The Forest Products Trade Flow Database − A reproducible method and tool to support the analysis of international forest products trade

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Contents

1. Introduction

The availability of accurate and complete data on the trade of forest products between countries has gained importance through several recent policy developments, relating e.g. to FLEGT, REDD+, renewable energy production and the bio-economy. Forest Law Enforcement, Governance and Trade (FLEGT) requires such data to monitor if due diligence requirements towards producers, traders and operators would result in a shift of trade patterns e.g. a redirection of trade from 'high-risk countries' towards less demanding markets, or e.g. an increase in trade from countries that have invested in significantly improving the legality of their forest sector. The impact of the United Nations Framework Convention on Climate Change mechanism on Reducing Emissions, Deforestation and Degradation (REDD+) could in part be monitored by analysing e.g. the reduction in the trade of certain forest product commodities that are sourced from tree species growing in natural forests. Monitoring the effects of renewable energy policy could look into e.g. the evolution of trade of fuelwood, sawdust and wood waste and scrap (which includes also pellets). Beyond simple import and export values, bilateral trade flows from one country to another provide a deeper understanding of ongoing global changes in biomass trade. The forest sector being an important contributor to the bio-economy, forest products trade data can give important insights in the development of the bio-economy, even while some commodities of importance do not emerge from international datasets with specific codes.

Import and export data which specifies country of origin and country of destination are referred to as dyadic data or bilateral trade flow data. Such data provide useful insights into the state and development of globalised forest products and related markets. But data quality varies greatly throughout the product range and across countries: trade flow data might be erroneous or missing, either from the exporter's side, from the importer's side, or both.

Trade data experts typically use various techniques to provide best possible estimates based on data available to them. This will result in two experts coming up with different estimates, which is confusing to end-users. In part, to counter this situation, between 2000 and 2007, the European Forest Institute maintained a forest products trade database documented in Michie and Wardle (2002). Based on the United Nations Comtrade database, it used a trade flow data validation routine to produce consolidated trade data. It tackled issues of missing data and inconsistencies in trade quantities. For example, trade volumes were estimated by dividing trade values by a unit price. After 2007, the first version of the forest products trade database stopped being updated due to a lack of resources. A drawback of this method was that the updating routine was labour intensive and thus requiring significant resources.

In 2014, the International Tropical Timber Organisation (ITTO) encouraged EFI to update the bilateral trade flow database and related validation methodology. Reproducibility of data estimates were an essential part of the design that EFI in turn proposed to ITTO. The system was expected to update itself on a regular basis, by automatically loading trade data from relevant data sources (UN Comtrade in a first stage, EU Comext possibly in a second stage). The goal was to provide several estimated trade volumes for a given trade flow between reporter country A and partner country B. The system

was required to provide a transparent method of choosing one of these estimates. The present report describes the data refining process and its technical implementation.

2. Data sources

2.1. Harmonized System of trade classifications

Historically the organisation collecting data on the international trade in goods is the Customs Cooperation Council (CCC), established in 1952 and which was renamed in 1994 to World Customs Organisation (WCO). The main function of this organisation was the application of tarif, not the collection of statistical data. Traded products were classified according to the Standard International Trade Classification (SITC) until the CCC adopted a new trade classification called the Harmonized System (HS). The International Convention on the Harmonized Commodity Description and Coding System was adopted in 1983 and the first version of the Harmonized System entered into use as of 1988. The Harmonized System is a hierarchical classification in which commodities are encoded with unique 6 digit codes, explained with corresponding definitions. The classification system is issued with revisions about every 5 years. As such, consecutive revisions entered into force in 1992, 1996, 2002, 2007, 2012, and soon 2017. Each of these revisions included additions or deletions of codes, in response to changing significance either in terms of commodity values or quanitities or in terms of policy or societal values or both.

Currently in total 7 HS chapters relate to forest fibre commodities. For the project presented in this report, we compiled yearly COMTRADE data for the wood-based forest commodities from the following chapters:

- Chapter 44: Wood and articles of wood; wood charcoal
- Chapter 45: Cork and articles of cork
- Chapter 46: Manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork (including products made of bamboo and rattan)
- Chapter 47: Pulp of wood or of other fibrous cellulosic material; Recovered paper and paperboard
- Chapter 48: Paper and paperboard; Articles of paper pulp, of paper or of paperboard
- Chapter 49: Printed books, newspapers, pictures and other products of the printing industry; Manuscripts, typescripts and plans
- Chapter 94: Furniture; Bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; Lamps and lighting fittings, not elsewhere specified or included; Illuminated signs, illuminated name-plates and the like; prefabricated buildings.

Products sharing the same first two digits belong to a product chapter, for example codes beginning with the digits 44 are wood based products. The third and fourth digits represent a product group, for example codes starting with 4403 concern logs and codes starting with 4407 concern sawnwood products. The fifth and sixth digits represent a sub-product, for example code 440727 represent sawnwood made of Sapelli and 440791 represent Oak sawnwood. But product information contained in the last 2 digits is not always as informative or clear-cut as one would expected. In fact, a large share of the sawnwood trade volume for example is classified under unspecified tropical sawnwood with product code 440729 or under unspecified non-coniferous sanwood with product code 440799.

The European Commission Statistical Services (Eurostat) further specifies Harmonized System codes by using 8-digit codes using the EU's Combined Nomenclature. In terms of commodity classification, the Combined Nomenclature follows the 6 first digits of the HS classification that is in force at a certain period, but in its following digits it provides for a more detailed classification. The European Union publishes its Combined Nomenclature yearly in the Offical Journal, which can be consulted via the EU's Eur-Lex website. The work presented in this report focused on UN Comtrade as a data source because trade flows are available for nearly all countries in the world.

In principle the methodolgoy for the mirror flow comparison detailed below (Section 3.5 on page 13) could also be used on the Eurostat Comext data. However the more detailed commodity classifications that change over time, and an aim to benefit from the detail in Comext monthly data requires a different approach in the validation process. Effects from e.g. trade flows across calendar years (an export leaving in december and arriving in january of the following year) and method of how to treat and represent these, deserve further study.

For a comprehensive overview of forest products trade data classifications and collection methodologies, please refer to Wardle et al. (2003). For more information on the Harmonized System, please refer to the WCO website and to the annex section A.1 Harmonized System - product classifications and definitions for forest products.

2.2. Data availability and quality issues

One of the first issues to consider before analysing data is that some trade quantities are not available and some discrepancies are evident between trade flows reported by some countries and their partner countries. Three figures might be available for each trade flow, between reporter country A and partner country B: trade value in $US\$$, weight in kg and quantity in m^3 (or other quantity units such as e.g. boardfeet, m^2or number of pieces). Table 1 illustrates a discrepancy between mirror flows and missing weight and quantity figures. The import flow between reporter B and partner A is the mirror of the export flow between reporter A and partner B. Weight and volume figures should be similar, but the export flow appears to be 10 times higher than the import flow. We will deal with this issue by comparing changes of unit prices between the two partners over the years. In the third line, country A reported an export value to country C but the quantity is missing. Country B reported an import value from country D, but both quantity and weight were missing. Data manipulations detailed below deal with each of these issues.

Table 1: Sawn wood trade flows between fictitious countries A, B, C and D (NA means not available).

Reporter	Partner	Flow	Trade Value $US\$$	Weight kg	Quantity m^3	Conversion Factor kg/m^3	Unit Price $\$/m^3$
A	B	Export	1 000 000	1 228 102	18 250	673	55
B	A	Import	1 277 372	1 313 869	1 825	720	700
A	C	Export	2 000 000	2 456 204	NA	673	548
B	D	Export	8 000 000	NA	NA	663	549

3. Refining quantity data

Figure 1 illustrates how various data manipulation steps are connected to handle missing quantity data, out of bounds prices and information from the trade partner. Each step in the workflow will be detailed in the section below.

3.1. Extracting conversion factors

Products trade flows of roundwood, sawnwood and wood panels are available both in cubic meter quantity and in ton. Conversion factors can be calculated based on the available weight and quantity in the dataset. Within each world region[1], a median conversion factor was calculated for each product in each flow direction (import, export) in each year. Table 2 shows conversion factor, calculated for the product "other sawnwood", Comtrade code 440799. The UNECE-FAO timber section published conversion

[1]ITTO considers 6 world regions: Asia, Europe, North America, Africa, South America, Oceania

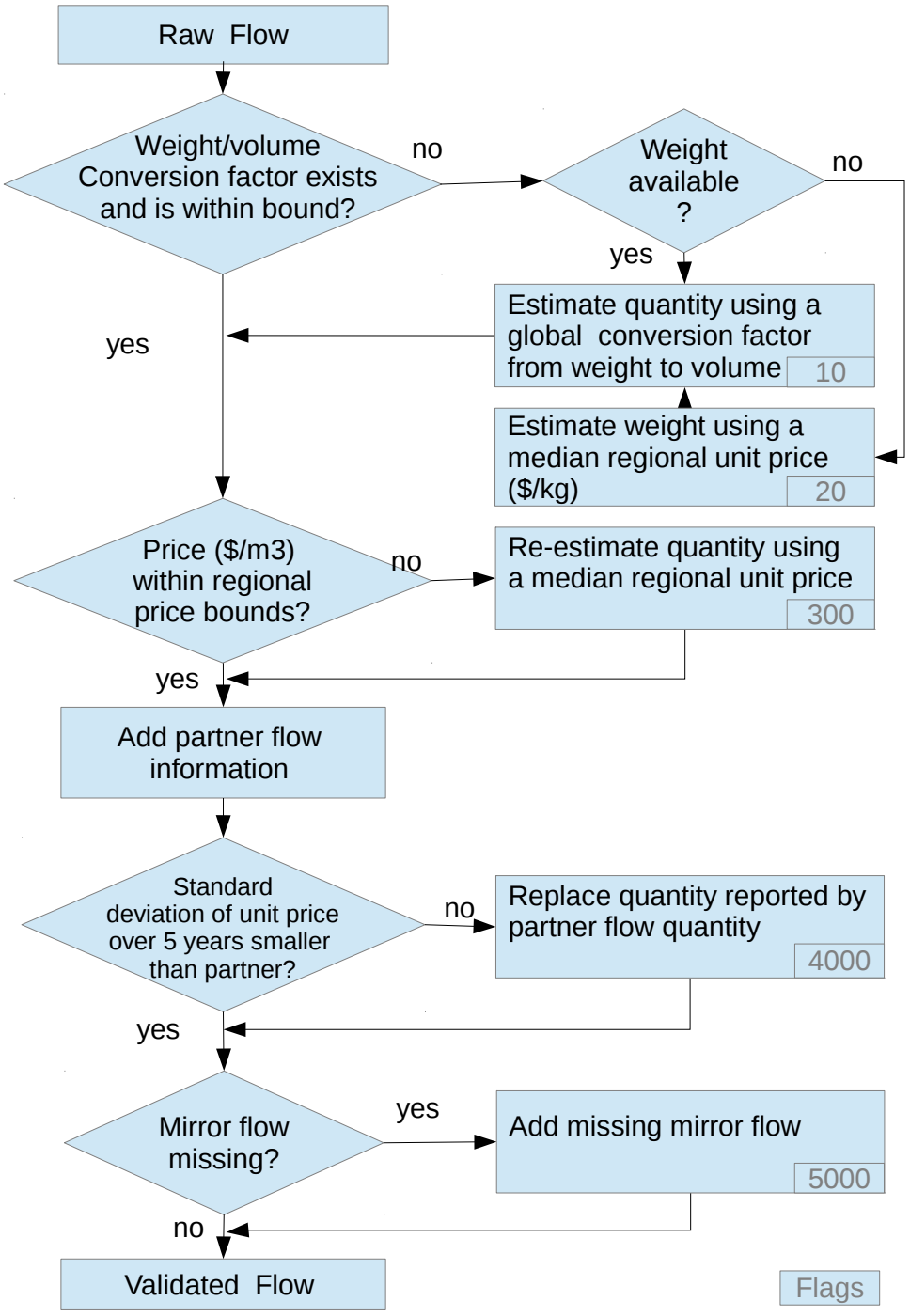


Figure 1: Flowchart of quantity estimation steps.

factors between volume and weight for forest products, which can be compared with the obtained values.

Table 2: Median conversion factor of other sawnwood HS code 440799 by world region.

flow	regionreporter	year	medianconversion
Export	Africa	2010	823
Export	Asia	2010	638
Export	Europe	2010	688
Export	North America	2010	930
Export	Oceania	2010	821
Export	South America	2010	735
Import	Africa	2010	584
Import	Asia	2010	705
Import	Europe	2010	678
Import	North America	2010	700
Import	Oceania	2010	745
Import	South America	2010	550
Export	Africa	2011	769
Export	Asia	2011	663
Export	Europe	2011	669
Export	North America	2011	1260
Export	Oceania	2011	713
Export	South America	2011	896
Import	Africa	2011	572
Import	Asia	2011	720
Import	Europe	2011	680
Import	North America	2011	664
Import	Oceania	2011	686
Import	South America	2011	572

3.2. Extracting unit prices

Median unit prices were extracted for each world region in each year. Paper product prices were calculated in United States dollars per kg. Sawnwood, roudnwood and wood panel prices were reported in dollars per m^3. For some reported trade flows, quantity units change in time from litre to m^3. In those very rare cases unit prices were calculated for all units, no unit conversion was performed. Later quantity estimates were based on the quantity unit which was most present in all years.

Re-import and re-export were filtered out for unit price calculations. The choice was made to use median regional unit prices, weighted average prices would have been lower as illustrated in the graph below. Higher prices lead to lower estimation of the quantity. Figure 2 illustrates import and export price distribution in terms of quantity, trade value and number of flows. Looking at the bottom right plot (number of import flows), it can be seen that a large number of flows have the same unit price around $700\$/m^3$. Most of

Table 3: Lower, median, upper and weighted average prices per cubic meter of other sawnwood by region

Region	Year	Flow	Lower	Median	Upper	Weighted_Average
Africa	2010	Export	291	588	1255	34
Africa	2010	Import	117	636	1345	26
Africa	2011	Export	268	549	1254	19
Africa	2011	Import	77	547	1419	25
Asia	2010	Export	221	588	1363	248
Asia	2010	Import	200	671	1346	284
Asia	2011	Export	228	549	1554	252
Asia	2011	Import	205	700	1409	312
Europe	2010	Export	117	583	1601	279
Europe	2010	Import	194	671	1986	157
Europe	2011	Export	118	548	1614	281
Europe	2011	Import	212	700	2073	146
North America	2010	Export	270	591	2050	302
North America	2010	Import	173	671	1788	177
North America	2011	Export	264	600	2725	425
North America	2011	Import	162	700	1548	171
Oceania	2010	Export	166	653	2206	275
Oceania	2010	Import	334	699	2129	176
Oceania	2011	Export	122	655	2376	40
Oceania	2011	Import	292	706	2288	512
South America	2010	Export	291	588	1187	370
South America	2010	Import	262	671	1437	415
South America	2011	Export	267	551	1511	138
South America	2011	Import	194	686	1603	173

these flows carry flag number 2 (quantity was estimated) or flag number 6 (both quantity and net weight were estimated). The frequency of these flags show us that Comtrade mostly used a price around $700\$/m^3$ to estimate import quantities from the trade value.

3.3. Estimating missing quantities

The main quantity of interest are volumes in m^3 for products such as roundwood and sawnwood and weights in kg for paper products. The goal was to obtain trade quantities for each bilateral forest products flows. A trade flow with available quantity was available left unmodified in a first stage. If the quantity was missing, it was estimated following this procedure:

- If the weight was available in kg, it was converted to volume using a regional median conversion factor in kg/m^3.
- If neither volume nor quantity were available, the missing quantity was estimated from the trade value using a regional unit price in $\$/m^3$.

