from the same source: customs offices at the destination.

Within the UN Comtrade database, products are registered on a six-digit Harmonized System (HS) basis UN Trade Statistics (2017), meaning that the level of detail is high.

However, this also signals the creation of a unique taxonomy that allows merging those data on imports of genuine goods with data on seizures of counterfeit goods included in the IPERICO database. It follows that the impact analysis conducted in this report will be performed for the following product categories: clothing, footwear, leather and related products; perfumes, cosmetics and other body care items; computers and computer equipment; electrical and electronic equipment; toys, games and sporting articles; watches and jewellery; other goods.

All correspondence tables between this unique taxonomy, the HS classification system, and the product categories defined in the context of the IPERICO database are presented in the Annex B.

Additional data

Other statistical information was used to develop a methodology to gauge the economic impact of trade in fake goods. This includes:

- statistical information on Italian sectorial production, sales, jobs, and wages, extracted from the Eurostat database Eurostat (2018). Correspondence tables between the classification of economic activities for manufacturing and wholesale and retail industries used by Eurostat (NACE) and the Harmonized System (HS) classification, which is used to calculate both infringements of Italian IPR in global trade and fake imports in Italy, are provided in Annex B.
- statistical information on Italian taxes extracted from the OECD TAX database OECD (2018).
- information on consumers' substitution rates (see below) between genuine goods and fake goods contained in various academic studies and consumer surveys.

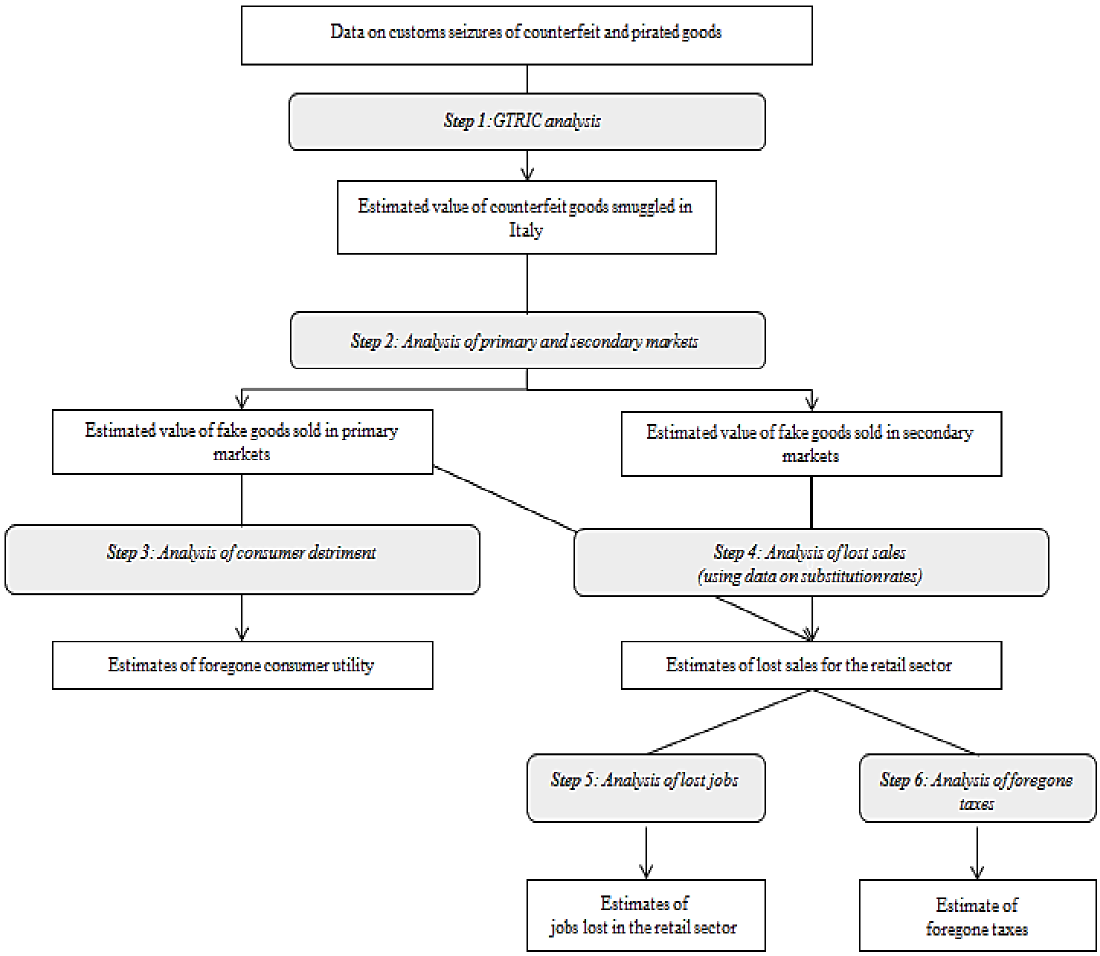
A more detailed discussion of these datasets is presented later in this annex.

A.2. Gauging the direct effects of fake goods smuggled into Italy

The impact areas of fake goods smuggled into Italy, as described in chapter 2, can be calculated following a number of steps (Figure A.1):

1. estimating the value of counterfeit products smuggled into Italy
2. estimating the value of those products sold in the primary and secondary markets
3. estimating consumer detriment
4. estimating lost sales for retailers and wholesalers
5. estimating job losses in the retail and wholesale sector
6. estimating taxes forgone

Figure A.1. Steps involved in analysing the economic effects of counterfeit imports in Italy



Step 1: Estimating the value of imports of counterfeit and pirated products

This first step involves tailoring the databases on customs seizures of IP-infringing products and on imports of genuine goods, to estimate the value of counterfeit imports in Italy by product category and provenance economy. This partial dataset will then form the basis for the following impact analysis.

The main task of this step is to apply the General Trade-Related Index of Counterfeiting (GTRIC) methodology developed in OECD/EUIPO (2016) to the database of customs seizures in order to gauge the value of fake goods smuggled in Italy, for each product category and provenance economy identified. The GTRIC methodology allows the Italian trade-specific context to be taken into account, and relies on two key econometric components (see Annex A.4 and OECD/EUIPO, 2016 for more detail):

- The GTRIC indices for economies (GTRIC-e) and for products (GTRIC-p). GTRIC-e is an index that ranks economies according to their relative likelihood to being an economy of provenance for counterfeit products smuggled into Italy. GTRIC-p is an index of industries according to their relative proneness to being targeted by counterfeiting.

- The GTRIC matrix, obtained by combining GTRIC-e and GTRIC-p. This matrix assigns a relative probability for each given type of product imported from a given provenance economy to be subject of counterfeiting as compared to the most vulnerable "product category-economy" pair.

Importantly, two assumptions are made to calculate the GTRIC vectors. The first is that the volume of seizures of a given product or from a given source economy is positively correlated with the actual frequency of imports of counterfeit goods in this product category or from that economy. The second assumption acknowledges that this relationship is not linear, as there may be biases in the detection and seizure procedures. For instance, the fact that infringing goods are detected more frequently in certain categories by customs or police forces could imply that differences in counterfeiting factors across products merely reflect that some goods are easier to detect than others – or that some goods, for one reason or another, have been specially targeted for inspection.

While the GTRIC matrix does not provide a direct measure of the overall magnitude of counterfeit imports, it establishes statistical relationships that are useful for this purpose. More specifically, applying the GTRIC matrix to statistics on imports of genuine products allows the upper limit value of counterfeit goods smuggled into Italy to be gauged.

Similar to the approach used in OECD/EUIPO (2016), the approach here establishes an upper limit of counterfeiting (in percentages of imports) for the key "provenance economy-product category" pairs that are the most vulnerable to counterfeiting, i.e. with the highest relative likelihood of being counterfeit (highest GTRIC score). Following OECD/EUIPO (2016), these values are called "fixed points".

In their main report on counterfeit trade, the OECD and EUIPO (2016) gauged six points for a range of six "product category-provenance" pairs where shares of counterfeit products are highest, based on a focus group meeting and on interviews with customs officials. The results were refined using a set of supplementary data on seizures in dedicated actions provided by the European Anti-Fraud Office (OLAF).

Once established, the fixed points combined with the relative probabilities included in the GTRIC matrix allow the share of fake products contained in every "product category-provenance economy" pair to be determined. These shares are then applied to existing statistics on imports of genuine products to estimate the total value of counterfeit imports in Italy.

Step 2: Estimating the value of fake goods sold in the primary and secondary markets

Two questions are crucial in assessing the economic impact of imports of counterfeit and pirated products in Italy for domestic retail and wholesale industry, consumers, and the government. First, what is the proportion of these counterfeit products that are sold on primary versus secondary markets in Italy? Second, within secondary markets, what is the rate at which Italian consumers are substituting counterfeit goods for legitimate products?

Regarding the first question, every sale of a fake item on a primary market clearly represents a direct loss for the retail and wholesale industry. In secondary markets, however, only a share of consumers would have deliberately substituted their purchases of counterfeit products for legitimate ones, because they know that what they are buying is fake. The key issue then is how to calculate the consumers' substitution rate, i.e. the extent to which every knowing illegal purchase displaces a legal sale.

Estimating the share of fakes sold on primary and secondary markets

In order to distinguish fake products counterfeiters intended to sell on the primary market from those intended for sale on the secondary market, the price gap between both types of fakes is calculated. For each seizure specified in the database, Italian customs authorities report the declared value of goods, the quantity seized, the product's HS code, and the infringed trademark. This allows the unit value of each seized "product type-brand" pair (*brand* would include the associated trademark or patent) to be determined. These unit values can then serve as a proxy for the retail prices of the fake goods.

For each type of product associated with a given trademark or patent, the prices of seized goods are used to estimate a confidence interval that contains the actual retail price of the corresponding genuine item. Counterfeit items whose unit price, calculated as described above, are higher than or included in this interval are then classified as intended for sale on the primary market. Those whose price is below this interval are classified as targeting the secondary market.

