# faoswsTrade: `complete_tf_cpc` and `total_trade_CPC` modules

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**Abstract**

The trade module is divided in two submodules: `complete_tf_cpc` and `total_trade_CPC`. The `complete_tf_cpc` module uses the most disaggregated bilateral transactions between countries (obtained from Eurostat for European countries, and from UNSD for the remaining countries), filters the agriculture-related flows of interest for the Organisation, standardises units of measurement, maps item and country codes to a standard set of codes, imputes missing quantities, and computes unit values. The `total_trade_CPC` aggregates bilateral trade (i.e., the results of `complete_tf_cpc`) at reporter level. Each module is year specific, i.e, the trade modules run independently for each year (not necessarily in a chronological order). To run the `total_trade_CPC` module, the output of the `complete_tf_cpc` module is required. Data is validated with complimentary tools that detect outliers and allows analysts to correct flows in an informed way. In this document, an overall narrative of what the modules do is presented. A detailed step-by-step illustration of the modules/tools is given in separate documents.

## 1 Complete tf cpc

### 1.1 Data

Raw data are harvested and provided by the SWS Team (subunit of Team F) for both UNSD Tariff line and Eurostat Data. The dataset is prefiltered by downloading only chapters of interest, which are:

```
01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17,
18, 19, 20, 21, 22, 23, 24, 33, 35, 38, 40, 41, 43, 50, 51, 52, 53.
```

In the following table, an example of filtered UNSD data is shown (variable names have been modified). It contains information on the reporter, partner, flow (1 = imports; 2 = exports; 3 = re-exports; 4 = re-imports), HS codes (variable length), monetary value (in USD dollars), weight (in kilograms), supplementary quantity, the unit in which the supplementary quantity is given (`qunit`, e.g., 8 = kilograms, 7 = liters), and the chapter.

Table 1: Subset of Tariff line data

| year | reporter | partner | flow | hs | value | weight | qty | qunit | chapter |
|---|---|---|---|---|---|---|---|---|---|
| 2014 | 12 | 699 | 1 | 38089119 | 109821.79 | 7160.22 | 7160.22 | 5 | 38 |
| 2014 | 600 | 380 | 2 | 08140000000 | 24456.00 | 15870.00 | 15870.00 | 8 | 08 |
| 2014 | 398 | 276 | 1 | 400259 | 532.12 | 0.20 | 0.20 | 8 | 40 |
| 2014 | 703 | 616 | 1 | 05119910 | 39.83 | 6.00 | 6.00 | 8 | 05 |
| 2014 | 251 | 76 | 1 | 20081912 | 1933.60 | 148.00 | 148.00 | 8 | 20 |
| 2014 | 702 | 156 | 1 | 382311 | 117527.41 | 60000.00 | 60000.00 | 8 | 38 |
| 2014 | 203 | 682 | 1 | 100620 | 143.00 | 20.00 | NA | 1 | 10 |
| 2014 | 344 | 840 | 3 | 16055900 | 17245.07 | 907.00 | 907.00 | 8 | 16 |
| 2014 | 48 | 682 | 1 | 19059093 | 753403.97 | 368416.00 | 368416.00 | 8 | 19 |
| 2014 | 616 | 428 | 1 | 401693 | 362.00 | 20.00 | 20.00 | 8 | 40 |
| 2014 | 384 | 466 | 2 | 19021900 | 901389.92 | 1238270.00 | 1238270.00 | 8 | 19 |

| year | reporter | partner | flow | hs | value | weight | qty | qunit | chapter |
|---|---|---|---|---|---|---|---|---|---|
| 2014 | 764 | 152 | 2 | 400942 | 108.10 | NA | NA | 1 | 40 |
| 2014 | 414 | 380 | 1 | 38089990 | 574.72 | 2.00 | 2.00 | 8 | 38 |
| 2014 | 158 | 324 | 2 | 19059090006 | 462.59 | 103.00 | 103.00 | 8 | 19 |
| 2014 | 690 | 784 | 1 | 18069090 | 1210.97 | 28.80 | 15.00 | 5 | 18 |

In the following table, an example on filtered Eurostat data is reported (also in this case, the original variable names were modified). The main differences are: reporter and partner codes are "geonomenclature" codes (in UNSD they are "M49"); the HS length is maximum 8-digits; monetary values are in thousands of euros; weight is reported in tonnes; the supplementary quantity is always commodity specific (in Tariff line data it can happen that the same HS code is reported in different units).