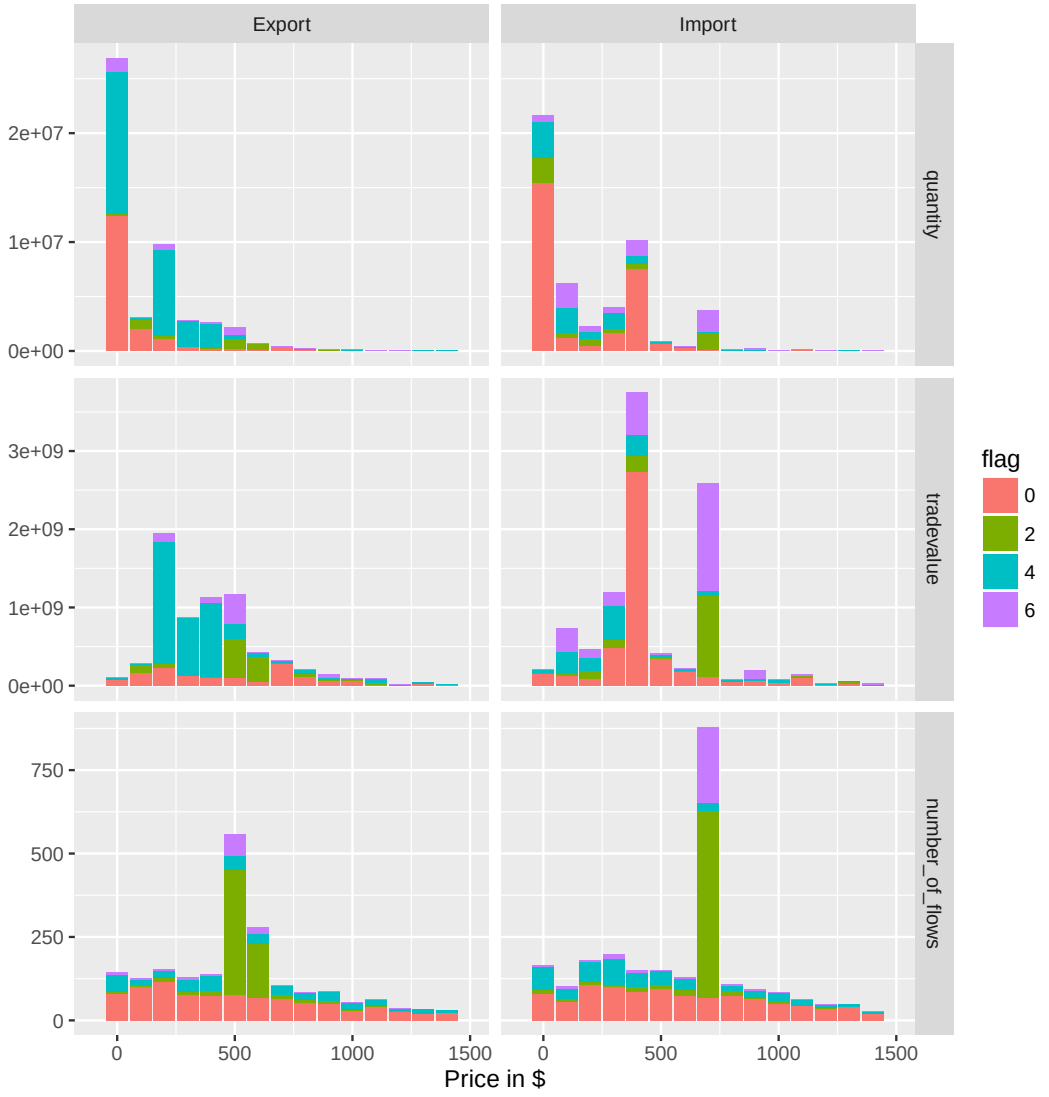


Figure 2: Global price distribution in terms of quantity in m^3, in terms of trade value in US $ and in terms of number of flows for the product "other sawnwood" (HS code 440799). Flags are an indication of data modifications done by Comtrade, explained in section 3.6.1: 0 = no estimation, 2 = quantity estimation only, 4 = net weight estimation only, 6 = both quantity and net weight are estimated.

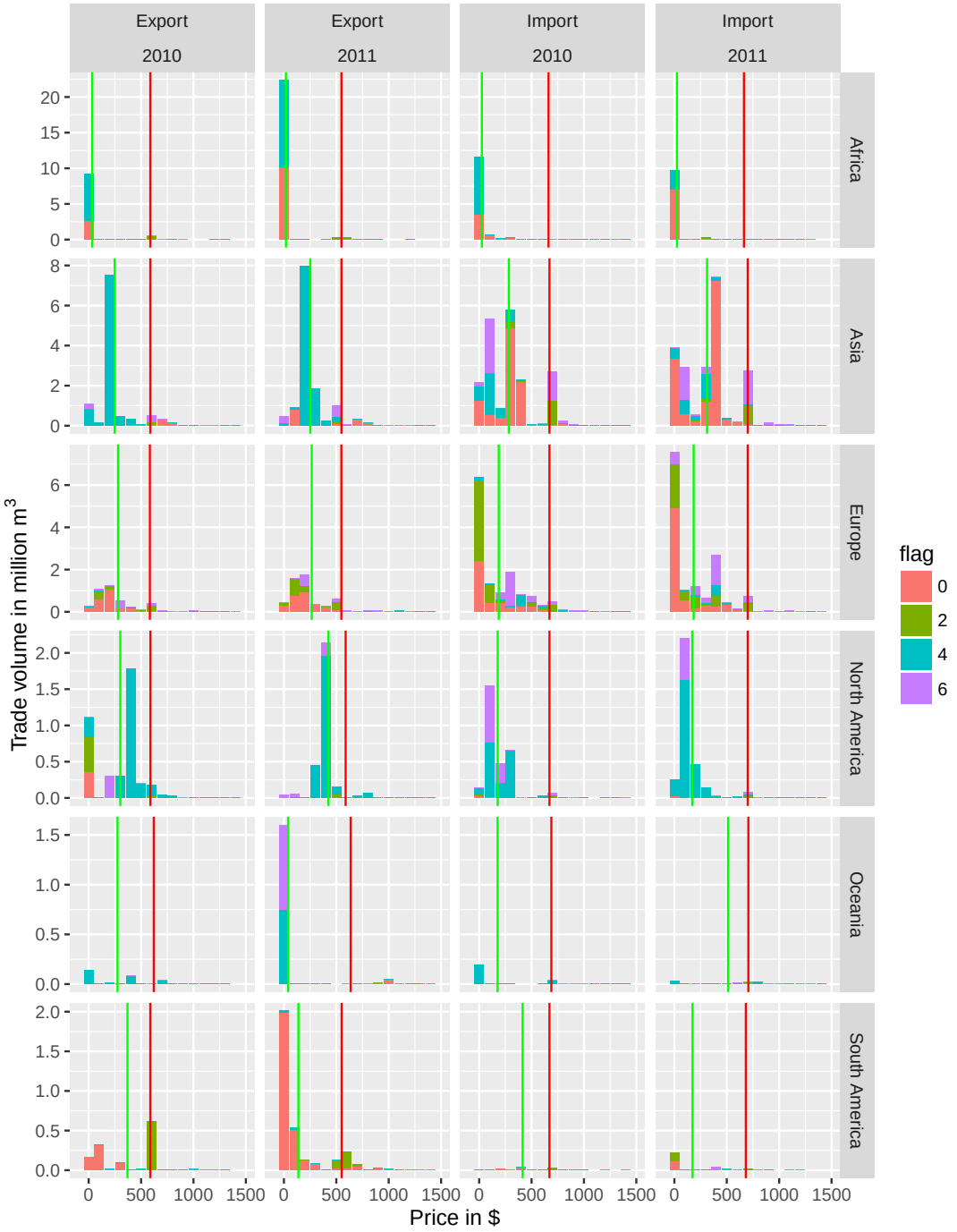


Figure 3: Price volume distribution for other sawnwood (HS code 440799) by region and by year. Vertical red lines represent median unit prices (in number of reported flows for each region) and vertical green lines represent the weighted average unit price for each region. Flags are an indicator of data modifications done by Comtrade, explained in section 3.6.1 below.

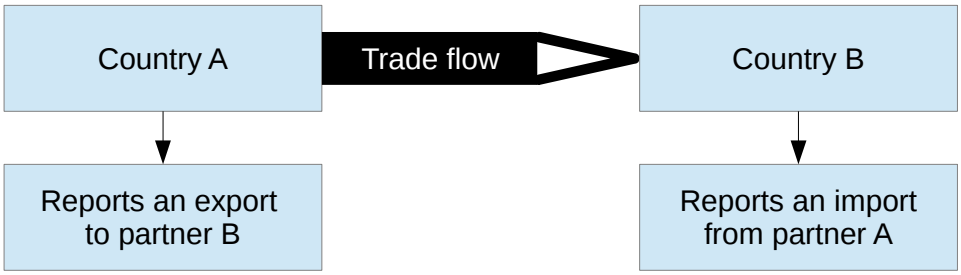


Figure 4: Trade flow between country A and country B.

This section focuses on products reported in m^3, but with the exeption of conversion from methods are equally applicable to trade flows reported in kg.

3.4. Correcting quantity based on price bounds

The price of each trade flow was compared to the lower and upper price bounds (illustrated for example in table 3). For flows that had a price outside the price bound, the regional median unit price was used to re-estimate the quantity based on the trade value.

3.5. Comparing mirror flows

We suppose that every physical flow of goods was reported by both the exporting country and the importing country. We call these 2 reports mirror flows as illustrated in figure 4. Country A reported an export flow to its partner country B. Country B reported a symmetrical import flow from its partner country A. These could be represented by the first two lines of table 1. These flows might be different in trade value but the reported quantities should in principle be equal.

When quantities differ, the reporting country which reported the lowest variation in prices in recent years will be considered more reliable. The program compares the standard deviation of unit prices over recent years (defaults to the last 5 years). The example table 4 illustrates exports from country A to country B in 2010 and 2011 and the corresponding import reported by country B. Looking at the price column, the export price reported by A in 2011 appears to be much lower than the price reported in 2010. This increased the standard deviation for reporter A. As a consequence, for those flows, the import quantity reported by B would be preferred.

When one of the mirror flows is missing completely, data reported by its trade partner is used to complete the missing value. By duplicating potential errors this technique is likely to inflate world trade flows. If necessary, flows estimated based on the partner value can be ignored by filtering all flows which have a flag equal to 5000.

Table 4: Example of sawn wood trade flows between fictitious countries A and B

Year	Reporter	Partner	Flow	Trade Value $US\$$	Quantity m^3	Unit Price $\$/m^3$	Standard deviation
2010	A	B	Export	1166000	2000	583	373.50
2011	A	B	Export	1000000	18250	55	
2010	B	A	Import	1342000	2000	671	20.51
2011	B	A	Import	1277500	1825	700	

3.6. Keeping a record of modifications

Each procedure modifying quantity data, records a distinct number in a column called flag. Flags help keeping track of various corrections mentioned above and enable to distinguish unmodified data.

3.6.1. Comtrade estimates and flags

Comtrade data contains quantity estimates based on conversion factors (Comtrade, 2009). For example the conversion factor from volume to weight used for product code 440799 "Lumber, non-coniferous nes" was equal to 0.7. In the raw dataset, flows with corrected volume and weight were marked with the following flags (Comtrade, 2009):

0 = no estimation

2 = quantity estimation only

4 = net weight estimation only

6 = both quantity and net weight are estimated.

3.6.2. Tradeflows database estimates and flags

In the validated dataset, Comtrade flags (x value in the example below) were extended with the following numbers:

10 = estimated quantity based on weight

20 = estimated quantity based on the trade value.

300 = shaved quantity based on unit price because the unit price was too high or too low

4000 = quantity replaced by the partner quantity because it had a smaller standard deviation of unit price over a period of 5 years

5000 = When a flow does not have a mirror flow, add the partner flow quantity and trade value

Throughout the trade flow modification procedure, flags add up to each other, in order to track flows corrected several times. For example flag 310 would mean that the quantity was estimated from the weight using a conversion factor (flag 10), then the quantity was estimated again because the unit price was to high or too low (flag 300). The refining procedure can be deactivated for flag 300 and flag 4000.

4. Technical Implementation

The trade flows database interacts with three modules illustrated in figure 5: data extractor, data cleaning and query interface. The data extractor is capable of automatically querying products trade flows from the ComTrade API, parsing them and inserting them into the database. The data cleaning module is implemented in the R statistical language. Trade flows are cleaned by using an automated and reproducible procedure. The query interface - accessible through a web server - allows users to visualise trade flows and generate PDF-reports.

4.1. Loading data from the Comtrade Application Programming Interface

The project developed two different data extractors: one to download data from Comtrade and one to download and parse data from Comext.

The first extractor is responsible for downloading data from Comtrade by using their new API. In 2014, new development of the UN Comtrade database server made it easier to load and update data. The Comtrade database became accessible through an Application Programming Interface (API). EFI developed a programme to harvest a range of forest products from that API. Data can be loaded from the Comtrade API in the form of XML or JSON files. EFI programmed a data harvester that loads product codes at the 6 digit level, mainly under HS chapter 44, 47 and 48, other product codes such as furniture under chapter 94 were also loaded. The harvester, programmed in the PHP language, loads all world trade flows for a given product in a given year, for all HS classification systems as reported by the different countries. It stores data in a database, for later use by the R statistical software. The API is given a list of codes to download for specified time period. The data is parsed and inserted to a database at EFI. The ComTrade API has a set limit of 100 requests per hour and the data extractor has been made to wait when the limit is reached. Download time is recorded for each flow. If a single trade flow has a newer time stamp in the raw database than in the validated database, then all world trade flows for the corresponding product will be added to a list of products to be updated.

The data extractor module can also parse data from the Comext bulk-download facility. The functionality works in a similar way to the Comtrade data extraction. Batch files with monthly trade flow data are first downloaded and then the forest products data is extracted and put into a database on EFI side. The Comext data resides in an own table in the database.

More information is available in the annex section A.2 Data Extractor Requirements, section A.3 Software architecture, section A.4 Server setup and section A.5 Extractor and Validator.