Formally, let $\mathrm{s_c}$ and $\mathrm{\bar{s}_c}$ denote, respectively, the import value and quantity of any custom seizure of counterfeit products, with $c \in \{1, \ldots, N\}$ the range of customs seizures, and N their total number. $p_c = s_c/\bar{s}_c$ then refers to the unit value of each custom seizure, and can serve as a proxy for their unit price. Let $p_{bp} = \left(\sum_{c\in\{bp\}} p_c\right)/N_{bp}$ defines the (unweighted) price average of any type of product p associated with the brand or patent b, with N_{bp} the total number of custom seizures reported for this "product category - brand" combination. The standard deviation of this price is denoted σ_{bp} .

X_c is defined as a dichotomous (binary) variable that takes the value of 0 if the fake goods included in the seized shipment were intended to be sold on the primary market, or 1 if they were intended to be sold on the secondary market. In accordance with the arguments mentioned in the main text, X_c is assumed to be defined as follows:

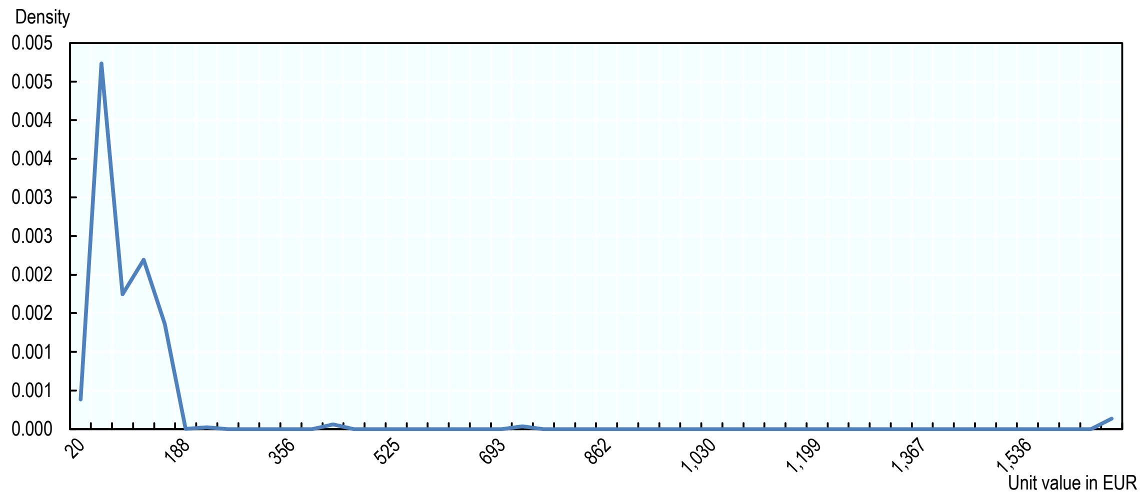
$$X_c = \begin{cases} = 0 \text{ if } p_c \in \left[p_{bp} - \dfrac{1.96 \times \sigma_{bp}}{\sqrt{N_{bp}}};\ \max\limits_{c\epsilon\{bp\}} p_c\right] \\ = 1 \text{ if } p_c \epsilon \left[\min\limits_{c\epsilon\{bp\}} p_c\,;\ p_{bp} - \dfrac{1.96 \times \sigma_{bp}}{\sqrt{N_{bp}}}\right[\end{cases}; \qquad \forall c\{bp\}$$

It follows that the share of products sold on the primary market can be calculated by product category, τ_p^1, and/or for the entire mass of fake imports, and is given by:

$$\tau_p^1 = \left(\sum\nolimits_b \sum\nolimits_c x_c s_c\right) / \left(\sum\nolimits_b \sum\nolimits_c s_c\right), \quad \forall c\epsilon\{bp\}$$

For example, Figure A.2 shows the price distribution of fake Rolex watches produced that were seized by Italian customs between 2011 and 2013. Using the methodology outlined indicates that most fake Rolex watches with prices lower than EUR 250 were destined for the secondary market, while those with values higher than EUR 250 (observations in the middle and on the right hand side of the distribution) were targeted at the primary market.

Figure A.2. Price distribution of fake Rolex watches seized by Italian customs, 2011-2013



Substitution rates on secondary markets

In primary markets, consumers pay the full retail price for a fake product thinking it is the genuine article. The assumption can be made that a legitimate item would have been bought in the absence of the fake product. This represents a one-to-one substitution rate (a 100% displacement rate), and therefore a one-to-one direct loss for the industry. Note that this one-to-one substitution rate requires three important conditions: 1) the consumer is paying full retail price (or near enough) for the fake product; 2) the consumer is not aware they are purchasing a counterfeit product; and 3) the fake good is almost identical in appearance to the genuine one.

In secondary markets, consumers knowingly purchase IP-infringing products. The issue then is to estimate the likelihood that consumers would have purchased the genuine product at its full price. Clearly, these substitution rates vary by industry and economy, since factors such as product quality, distribution channels, and information available about the product can differ significantly. They also depend on the consumer's motives for purchasing counterfeit and pirated goods. For example, some consumers buy counterfeits for fun, which may not provide any guidance on specific values to use.

As mentioned previously, the substitution rate is the assumed rate at which a consumer is willing to switch from purchasing a fake good to the genuine product. In other words, this displacement analysis seeks to identify the extent to which consumers substitute purchases of counterfeit and pirated products for legitimate ones. The main goal is to identify sales that were never realised by industries due to counterfeiting and piracy. Formally, a displacement rate of $x\%$ means that every $100/x$ illegal purchases of a given counterfeit product displace a legal sale.

Information on substitution rates can be obtained from two different sources: academic research on consumers' socio-economic behaviour, and consumer surveys. The majority of academic research, however, has focused on intangible pirated products, such as digital piracy.

Findings are rarer for tangible products, with the exception of luxury items. For example, Yoo and Lee (2009) studied the behaviour of Korean female college students and found a substitution rate of 21% for luxury fashion clothing and accessories.

In another study, consumers were presented with an opportunity to purchase counterfeit products in a simulated shopping experience (Tom et al., 1998). When given the choice between a counterfeit or legitimate version of the product, 32% of the consumers selected the counterfeit version and 68% opted for the legitimate version.[1,2] The preference for counterfeit or legitimate versions differs by product category. Counterfeit T-shirts were the most popular (42% stated a preference for the counterfeit version), while counterfeit software was the least popular (17% stated a preference for the fake software).

The issue of the variability of substitution rates between product categories has barely been addressed in consumer surveys. One of the exceptions is a survey conducted by the Anti-Counterfeiting Group (2007), in which a sample of 1 003 representative UK consumers aged 16 and over were asked if they would have bought the corresponding legitimate item had the fake item not been available Anti-Counterfeiting Group (2007). Among this sample, 39% responded that they would have bought a genuine alternative (either made by the brand or another brand) in the case of clothing or footwear products, 49% in the case of fragrance, and 27% in the case of watches.[3]

Given the scarcity of data, the empirical exercise performed in Chapter 2 relies on three different scenarios. The first scenario assumes substitution rates that follow the results of the Anti-Counterfeiting Group (2007)'s consumer survey. In this scenario, a substitution rate of 39% has been chosen for the product category relating to clothing and footwear – meaning that every EUR 2.5 spent on fake clothes, accessories or footwear in secondary markets translates into EUR 1 in lost sales for the retail and wholesale industry. Also in accordance with this consumer survey, the selected rates in scenario 1 are 49% for products relating to the perfumery and cosmetics sector, and 27% for products belonging to the watch and jewellery industries. Finally, according to the study carried out by Tom et al. (1998), the selected substitution rate is 32% for all other fake products sold on secondary markets. The second scenario is more conservative, and assumes substitution rates 10 percentage points lower. The third scenario is the most conservative; it assumes the substitution rates to be 20 percentage points lower than in the first scenario.

In order to test the robustness of the results, the estimates of lost sales, lost jobs and lost taxes thus rely on three alternative scenarios, based on lower assumed consumers' substitution rates. These are presented in Section A.6 of this Annex A.

Step 3: Estimating consumer detriment

Individual consumer detriment is the price premium unjustly paid by the consumer in the belief they are buying a genuine product. As consumers who choose to purchase counterfeit products on secondary markets deliberately accept a cost-quality trade-off, consumer detriment only occurs in primary markets. For each product category the individual consumer detriment is estimated by calculating the difference between the average price paid in the primary market (by deceived consumers) and that paid in the secondary market (by consumers who knowingly buy fake goods). This individual consumer detriment is then multiplied by the total volume of transactions in the primary market in a given product category. Finally, for all product categories the detriments are added together to give a general estimate of overall consumer detriment.

More formally, the principle behind the measure of consumer detriment is as follows. First, for any type of product p related to the brand b, the average price paid on primary market, p_{bp}^1, and the average price paid on secondary market, p_{bp}^2, are calculated. Since the gap between these prices represents the "value of consumers' deception", it can be used as a proxy for consumer detriment of purchasing a given branded product bp on the primary market: $d_{bp} = p_{bp}^1 - p_{bp}^2$. Finally, these detriments can be aggregated by product category, or at the national level, multiplying them by the estimated volume of sales on primary markets, Q_{bp}^1, as follows: $D = \sum_b \sum_p \left(d_{bp} Q_{bp}^1\right)$.

Step 4: Estimating lost sales for retailers and wholesalers

In order to measure lost sales for retailers and wholesalers due to counterfeit products, three sets of information are used:

1. The estimated value of counterfeit products smuggled into Italy by product category, as obtained in Step 1.
2. The shares of primary and secondary markets, which are estimated at the most detailed level (ideally by brand and product type) using the methodology described in the first part of Step 2.
3. Information on consumers' substitution rates, which are extracted from consumer surveys, as explained in the second part of Step 2.

The estimated value of counterfeit products smuggled into Italy combined with the share of the primary market gives the total volume of lost sales for Italian retailers and wholesalers due to the unsuspecting purchase of counterfeit products. The estimated value of counterfeit goods smuggled into Italy, combined with the shares of the secondary market and consumers' substitution rates, equals the total volume of lost sales for Italian retailers and wholesalers due to the knowing purchase of counterfeit products. This takes into account the fact that those consumers would not necessarily have bought the genuine alternatives if the fakes had not been available. Finally, the sum of both estimates reveals the total value of lost sales for wholesalers and retailers due to counterfeit imports.