Table 2: Subset of Eurostat data

| year | reporter | partner | flow | hs | value | weight | qty |
|---|---|---|---|---|---|---|---|
| 201452 | 003 | 0346 | 2 | 18069060 | 6.88 | 2.2 | NA |
| 201452 | 008 | 0001 | 2 | 40119200 | 26.65 | 14.8 | 1225 |
| 201452 | 068 | 0005 | 2 | 10MMM000 | 42.17 | 0.0 | NA |
| 201452 | 005 | 0006 | 2 | 52053400 | 0.11 | 0.0 | NA |
| 201452 | 006 | 0647 | 2 | 52085100 | 1361.25 | 17.7 | 180134 |
| 201452 | 017 | 0004 | 2 | 09096100 | 7.45 | 1.2 | NA |
| 201452 | 001 | 0011 | 2 | 02042300 | 4.76 | 0.6 | NA |
| 201452 | 060 | 0032 | 2 | 19049080 | 17.55 | 3.1 | NA |
| 201452 | 008 | 0032 | 2 | 02031955 | 1947.23 | 438.4 | NA |
| 201452 | 017 | 0212 | 2 | 33051000 | 282.50 | 11.4 | NA |
| 201452 | 001 | 0690 | 2 | 03061410 | 9.05 | 0.3 | NA |
| 201452 | 008 | 0001 | 1 | 35030080 | 1002.17 | 7.4 | NA |
| 201452 | 018 | 0006 | 1 | 52094300 | 0.33 | 0.0 | 93 |
| 201452 | 017 | 0604 | 2 | 22011019 | 0.09 | 0.1 | 70 |
| 201452 | 006 | 0091 | 2 | 38089110 | 1.71 | 1.6 | NA |

Besides filtering by chapters, only some HS codes inside the chapters are considered. These codes are given in the `hs6faointerest` datatable, of which the next table shows a subset:

Table 3: HS-6 codes of interest

| hs6_code |
|---|
| 180520 |
| 020576 |
| 090838 |
| 110243 |
| 150379 |
| 530211 |
| 020892 |
| 210546 |
| 010525 |
| 510425 |

As seen before, both Eurostat and Tariff line data are given the same variable names and data types before being processed further.

#### 1.1.1 Eurostat

- only `stat_regime` equal to 4 is kept.

  > In this system *["Statistical regime 4" or "Total trade"]*, the recorded aggregates include all goods entering or leaving the economic territory of a country with the exception of simple transit trade. In particular, all goods received into customs warehouses are recorded as imports, regardless of whether they subsequently go into free circulation in the Member State of receipt. Similarly, outgoing goods from customs warehouses are included in the general trade aggregates, at the time they leave the Member State.

  See pag. 9 in *DG Trade Statistical Guide*, June 2016, http://trade.ec.europa.eu/doclib/docs/2013/may/tradoc_151348.pdf

- only numeric codes of reporters and partners are kept (letters are not allowed; basically this removes the "EU" total).
- only numeric CN8 codes (`hs`) are kept (letters are not allowed; in the example it is possible to see a non numeric HS: it will be removed).

#### 1.1.2 UNSD

- only numeric HS (`hs`) codes are kept (letters are not allowed).

### 1.2 Process

#### 1.2.1 Aggregate UNSD Tariff line individual Shipments

The tariffline data from UNSD contains multiple rows with identical combination of `reporter` / `partner` / `commodity` / `flow` / `year` / `qunit`. Those are transactions registered separately, thus rows containing non-missing values and quantities can be aggregated. Missing variables of the same type are also aggregated if they are *all* missing, as they will produce a missing aggregated value for missing disaggregated values while correctly summing the remaining variables.

Table 4: Example of multiple transactions by `reporter` / `partner` / `flow` / `year` / `hs`

| year | reporter | partner | flow | hs | value | weight | qty | qunit | chapter |
|---|---|---|---|---|---|---|---|---|---|
| 2014 | 508 | 710 | 1 | 22071090 | 99570 | NA | 126000 | 7 | 22 |
| 2014 | 508 | 710 | 1 | 22071090 | 126530 | NA | 168000 | 7 | 22 |
| 2014 | 508 | 710 | 1 | 22071090 | 87950 | NA | 77141 | 7 | 22 |
| 2014 | 508 | 710 | 1 | 22071090 | 194740 | NA | 190719 | 7 | 22 |
| 2014 | 508 | 710 | 1 | 22071090 | 69580 | 116332 | 116261 | 7 | 22 |
| 2014 | 508 | 710 | 1 | 22071090 | 1050 | NA | 2871 | 7 | 22 |
| 2014 | 508 | 710 | 1 | 22071090 | 109770 | NA | 126000 | 7 | 22 |
| 2014 | 508 | 710 | 1 | 22071090 | 30050 | NA | 40000 | 7 | 22 |
| 2014 | 508 | 710 | 1 | 22071090 | 147840 | NA | 210000 | 7 | 22 |
| 2014 | 508 | 710 | 1 | 22071090 | 252100 | NA | 230538 | 7 | 22 |
| 2014 | 508 | 710 | 1 | 22071090 | 300 | 500 | 23 | 7 | 22 |
| 2014 | 508 | 710 | 1 | 22071090 | 28690 | NA | 40000 | 7 | 22 |
| 2014 | 508 | 710 | 1 | 22071090 | 36360 | 37847 | 42020 | 7 | 22 |
| 2014 | 508 | 710 | 1 | 22071090 | 2240 | 3197 | 2500 | 7 | 22 |
| 2014 | 508 | 710 | 1 | 22071090 | 75540 | 101700 | 126000 | 7 | 22 |