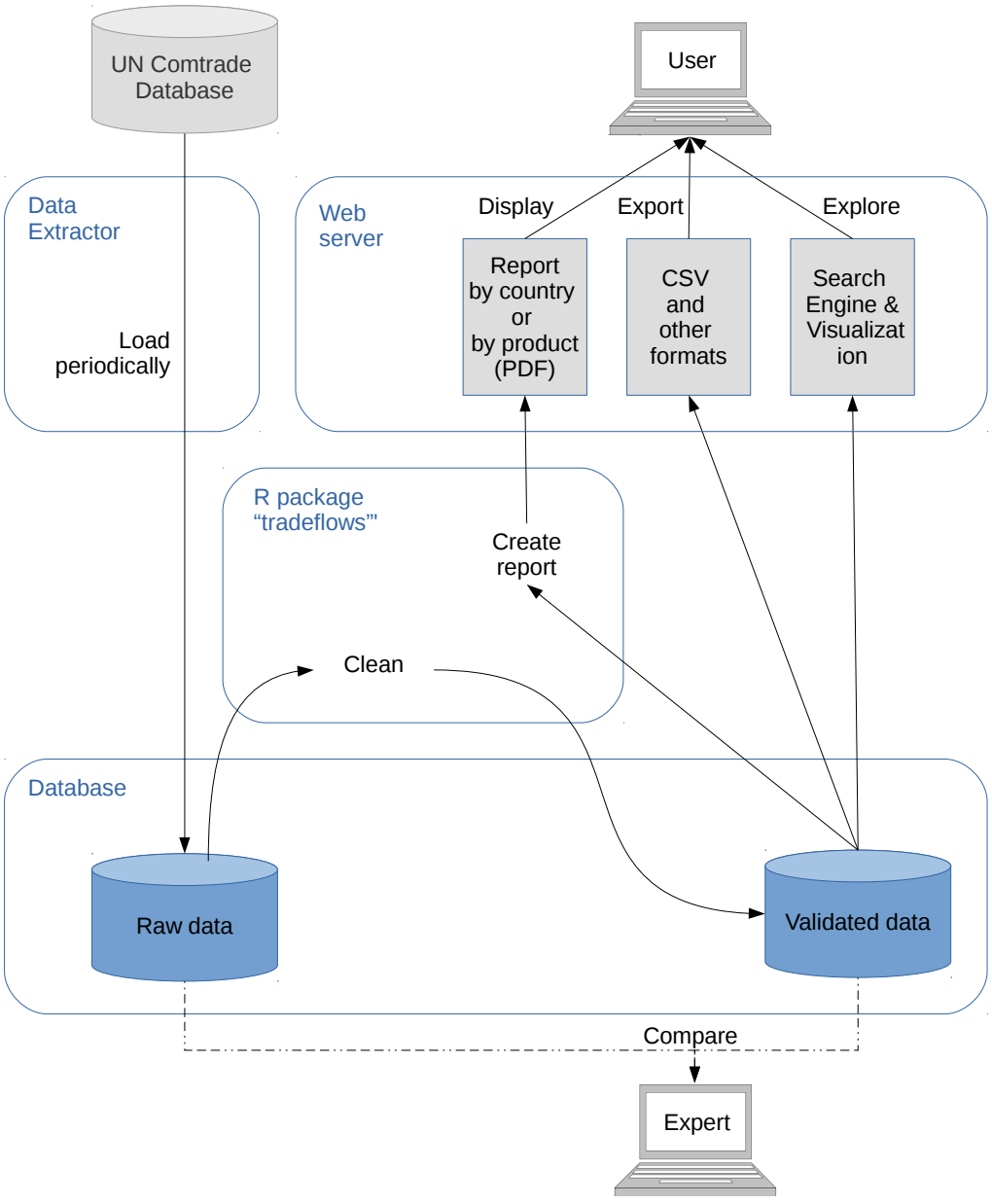


Figure 5: Three software modules interact with the trade flows database to perform data extraction, cleaning and display processes.

4.2. Validating data with the R software

The R statistical software (R Core Team, 2014) is a programming language suited for the extraction, transformation and analysis of large data tables. We created a software package called "tradeflows" which groups all functions implementing the workflow (figure 1 above). Once the tradeflows package has been installed in an R environment, function documentation can be accessed by pressing a question mark before the function name. For example entering "?estimatequantity" at the R prompt will display the documentation for that function. Table 5 contains four examples of functions and their parameters.

Table 5: Example of functions in the trade flows package

Function name (parameters)	**Description**
extractconversionfactors(dtf, geoaggregation = "region", includeqwestimates = TRUE) **dtf** dataframe containing all trade flows for one product and their individual conversion factors **geoaggregation** character vector specifying the regional aggregation level, "world" to extract world conversion factors, "region" to extract regional conversion factors. **includeqwestimates** logical TRUE when Comtrade quantity and weight estimates can be included	Group trade flows by the given geographical aggregation level and extract the median conversion factors.

Table 5 (continued): Example of functions in the trade flows package

Function name (parameters)	Description
extractprices(dtf, lowercoef = 0.5, uppercoef = 2, geoaggregation = "regionreporter", includeqestimates = TRUE) **dtf** dataframe containing all trade flows for one product and their individual unit prices **lowercoef** numeric multiplier of the lower bound on prices **uppercoef** numeric multiplier of the upper bound on prices **geoaggregation** a character vector specifying the regional aggregation level, a column name in the reportercomtrade table **includeqestimates** logical TRUE when comtrade quantity estimates can be included	Group trade flows by the given geographical aggregation level (region or subregion) and extract the median prices. Prices depend on the quantity unit.
estimatequantity(dtf, price, conversionfactor) **dtf** dataframe containing all trade flows for one product **price** a data frame of unit prices which can be merge with dtf **conversionfactor** a data frame of conversion factors which can be merged with dtf	For each trade flow in the given data frame, compute quantity_cf from the weight using a conversion factor and comput quantity_up from the trade value using a unit price. These columns will be available in the data frame output of this function, but they will not be saved in the validated database.
shaveprice(dtf) **dtf** dataframe containing all trade flows for one product	This function comes after estimatequantity() and after addpartnerflow(). Split trade flows between those which are within the price bounds and those which are out of the price bounds. For trade flows outside the price bounds, use the unit price to estimate the quantity.

Following the principle of reproducible research (Wilson et al., 2014; Peng, 2011), this R package was made available on the web[2], so that interested researchers can reproduce quantity estimates. The package is available under a free software licence, modified versions can be published under the same licence, provided that the original authors are quoted.

4.3. Storing in the database

A MySQL database was chosen to implement the trade flows database. A table called "raw_flow_yearly" stores the raw data and a table called "validated_flow_yearly" stores the validated data . The above mentioned harvester regularly feeds data into the raw database. Raw data is then processed through the workflow (figure 1) and stored in the validated table. A user interface interacts with the validated table to display data to interested users.

A consistent naming convention was used for all variables throughout the project in order to facilitate the maintenance of the code base. COMTRADE, Eurostat and FAOSTAT have different naming conventions. For example trade partner names are stored under a variable called "ptTitle" in COMTRADE, a variable called "PartnerName" in FAOSTAT and a variable called "PARTNER" in EUROSTAT. This variable could have been named "reporting country", but in the raw data, a trade partner could be a country or a group of country, such as the EU. Therefore the variable was named "partner". Table 6 illustrates naming convention issues, by giving three examples of variable names in the different data sources.

Table 6: Differences of variable names between sources of bilateral trade data

Data sources	Examples of column names		
Comtrade	rtTitle	ptTitle	cmdDescE
EUROSTAT (COMEXT)	REPORTER	PARTNER	PRODUCT
FAOSTAT (2014)	ReporterName	PartnerName	ItemName
EFI database (2005)	Reporting country	Trading partner	Products
Proposed column names	reporter	partner	product

4.4. Serving data to a user interface

The forest products trade flow database can be queried through a website interface, which has two sub-components. The first component allows browsing large amounts of data easily through pre-formatted but customizable reports. The second component provides a more standard data interface, allowing querying trade flow data between a reporting country and a multitude of trade partner countries, in volume or quantity, for a selected period of time. Free and open source softwares were used during the development of this website.

[2]R package "tradeflows" available at https://github.com/EuropeanForestInstitute/tradeflows

On the added complexity of bilateral trade data

Analysts may find it harder to deal with bilateral trade flows data compared to simple summarised trade data. To illustrate the added complexity, consider on one side an aggregated trade dataset assembled by the FAO and on the other side a bilateral trade flows dataset available from Comtrade. The FAO dataset distinguishes coniferous and non coniferous sawnwood. There are approximately 200 countries and 2 direction of flows: only the total import and total export figures are reported for each country. This example dataset contains roughly 800 trade flows per year and can be easily analysed in a spreadsheet. On the other hand, the bilateral trade dataset contains 17 sawnwood products. There are approximately 150 reporter countries, 200 partner countries and 2 direction of flows between them (excluding re-import and re-export). This dataset contains approximately 20'000 trade flows per year. Its size starts to be large for basic spreadsheet operations and is best handled with pivot tables, a database or a statistical software.

4.4.1. Automated reports

Five report types can be generated by the system. For each report type, tailored reports can be generated on demand, by making a selection of reporting country, product, starting year, ending year (specification options depend on the report type as described below). The 5 report types are:

- Completeness report for one product and all countries– based on raw data.
- Discrepancy report for one reporter and product with all partners – based on raw data.
- Overview report of major flows for one reporter and all products, for value data – based on cleaned data.
- Overview report of major flows for one reporter and all products, for quantity data – based on cleaned data.
- Trade network report for one product and one year, based on value data – based on cleaned data.

Tailored reports may be cached if the data from which they are generated does not change. This means that if an exact same query would be submitted through the user interface, independent of the user, the report does not need to be made from scratch, but can be loaded much faster from the cache memory. The report interface has tool-tips for displaying instructions to the user. When a report is being generated a progress indicator is shown to the user.

Completeness report 3 figures are reported for each trade flows: trade value in US $, weight in kg and quantity (in various units). For a given product, the completeness report gives an overview of countries for which weight and quantity figures are not available. Missing figures are plotted in red. For example data availability for the product code 440799 in France is visible in figure 6. The report also compares the number of flows reported by one country with the number of flows reported by its partner countries.

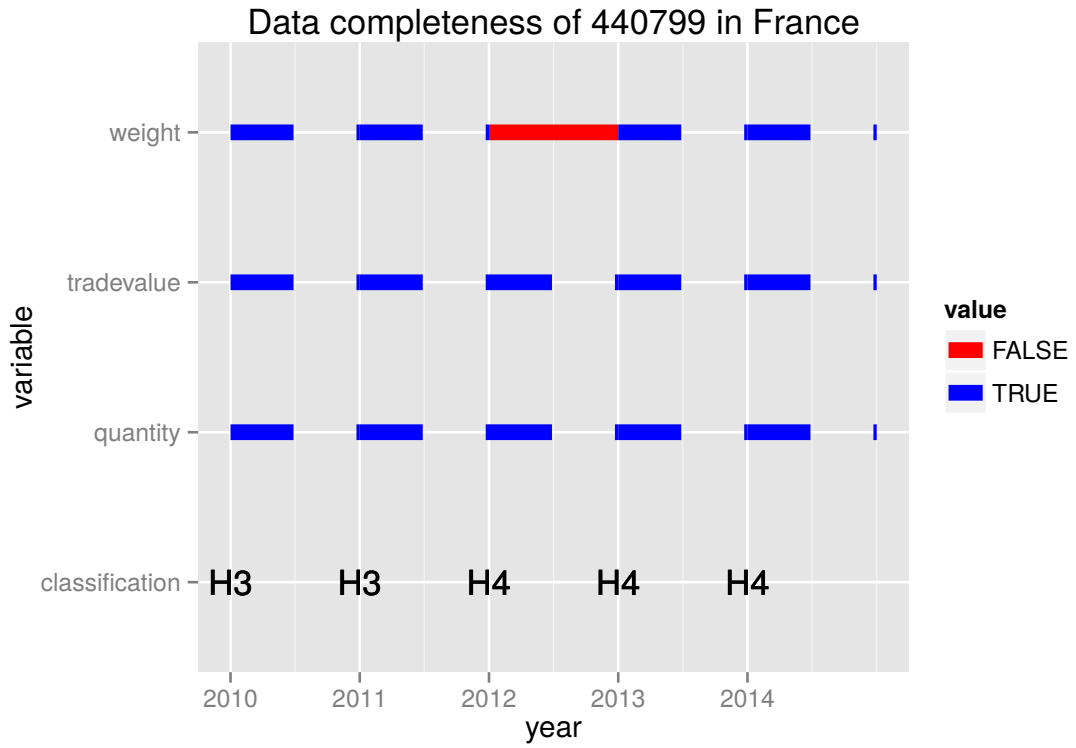


Figure 6: Data completeness for the product 440799 in France.

Discrepancy report The discrepancy report is based on the raw, unmodified data. It compares trade volumes reported by one country with trade volumes reported by its partner country (figure 4 illustrates 2 partner countries). For example the plot 7 below illustrates trade discrepancies between Finland and its main partner for the product 440710, coniferous sawnwood between 2010 and 2014. The year to year variation might help an analyst to distinguish between a discrepancy due to a one time error in reporting and a discrepancy that persists over the years. Such visualisation of the raw, unmodified data set is an entry point for further investigation.

Overview reports The overview reports illustrate major forest product trade flows for all products in a given country. Two versions of the report can be generated: one version that works with value data and one version that works with quantity data. Products are grouped according to the product groups as used in the annual FAO/ECE/Eurostat/ITTO Joint Forest Sector Questionnaire. For example figure 8 illustrates log imports and exports between France and its 5 major trade partners between 2010 and 2014. This report is based on the validated trade flows data.