Formally, for each product type p, the loss of sales incurred by domestic wholesalers and retailers due to counterfeit and pirated imports, S_p, is given by adding the estimated value of counterfeit and pirated imports sold on the primary market – i.e. the total value of counterfeit and pirated imports, C_p (estimated in Step 1), times the share of the primary market, τ_p^1 (estimated in Step 2) – to the estimated value of fakes sold on the secondary market times the consumers' substitution rates, ρ_p:

$$S_p = \left[\tau_p^1 \times C_p\right] + \left[(1 - \tau_p^1) \times C_p \times \rho_p\right]$$

Step 5: Estimating job losses in the retail and wholesale sector

Estimates of lost jobs for each Italian retail and wholesale industries are based on two key factors: (i) the share of lost sales as calculated in Step 4; and (ii) the transmission rates between lost sales and lost jobs for each industry, which are calculated as presented below.

Transmission rates between lost sales and jobs in Italian wholesale and retail industries

The economic literature does not make clear links between the values of lost sales and lost jobs for each industry. This study therefore developed a simple econometric model to address that issue. The aim is to explain the extent to which the retail and wholesale industry adjusts employment when sales vary.

The idea behind the model is to invert a basic production function in a partial equilibrium model in order to estimate the response of employment to a sales shock. $\hat{p}_p$ and $\hat{Q}_P$ can denote, respectively, the average unit price and the total production in volume of (genuine) goods in industry p, so that the total sales of (genuine) goods in an industry is defined by

$$\hat{S}_p = \hat{p}_p \times \hat{Q}_P$$

The goods in the industry are produced using labour, $\hat{L}_p$, capital $\hat{K}_p$, and intermediate inputs $\hat{I}_p$, following a Cobb-Douglas production:

$$\hat{Q}_P = A_p \, \hat{L}_p^{\alpha} \, \hat{K}_p^{\beta} \, \hat{I}_p^{\gamma}$$

with A_p the total factor productivity (TFP). In accordance with traditional economic literature, the firms' profit maximisation problem within an industry yield an optimal price which equalises a markup φ_p, over a marginal cost, here the productivity-adjusted wage w_p :

$$\hat{p}_p = \varphi_p \, w_p$$

Combining the three equations above and taking the log yields:

$$\ln(\hat{S}_p) = \ln(\varphi_p) + \ln(w_p) + \ln(A_p) + \alpha \ln(\hat{L}_p) + \beta \ln(\hat{K}_p) + \gamma \ln(\hat{I}_p)$$

By inverting this equation, employment can be expressed as a function of the other variables, including sales. Adding the subscripts $t$for a given year, as well as (i) year fixed-effects, δ_t, to account for common macroeconomic shocks across industries; (ii) industry fixed-effects, δ_p, to account for the level of mark-up – which depends on competition within the industry, the price elasticity of demand, etc.; and the TFP, which may be considered as constant in the short run (i.e. in the case of this study, three years) – the following econometric specification is obtained:

$$\ln(\hat{L}_{pt}) = \beta_0 + \delta_t + \delta_p + \beta_1 \ln(\hat{K}_{pt}) + \beta_2 \ln(\hat{I}_{pt}) + \beta_3 \ln(\hat{S}_{pt}) + \sum_p \beta_p [\ln(\hat{S}_{pt}) \times \delta_p] + \varepsilon_{pt}$$

with β_0 a constant and ε_{pt} the error term. The estimates of the elasticity of employment with respect to sales for each industry can then be extracted from the equation above, and are given by $\xi_p = \beta_3 + \beta_p$. An estimated elasticity of ξ_p means that a decrease of 1% in sales translates into a decrease of ξ_p% in jobs.

The results of the econometric specification summarized by the last equation for the Italian retail and wholesale sector are displayed in Table A.1. The first column shows the coefficients estimated without the inclusion of industry fixed-effects, and indicates an increase of 1% in sales in the retail and wholesale sector implies on average a 0.37% increase in the number of employees within the sector. The second column of Table A.1 adds cross-effects between the logarithm of sales and the industry fixed-effects to the econometric specification, which leads to the industry-specific estimates of the elasticity of employment with respect to sales displayed below.

Table A.1. Estimations of sales elasticity of employment, Italian wholesale and retail sector

Dependent variable: log employment		
log Capital	0.019**	0.020***
	(0.008)	(0.008)
log Intermediate inputs	-0.278*	-0.216*
	(0.155)	(-0.071)
log Productivity	-0.095**	-0.101**
	(-0.019)	(-0.023)
log Wages	-0.467***	-0.460***
	(0.103)	(0.098)
log Sales	0.410***	0.420***
	(0.107)	(0.096)
constant	5.531***	5.615***
	(0.264)	(0.781)
Industry fixed-effects	Yes	Yes
Year fixed-effects	Yes	Yes
Cross log Sales x Industry fixed-effects	No	Yes
Adjusted R2	0.883	0.888
Number of observations	72	72

Notes: Standard errors in parentheses. * p<0.10; ** p<0.05; *** p<0.01. The industrial data for Italian industries over the period 2008-15 are provided by Eurostat Eurostat (2018). Employment is measured by the number of full-time equivalent employees; capital by the gross investment in intangible goods; intermediate inputs by total purchases of goods and services; sales by turnovers; wages by the ratio of total personal costs.

The estimates of the sales elasticity of employment for each category of the Italian retail and wholesale industry are reported in Table A.2. Clearly, a decrease in sales does not translate into the same proportion of lost jobs in each sector. For instance, while a decline of 1% in sales for the Italian wholesale and retail sector of watches and jewellery induces a 0.35% decline in the number of employees within this sector, the elasticity is far higher for the wholesale and retail sector of food, beverage and tobacco, with an estimated transmission rate of 0.42%.

Table A.2. Elasticity of employment with respect to sales in the Italian wholesale and retail sector

Estimates for 2011-2013

Sector	Sales elasticity of employment (ε_p)
Food, beverages and tobacco	0.419
Mineral products (e.g. fuels, ores)	0.377
Chemical and allied products; except pharmaceuticals, perfumery and cosmetics	0.348
Pharmaceutical and medicinal chemical products	0.373
Perfumery and cosmetics	0.392
Textiles and other intermediate products (e.g. plastics; rubbers; paper; wood)	0.391
Clothing, footwear, leather and related products	0.400
Watches and jewellery	0.355
Non-metallic mineral products (e.g. glass and glass products, ceramic products)	0.390
Basic metals and fabricated metal products (except machinery and equipment)	0.384
Electrical household appliances, electronic and telecommunications equipment	0.371
Machinery, industrial equipment; computers and peripheral equipment; ships and aircrafts	0.377
Motor vehicles and motorcycles	0.405
Household cultural and recreation goods; including toys and games, books and musical instruments	0.365
Furniture, lighting equipment, carpets and other manufacturing n.e.c	0.396

Estimates of job losses

Once estimated, these transmission rates between sales and jobs can be used to estimate the share of lost jobs due to counterfeit products smuggled into Italy in total employment. For each Italian retail and wholesale sector, this is done by multiplying the transmission rate with the share of lost sales by the total sales of genuine products. Finally, applying these shares of lost jobs onto data on the level of employment in a given sector makes it possible to estimate the number of jobs lost in the Italian wholesale and retail industry due to counterfeit products smuggled into Italy.

More formally, the estimated transmission rates between sales and jobs, ε_p, allow recovering the number of lost jobs as follows. First, the share of lost jobs due to counterfeit and pirated imports into the total employment within each retail and wholesale industry, ϑ_p, is calculated by multiplying the share of lost sales into the total sales of genuine products in the industry, $S_p/\hat{S}_p$, with the transmission rates:

$$\vartheta_p = \varepsilon_p \times \left(S_p/\hat{S}_p\right)$$

Second, these shares of lost jobs are applied onto data on the level of employment, $\hat{L}_p$. This give us the amount of lost jobs in the wholesale and retail industries due to counterfeit and pirated imports, J_p:

$$J_p = \vartheta_p \times \hat{L}_p$$

Step 6: Determining taxes forgone

Lower genuine sales due to counterfeit and pirated imports reduce several sources of revenue for the Italian Government:

- value-added taxes (VAT) that would have been collected on consumption at purchase.

- corporate income taxes (CIT) that would have been collected from firms in the wholesale and retail industry.
- social security contributions (SSC) from employees and employers in the retail and wholesale industry.
- personal income taxes (PIT) from employees and employers in the retail and wholesale industry.

In order to calculate the lost VAT, one simply needs to apply the VAT rates on the amount of total lost sales due to counterfeit and pirated imports estimated in Step 4.

The amount of government taxes lost from CIT is calculated by multiplying the average profit rates within each category of retail and wholesale industry by the average rate of corporation tax taking into account the estimated value of lost sales.

To calculate losses in social security contributions, the share of the actual average amount of SSC paid by employees and employers for one unit of employment is multiplied by the amount of estimated lost jobs due to counterfeit and pirated imports estimated in Step 5.

The PIT foregone is calculated by multiplying the average salary in a given industry by the average income tax rate times the amount of lost jobs.

Note that in order to estimate the results as accurately as possible, these four types of lost revenues were calculated by industry. The final result at the national level was obtained by adding the estimated amounts of forgone tax revenues across industries.