The results of the aggregation of the previous example are shown in the following table. In this case, even if there is a unique combination of `reporter` / `partner` / `flow` / `year` / `hs`, the rows are two: indeed, one reports the aggregated transactions where the `weight` variable was available, and the other reports the aggregated cases where it was missing.

Table 5: Results of the aggregation of multiple transactions

| year | reporter | partner | flow | hs | qunit | value | weight | qty | nrows |
|---|---|---|---|---|---|---|---|---|---|
| 2014 | 508 | 710 | 1 | 22071090 | 7 | 184020 | 259576 | 286804 | 5 |
| 2014 | 508 | 710 | 1 | 22071090 | 7 | 1078290 | NA | 1211269 | 10 |

After quantity conversions are made, or missing quantities get imputed (see further), the two different rows in the previous table will be aggregated into a single transaction.

### 1.2.2 Mapping UNSD Tariff line and Eurostat data

At this stage a standardization/mapping step is performed. The details are divided between UNSD Tariff line and Eurostat due to the nature of the differences among the two datasets.

#### 1.2.2.1 UNSD Tariff line

1. UNSD Tariff line data reports area code with Tariff line M49 standard codes (which are different from official M49). The area code is converted in FAO country code using a specific conversion table provided by Team ENV.

Table 6: Subset of the M49 to FAO codes mapping table

| m49 | fao |
|---|---|
| 72 | 20 |
| 278 | 79 |
| 270 | 75 |
| 530 | 151 |
| 352 | 99 |
| 50 | 16 |
| 230 | 62 |
| 434 | 124 |
| 175 | 270 |
| 839 | 252 |

2. Countries that are not supposed to exist in the year for which the module runs are removed from the data (e.g., Serbia did not exist as a single official country before 2006).

Table 7: Subset of the tables with countries and their `startDate` and `endDate`

| code | description | selectionOnly | type | startDate | endDate |
|---|---|---|---|---|---|
| 272 | Serbia, Republic of | FALSE | country | 2006-01-01 | 2999-12-31 |
| 183 | Romania | FALSE | country | 1900-01-01 | 2999-12-31 |
| 178 | Eritrea | FALSE | country | 1993-01-01 | 2999-12-31 |
| 40 | Chile | FALSE | country | 1900-01-01 | 2999-12-31 |

| code | description | selectionOnly | type | startDate | endDate |
|---|---|---|---|---|---|
| 194 | Saudi Arabia | FALSE | country | 1900-01-01 | 2999-12-31 |
| 190 | Saint Pierre & Miquelon | FALSE | country | 1900-01-01 | 2999-12-31 |
| 252 | Unspecified | FALSE | country | 1900-01-01 | 2999-12-31 |
| 195 | Senegal | FALSE | country | 1900-01-01 | 2999-12-31 |
| 208 | Tajikistan | FALSE | country | 1992-01-01 | 2999-12-31 |
| 212 | Syrian Arab Republic | FALSE | country | 1900-01-01 | 2999-12-31 |
| 64 | Faeroe Islands | FALSE | country | 1900-01-01 | 2999-12-31 |
| 31 | Bouvet Island | FALSE | country | 1900-01-01 | 2999-12-31 |
| 211 | Switzerland | FALSE | country | 1900-01-01 | 2999-12-31 |
| 167 | Czechia | FALSE | country | 1993-01-01 | 2999-12-31 |
| 157 | Nicaragua | FALSE | country | 1900-01-01 | 2999-12-31 |

3. European countries (as reporters) already in Eurostat data are removed.

4. Area codes not mapping to any FAO country code are removed and will be mirrored in a later step. All countries mapping to code 252 (which corresponds to undefined areas) are mapped to the 896 M49 code ("Other nei").