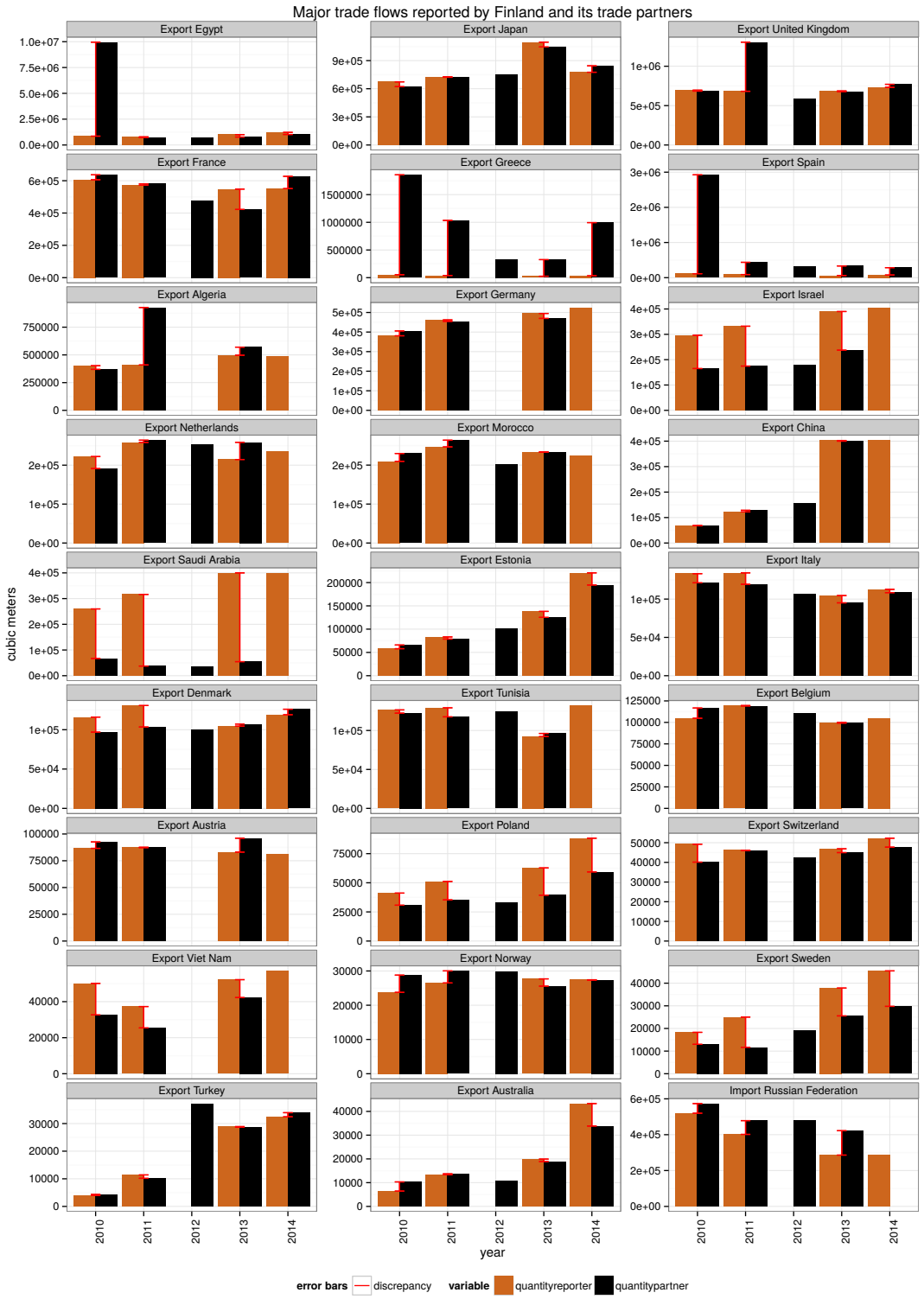
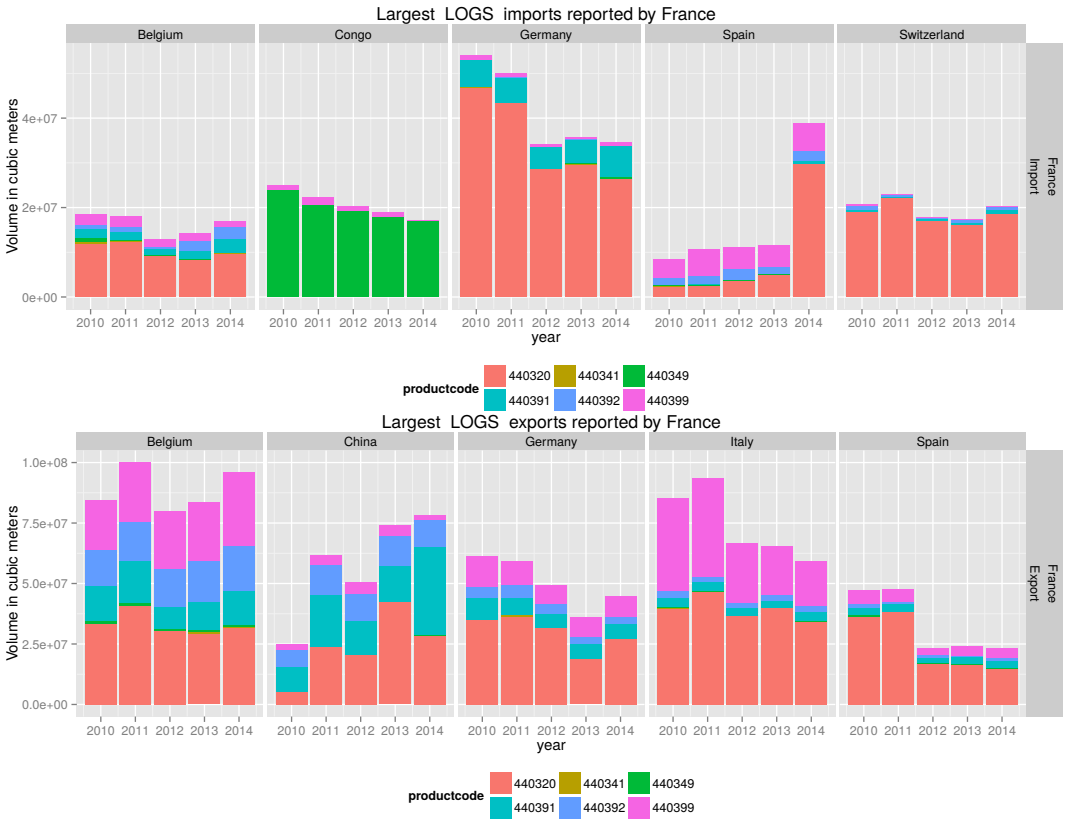


Figure 7: Trade flows discrepancies between Finland and its main trade partners. Volumes reported by Finland are displayed in brown, volumes reported by its partner are displayed in black.



440320: - Logs, poles, coniferous not treated or painted

440341: - Logs, Meranti red(dark,l

440349: - Logs, tropical woods nes

440391: - Logs, Oak (Quercus spp)

440392: - Logs, Beech (Fagus spp)

440399: - Logs, non-coniferous nes

Figure 8: Sample plot from the overview report, log import and export reported by France.

Trade Network reports A fifth report option assists interpretation of trade relationships through visualisations of international trade network of forest products. In its current form, the report is based on the value of trade flows. The trade network report presents nine different types of network visualisations (see bullet list here below). Five visualisations present global trade flows and four visualisations present trade network of a focal (ego) country. Following visualisation types are described in annex section A.6 Trade network visualisation:

- Whole network visualisations
  - World map layout
  - Export-import layout
  - Concentric circles layout
  - Inner circle layout
  - Spring-embedded layout
- Ego network visualisations
  - World map layout
  - Export-import
  - Concentric circles layout
  - Spring-embedded layout

The input variables are product group(s), year and the focal country. The visualisations follow the analytical tenants of social network analysis, where each of the visualisations focuses on a different aspect of the trade network. No numeric parameters are presented; rather, they are expressed in the visualisations themselves. The input variables are product group(s), year and the focal country.

New templates can be added In line with the reproducible research movement, our platform encourages additional automated reports, visualisations and analysis. New proposed reports have to be in R-script and need configuration (specifications of country/countries, product, years) and testing to allow using the template on the automatic generation system. Report templates are available online at:
https://github.com/EuropeanForestInstitute/tradeflows/tree/master/inst/templates.

4.4.2. Data query and visualisation

Query and visualisation The structure of the data query and visualisation interface is shown in the image below. The interface allows selecting a product code, a trade reporter, a trade partner country group or multiple trade partner countries, imports/exports, value/quantity. The database currently holds data from 2005-2014. An HS code's matching definition will be shown in a pop-up box while hoovering the mousepointer over the code. The country groups include UN official regions and subregions, as well as special interest groupings such as tropical countries and VPA countries. The website, providing the interface with the database, was developed under the Codeigniter

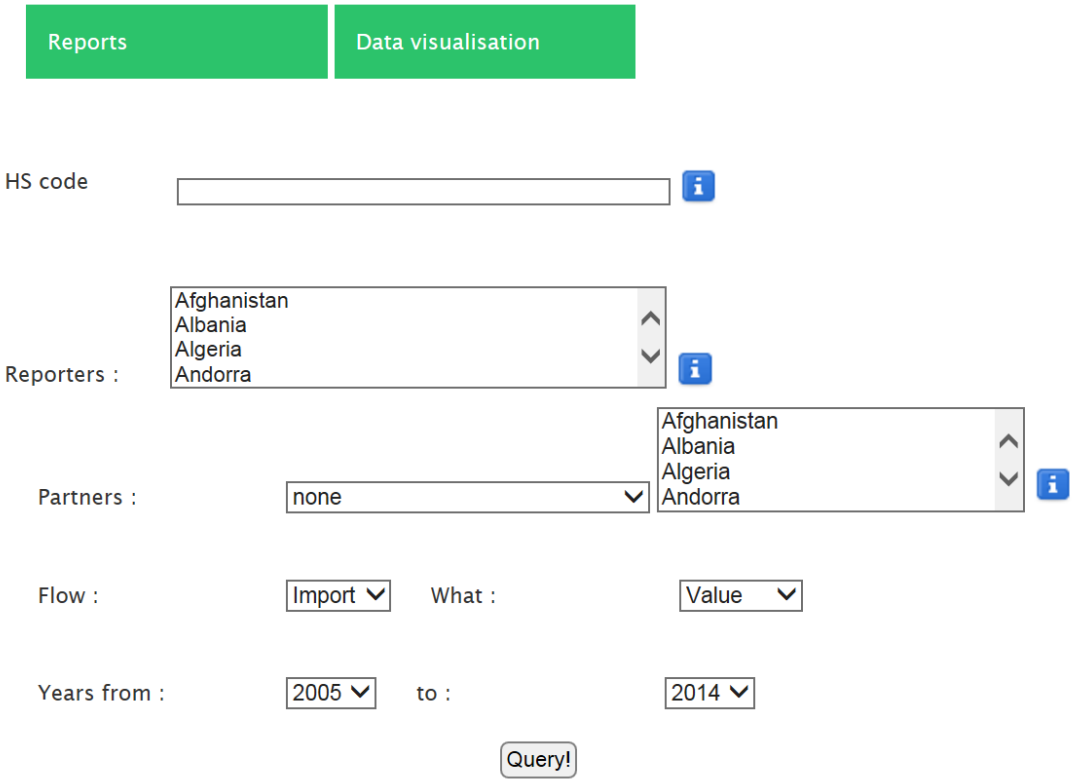


Figure 9: The data visualisation interface allows selecting a product code, a trade reporter, a trade partner country group or multiple trade partner countries, imports/exports, value/quantity.

WEB framework (https://codeigniter.com). The main features such as connection to the database, querying, preparation data for download, graphical user interface (GUI) elements were developed with PHP server-side scripting language. For some GUI elements JQuery javascript library (https://jquery.com) were used. JQuery is widely used by web developers to produce a dynamic and user friendly web content.

The database currently holds data from 2005-2014. An HS code's matching definition will be shown in a pop-up box while hoovering the mousepointer over the code. The country groups include UN official regions and subregions, as well as special interest groupings such as tropical countries and VPA countries.

A query output can be shown in three output options:

- A data table, which can be exported as MS Excel or CSV file
- A data chart
- A trade flow map

Data charts are based on Google Chart API (https://developers.google.com/chart/?hl=en), a javascript library provided to web developers by Google. Map-based trade flow visualisation was built based on HumanGeo's Leaflet Data visualisation Framework (DVF)

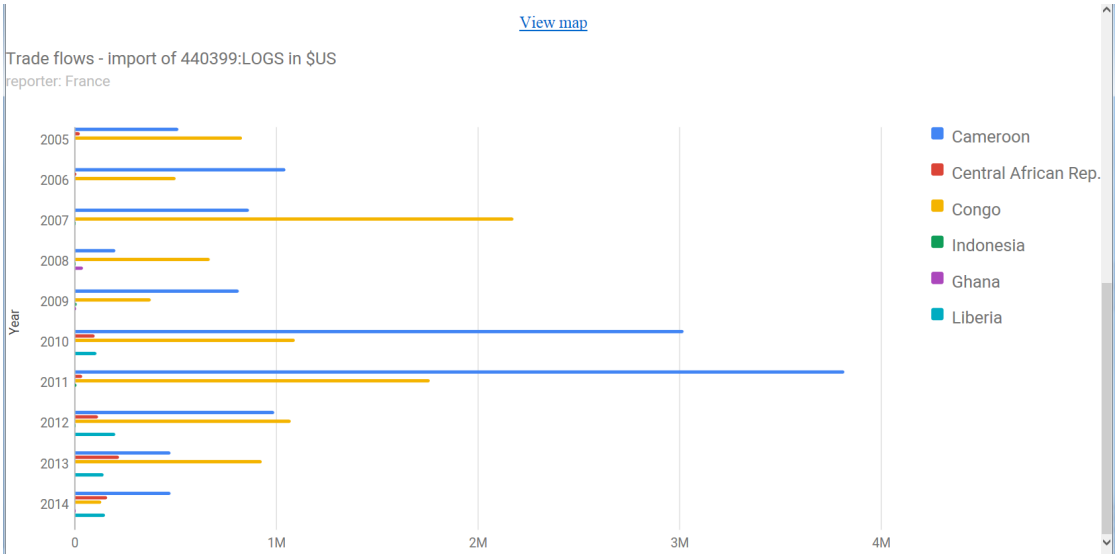


Figure 10: An example of chart output, in this case for French imports of logs from countries that have a Voluntary Partnership.

(http://blog.thehumangeo.com/2013/04/02/leaflet-dvf-overview). This is an extension of the well-known Leaflet javascript library, which allow data visualisation in intelligent manner, including possibility of managing spatial referenced data. An ESRI shape file showing current globally recognized countries was used as a background in the map tool. Background cartography data produced with ESRI ArcGIS software.

5. Conclusion and outlook

The project demonstrated and operationalised how global trade flow data can be loaded, how missing data can be estimated and erroneous data replaced with estimates, by calculations based on conversion factors, unit prices and mirror flows. This resulted in an on-line database as a reliable source of forest product trade flow data, for any wood and bamboo-based commodity traded between any country in the World. Counting on the fact that the supporting R-software will remain operational, the system inherently will process commodities according HS codes that will remain in force until at least 2022. A user interface was developed that enables both expert and non-expert users to quickly get a grasp of trade patterns between trading partners or trading patterns of a certain commodity of interest.

However, analysts should remain aware of the caveats of data correction methods. Estimating trade flows based on unit prices reduced the price distribution. This was addressed by taking a different price for each region and direction of flow instead of a world price. Another issue is that estimations based on mirror flows might have duplicated errors in the country of origin/destination.

We believe that the global and continuously updated dataset will be useful to a wide variety of end-users, ranging from trade analysts and modellers, economists, resource modellers, to policy makers, forest-based industry and investors, and civil society. However, for some intended uses, we acknowledge that instead of HS-based yearly data, it would be very useful to have monthly data for a greater degree of detail, e.g. as provided in the European Union's Combined Nomenclature. Therefore it is intended to further expand the database with more detailed commodity data for global trade with/between EU countries, as recorded in the Eurostat COMEXT database, and to develop data validation and cleaning routines based on monthly data.

The data refining software was made available by EFI on an open-source repository available at: https://github.com/EuropeanForestInstitute/tradeflows. Researchers from various disciplines using forest products trade data can submit their suggestions online or to the authors directly. Different types of reports will be taken into consideration for integration with the on-line system. Analysts are encouraged to reproduce our research and suggest improvement to the process.

6. Acknowledgements

The project for a Forest Products Trade Flow Database System Update could only be realised thanks to the generous support from the International Tropical Timber Organisation and its programme for Independent Market Monitoring. This allowed us to modernise the way trade flow data are downloaded from UN COMTRADE, stored, validated and presented in a way that has more value added for the end-user. We would like to thank Steve Johnson, Rupert Oliver and Jean-Christophe Claudon at ITTO, as they provided us with very constructive support and advice based on their longstanding expertise with the analysis of trade flow data. We would also like to thank Ronald Jansen, Markie Muryawan, Daniel Eshetie and Nancy Snyder at UN COMTRADE for granting us unrestricted access and for help with setting up the connection to the database. We

wish to congratulate UN COMTRADE with the important step to increasing timely, speedily and free access of their data through the COMTRADE API. Special thanks go also to Ed Pepke who with his colleagues at the EU FLEGT Facility Analysis Team were at the crib of the concept to redevelop towards a more automated and open system for updating and validating the forest products trade flow database that was originally developed at EFI by Bruce Michie and Philip Wardle. All mistakes remain ours.

Finally, we wish to thank those who will still contribute to this living project. In connection to this report we publish open-source code and templates in the R programming language, that we invite the community of forest products trade researchers and analysts to help further develop and customise. Welcome to the team!

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Nomenclature

EU Comext	European Union Community External Trade Statistics
Eurostat	European Commission Statistical Services
FLEGT	Forest Law Enforcement, Governance and Trade
HS	The Harmonized Commodity Description and Coding System, Harmonized System
ITTO	International Tropical Timber Organisation
JSON	JavaScript Object Notation
REDD+	Reducing Emissions, Deforestation and Degradation
SITC	Standard International Trade Classification
UN Comtrade	United Nations Commodity Trade Statistics Database
WCO	World Customs Organisation

A. Annexes

A.1. Harmonized System - product classifications and definitions for forest products

Annex 1. Harmonized System - Product classifications and definitions for forest products

Note: The trade flow database system regularly looks up data from the UN Comtrade database from all countries that report data to COMTRADE, following the 6-digit codes in the following table. Commodity classifications change through time, and therefore it is important to note for which period a code is valid. The table comprises the codes of the Harmonized System versions as in use by member countries of the WCO in respectively 1992, 1996, 2002, 2007, 2012 and 2017. Each version is in principle in use until a next version comes into force, however not all countries immediately follow to make the switch to a new version. Initially the forest products trade flow database contains data from a previous calendar year, and all years going back to 2005. However, the system is in principle ready to compile data as far back as 1992. As the system already includes the new codes that will be into use as of 2017, the database should in principle be able to load comprehensive datasets until about 2022, when a new revision might be expected.