A.3. Gauging the direct effects of trade in fake goods that infringe Italian trademarks and patents

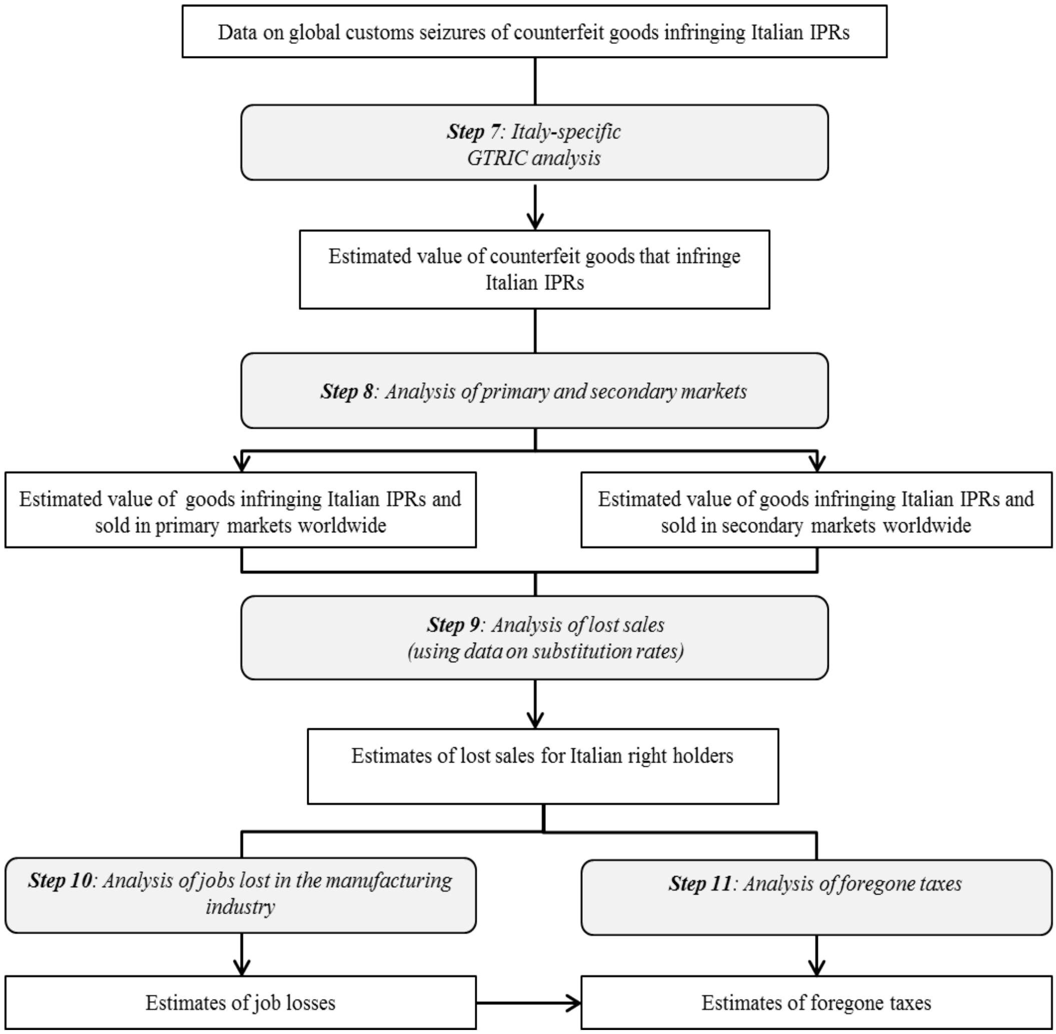
There are three ways through which global trade in goods infringing Italian trademarks and patents can affect the Italian economy: 1) loss of sales for IPR owners; 2) job losses in the manufacturing sector; 3) forgone tax revenues for the Italian Government. These can be calculated using a harmonised methodology that follows a number of steps:

- Step 7: Evaluation of the worldwide volume of infringement of Italian IP rights holders
- Step 8: Market analysis of residents' IPR-infringing goods sold worldwide (primary/secondary)
- Step 9: Analysis of lost sales for IP right holders
- Step 10: Estimation of lost jobs for manufacturing industries
- Step 11: Estimation of forgone taxes.

All these steps are presented in Figure A.3 and described in detail in the paragraphs that follow.

Importantly, all other impact areas are hard to measure quantitatively, or are likely to occur in the long term, and are therefore excluded from the analysis.

Figure A.3. Analysis of the direct effects on Italian IPR holders of global trade in fakes



Step 7: Evaluating the worldwide volume of infringements of IPRs on Italian rights holders.

The first step is to estimate the value of counterfeit goods traded worldwide that infringe trademarks or patents held by Italian rights owners. For this purpose, observations in the database that refer to trademarks or patents whose rights holders' address is registered in Italy were selected. Note that the identification of rights holders' locations was done using the Global Brand Database WIPO (2016) and the PATENTSCOPE database WIPO (2017), both provided by the World Intellectual Property Organisation.

From this data selection, the value of global counterfeiting targeting the IPR of Italian residents can be assessed by product category and destination economy, by adapting the GTRIC methodology developed in OECD/EUIPO (2016) for exports and domestic sales.

The indices included in the GTRIC matrix refer to the likelihood that a given type of counterfeit product of a brand or patent whose rights holder's location is registered in Italy is sold in a given destination economy, including Italy. These indices are then applied to existing statistics on exports and domestic sales to estimate the overall magnitude of global trade in counterfeit and pirated products that infringe Italian residents' IPR.

This methodology allows the general exporting and selling behaviour of industries to be taken into account, and relies on three key econometric components:

- The General Trade-Related Index of Counterfeiting for economies (GTRIC-e) – an index that lists economies according to their proneness to be a destination for counterfeit and pirated products of brands registered in Italy (Step 7)
- The General Trade-Related Index of Counterfeiting for Italian products (GTRIC-p) – an index that lists Italian industries according to their proneness to sell products that are sensitive to global counterfeiting and piracy (Step 8)
- The general matrix (GTRIC) that compares the likelihood of products sold by a given industry in a given destination economy to be counterfeit or pirated with the most sensitive "product category-destination economy" pair (Step 9).

Applying the GTRIC matrix to data on exports and domestic sales allows the "ceiling" value to be gauged for trade in counterfeit and pirated goods infringing the IPR owned by Italian residents. One issue, however, is how to establish a fixed point, i.e. an upper limit of counterfeit trade in percentage of exports, for the "product category–destination economy" pairs most sensitive to global counterfeiting and piracy.

Since the interviews with customs officials and experts could not determine these fixed points, the empirical application is based on three scenarios, with selected values of 10%, 15% and 20%. Note that all of these scenarios take much more conservative values of fixed points than the actual fixed points applied to imports in OECD-EUIPO (2016).

These fixed points, when combined with the relative likelihood included in the GTRIC matrix, enable calculation of the share of exports and, importantly, of domestic sales of products infringing residents' IPRs. Applying these shares to statistics on the value of exports and domestic sales gives the estimated value of goods infringing residents' IPR by product category and destination economy.

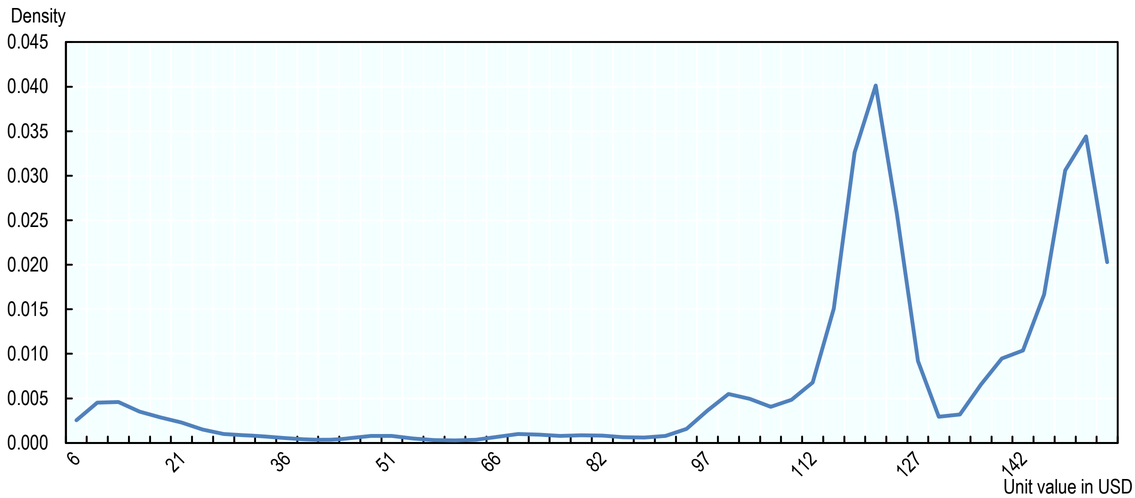
Step 8: Market analysis of fake goods infringing Italian IPRs

As with the previous analysis, two issues now need to be addressed in order to assess the economic impact of infringements of domestic rights owners' trademarks and patents in global trade. First, what share of these counterfeit products is traded on primary versus secondary markets worldwide? Second, within secondary markets, what is the rate at which consumers across the world would have substituted counterfeit goods for their legitimate copies?

The first issue is addressed with the exact same methodology as described in the first part of Step 2. The only slight difference is that the unit value distributions are estimated for each "product category - trademark (or patent) - destination economy" triplet, in order to take into account differences in retail prices between economies.

For example, between 2011 and 2013, the most counterfeited "Italian" products were the Ray-Ban sunglasses produced by the Italian eyewear conglomerate Luxottica Group. The OECD database on global customs seizures includes almost 5 600 customs seizures of this product recorded in 64 destination economies. Figure A.4 shows the unit value distribution of those fake sunglasses seized worldwide. Using the methodology outlined indicates that fake Ray-Ban sunglasses with prices lower than 120 euros were destined for the secondary market, while those with values higher than 120 euros (the peaks on the right hand side of the distribution) were targeted at the primary market.

Figure A.4. Price distribution of counterfeit Ray-Ban sunglasses seized worldwide, 2011-2013



Finally, because of a lack of data, the consumers' substitution rates chosen are the same as those selected in the second part of Step 2. Again, different scenarios of lost sales, lost jobs and lost taxes will be presented depending on the assumed rates.

Step 9. Estimating lost sales for Italian IPR owners

In order to discover the value of lost sales for Italian IPR owners, the estimated value of products sold worldwide that are fake versions of these brands or patents are **combined** with information on 1) the share of primary and secondary markets for these products by destination economy; and 2) consumers' substitution rates (see Step 8).

The calculation is very close to the one described in Step 4, the only exception being that it is first performed by destination economy before being aggregated. The total value of lost sales for domestic rights owners is given by adding the value of sales of fake products on primary markets to the value of sales on the secondary market, adjusted for consumers' substitution rates.

Formally, by denoting τ_{pd}^1 the share of the primary market in destination economy d for all products of type p that infringe residents' IPR, and C_{pd} the estimated value of fake sales of those products in that destination, the estimated value of lost sales for domestic right holders by product category p is given by:

$$S_p = \sum_d \left[\tau_{pd}^1 \times C_{pd}\right] + \left[(1 - \tau_{pd}^1) \times C_{pd} \times \rho_p\right]$$

with ρ_p denoting the product type-specific consumers' substitution rates.

Step 10: Estimating job losses in the Italian manufacturing sector

This step requires estimating the extent to which employment in the Italian manufacturing sector responds to changes in sales on export markets and on the domestic market. This is done by applying the econometric model developed in Step 5 to data specific to the manufacturing industries.

The results of this estimation for the Italian manufacturing sector are displayed in Table A.3. The main insight at the aggregate level is that an increase of 1% in sales in the Italian manufacturing sector implies on average a 0.51% increase in the number of employees within the sector.

Table A.3. Estimation of sales elasticity of employment, Italian manufacturing sector

Dependent variable: log employment		
log Capital	0.021*	0.023*
	(0.009)	(0.012)
log Intermediate Inputs	-0.416*	-0.556*
	(0.181)	(0.221)
log Productivity	-0.295***	-0.241***
	(0.044)	(0.057)
log Wages	-0.614***	-0.596***
	(0.108)	(0.128)
log Sales	0.513***	0.612***
	(0.141)	(0.193)
constant	-1.712**	-1.867**
	(0.612)	(0.639)
Industry fixed-effects	Yes	Yes
Year fixed-effects	Yes	Yes
Cross log Sales x Industry fixed-effects	No	Yes
Adjusted R^2	0.905	0.907
Number of observations	55	55

Notes: Standard errors in parentheses. * p<0.05; ** p<0.01; *** p<0.001. The industrial data for Italian industries over the period 2011-13 are provided by Eurostat (2018). Employment is measured by the number of full-time equivalent employees; capital by the gross investment in intangible goods; intermediate inputs by total purchases of goods and services; sales by turnovers; wages by the ratio of total personal costs, including social security costs, to the number of full-time equivalent employees; productivity by labour productivity.

The estimates of the sales elasticity of employment for each Italian manufacturing industry are reported in Table A.4. Again, a decrease in sales does not translate into the same proportion of lost jobs in each one of them. For instance, while a decline of 1% in sales for the industry of pharmaceuticals and medicinal chemical products induces a 0.7285% decline in the number of employees within this sector, the transmission rate is far lower for the building of machinery and industrial equipment, with an estimated transmission rate of 0.43%.

Table A.4. Elasticity of employment with respect to sales in the Italian manufacturing sector

Estimates for 2011-2013

Sector	Sales elasticity of employment (ε_p)
Food, beverages and tobacco	0.593
Mineral products (e.g. fuels, ores)	0.507
Chemical and allied products; except pharmaceuticals, perfumery and cosmetics	0.483
Pharmaceutical and medicinal chemical products	0.720
Perfumery and cosmetics	0.524
Textiles and other intermediate products (e.g. plastics; rubbers; paper; wood)	0.634
Clothing, footwear, leather and related products	0.638
Watches and jewellery	0.484
Non-metallic mineral products (e.g. glass and glass products, ceramic products)	0.667
Basic metals and fabricated metal products (except machinery and equipment)	0.520
Electrical household appliances, electronic and telecommunications equipment	0.457
Machinery, industrial equipment; computers and peripheral equipment; ships and aircrafts	0.432
Motor vehicles and motorcycles	0.451
Household cultural and recreation goods; including toys and games, books and musical instruments	0.534
Furniture, lighting equipment, carpets and other manufacturing n.e.c	0.432

Once estimated, these transmission rates between sales and jobs can be used to estimate the share of lost jobs due to infringements in global trade of Italian trademarks and patents in total employment. For each Italian manufacturing industry, this is done by multiplying the transmission rate with the share of lost sales for Italian IPR owners. Finally, multiplying these shares of lost jobs onto data on the level of employment within each manufacturing industry makes it possible to estimate the number of jobs lost in Italian manufacturing industries lost due to infringements of Italian IPR in global trade.

More formally, the estimated transmission rates between sales and jobs,ε_p, allow recovering the number of lost jobs as follows. First, the share of lost jobs due to infringements in global trade of Italian trademarks and patents into the total employment within each manufacturing industry, ϑ_p, is calculated by multiplying the share of lost sales into the total sales of genuine products in the industry, $S_p/\hat{S}_p$, with the transmission rates.

Step 11: Determining forgone tax revenues

Jobs lost due to infringements of IPRs, unlike those lost due to counterfeit and pirated imports, affect only three types of tax revenues: corporate income taxes of rights holders; social security contributions; and personal income taxes paid by employers and employees in the manufacturing sector. The value-added taxes on domestic sales of Italian IPR-infringing products are not calculated, since they have already been taken into account when estimating the value of forgone tax revenues induced by lost sales due to counterfeit and pirated imports.

The methodologies applied to calculate each of these forgone tax revenues are exactly the same as those described in Step 6. Again, this is done industry by industry in order to obtain estimates as accurate as possible.

A.4. Construction of the GTRIC for the counterfeit market in Italy

Construction of GTRIC-p

GTRIC-p is constructed in three steps:

1. For each product category, the seizure percentages for sensitive goods are formed.
2. From these, a counterfeit source factor is established for each industry, based on the industries' weight in terms of Italian imports.
3. Based on these factors, the GTRIC-p is formed.

Step 1: Measuring product seizure frequencies

v_p and m_p are, respectively, the seizure and import values of product type p (as registered according to the HS on the two-digit level) sold in Italy from *any* provenance economy in a given year. The relative seizure frequencies (seizure percentages) of good p, denoted below by γ_p, is then defined by:

$$\gamma_p = \frac{v_p}{\sum_p v_p}, \text{ such that } \sum\nolimits_p \gamma_p = 1$$

Step 2: Measuring industry -specific counterfeiting factors

$M = \sum_p m_p$ is defined as the total registered imports of all sensitive goods in Italy.

The share of good p in Italian imports, denoted by s_p, is therefore given by:

$$s_p = \frac{m_p}{M}, \text{ such that } \sum\nolimits_p s_p = 1$$

The counterfeiting factor of product category p, denoted by C_p, is then determined as the following.

$$C_p = \frac{\gamma_p}{s_p}$$

The counterfeiting factor reflects the sensitivity of product infringements occurring in a particular product category, relative to its share in Italian imports. These constitute the foundation for forming GTRIC-p.

Step 3: Establishing GTRIC-p

GTRIC-p is constructed from a transformation of the counterfeiting factor; it measures the relative likelihood of different types of product categories being subject to counterfeiting and piracy in Italian imports. The transformation of the counterfeiting factor is based on two main assumptions:

1. The first (A1) is that the counterfeiting factor of a particular product category is positively correlated with the actual degree of trade in counterfeit and pirated goods covered by that chapter. The counterfeiting factors must thus reflect the real intensity of actual counterfeit trade in the given product categories.
2. The second (A2) acknowledges that the assumption A1 may not be entirely correct. For instance, the fact infringing goods are detected more frequently in certain categories could imply differences in counterfeiting factors across products merely reflect that some goods are easier to detect than others, or that some goods, for one reason or another, have been specially targeted for inspection. The counterfeiting

factors of product categories with lower counterfeiting factors could therefore underestimate actual counterfeiting and piracy intensities in these cases.

In accordance with assumption A1 (positive correlation between counterfeiting factors and actual infringement activities) and assumption A2 (lower counterfeiting factors may underestimate actual activities), GTRIC-p is established by applying a positive monotonic transformation of the counterfeiting factor index using natural logarithms. This standard technique of linearisation of a non-linear relationship (in the case of this study, between counterfeiting factors and actual infringement activities) allows the index to be flattened and gives a higher relative weight to lower counterfeiting factors Verbeek (2008).

In order to address the possibility of outliers at both ends of the counterfeiting factor index – i.e. some categories may be measured as particularly susceptible to infringement even though they are not, whereas others may be measured as unsusceptible although they are – it is assumed that GTRIC-p follows a left-truncated normal distribution, with GTRIC-p only taking values of zero or above.

The transformed counterfeiting factor is defined as:

$$c_p = \ln(C_p + 1)$$

Assuming the transformed counterfeiting factor can be described by a left-truncated normal distribution with $c_p \geq 0$; then, following Hald (1952), the density function of GTRIC-p is given by:

$$f_{LTN}(c_p) = \begin{cases} 0 & if\, c_p \leq 0 \\ \dfrac{f(c_p)}{\int_0^\infty f(c_p)\, dc_p} & if\, c_p \geq 0 \end{cases}$$

where $f(c_p)$ is the non-truncated normal distribution for c_p , specified as:

$$f(c_p) = \frac{1}{\sqrt{2\pi\sigma_p^2}} \exp\left(-\frac{1}{2}\left(\frac{c_p - \mu_p}{\sigma_p}\right)^2\right)$$

The mean and variance of the normal distribution, here denoted by μ_p and σ_p^2 , are estimated over the transformed counterfeiting factor index, c_p, and given by $\hat{\mu}_p$ and $\hat{\sigma}_p^2$. This enables the calculation of the counterfeit import proneness index (GTRIC-p) across product categories, corresponding to the cumulative distribution function of c_p.

Construction of GTRIC-e

GTRIC-e is also constructed in three steps:

1. For each provenance economy, the seizure percentages are calculated.
2. From these, each provenance economy's counterfeit source factor is established, based on the provenance economies' weight in terms of Italian total imports.
3. Based on these factors, the GTRIC-e is formed.

Step 1: Measuring seizure intensities from each provenance economy

v_e is Italy's registered seizures of all types of infringing goods (i.e. all p) originating from economy e during a given year in terms of their value.