HS	17	12	7	2	96	92	**Description** (HS2012 or earlier, HS2017 definitions for new codes)
Chapter 44							**Wood and articles of wood; wood charcoal**
4401							**Fuel wood, in logs, in billets, in twigs, in faggots or in similar forms; wood in chips or particles; sawdust and wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms.**
440110	1	1	1	1	1	1	- Fuel wood, in logs, in billets, in twigs, in faggots or in similar forms
440121	1	1	1	1	1	1	-Wood in chips or particles : -- Coniferous
440122	1	1	1	1	1	1	-Wood in chips or particles : -- Non-Coniferous
440130	0	0	1	1	1	1	- Sawdust and wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms
440131	1	1	0	0	0	0	- Sawdust and wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms : -- Wood pellets
440139	1	1	0	0	0	0	- Sawdust and wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms : -- Other
4402							**Wood charcoal (including shell or nut charcoal), whether or not agglomerated.**
440200	0	0	0	1	1	1	Wood charcoal (including shell or nut charcoal), whether or not agglomerated.
440210	1	1	1	0	0	0	-Of bamboo
440290	1	1	1	0	0	0	-Other
4403							**Wood in the rough, whether or not stripped of bark or sapwood, or roughly squared.**
440310	1	1	1	1	1	1	-Treated with paint, stains, creosote or other preservatives
440320	1	1	1	1	1	1	-Other, coniferous
440331	0	0	0	0	0	1	-Logs, Meranti (light or dark red), Bakau
440332	0	0	0	0	0	1	-Logs, white Lauan/Meranti/Seraya/yellow Meranti/Alan
440333	0	0	0	0	0	1	-Logs, Keruing/Ramin/Kapur/Teak/Jongkong/Merbau/etc
440334	0	0	0	0	0	1	-Logs, Okoume/Obeche/Sapelli/Sipo/Acajou d'Afrique/etc
440335	0	0	0	0	0	1	-Logs, Tiama, Mansonia, Ilomba, Dibetou, Limba, Azobe
440341	1	1	1	1	1	0	-Other, of tropical wood specified in Subheading Note 2 to this Chapter : -- Dark Red Meranti, Light Red Meranti and Meranti Bakau
440349	1	1	1	1	1	0	-Other, of tropical wood specified in Subheading Note 2 to this Chapter : -- Other
440391	1	1	1	1	1	1	-Other : -- Of oak (Quercus spp.)
440392	1	1	1	1	1	1	-Other : -- Of beech (Fagus spp.)
440399	1	1	1	1	1	1	-Other : -- Other
4404							**Hoopwood; split poles; piles, pickets and stakes of wood, pointed but not sawn lengthwise; wooden sticks, roughly trimmed but not turned, bent or otherwise worked, suitable for the manufacture of walking-sticks, umbrellas, tool handles or the like; chipwood and the like.**

HS	17	12	7	2	96	92	**Description** (HS2012 or earlier, HS2017 definitions for new codes)
440410	1	1	1	1	1	1	-Coniferous
440420	1	1	1	1	1	1	-Non-Coniferous
440500	1	1	1	1	1	1	**Wood wool; wood flour.**
4406							**Railway or tramway sleepers (cross-ties) of wood.**
440610	1	1	1	1	1	1	-Not impregnated
440690	1	1	1	1	1	1	-Other
4407							**Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6 mm.**
440710	1	1	1	1	1	1	-Coniferous
440721	1	1	1	0	0	1	-Of tropical wood specified in Subheading Note 2 to this Chapter : -- Mahogany (Swietenia spp.)
440722	1	1	1	0	0	1	-Of tropical wood specified in Subheading Note 2 to this Chapter : -- Virola, Imbuia and Balsa
440723	0	0	0	0	0	1	-Of tropical wood specified in Subheading Note 2 to this Chapter : --Lumber, Baboen, Mahogany, Imbuia, Balsa
440724	0	0	0	1	1	0	-Of tropical wood specified in Subheading Note 2 to this Chapter : -- Virola, Mahogany (Swietenia spp.), Imbuia and Balsa
440725	1	1	1	1	1	0	-Of tropical wood specified in Subheading Note 2 to this Chapter : -- Dark Red Meranti, Light Red Meranti and Meranti Bakau
440726	1	1	1	1	1	0	-Of tropical wood specified in Subheading Note 2 to this Chapter : -- White Lauan, White Meranti, White Seraya, Yellow Meranti and Alan
440727	1	1	1	0	0	0	-Of tropical wood specified in Subheading Note 2 to this Chapter : -- Sapelli
440728	1	1	1	0	0	0	-Of tropical wood specified in Subheading Note 2 to this Chapter : -- Iroko
440729	1	1	1	1	1	0	-Of tropical wood specified in Subheading Note 2 to this Chapter : -- Other
440791	1	1	1	1	1	1	-Other : -- Of oak (Quercus spp.)
440792	1	1	1	1	1	1	-Other : -- Of beech (Fagus spp.)
440793	1	1	1	0	0	0	-Other : -- Of maple (Acer spp.)
440794	1	1	1	0	0	0	-Other : -- Of cherry (Prunus spp.)
440795	1	1	1	0	0	0	-Other : -- Of ash (Fraxinus spp.)
440799	1	1	1	1	1	1	-Other : -- Other
4408							**Sheets for veneering (including those obtained by slicing laminated wood), for plywood or for similar laminated wood and other wood, sawn lengthwise, sliced or peeled, whether or not planed, sanded, spliced or end-jointed, of a thickness not exceeding 6 mm.**
440810	1	1	1	1	1	1	-Coniferous
440820	0	0	0	0	0	1	-Veneer or ply sheet, tropical woods, <6 mm thick
440831	1	1	1	1	1	0	-Of tropical wood specified in Subheading Note 2 to this Chapter : -- Dark Red Meranti, Light Red Meranti and Meranti Bakau
440839	1	1	1	1	1	0	-Of tropical wood specified in Subheading Note 2 to this Chapter : -- Other
440890	1	1	1	1	1	1	-Other
4409							**Wood (including strips and friezes for parquet flooring, not assembled) continuously shaped (tongued, grooved, rebated, chamfered, V-jointed, beaded, moulded, rounded or the like) along any of its edges, ends or faces, whether or not planed, sanded or end-jointed.**
440910	1	1	1	1	1	1	-Coniferous
440920	0	0	0	1	1	1	- Non-coniferous

HS	17	12	7	2	96	92	**Description** (HS2012 or earlier, HS2017 definitions for new codes)
440921	1	1	1	0	0	0	-Non-coniferous : -- Of bamboo
440922	1	0	0	0	0	0	-- Of tropical wood
440929	1	1	1	0	0	0	-Non-coniferous : -- Other
4410							**Particle board, oriented strand board (OSB) and similar board (for example, waferboard) of wood or other ligneous materials, whether or not agglomerated with resins or other organic binding substances.**
441010	0	0	0	0	0	1	-Of wood
441011	1	1	1	0	1	0	-Of wood : -- Particle board
441012	1	1	1	0	0	0	-Of wood : -- Oriented strand board (OSB)
441019	1	1	1	0	1	0	-Of wood : -- Other
441021	0	0	0	1	0	0	- Oriented strand board and waferboard, of wood : -- Unworked or not further worked than sanded
441029	0	0	0	1	0	0	- Oriented strand board and waferboard, of wood : -- Other
441031	0	0	0	1	0	0	- Other, of wood : -- Unworked or not further worked than sanded
441032	0	0	0	1	0	0	- Other, of wood : -- Surface-covered with melamine-impregnated paper
441033	0	0	0	1	0	0	- Other, of wood : -- Surface-covered with decorative laminates of plastics
441039	0	0	0	1	0	0	- Other, of wood : -- Other
441090	1	1	1	1	1	1	-Other
4411							**Fibreboard of wood or other ligneous materials, whether or not bonded with resins or other organic substances.**
441111	0	0	0	1	1	1	- Fibreboard of a density exceeding 0.8 g/cm3 : -- Not mechanically worked or surface covered
441112	1	1	1	0	0	0	-Medium density fibreboard (MDF) : -- Of a thickness not exceeding 5 mm
441113	1	1	1	0	0	0	-Medium density fibreboard (MDF) : -- Of a thickness exceeding 5 mm but not exceeding 9 mm
441114	1	1	1	0	0	0	-Medium density fibreboard (MDF) : -- Of a thickness exceeding 9 mm
441119	0	0	0	1	1	1	- Fibreboard of a density exceeding 0.8 g/cm3 : -- Other
441121	0	0	0	1	1	1	- Fibreboard of a density exceeding 0.5 g/cm3 but not exceeding 0.8 g/cm3 : -- Not mechanically worked or surface covered
441129	0	0	0	1	1	1	- Fibreboard of a density exceeding 0.5 g/cm3 but not exceeding 0.8 g/cm3 : -- Other
441131	0	0	0	1	1	1	- Fibreboard of a density exceeding 0.35 g/cm3 but not exceeding 0.5 g/cm3 : -- Not mechanically worked or surface covered
441139	0	0	0	1	1	1	- Fibreboard of a density exceeding 0.35 g/cm3 but not exceeding 0.5 g/cm3 : -- Other
441191	0	0	0	1	1	1	- Other : -- Not mechanically worked or surface covered
441192	1	1	1	0	0	0	-Other : -- Of a density exceeding 0.8 g/cm³
441193	1	1	1	0	0	0	-Other : -- Of a density exceeding 0.5 g/cm³ but not exceeding 0.8 g/cm³
441194	1	1	1	0	0	0	-Other : -- Of a density not exceeding 0.5 g/cm³

HS	17	12	7	2	96	92	**Description** (HS2012 or earlier, HS2017 definitions for new codes)
441199	0	0	0	1	1	1	- Other : -- Other
4412							**Plywood, veneered panels and similar laminated wood.**
441210	1	1	1	0	0	0	-Of bamboo
441211	0	0	0	0	0	1	-Plywood 1 or 2 outer ply tropical hardwood (ply <6 mm)
441212	0	0	0	0	0	1	-Plywood, 1 or 2 outer ply non-conifer nes (ply <6 mm)
441213	0	0	0	1	1	0	- Plywood consisting solely of sheets of wood, each ply not exceeding 6 mm thickness : -- With at least one outer ply of tropical wood specified in Subheading Note 1 to this Chapter
441214	0	0	0	1	1	0	- Plywood consisting solely of sheets of wood, each ply not exceeding 6 mm thickness : -- Other, with at least one outer ply of non-coniferous wood
441219	0	0	0	1	1	1	- Plywood consisting solely of sheets of wood, each ply not exceeding 6 mm thickness : -- Other
441221	0	0	0	0	0	1	-Panels, 1 outer ply nonconifer & 1 ply particle boar
441222	0	0	0	1	1	0	- Other, with at least one outer ply of non-coniferous wood : -- With at least one ply of tropical wood specified in Subheading Note 1 to this Chapter
441223	0	0	0	1	1	0	- Other, with at least one outer ply of non-coniferous wood : -- Other, containing at least one layer of particle board
441229	0	0	0	1	1	1	- Other, with at least one outer ply of non-coniferous wood : -- Other
441231	1	1	1	0	0	0	-Other plywood, consisting solely of sheets of wood (other than bamboo), each ply not exceeding 6 mm thickness : -- With at least one outer ply of tropical wood specified in Subheading Note 2 to this Chapter
441232	1	1	1	0	0	0	-Other plywood, consisting solely of sheets of wood (other than bamboo), each ply not exceeding 6 mm thickness : -- Other, with at least one outer ply of non-coniferous wood
441239	1	1	1	0	0	0	-Other plywood, consisting solely of sheets of wood (other than bamboo), each ply not exceeding 6 mm thickness : -- Other
441291	0	0	0	0	0	1	- Panels, 1 outer ply conifer wood,1 ply particle board
441292	0	0	0	1	1	0	- Other : -- With at least one ply of tropical wood specified in Subheading Note 1 to this Chapter
441293	0	0	0	1	1	0	- Other : -- Other, containing at least one layer of particle board
441294	1	1	1	0	0	0	-Other : -- Blockboard, laminboard and battenboard
441299	1	1	1	1	1	1	-Other : -- Other
441300	1	1	1	1	1	1	**Densified wood, in blocks, plates, strips or profile shapes.**
441400	1	1	1	1	1	1	**Wooden frames for paintings, photographs, mirrors or similar objects.**
4415							**Packing cases, boxes, crates, drums and similar packings, of wood; cable-drums of wood; pallets, box pallets and other load boards, of wood; pallet collars of wood.**
441510	1	1	1	1	1	1	-Cases, boxes, crates, drums and similar packings; cable-drums
441520	1	1	1	1	1	1	- Pallets, box pallets and other load boards; pallet collars
441600	1	1	1	1	1	1	**Casks, barrels, vats, tubs and other coopers' products and parts thereof, of wood, including staves.**
441700	1	1	1	1	1	1	**Tools, tool bodies, tool handles, broom or brush bodies and handles, of wood; boot or shoe lasts and trees, of wood.**
4418							**Builders' joinery and carpentry of wood, including cellular wood panels, assembled flooring panels, shingles and shakes.**
441810	1	1	1	1	1	1	-Windows, French-windows and their frames
441820	1	1	1	1	1	1	-Doors and their frames and thresholds
441830	0	0	0	1	1	1	- Parquet panels

HS	17	12	7	2	96	92	**Description** (HS2012 or earlier, HS2017 definitions for new codes)
441840	1	1	1	1	1	1	- Shuttering for concrete constructional work
441850	1	1	1	1	1	1	- Shingles and shakes
441860	1	1	1	0	0	0	- Posts and beams
441871	0	1	1	0	0	0	-Assembled flooring panels :
							-- For mosaic floors
441872	0	1	1	0	0	0	-Assembled flooring panels :
							-- For mosaic floors
441873	1	0	0	0	0	0	- Assembled flooring panels :
							-- Of bamboo or with at least the top layer (wear layer) of bamboo
441874	1	0	0	0	0	0	- Assembled flooring panels :
							-- Other, for mosaic floors
441875	1	0	0	0	0	0	- Assembled flooring panels :
							-- Other, multilayer
441879	1	1	1	0	0	0	-Assembled flooring panels :
							-- For mosaic floors
441890	0	1	1	1	1	1	-Other
441891	1	0	0	0	0	0	- Other :
							-- Of bamboo
441899	1	0	0	0	0	0	- Other :
							-- Other".
441900	0	1	1	1	1	1	**Tableware and kitchenware, of wood.**
441911	1	0	0	0	0	0	- Of bamboo
							-- Bread boards, chopping boards and similar boards
441912	1	0	0	0	0	0	- Of bamboo
							-- Chopsticks
441919	1	0	0	0	0	0	- Of bamboo
							-- Other
441990	1	0	0	0	0	0	- Other".
4420							**Wood marquetry and inlaid wood; caskets and cases for jewellery or cutlery, and similar articles, of wood; statuettes and other ornaments, of wood; wooden articles of furniture not falling in Chapter 94.**
442010	1	1	1	1	1	1	- Statuettes and other ornaments, of wood
442090	1	1	1	1	1	1	-Other
4421							**Other articles of wood.**
442110	1	1	1	1	1	1	-Clothes hangers
442190	0	1	1	1	1	1	-Other
442191	1	0	0	0	0	0	- Other :
							-- Of bamboo
442199	1	0	0	0	0	0	- Other :
							-- Other".
Chapter 45							**Cork and articles of cork**
4501							**Natural cork, raw or simply prepared; waste cork; crushed, granulated or ground cork.**
450110	1	1	1	1	1	1	-Natural cork, raw or simply prepared
450190	1	1	1	1	1	1	-Other
450200	1	1	1	1	1	1	**Natural cork, debacked or roughly squared, or in rectangular (including square) blocks, plates, sheets or strip (including sharpedged blanks for corks or stoppers).**
4503							**Articles of natural cork.**
450310	1	1	1	1	1	1	-Corks and stoppers
450390	1	1	1	1	1	1	-Other
4504							**Agglomerated cork (with or without a binding substance) and articles of agglomerated cork.**
450410	1	1	1	1	1	1	-Blocks, plates, sheets and strip; tiles of any shape; solid cylinders, including discs