γ_e is Italy's relative seizure frequency (seizure percentage) of all infringing items that originate from economy e, in a given year:

$$\gamma_e = \frac{v_e}{\sum_e v_e}, \text{ such that } \sum_e \gamma_e = 1$$

Step 2: Measuring economy-specific counterfeiting factors

m_e is defined as the total registered Italian imports of all sensitive products from e, and $M = \sum_e m_e$ is the total Italian import of sensitive goods from all provenance economies.

The share of imports from provenance economy e in total Italian imports of sensitive goods, denoted by s_e, is then given by:

$$s_e = \frac{m_e}{M}, \text{ such that } \sum_e s_e = 1$$

From this, the economy-specific counterfeiting factor is established by dividing the general seizure frequency for economy e with the share of total imports of sensitive goods from e.

$$C_e = \frac{\gamma_e}{s_e}$$

Step 3: Establishing GTRIC-e

Gauging the magnitude of counterfeiting and piracy from a provenance economy perspective can be undertaken in a fashion similar to that for sensitive goods. Hence, a general trade-related index of counterfeiting for economies (GTRIC-e) is established along similar lines and assumptions:

1. The first assumption (A3) is that the frequency with which any counterfeit or pirated article from a particular economy is detected and seized by customs is positively correlated with the actual amount of counterfeit and pirate articles imported from that location.
2. The second assumption (A4) acknowledges that assumption A3 may not be entirely correct. For instance, a high seizure intensity of counterfeit or pirated articles from a particular provenance economy could be an indication that the provenance economy is part of a customs profiling scheme, or that it is specially targeted for investigation by customs. The role that provenance economies with low seizure intensities play regarding actual counterfeiting and piracy activity could therefore be underrepresented by the index and lead to an underestimation of the scale of counterfeiting and piracy.

As with the product-specific index, GTRIC-e is established by applying a positive monotonic transformation of the counterfeiting factor index for provenance economies using natural logarithms. This follows from assumption A3 (positive correlation between seizure intensities and actual infringement activities) and assumption A4 (lower intensities tend to underestimate actual activities). Considering the possibilities of outliers at both ends of the GTRIC-e distribution – i.e. some economies may be wrongly measured as being particularly susceptible sources of counterfeit and pirated imports, and vice versa – GTRIC-e is approximated by a left-truncated normal distribution as it does not take values below zero.

The transformed general counterfeiting factor across provenance economies on which GTRIC-e is based is therefore given by applying logarithms onto economy-specific general counterfeit factors Verbeek (2008):

$$c_e = \ln(C_e + 1)$$

In addition, following GTRIC-p it is assumed that GTRIC-e follows a truncated normal distribution with $c_e \geq 0$ for all e. Following Hald (1952), the density function of the left-truncated normal distribution for c_e is given by

$$g_{LTN}(c_p) = \begin{cases} 0 & if\, cf_e \leq 0 \\ \dfrac{g(e)}{\int_0^\infty g(c_e)\ dc_e} & if\, cf_e \geq 0 \end{cases}$$

where $g(c_e)$ is the non-truncated normal distribution for c_e , specified as:

$$g(c_e) = \frac{1}{\sqrt{2\pi\sigma_e^2}} \exp\left(-\frac{1}{2}\left(\frac{c_e - \mu_e}{\sigma_e}\right)^2\right)$$

The mean and variance of the normal distribution, here denoted by μ_e and σ_e^2, are estimated over the transformed counterfeiting factor index, c_e, and given by $\hat{\mu}_e$ and $\hat{\sigma}_e^2$. This enables the calculation of the counterfeit import propensity index (GTRIC-e) across provenance economies, corresponding to the cumulative distribution function ofc_e.

Construction of GTRIC

The combined index of GTRIC-e and GTRIC-p, denoted by GTRIC, is an index that approximates the relative proneness of particular product types, imported by Italy from specific trading partners, to be counterfeit and/or pirated.

Step 1: Establishing intensities for products and provenance economies

In this step the proneness to contain counterfeit and pirated products will be established for each trade flow from a given provenance economy and in a given product category.

The general proneness of product category p to be infringed, from any economy, is denoted by P_p and given by GTRIC-p so that:

$$P_p = F_{LTN}(c_p)$$

where $F_{LTN}(c_p)$ is the cumulative probability function of $f_{LTN}(c_p)$.

Furthermore, the general propensity of infringing goods of any type from economy e is denoted by P_e, and given by GTRIC-e, so that:

$$P_e = G_{LTN}(c_e)$$

where $G_{LTN}(c_e)$ is the cumulative probability function of $g_{LTN}(c_e)$.

The general likelihood of items of type p originating from economy e to be counterfeit or pirated is then denoted by P_{ep} and approximated by:

$$P_{ep} = P_p P_e$$

Therefore, $P_{ep} \in [\varepsilon_p \varepsilon_e \,; 1]$, $\forall e, p$, with $\varepsilon_p \varepsilon_e$ denoting the minimum average counterfeit export rate for each sensitive product category and each provenance economy. It is assumed that $\varepsilon_e = \varepsilon_p = 0.05$.

Step 2: Calculating the absolute value

α is the fixed point, i.e. the maximum average counterfeit rate of a given type of infringing good, p, originating from a given economy e. α can therefore be applied onto likelihood of goods of type p from trading partner e to be infringed (αP^{jk}).

As a result, a matrix of counterfeit proneness C is obtained.

$$C = \begin{pmatrix} \alpha P_{11} & \alpha P_{12} & & & \alpha P_{1P} \\ \alpha P_{21} & \ddots & & & \\ & & \alpha P_{ep} & & \\ & & & \ddots & \\ \alpha P_{E1} & & & & \alpha P_{EP} \end{pmatrix} \text{ with dimension } E \times P$$

The matrix of Italian imports is denoted by M. Applying C on M yields the absolute volume of counterfeit and pirated imports in the Italy. In particular, the imports matrix M is given by:

$$M = \begin{pmatrix} m_{11} & m_{12} & & & m_{1P} \\ m_{21} & \ddots & & & \\ & & m_{ep} & & \\ & & & \ddots & \\ m_{E1} & & & & m_{EP} \end{pmatrix} \text{ with dimension } E \times P$$

Hence, the element m_{ep} denotes Italian imports of product category p from partner e, with $e = [1, \dots, E]$ and $p = [1, \dots, P]$.

Denoted by Ψ, the product-by-economy percentage of counterfeit and pirated imports can be determined as the following:

$$\Psi = \mathrm{C'M} \div \mathrm{M}$$

The value of total imports of counterfeit and pirated goods, denoted by the scalar TC, is then given by:

$$\mathrm{TC} = \mathrm{I}_1' \Psi \mathrm{I}_2$$

where I_1 is an identity matrix with dimension $E \times 1$, and I_2 is an identity matrix with dimension $P \times 1$.

By denoting total world trade by the scalar $\mathrm{TM} = \mathrm{I}_1 \mathrm{M'} \mathrm{I}_2$, the share of imports of counterfeit and pirated products into total Italian imports, S_{TC}, is determined by:

$$S_{TC} = \frac{TC}{TM}$$

A.5. Construction of the GTRIC for products infringing Italian IPR

Construction of Italian GTRIC-p

Italian GTRIC-p is constructed in three steps:

- For each product category, the seizure percentages for sensitive goods are formed.
- From these, a counterfeit source factor is established for each industry, based on the industries' weight in terms of total trade.
- Based on these factors, the GTRIC-p is formed.

Step 1: Measuring product seizure frequencies

w_q is the seized value of product type q infringing Italian residents' IPR from *any* provenance economy in a given year. The relative seizure frequency (seizure percentages) of good q, denoted below as η_q, is then defined by:

$$\eta_q = \frac{w_q}{\sum_q w_q}, \text{ such that } \sum_q \eta_q = 1$$

Step 2: Measuring product-specific counterfeiting factors

e_q is the global sales value (exports plus domestic sales) of all Italian branded products of type q, so that $E = \sum_q e_q$ is defined as the global registered sales by Italian manufacturing industries of *all* sensitive goods.

The share of good q in Italian total sales, denoted by ς_q, is therefore given by:

$$\varsigma_q = \frac{e_q}{E}, \text{ such that } \sum_q \varsigma_q = 1$$

The counterfeiting factor of product category q, denoted C_q, is then determined as the following.

$$C_q = \frac{\eta_q}{\varsigma_q}$$

The counterfeiting factor reflects the sensitivity of infringements of Italian trademarks and patents occurring in a particular product category, relative to its share in Italian global sales. These constitute the foundation for forming GTRIC-p.

Step 3: Establishing Italian GTRIC-p

GTRIC-p is constructed from a transformation of the counterfeiting factor; it measures the relative proneness with which Italian trademarks and patents in different types of product categories are subject to counterfeiting and piracy. The transformation of the counterfeiting factor is based on two main assumptions, described in OECD/EUIPO (2016):

1. The first (A5) is that the counterfeiting factor for goods infringing Italian IPR of a particular product category is positively correlated with the actual degree of trade in counterfeit and pirated goods covered by that chapter. The counterfeiting factors must thus reflect the real intensity of actual counterfeit trade for products infringing Italian IPR in the given product categories.

2. The second (A6) acknowledges that the assumption A5 may not be entirely correct. For instance, the fact Italian IPR infringing goods are detected more frequently in certain categories could imply that differences in counterfeiting factors across products merely reflect that some goods infringing Italian IPR are easier to detect than others, or that some of these goods, for one reason or another, have been specially targeted by customs worldwide. The counterfeiting factors of product categories with lower counterfeiting factors could therefore underestimate actual counterfeiting and piracy intensities in these cases.

In accordance with assumptions A5 and A6, GTRIC-p for products infringing Italian IPR traded worldwide is established by applying a positive monotonic transformation of the counterfeiting factor index using natural logarithms. This standard technique of linearisation of a non-linear relationship – in the case of this study between counterfeiting factors and actual infringement activities – allows the index to be flattened and gives a higher relative weight to lower counterfeiting factors Verbeek (2008).

In addition, in order to address the possibility of outliers at both ends of the counterfeiting factor index – i.e. some categories may be measured as particularly susceptible to infringement even though they are not, whereas others may be measured as unsusceptible although they are – it is assumed that GTRIC-p follows a left-truncated normal distribution, with GTRIC-p only taking values of zero or above.

The transformed counterfeiting factor is defined as:

$$c_q = \ln(C_q + 1)$$

Assuming that the transformed counterfeiting factor can be described by a left-truncated normal distribution with $c_k \geq 0$; then, following Hald (1952), the density function of GTRIC-p is given by:

$$h_{LTN}(c_q) = \begin{cases} 0 & if\, c_q \leq 0 \\ \dfrac{h(c_q)}{\int_0^\infty h(c_q)\, dc_q} & if\, c_q \geq 0 \end{cases}$$

where $h(c_q)$ is the non-truncated normal distribution for c_k, specified as:

$$h(c_q) = \frac{1}{\sqrt{2\pi\sigma_q^2}} \exp\left(-\frac{1}{2}\left(\frac{c_q - \mu_q}{\sigma_q}\right)^2\right)$$

The mean and variance of the normal distribution, here denoted by μ_q and σ_q^2 , are estimated over the transformed counterfeiting factor index, c_q, and given by $\hat{\mu}_q$ and $\hat{\sigma}_q^2$. This enables calculation of the counterfeit propensity index (GTRIC-p) across HS chapters, corresponding to the cumulative distribution function of c_q.

Construction of GTRIC-e

GTRIC-e is also constructed in three steps:

- For each provenance economy, the seizure percentages are calculated.
- From these, each provenance economy’s counterfeit source factor is established, based on the provenance economies’ weight in terms of Italian total sales.
- Based on these factors, the GTRIC-e is formed.

Step 1: Measuring seizure intensities for each destination economy

w_d is the registered seized value of all types of goods infringing Italian residents' IP rights (i.e. all q) exported to destination economy d from any provenance economy at a given year. η_d is the relative seizure intensity (seizure percentage) of all products infringing Italian trademarks and patents that are shipped to country d, in a given year:

$$\eta_d = \frac{w_d}{\sum_d w_d}, \text{ such that } \sum_d \eta_d = 1$$

Step 2: Measuring destination-specific counterfeiting factors

e_d is defined as the global registered sales value of Italian branded or patented products (exports plus domestic manufacturing sales) shipped to d (including Italy) and $E = \sum_d e_d$ is the global value of Italian sales of sensitive goods to all destination economies.

The share of sales to destination economy d in Italian global sales of sensitive goods, denoted ς_d, is then given by:

$$\varsigma_d = \frac{e_d}{E}, \text{ such that } \sum_d \varsigma_d = 1$$

From this, the economy-specific counterfeiting factor is established by dividing the seizure intensity for economy *d* by the share of total sales of sensitive goods to *d*:

$$C_d = \frac{\eta_d}{\varsigma_d}$$

Step 3: Establishing GTRIC-e

GTRIC-e is constructed from a transformation of the counterfeiting factor; it measures the relative proneness with which counterfeit products infringing Italian trademarks and patents are shipped to a given destination economy. The transformation of the counterfeiting factor is based on two main assumptions, described in OECD/EUIPO, (2016):

1. The first assumption (A7) is that the frequency with which any counterfeit Italian branded or patented article shipped to a particular destination economy is detected and seized by customs is positively correlated with the actual amount of counterfeit and pirated Italian products exported to that location; and
2. The second assumption (A8) acknowledges that assumption A7 may not be entirely correct. For instance, a high seizure intensity of products infringing Italian IPR in a particular destination economy could be an indication that the destination economy implements a particular customs profiling scheme, or that these products are specially targeted for investigation by customs in that locale. The role some destination economies with low seizure intensities of Italian IPR infringing products play regarding actual counterfeiting and piracy activity could therefore be underrepresented by the index and lead to an underestimation of the scale of counterfeiting activities and piracy targeting Italian branded or patented products there.

Following assumptions A7 and A8, GTRIC-e for products infringing Italian IPR is established by applying a positive monotonic transformation of the counterfeiting factor index using natural logarithms. This standard technique of linearisation of a non-linear relationship (in the case of this study, between counterfeiting factors and actual infringement activities) allows the index to be flattened and gives a higher relative weight to lower counterfeiting factors Verbeek (2008).

In addition, in order to address the possibility of outliers at both ends of the counterfeiting factor index – i.e. some destination economies may be measured as particularly susceptible to infringement even though they are not, whereas others may be measured as unsusceptible although they are – it is assumed GTRIC-e follows a left-truncated normal distribution, with GTRIC-e only taking values of zero or above.

The transformed general counterfeiting factor across destination economies on which GTRIC-e is based is therefore given by applying logarithms onto economy-specific general counterfeit factors Verbeek (2008):

$$c_d = \ln(C_d + 1)$$

In addition, following GTRIC-p it is assumed that GTRIC-e follows a truncated normal distribution with $c_d \geq 0$ for all d. Following Hald (1952)[24], the density function of the left-truncated normal distribution for c_d is given by

$$i_{LTN}(c_d) = \begin{cases} 0 & if\, c_d \leq 0 \\ \dfrac{i(c_d)}{\int_0^\infty i(c_d)\ dc_d} & if\, c_d \geq 0 \end{cases}$$

where $i(c_d)$ is the non-truncated normal distribution for c_d specified as:

$$i(c_d) = \frac{1}{\sqrt{2\pi\sigma_d^2}} \exp\left(-\frac{1}{2}\left(\frac{c_d - \mu_d}{\sigma_d}\right)^2\right)$$

The mean and variance of the normal distribution, here denoted by μ_d and σ_d^2, are estimated over the transformed counterfeiting factor index, c_d, and given by $\hat{\mu}_d$ and $\hat{\sigma}_d^2$. This enables the calculation of the counterfeit propensity index (GTRIC-e) across destination economies, corresponding to the cumulative distribution function of c_d.

Construction of GTRIC

The combined index of GTRIC-e and GTRIC-p, denoted GTRIC, is an index that approximates the relative proneness for goods associated with Italian residents' IP rights in a given product category and a given destination economy to be counterfeit and/or pirated.

Step 1: Establishing proneness for products and destination economies

The general proneness of Italian trademarks and patents to be counterfeit or pirated in product category q, is denoted by P_q, and is given by GTRIC-p, so that:

$$P_q = H_{LTN}(c_q)$$

where $H_{LTN}(c_q)$ is the cumulative probability function of $h_{LTN}(c_q)$.

Furthermore, the general proneness of all Italian trademarks and patents to be infringed and shipped to economy d is denoted by P_d, and is given by GTRIC-e, so that:

$$P_d = I_{LTN}(c_d)$$

where $I_{LTN}(c_d)$ is the cumulative probability function of $i_{LTN}(c_d)$

The general proneness of Italian residents' IP rights to be counterfeit or pirated in a given product category q and to be shipped to a given destination d from any provenance economy is then denoted by P_{kd} and approximated by:

$$P_{qd} = P_q \times P_d$$

Therefore, $P_{qd} \in [\varepsilon_q \varepsilon_d\, ; 1]$, $\forall k, d$, with $\varepsilon_q \varepsilon_d$ denoting the minimum average counterfeit export rate for each sensitive product category and each destination economy. It is assumed that $\varepsilon_q = \varepsilon_d = 0.05$.

Step 2: Calculating the absolute value

β is the fixed point, i.e. the maximum average counterfeit rate of Italian trademarks and patents for a given product type q, shipped to a given trading partner, d. β can therefore be applied onto the proneness of Italian-related IP rights of type q to be counterfeit and shipped to destination partner d ($\beta \times P_{qd}$).

As a result, a matrix of counterfeit import propensities Λ is obtained.

$$\Lambda = \begin{pmatrix} \beta P_{11} & \beta P_{12} & & & \beta P_{1Q} \\ \beta P_{21} & \ddots & & & \\ & & \beta P_{dq} & & \\ & & & \ddots & \\ \beta P_{D1} & & & & \beta P_{DQ} \end{pmatrix} \text{with dimension } D \times Q$$

The matrix of Italian global sales is denoted by E. Applying Λ on E yields the absolute volume of counterfeit and pirated trade in products that infringe Italian residents' IPR. In particular, the sales matrix E is given by:

$$E = \begin{pmatrix} e_{11} & e_{12} & & & e_{1Q} \\ e_{21} & \ddots & & & \\ & & e_{dq} & & \\ & & & \ddots & \\ e_{D1} & & & & e_{DQ} \end{pmatrix} \text{with dimension } D \times Q$$

Hence, the element e_{dq} denotes Italian sales of products in category q to destination d, including Italy, with $d = [1, \ldots, D]$ and $q = [1, \ldots, Q]$.

Denoted by Z, the product-by-economy percentage of counterfeit and pirated imports can be determined as the following:

$$\mathrm{Z} = \Lambda' \mathrm{E} \div \mathrm{E}$$

Total trade in counterfeit and pirated goods that infringe Italian trademarks and patents, denoted by the scalar TΛ, is then given by:

$$\mathrm{T}\Lambda = \mathrm{I}_1{}' \mathrm{Z} \mathrm{I}_2$$

where I_1 is an identity matrix with dimension $D \times 1$, and I_2 is an identity matrix with dimension $Q \times 1$.

Then, by denotingglobal Italian sales by the scalar $\mathrm{TE} = \mathrm{I}_1{}'\mathrm{ZE}_2$, the share of counterfeit and pirated products infringing Italian residents' IPR in Italian global manufacturing sales, $\varsigma_{\mathrm{T\Lambda}}$, is determined by:

$$\varsigma_{\mathrm{T\Lambda}} = \frac{\mathrm{T\Lambda}}{\mathrm{TE}}$$

A.6. Sensitivity analysis

The sensitivity analysis is done to address the scarcity of data on substitution rates between fake and genuine goods. To carry out the analysis three different scenarios are introduced.

The first assumes substitution rates that follow the results of the Anti-Counterfeiting Group (2007) consumer survey and a survey carried out by Tom et al. (1998), the selected substitution rate is 32% for all other fake products sold on secondary markets. The second scenario is more conservative, and assumes substitution rates 10 percentage points lower. The third scenario is the most conservative one, and assumes the substitution rates to be 20 percentage points lower than in the first scenario. The three are recapped in Table A.5.