HS	17	12	7	2	96	92	**Description** (HS2012 or earlier, HS2017 definitions for new codes)
450490	1	1	1	1	1	1	-Other
Chapter 46							**Manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork**
4601							**Plaits and similar products of plaiting materials, whether or not assembled into strips; plaiting materials, plaits and similar products of plaiting materials, bound together in parallel strands or woven, in sheet form, whether or not being finished articles (for example, mats, matting, screens).**
460110	0	0	0	0	1	1	-Plaits and similar products of plaiting materials worked
460120	0	0	0	1	1	1	- Mats, matting and screens of vegetable materials
460121	1	1	1	0	0	0	-Mats, matting and screens of vegetable materials : -- Of bamboo
460122	1	1	1	0	0	0	-Mats, matting and screens of vegetable materials : -- Of rattan
460129	1	1	1	0	0	0	-Mats, matting and screens of vegetable materials : -- Other
460191	0	0	0	1	1	1	- Mats, matting and screens of vegetable materials -- Of vegetable materials
460192	1	1	1	0	0	0	-Other : -- Of bamboo
460193	1	1	1	0	0	0	-Other : -- Of rattan
460194	1	1	1	0	0	0	-Other : -- Of other vegetable materials
460199	1	1	1	1	1	1	-Other : -- Other
4602							**Basketwork, wickerwork and other articles, made directly to shape from plaiting materials or made up from goods of heading 46.01; articles of loofah.**
460210	0	0	0	1	1	1	- Of vegetable materials
460211	1	1	1	0	0	0	-Of vegetable materials : -- Of bamboo
460212	1	1	1	0	0	0	-Of vegetable materials : -- Of rattan
460219	1	1	1	0	0	0	-Of vegetable materials : -- Other
460290	1	1	1	1	1	1	-Other
Chapter 47							**Pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard**
470100	1	1	1	1	1	1	**Mechanical wood pulp.**
470200	1	1	1	1	1	1	**Chemical wood pulp, dissolving grades.**
4703							**Chemical wood pulp, soda or sulphate, other than dissolving grades.**
470311	1	1	1	1	1	1	-Unbleached : -- Coniferous
470319	1	1	1	1	1	1	-Unbleached : -- Non-coniferous
470321	1	1	1	1	1	1	- Semi-bleached or bleached : -- Coniferous
470329	1	1	1	1	1	1	- Semi-bleached or bleached : -- Non-coniferous
4704							**Chemical wood pulp, sulphite, other than dissolving grades.**
470411	1	1	1	1	1	1	-Unbleached : -- Coniferous

HS	17	12	7	2	96	92	**Description** (HS2012 or earlier, HS2017 definitions for new codes)
470419	1	1	1	1	1	1	-Unbleached : -- Non-coniferous
470421	1	1	1	1	1	1	- Semi-bleached or bleached : -- Coniferous
470429	1	1	1	1	1	1	- Semi-bleached or bleached : -- Non-coniferous
470500	1	1	1	1	1	1	**Wood pulp obtained by a combination of mechanical and chemical pulping processes.**
4706							**Pulps of fibres derived from recovered (waste and scrap) paper or paperboard or of other fibrous cellulosic material.**
470610	1	1	1	1	1	1	-Cotton linters pulp
470620	1	1	1	1	1	0	- Pulps of fibres derived from recovered (waste and scrap) paper or paperboard
470630	1	1	1	0	0	0	-Other, of bamboo
470691	1	1	1	1	1	1	-Other : -- Mechanical
470692	1	1	1	1	1	1	-Other : -- Chemical
470693	1	1	1	1	1	1	-Other : -- Obtained by a combination of mechanical and chemical processes
4707							**Recovered (waste and scrap) paper or paperboard.**
470710	1	1	1	1	1	1	-Unbleached kraft paper or paperboard or corrugated paper or paperboard
470720	1	1	1	1	1	1	-Other paper or paperboard made mainly of bleached chemical pulp, not coloured in the mass
470730	1	1	1	1	1	1	- Paper or paperboard made mainly of mechanical pulp (for example, newspapers, journals and similar printed matter)
470790	1	1	1	1	1	1	-Other, including unsorted waste and scrap
Chapter 48							**Paper and paperboard; articles of paper pulp, of paper or of paperboard**
480100	1	1	1	1	1	1	**Newsprint, in rolls or sheets.**
4802							**Uncoated paper and paperboard, of a kind used for writing, printing or other graphic purposes, and non perforated punchcards and punch tape paper, in rolls or rectangular (including square) sheets, of any size, other than paper of heading 48.01 or 48.03; hand-made paper and paperboard.**
480210	1	1	1	1	1	1	-Hand-made paper and paperboard
480220	1	1	1	1	1	1	- Paper and paperboard of a kind used as a base for photo-sensitive, heat-sensitive or electro-sensitive paper or paperboard
480240	1	1	1	1	1	1	-Wallpaper base
480251	0	0	0	0	1	1	- Other paper and paperboard, not containing fibres obtained by a mechanical process or of which not more than 10% by weight of the total fibre content consists of such fibres: -- Weighing less than 40 g/m2
480252	0	0	0	0	1	1	- Other paper and paperboard, not containing fibres obtained by a mechanical process or of which not more than 10% by weight of the total fibre content consists of such fibres: -- Weighing 40 g/m2 or more but not more than 150 g/m2, in rolls:
480253	0	0	0	0	1	1	- Other paper and paperboard, not containing fibres obtained by a mechanical process or of which not more than 10% by weight of the total fibre content consists of such fibres: -- Weighing more than 150 g/m2:
480254	1	1	1	1	0	0	-Other paper and paperboard, not containing fibres obtained by a mechanical or chemi-mechanical process or of which not more than 10 % by weight of the total fibre content consists of such fibres : -- Weighing less than 40 g/m²
480255	1	1	1	1	0	0	-Other paper and paperboard, not containing fibres obtained by a mechanical or chemi-mechanical process or of which not more than 10 % by weight of the total fibre content consists of such fibres : -- Weighing 40 g/m² or more but not more than 150 g/m², in rolls

HS	17	12	7	2	96	92	**Description** (HS2012 or earlier, HS2017 definitions for new codes)
480256	1	1	1	1	0	0	-Other paper and paperboard, not containing fibres obtained by a mechanical or chemi-mechanical process or of which not more than 10 % by weight of the total fibre content consists of such fibres : -- Weighing 40 g/m² or more but not more than 150 g/m², in sheets with one side not exceeding 435 mm and the other side not exceeding 297 mm in the unfolded state
480257	1	1	1	1	0	0	-Other paper and paperboard, not containing fibres obtained by a mechanical or chemi-mechanical process or of which not more than 10 % by weight of the total fibre content consists of such fibres : -- Other, weighing 40 g/m² or more but not more than 150 g/m²
480258	1	1	1	1	0	0	-Other paper and paperboard, not containing fibres obtained by a mechanical or chemi-mechanical process or of which not more than 10 % by weight of the total fibre content consists of such fibres : -- Weighing more than 150 g/m²
480260	0	0	0	0	1	1	
480261	1	1	1	1	0	0	-Other paper and paperboard, of which more than 10 % by weight of the total fibre content consists of fibres obtained by a mechanical or chemi-mechanical process : -- In rolls
480262	1	1	1	1	0	0	-Other paper and paperboard, of which more than 10 % by weight of the total fibre content consists of fibres obtained by a mechanical or chemi-mechanical process : -- In sheets with one side not exceeding 435 mm and the other side not exceeding 297 mm in the unfolded state
480269	1	1	1	1	0	0	-Other paper and paperboard, of which more than 10 % by weight of the total fibre content consists of fibres obtained by a mechanical or chemi-mechanical process : -- Other
480300	1	1	1	1	1	1	**Toilet or facial tissue stock, towel or napkin stock and similar paper of a kind used for household or sanitary purposes, cellulose wadding and webs of cellulose fibres, whether or not creped, crinkled, embossed, perforated, surface-coloured, surfacedecorated or printed, in rolls or sheets.**
4804							**Uncoated kraft paper and paperboard, in rolls or sheets, other than that of heading 48.02 or 48.03.**
480411	1	1	1	1	1	1	-Kraftliner : -- Unbleached
480419	1	1	1	1	1	1	-Kraftliner : -- Other
480421	1	1	1	1	1	1	- Sack kraft paper : -- Unbleached
480429	1	1	1	1	1	1	- Sack kraft paper : -- Other
480431	1	1	1	1	1	1	-Other kraft paper and paperboard weighing 150 g/m² or less : -- Unbleached
480439	1	1	1	1	1	1	-Other kraft paper and paperboard weighing 150 g/m² or less : -- Other
480441	1	1	1	1	1	1	-Other kraft paper and paperboard weighing more than 150 g/m² but less than 225 g/m² : -- Unbleached
480442	1	1	1	1	1	1	-Other kraft paper and paperboard weighing more than 150 g/m² but less than 225 g/m² : -- Bleached uniformly throughout the mass and of which more than 95 % by weight of the total fibre content consists of wood fibres obtained by a chemical process
480449	1	1	1	1	1	1	-Other kraft paper and paperboard weighing more than 150 g/m² but less than 225 g/m² : -- Other
480451	1	1	1	1	1	1	-Other kraft paper and paperboard weighing 225 g/m² or more : -- Unbleached
480452	1	1	1	1	1	1	-Other kraft paper and paperboard weighing 225 g/m² or more : -- Bleached uniformly throughout the mass and of which more than 95 % by weight of the total fibre content consists of wood obtained by a chemical process
480459	1	1	1	1	1	1	-Other kraft paper and paperboard weighing 225 g/m² or more : -- Other

HS	17	12	7	2	96	92	**Description** (HS2012 or earlier, HS2017 definitions for new codes)
4805							**Other uncoated paper and paperboard, in rolls or sheets, not further worked or processed than as specified in Note 3 to this Chapter.**
480510	0	0	0	0	1	1	- Semi-chemical fluting paper (corrugating medium):
480511	1	1	1	1	0	0	- Fluting paper : -- Semi-chemical fluting paper
480512	1	1	1	1	0	0	- Fluting paper : -- Straw fluting paper
480519	1	1	1	1	0	0	- Fluting paper : -- Other
480521	0	0	0	0	1	1	- Multi-ply paper and paperboard: -- Each layer bleached
480522	0	0	0	0	1	1	- Multi-ply paper and paperboard: -- With only one outer layer bleached
480523	0	0	0	0	1	1	- Multi-ply paper and paperboard: -- Having three or more layers, of which only the two outer layers are bleached
480524	1	1	1	1	0	0	-Testliner (recycled liner board) : -- Weighing 150 g/m² or less
480525	1	1	1	1	0	0	-Testliner (recycled liner board) : -- Weighing more than 150 g/m²
480529	0	0	0	0	1	1	- Multi-ply paper and paperboard: -- Other
480530	1	1	1	1	1	1	- Sulphite wrapping paper
480540	1	1	1	1	1	1	- Filter paper and paperboard
480550	1	1	1	1	1	1	- Felt paper and paperboard
480560	0	0	0	0	1	1	- Other paper and paperboard, weighing 150 g/m2 or less
480570	0	0	0	0	1	1	- Other paper and paperboard, weighing more than 150 g/m2 but less than 225 g/m2
480580	0	0	0	0	1	1	- Other paper and paperboard, weighing 225 g/m2 or more
480591	1	1	1	1	0	0	-Other : -- Weighing 150 g/m² or less
480592	1	1	1	1	0	0	-Other : -- Weighing more than 150 g/m² but less than 225 g/m²
480593	1	1	1	1	0	0	-Other : -- Weighing 225 g/m² or more
4806							**Vegetable parchment, greaseproof papers, tracing papers and glassine and other glazed transparent or translucent papers, in rolls or sheets.**
480610	1	1	1	1	1	1	-Vegetable parchment
480620	1	1	1	1	1	1	-Greaseproof papers
480630	1	1	1	1	1	1	-Tracing papers
480640	1	1	1	1	1	1	-Glassine and other glazed transparent or translucent papers
480700	1	1	1	1	0	0	**Composite paper and paperboard (made by sticking flat layers of paper or paperboard together with an adhesive), not surfacecoated or impregnated, whether or not internally reinforced, in rolls or sheets.**
480710	0	0	0	0	1	1	- Paper and paperboard, laminated internally with bitumen, tar or asphalt
480790	0	0	0	0	1	0	- Other
480791	0	0	0	0	0	1	--Other : -Straw paper and paperboard, whether or not covered with paper other than straw paper
480799	0	0	0	0	0	1	-Other : --Other
4808							**Paper and paperboard, corrugated (with or without glued flat surface sheets), creped, crinkled, embossed or perforated, in rolls or sheets, other than paper of the kind described in heading 48.03.**
480810	1	1	1	1	1	1	-Corrugated paper and paperboard, whether or not perforated
480820	0	0	1	1	1	1	- Sack kraft paper, creped or crinkled, whether or not embossed or perforated
480830	0	0	1	1	1	1	- Other kraft paper, creped or crinkled, whether or not embossed or perforated
480840	1	1	0	0	0	0	-Kraft paper, creped or crinkled, whether or not embossed or perforated
480890	1	1	1	1	1	1	-Other

HS	17	12	7	2	96	92	**Description** (HS2012 or earlier, HS2017 definitions for new codes)
4809							**Carbon paper, self-copy paper and other copying or transfer papers (including coated or impregnated paper for duplicator stencils or offset plates), whether or not printed, in rolls or sheets.**
480910	0	0	0	1	1	1	
480920	1	1	1	1	1	1	- Self-copy paper
480990	1	1	1	1	1	1	-Other
4810							**Paper and paperboard, coated on one or both sides with kaolin (China clay) or other inorganic substances, with or without a binder, and with no other coating, whether or not surfacecoloured, surface-decorated or printed, in rolls or rectangular (including square) sheets, of any size.**
481011	0	0	0	0	1	1	- Paper and paperboard of a kind used for writing, printing or other graphic purposes, not containing fibres obtained by a mechanical process or of which not more than 10% by weight of the total fibre content consists of such fibres: -- Weighing not more than 150 g/m2
481012	0	0	0	0	1	1	- Paper and paperboard of a kind used for writing, printing or other graphic purposes, not containing fibres obtained by a mechanical process or of which not more than 10% by weight of the total fibre content consists of such fibres: -- Weighing more than 150 g/m2
481013	1	1	1	1	0	0	- Paper and paperboard of a kind used for writing, printing or other graphic purposes, not containing fibres obtained by a mechanical or chemi-mechanical process or of which not more than 10 % by weight of the total fibre content consists of such fibres : -- In rolls
481014	1	1	1	1	0	0	- Paper and paperboard of a kind used for writing, printing or other graphic purposes, not containing fibres obtained by a mechanical or chemi-mechanical process or of which not more than 10 % by weight of the total fibre content consists of such fibres : -- In sheets with one side not exceeding 435 mm and the other side not exceeding 297 mm in the unfolded state
481019	1	1	1	1	0	0	- Paper and paperboard of a kind used for writing, printing or other graphic purposes, not containing fibres obtained by a mechanical or chemi-mechanical process or of which not more than 10 % by weight of the total fibre content consists of such fibres : -- Other
481021	0	0	0	0	1	1	- Paper and paperboard of a kind used for writing, printing or other graphic purposes, of which more than 10% by weight of the total fibre content consists of fibres obtained by a mechanical process: -- Light-weight coated paper
481022	1	1	1	1	0	0	- Paper and paperboard of a kind used for writing, printing or other graphic purposes, of which more than 10 % by weight of the total fibre content consists of fibres obtained by a mechanical or chemimechanical process : -- Light-weight coated paper
481029	1	1	1	1	1	1	- Paper and paperboard of a kind used for writing, printing or other graphic purposes, of which more than 10 % by weight of the total fibre content consists of fibres obtained by a mechanical or chemimechanical process : -- Other
481031	1	1	1	1	1	1	-Kraft paper and paperboard, other than that of a kind used for writing, printing or other graphic purposes : -- Bleached uniformly throughout the mass and of which more than 95 % by weight of the total fibre content consists of wood fibres obtained by a chemical process, and weighing 150 g/m² or less
481032	1	1	1	1	1	1	-Kraft paper and paperboard, other than that of a kind used for writing, printing or other graphic purposes : -- Bleached uniformly throughout the mass and of which more than 95 % by weight of the total fibre content consists of wood fibres obtained by a chemical process, and weighing more than 150 g/m²
481039	1	1	1	1	1	1	-Kraft paper and paperboard, other than that of a kind used for writing, printing or other graphic purposes : -- Other

HS	17	12	7	2	96	92	**Description** (HS2012 or earlier, HS2017 definitions for new codes)
481091	0	0	0	0	1	1	- Other paper and paperboard: -- Multi-ply
481092	1	1	1	1	0	0	-Other paper and paperboard: -- Multi-ply
481099	1	1	1	1	1	1	-Other paper and paperboard: -- Other
4811							**Paper, paperboard, cellulose wadding and webs of cellulose fibres, coated, impregnated, covered, surface-coloured, surfacedecorated or printed, in rolls or rectangular (including square) sheets, of any size, other than goods of the kind described in heading 48.03, 48.09 or 48.10.**
481110	1	1	1	1	1	1	-Tarred, bituminised or asphalted paper and paperboard
481121	0	0	0	0	1	1	- Gummed or adhesive paper and paperboard: -- Self-adhesive
441129	0	0	0	0	1	1	- Gummed or adhesive paper and paperboard: -- Other
481131	0	0	0	0	1	1	- Paper and paperboard coated, impregnated or covered with plastics (excluding adhesives): -- Bleached, weighing more than 150 g/m2
481139	0	0	0	0	1	1	- Paper and paperboard coated, impregnated or covered with plastics (excluding adhesives): -- Other
481140	0	0	0	0	1	1	- Paper and paperboard, coated, impregnated or covered with wax, paraffin wax, stearin, oil or glycerol
481141	1	1	1	1	0	0	-Gummed or adhesive paper and paperboard : -- Self-adhesive
481149	1	1	1	1	0	0	-Gummed or adhesive paper and paperboard : -- Other
481151	1	1	1	1	0	0	- Paper and paperboard coated, impregnated or covered with plastics (excluding adhesives) : -- Bleached, weighing more than 150 g/m²
481159	1	1	1	1	0	0	- Paper and paperboard coated, impregnated or covered with plastics (excluding adhesives) : -- Other
481160	1	1	1	1	0	0	- Paper and paperboard, coated, impregnated or covered with wax, paraffin wax, stearin, oil or glycerol
481190	1	1	1	1	1	1	-Other paper, paperboard, cellulose wadding and webs of cellulose fibres
481200	1	1	1	1	1	1	**Filter blocks, slabs and plates, of paper pulp.**
4813							**Cigarette paper, whether or not cut to size or in the form of booklets or tubes.**
481310	1	1	1	1	1	1	- In the form of booklets or tubes
481320	1	1	1	1	1	1	- In rolls of a width not exceeding 5 cm
481390	1	1	1	1	1	1	-Other
4814							**Wallpaper and similar wall coverings; window transparencies of paper.**
481410	0	0	1	1	1	1	- “Ingrain” paper
481420	1	1	1	1	1	1	-Wallpaper and similar wall coverings, consisting of paper coated or covered, on the face side, with a grained, embossed, coloured, design-printed or otherwise decorated layer of plastics
481430	0	0	0	1	1	1	- Wallpaper and similar wall coverings, consisting of paper covered, on the face side, with plaiting material, whether or not bound together in parallel strands or woven
481490	1	1	1	1	1	1	-Other
481500	0	0	0	1	1	1	**Products on a base of paper or paperboard, suitable for use both as floor coverings and as wall coverings.**
4816							**Carbon paper, self-copy paper and other copying or transfer papers (other than those of heading 48.09), duplicator stencils and offset plates, of paper, whether or not put up in boxes.**
481610	0	0	0	1	1	1	- Carbon or similar copying papers
481620	1	1	1	1	1	1	- Self-copy paper
481630	0	0	0	1	1	1	- Duplicator stencils
481690	1	1	1	1	1	1	-Other

HS	17	12	7	2	96	92	**Description** (HS2012 or earlier, HS2017 definitions for new codes)
4817							**Envelopes, letter cards, plain postcards and correspondence cards, of paper or paperboard; boxes, pouches, wallets and writing compendiums, of paper or paperboard, containing an assortment of paper stationery.**
481710	1	1	1	1	1	1	-Envelopes
481720	1	1	1	1	1	1	-Letter cards, plain postcards and correspondence cards
481730	1	1	1	1	1	1	-Boxes, pouches, wallets and writing compendiums, of paper or paperboard, containing an assortment of paper stationery
4818							**Toilet paper and similar paper, cellulose wadding or webs of cellulose fibres, of a kind used for household or sanitary purposes, in rolls of a width not exceeding 36 cm, or cut to size or shape; handkerchiefs, cleansing tissues, towels, tablecloths, serviettes, bed sheets and similar household, sanitary or hospital articles, articles of apparel and clothing accessories, of paper pulp, paper, cellulose wadding or webs of cellulose fibres.**
481810	1	1	1	1	1	1	-Toilet paper
481820	1	1	1	1	1	1	-Handkerchiefs, cleansing or facial tissues and towels
481830	1	1	1	1	1	1	-Tablecloths and serviettes
481840	0	0	1	1	1	1	- Sanitary towels and tampons, napkins and napkin liners for babies and similar sanitary articles
481850	1	1	1	1	1	1	-Articles of apparel and clothing accessories
481890	1	1	1	1	1	1	-Other
4819							**Cartons, boxes, cases, bags and other packing containers, of paper, paperboard, cellulose wadding or webs of cellulose fibres; box files, letter trays, and similar articles, of paper or paperboard of a kind used in offices, shops or the like.**
481910	1	1	1	1	1	1	-Cartons, boxes and cases, of corrugated paper or paperboard
481920	1	1	1	1	1	1	- Folding cartons, boxes and cases, of non-corrugated paper or paperboard
481930	1	1	1	1	1	1	- Sacks and bags, having a base of a width of 40 cm or more
481940	1	1	1	1	1	1	-Other sacks and bags, including cones
481950	1	1	1	1	1	1	-Other packing containers, including record sleeves
481960	1	1	1	1	1	1	-Box files, letter trays, storage boxes and similar articles, of a kind used in offices, shops or the like
4820							**Registers, account books, note books, order books, receipt books, letter pads, memorandum pads, diaries and similar articles, exercise books, blotting-pads, binders (loose-leaf or other), folders, file covers, manifold business forms, interleaved carbon sets and other articles of stationery, of paper or paperboard; albums for samples or for collections and book covers, of paper or paperboard.**
482010	1	1	1	1	1	1	-Registers, account books, note books, order books, receipt books, letter pads, memorandum pads, diaries and similar articles
482020	1	1	1	1	1	1	-Exercise books
482030	1	1	1	1	1	1	-Binders (other than book covers), folders and file covers
482040	1	1	1	1	1	1	-Manifold business forms and interleaved carbon sets
482050	1	1	1	1	1	1	-Albums for samples or for collections
482090	1	1	1	1	1	1	-Other
4821							**Paper or paperboard labels of all kinds, whether or not printed.**
482110	1	1	1	1	1	1	-Printed
482190	1	1	1	1	1	1	-Other
4822							**Bobbins, spools, cops and similar supports of paper pulp, paper or paperboard (whether or not perforated or hardened).**
482210	1	1	1	1	1	1	-Of a kind used for winding textile yarn
482290	1	1	1	1	1	1	-Other
4823							**Other paper, paperboard, cellulose wadding and webs of cellulose fibres, cut to size or shape; other articles of paper pulp, paper, paperboard, cellulose wadding or webs of cellulose fibres.**
482311	0	0	0	0	1	1	- Gummed or adhesive paper, in strips or rolls: -- Self-adhesive
482312	0	0	0	1	0	0	- Gummed or adhesive paper, in strips or rolls: -- Self-adhesive

HS	17	12	7	2	96	92	**Description** (HS2012 or earlier, HS2017 definitions for new codes)
482319	0	0	0	1	1	1	- Gummed or adhesive paper, in strips or rolls: -- Other
482320	1	1	1	1	1	1	- Filter paper and paperboard
482330	0	0	0	0	0	1	- Cards, not punched, for punchcard machines
482340	1	1	1	1	1	1	-Rolls, sheets and dials, printed for self-recording apparatus
482351	0	0	0	0	1	1	- Other paper and paperboard, of a kind used for writing, printing or other graphic purposes: -- Printed, embossed or perforated
482359	0	0	0	0	1	1	- Other paper and paperboard, of a kind used for writing, printing or other graphic purposes: -- Other
482360	0	0	0	1	1	1	- Trays, dishes, plates, cups and the like, of paper or paperboard
482361	1	1	1	0	0	0	-Trays, dishes, plates, cups and the like, of paper or paperboard : -- Of bamboo
482369	1	1	1	0	0	0	-Trays, dishes, plates, cups and the like, of paper or paperboard : -- Other
482370	1	1	1	1	1	1	-Moulded or pressed articles of paper pulp
482390	1	1	1	1	1	1	-Other
Chapter 49							**Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans**
4901							**Printed books, brochures, leaflets and similar printed matter, whether or not in single sheets.**
490110	1	1	1	1	1	1	- In single sheets, whether or not folded
490191	1	1	1	1	1	1	-Other : -- Dictionaries and encyclopaedias, and serial instalments thereof
490199	1	1	1	1	1	1	-Other : -- Other
4902							**Newspapers, journals and periodicals, whether or not illustrated or containing advertising material.**
490210	1	1	1	1	1	1	-Appearing at least four times a week
490290	1	1	1	1	1	1	-Other
490300	1	1	1	1	1	1	**Children's picture, drawing or colouring books.**
490400	1	1	1	1	1	1	**Music, printed or in manuscript, whether or not bound or illustrated.**
4905							**Maps and hydrographic or similar charts of all kinds, including atlases, wall maps, topographical plans and globes, printed.**
490510	1	1	1	1	1	1	-Globes
490591	1	1	1	1	1	1	-Other : -- In book form
490599	1	1	1	1	1	1	-Other : -- Other
490600	1	1	1	1	1	1	**Plans and drawings for architectural, engineering, industrial, commercial, topographical or similar purposes, being originals drawn by hand; hand-written texts; photographic reproductions on sensitised paper and carbon copies of the foregoing.**
490700	1	1	1	1	1	1	**Unused postage, revenue or similar stamps of current or new issue in the country in which they have, or will have, a recognised face value; stamp-impressed paper; banknotes; cheque forms; stock, share or bond certificates and similar documents of title.**
4908							**Transfers (decalcomanias).**
490810	1	1	1	1	1	1	-Transfers (decalcomanias), vitrifiable
490890	1	1	1	1	1	1	-Other
490900	1	1	1	1	1	1	**Printed or illustrated postcards; printed cards bearing personal greetings, messages or announcements, whether or not illustrated, with or without envelopes or trimmings.**

HS	17	12	7	2	96	92	**Description** (HS2012 or earlier, HS2017 definitions for new codes)
491000	1	1	1	1	1	1	**Calendars of any kind, printed, including calendar blocks.**
4911							**Other printed matter, including printed pictures and photographs.**
491110	1	1	1	1	1	1	-Trade advertising material, commercial catalogues and the like
491191	1	1	1	1	1	1	-Other : -- Pictures, designs and photographs
491199	1	1	1	1	1	1	-Other : -- Other
Chapter 94							**Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, not elsewhere specified or included; illuminated signs, illuminated name-plates and the like; prefabricated buildings**
9401							**Seats (other than those of heading 94.02), whether or not convertible into beds, and parts thereof.**
940130	1	1	1	1	1	1	- Swivel seats with variable height adjustment
940140	1	1	1	1	1	1	- Seats other than garden seats or camping equipment, convertible into beds
940150	0	0	0	1	1	1	- Seats of cane, osier, bamboo or similar materials
940151	0	1	1	0	0	0	- Seats of cane, osier, bamboo or similar materials : -- Of bamboo or rattan
940152	1	0	0	0	0	0	-- Of bamboo
940153	1	0	0	0	0	0	-- Of rattan".
940159	1	1	1	0	0	0	- Seats of cane, osier, bamboo or similar materials : -- Other
940161	1	1	1	1	1	1	-Other seats, with wooden frames : -- Upholstered
940169	1	1	1	1	1	1	-Other seats, with wooden frames : -- Other
940190	1	1	1	1	1	1	- Parts
9403							**Other furniture and parts thereof.**
940330	1	1	1	1	1	1	-Wooden furniture of a kind used in offices
940340	1	1	1	1	1	1	-Wooden furniture of a kind used in the kitchen
940350	1	1	1	1	1	1	-Wooden furniture of a kind used in the bedroom
940360	1	1	1	1	1	1	-Other wooden furniture
940380	0	0	0	1	1	1	- Furniture of other materials, including cane, osier, bamboo or similar materials
940381	0	1	1	0	0	0	- Furniture of other materials, including cane, osier, bamboo or similar materials : -- Of bamboo or rattan
940382	1	0	0	0	0	0	-- Of bamboo
940383	1	0	0	0	0	0	-- Of rattan".
940389	1	1	1	0	0	0	- Furniture of other materials, including cane, osier, bamboo or similar materials : -- Other
940390	1	1	1	1	1	1	- Parts
940600	0	1	1	1	1	1	**Prefabricated buildings.**
940610	1	0	0	0	0	0	- Of wood
940690	1	0	0	0	0	0	- Other".

A.2. Data Extractor Requirements

Purpose of this document This document contains all the features and requirements of the DataExtractor component of the TradeDB system. The list includes all the functional and non-functional requirements. This document should be kept updated. All agreed upon requirements are listed here. Functional requirements include the features and functions of the extractor component.

Extract data from ComTrade API It is possible to extract trade flow data from ComTrade API for the specified time periods and product codes. This data is extracted for all reporters available from ComTrade, and for every reporter all flows are included with all of its trade partners. The different flows are import, export, re-import, re-export. The extracted data will be stored in the database. No duplicate entries are allowed in the database. The format of the data will be provided by Paul Rougieux because it may change depending on the needs of the R-package that cleans the data. The R-package is provided by Paul.