Table A.5. Assumed consumer substitution rates in the three performed scenarios

Sector	Scenario 1	Scenario 2	Scenario 3
Perfumery and cosmetics	49%	39%	29%
Watches and jewellery	27%	17%	7%
Clothing, accessories, leather and related products	39%	29%	19%
Other sectors	32%	22%	12%

Sources: Authors' own calculations based on Anti-Counterfeiting Group (2007) and Tom et al. (1998).

The three different scenarios are carried out independently to verify if the final result differ significantly, depending on changes in inputs. This is done for the following exercises:

- Estimation of lost sales for the Italian retail and wholesale sector (Table A.6).
- Estimation of lost jobs in the Italian retail and wholesale sector (Table A.7).
- Gauging of forgone taxes for the Italian government due to counterfeit and pirated imports (Table A.8)
- Estimation of lost sales for Italian manufacturing industries, (Table A.9)
- Estimation of lost jobs in Italian manufacturing industries(Table A.10)
- Calculation of public revenue losses due to Italian IPR infringements in global trade (Table A.11)

Importantly, in all cases the estimated losses for the three scenarios are very close, which confirms the robustness of all the results.

Table A.6. Sensitivity analysis: lost sales for the Italian retail and wholesale sector, 2013

Sector	Scenario 1		Scenario 2		Scenario 3	
	Value in EUR mn	Share of sales	Value in EUR mn	Share of sales	Value in EUR mn	Share of sales
Food, beverages and tobacco	618	1.0%	615	1.0%	612	1.0%
Chemical and allied products	125	3.7%	121	3.5%	117	3.4%
Pharmaceutical and medicinal chemical products	254	2.3%	245	2.2%	237	2.1%
Perfumery and cosmetics	85	1.6%	75	1.4%	65	1.2%
Textiles and other intermediate products	446	4.3%	411	3.9%	375	3.6%
Clothing, footwear, leather and related products	1269	4.4%	1163	4.0%	1056	3.7%
Watches and jewellery	221	7.5%	195	6.6%	169	5.8%
Non-metallic mineral products	16	0.2%	15	0.2%	13	0.2%
Basic metals and fabricated metal products	475	4.0%	471	4.0%	468	4.0%
Electronic and electrical equipment, optical products, scientific instruments	1794	5.4%	1611	4.9%	1427	4.3%
Machinery, industrial equipment; computers and peripheral equipment	732	4.1%	682	3.8%	631	3.5%
Motor vehicles and motorcycles	569	1.9%	502	1.7%	435	1.5%
Household cultural and recreation goods	212	2.1%	198	2.0%	185	1.9%
Furniturecarpets and other manufacturing n.e.c	132	0.6%	125	0.6%	118	0.6%
Total wholesale and resale sector	6949	2.7%	6429	2.4%	5909	2.2%

Table A.7. Sensitivity analysis: lost jobs in the Italian retail and wholesale sector, 2013

Sector	Scenario 1		Scenario 2		Scenario 3	
	Number	Share of jobs	Number	Share of jobs	Number	Share of jobs
Food, beverages and tobacco	3374	0.6%	3357	0.6%	3340	0.6%
Chemical and allied products	244	1.7%	235	1.7%	227	1.6%
Pharmaceutical and medicinal chemical products	565	1.2%	546	1.1%	527	1.1%
Perfumery and cosmetics	340	0.9%	301	0.8%	261	0.7%
Textiles and other intermediate products	1847	2.3%	1701	2.1%	1554	1.9%
Clothing, footwear, leather and related products	6582	2.4%	6029	2.2%	5476	2.0%
Watches and jewellery	797	3.6%	703	3.2%	609	2.8%
Non-metallic mineral products	65	0.1%	60	0.1%	55	0.1%
Basic metals and fabricated metal products	1649	2.1%	1635	2.1%	1622	2.1%
Electronic electrical and optical products, scientific instruments	1712	2.7%	1536	2.5%	1361	2.2%
Machinery, industrial equipment; computers and peripheral equipment	2262	2.1%	2106	1.9%	1950	1.8%
Motor vehicles and motorcycles	2272	1.1%	2005	0.9%	1738	0.8%
Household cultural and recreation goods	813	1.1%	762	1.0%	711	0.9%
Furniture, and other manufacturing n.e.c	629	0.3%	596	0.3%	564	0.3%
Total wholesale and retail sector	23149	1.3%	21573	1.2%	19997	1.1%

Table A.8. Sensitivity analysis: public revenue losses due to the fake imports in Italy, 2013

Tax type	Scenario 1		Scenario 2		Scenario 3	
	Value in EUR mn	Share	Value in EUR mn	Share	Value in EUR mn	Share
Personal income taxes and social security contributions	1354	0.8%	1321	0.8%	1287.50	0.7%
Corporate income taxes	831	2.1%	799	2.0%	766.78	2.0%
Value added taxes	1529	1.6%	1414.379	1.5%	1300.017	1.4%
Total	3714	1.2%	3534	1.1%	3354	1.1%

Table A.9. Sensitivity analysis: lost sales for Italian manufacturing industries, 2013

Sector	Scenario 1		Scenario 2		Scenario 3	
	Value in EUR mn	Share of sales	Value in EUR mn	Share of sales	Value in EUR mn	Share of sales
Food, beverages and tobacco	4160.97	3.3%	4009.95	3.2%	3858.93	3.1%
Chemical and allied products	246.82	0.7%	230.26	0.7%	213.69	0.6%
Pharmaceutical and medicinal chemical products	20.94	0.1%	19.18	0.1%	17.42	0.1%
Perfumery and cosmetics	468.62	8.5%	444.10	8.0%	419.58	7.6%
Textiles and other intermediate products	3196.46	2.8%	2895.66	2.5%	2594.85	2.2%
Clothing, footwear, leather and related products	3534.91	8.8%	3253.56	8.2%	2972.21	7.5%
Watches and jewellery	1255.37	6.9%	1135.84	6.2%	1016.31	5.6%
Non-metallic mineral products	400.74	1.4%	363.92	1.3%	327.10	1.1%
Basic metals and fabricated metal products	2948.71	2.2%	2796.36	2.0%	2644.00	1.9%
Electronic, electrical, and optical products, scientific instruments	4646.64	8.0%	4487.05	7.7%	4327.46	7.4%
Machinery, industrial equipment; computers and peripheral equipment	2626.64	1.9%	2494.42	1.8%	2362.21	1.7%
Motor vehicles and motorcycles	920.89	2.0%	826.64	1.8%	732.40	1.6%
Household cultural and recreation goods	318.54	7.6%	298.63	7.1%	278.71	6.6%
Furniture and other manufacturing n.e.c	344.77	1.2%	313.09	1.1%	281.41	1.0%
Total manufacturing sector	25091.02	3.1%	23568.65	2.9%	22046.28	2.7%

Table A.10. Sensitivity analysis: lost jobs in Italian manufacturing industries, 2013

	Scenario 1		Scenario 2		Scenario 3	
Sector	Number	Share	Number	Share	Number	Share
Food, beverages and tobacco	8510	2.0%	8201	1.9%	7893	1.8%
Chemical and allied products	328	0.4%	306	0.3%	284	0.3%
Pharmaceutical and medicinal chemical products	38	0.1%	35	0.1%	32	0.1%
Perfumery and cosmetics	673	4.4%	638	4.2%	603	4.0%
Textiles and other intermediate products	11228	1.8%	10171	1.6%	9114	1.4%
Clothing, footwear, leather and related products	17407	5.1%	16021	4.7%	14636	4.3%
Watches and jewellery	1091	3.3%	987	3.0%	883	2.7%
Non-metallic mineral products	1916	0.9%	1740	0.9%	1564	0.8%
Basic metals and fabricated metal products	7589	1.1%	7197	1.1%	6805	1.0%
Electronic, electrical, and optical products, scientific instruments	7176	4.0%	6929	3.9%	6683	3.7%
Machinery, industrial equipment; computers and peripheral equipment	5210	0.8%	4948	0.8%	4686	0.7%
Motor vehicles and motorcycles	1516	0.9%	1361	0.8%	1206	0.7%
Household cultural and recreation goods	429	4.0%	402	3.8%	375	3.5%
Furniture and other manufacturing n.e.c	1204	0.5%	1093	0.5%	983	0.4%
Total manufacturing sector	64316	2.4%	60031	2.2%	55747	2.0%

Table A.11. Sensitivity analysis: public revenue losses due to infringements of Italian IPR, 2013

Tax type	Scenario 1		Scenario 2		Scenario 3	
	Value in EUR mn	Share	Value in EUR mn	Share	Value in EUR mn	Share
Personal income taxes and social security contributions	2616.9	1.5%	2446.9	1.4%	2281.0	1.2%
Corporate income taxes	1730.9	4.2%	1650.6	4.0%	1570.4	3.8%
Value added taxes	1508.6	1.6%	1293.8	1.4%	1079.0	1.1%
Total	5856.4	1.9%	5391.4	1.7%	4930.4	1.6%

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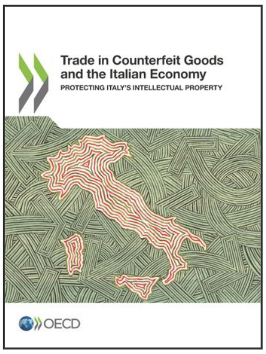
Notes

[1] The purposes of this exercise were: i) to assess the proportion of consumers who, given that choice, would choose to purchase the counterfeit item; ii) to determine their product attitudes; and iii) to obtain demographic characteristics.

[2] Note that 39% of the sample stated that they had knowingly purchased counterfeit products; 61% stated that they have never knowingly purchased counterfeit goods.

[3] The remaining share of consumers was split as follows: 45% of fake buyers would not have bought the corresponding legitimate item and 16% would have bought another fake item in the case of clothing and footwear. These figures are 39% and 33%, respectively, in the case of watches; and 37% and 14%, respectively, in the case of fragrances. No additional investigation about potential price differences between genuine and fake offerings was undertaken.



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