Extract data from Comext bulk download A separate extraction routine was developed to extract data automatically through the Comext bulk download website. The automated system is provided the time periods and products and it will download the necessary files and process them. The processed data is inserted into the database. No duplicate entries are allowed in the database. The format of the data is defined by the requirements set by the R-package that cleans the data.

Data handling – The Comext extractor can extract "raw data" meaning the data will not be transformed in any way except for some specific items.

- The product description is not present in the raw data and will be inserted from a look-up table in the database to every row of Comext data.
- Country codes will also be transformed to match the ComTrade nomenclature and this will be done based on a look-up table in the database.

A.3. Software architecture

The tradeflows methodology comprises a complex system consisting of several distinct parts. The main components are data extractor, web interface, report generation and data cleaning procedure that processes raw ComTrade data. The cleaning procedure and the report generation functionality have been programmed mainly in R-language. The web interface and the data extractor have been made using a PHP framework called CodeIgniter.

CodeIgniter introduction The CodeIgniter framework is a lightweight PHP framework designed for people who like to use basic PHP but don't want to write "boilerplate" code such as SQL to interact with the database. CodeIgniter has an abstraction layer where the programmer does not need to know the specific SQL dialect of the underlying database type but instead uses higher level functions of the CodeIgniter to manipulate

data. The framework also contains other useful utilities. It uses a model-view-controller model of dividing the program into conceptually coherent blocks.

Model The model classes represent a data model of the program. Functionality to interact with files, databases etc. is meant to reside in here because it is concerned with manipulating different data of the underlying data model i.e. data that is not directly meant to be displayed to the user.

View The views are concerned with the layout and the representation of the data. They are not meant to manipulate data but are meant to represent it visually to the user. This is basically the webpage that the users will see. In the Data Extractor no views are present.

Controller Functions in controllers are called from the URLs used to access the website. The controller is responsible for calling model functions to manipulate the data and then handling what data to pass to the views, and what views to display to the user. The controller connects the data provided by the model for representing in the view.

A.4. Server setup

The Trade Database runs on a Linux server. The EFI uses Ubuntu Server 14.04 and the following setup instructions are written for it. The system will run on other Linux variants too, the instructions can still be used but possibly cannot be followed precisely. Everything in this document is done from the command-line, a chosen GUI tool can be used instead of the apt-get command.

Prerequisites To set up the Trade Database a Linux server is needed. A basic installation with MySQL database, PHP and a web server is a good starting point. Additionally some other tools, such as basic development tools are needed, but instead of trying to specify each necessary package it is enough to install packages listed below. Other needed tools will get installed during the setup by the APT system that takes care of dependencies. If some other Linux variant is being used, build-essential basically installs an environment to compile C programs, that is gcc, make, libc-dev and such tools.

Install necessary tools To install tools that are not included in the basic installation run the following commands:

```
sudo apt-get install build-essential libmysqlclient-dev php-pear php5-dev
sudo pecl install sync
then edit the PHP configuration file, if you have other web server than the de
sudo vi /etc/php5/apache2/php.ini
and under the section Dynamic Extensions add a new row
extension=sync.so
save the file and restart the web server
sudo service apache2 restart
```

R setup An important component of the Trade Database is data validation. The validator program is written in R language, thus it is necessary to setup an R environment. The R provided by Ubuntu Server 14.04 is somewhat old for the needs of this project. While everything might run fine the EFI chose to use a newer version provided by a 3rd party. To setup the environment EFI uses run the following commands:

add installation repositories for R

```
sudo add-apt-repository ppa:marutter/rrutter
sudo add-apt-repository ppa:marutter/c2d4u
```

install R with packages

```
sudo apt-get install r-base r-cran-devtools r-cran-dbi r-cran-
    dplyr r-cran-knitr r-cran-ggplot2 r-cran-rmarkdown
```

to install R packages that are unavailable in the repository run R with root permission

```
sudo R
```

and then inside R install those packages

```
install.packages("RMySQL")
install.packages("argparser")
install.packages("lazyeval")
```

TEX setup The report generator uses TEX program, to install it with necessary packages run the following command:

```
sudo apt-get install pandoc tex-common texlive-latex-base
    texlive-latex-recommended texlive-latex-extra texlive-fonts-
    recommended
```

A.5. Extractor and Validator

Data extraction The data extraction is done running command tradeextract that calls function fetch_flows_product_time that does the actual data extraction from the COMTRADE database. The products to be extracted are defined in the variable PRODUCTS in the tradeextract file. The codes are six-digit codes separated by spaces.

File tradeextract

```
#!/bin/bash

PRODUCTS="440110 440121 440122 440130 440131 440139 440200
    440290 440320 440331"

echo $PRODUCTS | while read -r line
do
    set -- $line
    counter=$#
    while [ $counter -gt 0 ]; do
```

```
    product1="$1"
     shift
    product2="$1"
     shift
    product3="$1"
     shift
    product4="$1"
     shift
    product5="$1"
     shift
     let counter=counter-5
    echo
    date
    date > log-$product1,$product2,$product3,$product4,
$product5
    php index.php comtrade_controller fetch_flows_product_time
 $product1,$product2,$product3,$product4,$product5
2005,2006,2007,2008,2009 A >> log-$product1,$product2,
$product3,$product4,$product5
    php index.php comtrade_controller fetch_flows_product_time
 $product1,$product2,$product3,$product4,$product5
2010,2011,2012,2013,2014 A >> log-$product1,$product2,
$product3,$product4,$product5
    date >> log-$product1,$product2,$product3,$product4,
$product5
    date
  done
done
```

This file should be located in the root directory of the ComtradeExtractor software project.

This example prints the current time before it begins extraction of a set of five products as well as after it has finished. This can be disabled by commenting out rows that have command date. Additionally the same time information is stored in the log file, this can be disabled by commenting out rows that have command date > log-$product1,$product2,$product3,$product4,$product5 (also the row with two >). Moreover, the output of the extraction process gets stored in the log file too, this can disabled by commenting out the ends (after A) of two rows that begin with php index.php.

Data cleaning aka validating The data validation is done running command tradevalidator that runs R script tradevalidator.r for each product to be validated. The tradevalidator.r calls R function cleandbproduct() that does the actual cleaning. The products to be validated are defined in the variable PRODUCTS in the tradevalidator file. The codes are six-digit codes separated by spaces.

File tradevalidator

```
#!/bin/bash

PRODUCTS="440110 440121 440122 440130 440131 440139 440200
    440290 440320 440331"

for i in $PRODUCTS
do
    ./tradevalidator.r $i
done
File tradevalidator.r
#!/usr/bin/Rscript

args<-commandArgs(TRUE)

library(devtools)
library(RMySQL)
library(tradeflows)

cleandbproduct(args, tableread = "raw_flow_yearly", tablewrite =
    "validated_flow_yearly")
```

These files can be located in any directory.

A.6. Trade network visualisation

A.6.1. Whole network visualisations

World Map Layout This visualisation shows the most valuable trade flows. Global trade network graph is overlaid on GIS world map, in which only country borders are displayed. Borders reflect the status of world countries from 2005. The graph displays top 0.5% highest value trade flows in red color, while other trade flows are not shown. The width of the line represents the value of the trade flow. Only names of countries connected by these trade flows are presented. They are also marked by a black dot with blue center, which located on the centroids of respective countries. Dots and ISO3 codes of countries are of the same size.

Export - Import Layout This visualisation shows the largest importing and exporting countries. Top 0.5% highest value trade flows of the selected data set are presented with red lines, while other trade flows are presented by grey lines. ISO 3 codes of all countries are shown, and they are all of same size. The layout of the graph is such that y axis points to total import value of a given country, whereas x axis points to total export value of a given country (both expressed in 1000 USD). Most valuable trade flow is printed last, so the more valuable trade flows overlay the trade flows of smaller value.

Concentric Circles Layout This visualisation shows which countries have greatest market share, and to quickly see the 'position' of each country in the international trade

network. The visualisation divides countries into three concentric circles. Inner circle contains countries with market share larger than 1%, middle circle contains countries with market share between 1% and 0.1%, while outer circle contains countries with less than 0.1% of market share. Coordinates of country nodes are calculated depending on the number of countries in each market share category. In a given circle, the country with highest market share is positioned to the right (90 degrees position), and the market shares are decreasing following the counter-clockwise direction. Size of a circle represents the total value of a country's exports and imports. In the distribution of trade flows, first three quartiles (i.e. up to 75% of trade flows) are not shown. In an ascending order, dashed grey lines represent trade flows in 75%-85% range, solid grey lines represent trade flows in 85-95% range, dark grey lines represent trade flows in 95-99% range, orange lines represent trade flows in 99- 99.5% range, and the red lines represent the highest 0.5% of trade flows (99.5% - 100%). The width of the lines represents the value of the trade flow.

Inner Circle Layout The basic idea behind this visualisation is to show the trade flows between the most important countries in the international trade network. The graph shows only with countries with market share larger than 1%. The country with highest market share is positioned to the right (90 degrees position), and the market shares are decreasing following the counter-clockwise direction. Size of a circle represents the total value of a country's exports and imports. In the distribution of trade flows, first three quartiles (i.e. up to 75% of trade flows) are not shown. In an ascending order, dashed grey lines represent trade flows in 75%-85% range, solid grey lines represent trade flows in 85-95% range, dark grey lines represent trade flows in 95-99% range, orange lines represent trade flows in 99- 99.5% range, and the red lines represent the highest 0.5% of trade flows (99.5% - 100%). The width of the lines represents the value of the trade flow.

Spring-Embedded Layout This visualisation shows the overall 'structure' of the international trade network, where its viewer could easily grasp basic network notions (e.g. centrality and grouping). Spring-embedding layout is a visualisation method for displaying similarity of countries within a data set, where the proximity of countries represents their structural similarity (of having similar trade relations with other countries). Countries that are closer to the centre are more central, i.e. have many direct and strong trade flows with many other countries which are themselves well connected. The orientation of the graph (left-right, top-bottom) is arbitrary. Extreme distances between countries are shortened and overlap between positions of countries of the network is avoided (the basic form of this layout is Multi-dimensional scaling, where spring-embedded layout is its modification). Although some analytic power of positions is lost, it makes the graph easier to 'read'. All countries and all trade flows are taken up into the calculation of the layout. Countries with market share less than 0.01% are not displayed, nor are the first three quartiles (up to 75%) of trade flows. Circles that represent countries vary in size and shade of blue, where larger size and darker blue color represent high value of country's total export and import. In an ascending order, dashed grey lines represent trade flows in 75%-85% range, solid grey lines represent trade flows in 85-95% range, dark grey lines represent trade flows in 95-99% range, orange lines represent trade flows in 99- 99.5% range, and the red lines represent the highest 0.5% of trade flows (99.5% -

100%). The width of the lines represents the value of the trade flow

A.6.2. Ego Network Visualisations

The purpose of these visualisations is to display the immediate trade 'neighbourhood' of the focal (ego) country. Term 'immediate neighbourhood' corresponds to 'neighbourhood +1' term of social network analysis, i.e. it encompasses the focal county, all the countries which directly trade with the focal country, the relations between ego and its immediate trade partners, and also the trade relations between ego's immediate trade partners.

World Map Layout This visualisation illustrates the main trading partners of one focal country. The graph shows export and import trade flows of a single country, where the graph is presented in an overlay of world map. The surface of the focal country on the world map is coloured in grey colour, while the rest of the map is white. The ISO 3 code of the focal country is written in large red letters, while the labels of its trading partners are in small brown font. Export trade flows are represented by blue lines, while import trade flows are represented by green lines. Top five most valuable export and import trade flows are presented by wide lines in darker shades of blue and green, while all other trade flows are presented by narrow lines in pale blue and green. In order to make the graph more readable thin blue lines are also dashed, where the exporting partner of the focal country can most easily be identified by looking and the arrow heads. Unlike all the other ego network visualisations, this one does not display trade flows between ego's trade partners.

Export - Import Layout This visualisation displays export/import value of the focal country and of its main trading partners. The layout of the graph is such that y axis points to total import value of a given country, whereas x axis points to total export value of a given country (both expressed in 1000 USD). ISO 3 code of the focal country is presented by large red font. Export trade flows of the focal country are presented by blue lines, whereas it's importing trade flows are presented by green lines. Trade flows between trading partners of the focal country are presented by grey lines. The width of the lines represents the value of the trade flows. Top five export and import trade flows are presented with solid lines, while others are presented with dashed lines.

Concentric Circles Layout Three circles illustrates the market share of the focal country in relation to other countries in its neighborhood. Inner circle contains countries with market share larger than 1%, middle circle contains countries with market share between 1% and 0.1%, while outer circle contains countries with less than 0.1% of market share. In a given circle, the country with highest market share is positioned to the right (90 degrees position), and the market shares are decreasing following the counter-clockwise direction. Size of a circle represents the total value of a country's exports and imports. Circle which represents the focal country is yellow, while all other are blue. Only countries which trade with focal country are shown. ISO 3 code of the focal country is presented in large and red font. Export trade flows of the focal country are presented by blue lines, whereas it's importing trade flows are presented by green lines. Trade flows between trading partners

of the focal country are presented by grey lines. The width of the lines represents the value of the trade flows. In the distribution of value of trade flows in the network of the focal country (exports, imports and trade between the partnering countries combined), first 50% are presented with dashed lines, whereas other 50% are presented with solid lines

Spring - Embedded Layout This visualisation shows the overall 'structure' of the ego's neighborhood +1 network. The layout is such that more central countries are located in the centre of the graph, and the proximity of two countries represents similarity in patterns of their trade flows. Note that if ego has different exporting and importing partners, and if some of them trade with both ego's export and import partners, it is likely that such a country will be in the centre of the network; even it may have a smaller number of trading partners than ego. On the other hand, if ego's import and export networks in neighbourhood +1 partially overlap and there is a low level of trade between them, ego will most likely be at the centre of the graph. Export trade flows of the focal country are presented by blue lines, whereas it's importing trade flows are presented by green lines. Trade flows between trading partners of the focal country are presented by grey lines. The width of the lines represents the value of the trade flows. In the distribution of value of trade flows in the network of the focal country (exports, imports and trade between the partnering countries combined), first 50% are presented with dashed lines, whereas other 50% are presented with solid lines. Size of a circle represents the total value of a country's exports and imports. Circle which represents the focal country is yellow, while all other are blue. Only countries which trade with focal country are shown. ISO 3 code of the focal country is presented in large and red font.

R packages used The following R packages have been used to generate PDF reports containing trade network visualisations:

- knitr (A General-Purpose Package for Dynamic Report Generation in R)
- tradeflows (by Paul Rougieux, used for data manipulation)
- dplyr (A Grammar of Data Manipulation)
- igraph (Network Analysis and visualisation)
- caTools (Tools: moving window statistics)
- Hmisc (Harrell Miscellaneous)
- maps (Draw Geographical Maps)
- mapdata (Extra Map Databases)
- ggplot2 (An Implementation of the Grammar of Graphics)
- rworldmap (Mapping global data, vector and raster)

- maptools (Tools for Reading and Handling Spatial Objects)
- rworldxtra (Country boundaries at high resolution)
- plotrix (Various Plotting Functions)
- gplots (Various R Programming Tools for Plotting Data)

Current version of network visualisations are based on trade value data. The R script that generates those visualisations starts with the definition of input variables: product group(s), year and focal country. Two additional (csv) files are needed to run the script. They contain ISO3 codes of countries, and coordinates of their centroids.