Table 8: Example of unmapped countries

| m49 | fao |
|---|---|
| 270 | 75 |
| 280 | 79 |
| 716 | 181 |
| 634 | 179 |
| 471 | 252 |
| 51 | 1 |

5. The flow codes of re-Import (code 4) are recoded into Import (code 1) and codes of re-Export (code 3) to Export (code 2). This procedure is applied following UNSD standards:

> Exports of a country can be distinguished as exports of domestic goods and exports of foreign goods. The second class is generally referred to as re-exports. The exports shown in our database contain both the exports of domestic and foreign goods. Re-exports are exports of foreign goods in the same state as previously imported; they are to be included in the country exports. It is recommended that they be recorded separately for analytical purposes. This may require the use of supplementary sources of information in order to determine the origin of re-exports, i.e., to determine that the goods in question are indeed re-exports rather than the export of goods that have acquired domestic origin through processing. Re-imports are goods imported in the same state as previously exported. They are included in the country imports. It is recommended that they be recorded separately for analytical purposes. This may require the use of supplementary sources of information in order to determine the origin of re-imports, i.e., to determine that the goods in question are indeed re-imports rather than the import of goods that have acquired foreign origin through processing. There are several reasons why an exported good might return to the country of origin. The exported good might be defective, the importer might have defaulted on payments or cancelled the order, the authorities might have imposed an import barrier, or demand or prices in the country of origin might have made it worthwhile to bring the good back.

   See: http://unstats.un.org/unsd/tradekb/Knowledgebase/Reexports-and-Reimports

6. Set all HS codes to the maximum length (by reporter / flow) found in the HS-FCL mapping table valid

for the reporter in that year (see below).

7. Commodity codes are reported in HS codes (*Harmonized Commodity Description and Coding System*). The codes are converted in FCL (*FAO Commodity List*) codes. This step is performed using a table incorporated in the SWS that was built starting from the MDB files used in the previous system (known as *Shark/Jellyfish*). In this step, all the mapping between HS and FCL code is stored. If a country is not included in the mapping table for that specific year, all the records for the reporting country are removed. All records without an FCL mapping are filtered out and saved in specific variables.

Table 9: Subset of the HS to FCL mapping table

| area | flow | fromcode | tocode | fcl | startyear | endyear |
|---|---|---|---|---|---|---|
| 109 | 2 | 5301210000 | 5301219999 | 773 | 2007 | 2050 |
| 81 | 2 | 15159060 | 15159060 | 340 | 2000 | 2000 |
| 58 | 1 | 2009790000 | 2009790000 | 519 | 2003 | 2012 |
| 66 | 2 | 012355 | 012355 | 1069 | 2000 | 2001 |
| 134 | 2 | 0809401000 | 0809401000 | 536 | 2000 | 2003 |
| 17 | 2 | 04041004 | 04041004 | 900 | 2007 | 2008 |
| 165 | 1 | 11062039 | 11062039 | 150 | 2003 | 2050 |
| 119 | 2 | 220410 | 220410 | 564 | 2002 | 2003 |
| 131 | 1 | 071350 | 071350 | 181 | 2008 | 2050 |
| 181 | 2 | 19019091 | 19019091 | 115 | 2000 | 2050 |

Some codes can be unmapped in the previous table, i.e., no FCL code can be assigned to some HS codes. In this case, the module generates a list of these codes that is sent to Team B/C so that they can update the table by including these missing codes.

Table 10: Subset of additions to the HS to FCL mapping table

| year | reporter_fao | flow | hs | fcl | details |
|---|---|---|---|---|---|
| 2002 | 33 | 1 | 3301230000 | 753 | GTIS TL description |
| 2014 | 219 | 1 | 7099100 | 0 | NA |
| 2015 | 107 | 1 | 80261 | 234 | Generic HS2012 to FCL unique six-digit match |
| 2015 | 146 | 2 | 80830901 | 0 | NA |
| 2014 | 299 | 1 | 110510 | 0 | NA |
| 2015 | 230 | 1 | 80261 | 0 | NA |
| 2014 | 68 | 2 | 3081100 | 0 | FISHERY CODE: DROP |
| 2014 | 299 | 1 | 190240 | 0 | NA |
| 2015 | 299 | 1 | 100199 | 0 | NA |
| 2014 | 7 | 1 | 2075200 | 1073 | Standard_HS12 |
| 2014 | 230 | 2 | 20752 | 0 | NA |
| 2014 | 299 | 1 | 220600 | 517 | Generic HS2012 to FCL (could also be mapped to 26,39) |
| 2014 | 153 | 1 | 10085000 | 0 | NA |
| 2014 | 180 | 1 | 9011200 | 0 | NA |
| 2013 | 169 | 1 | 3083000000 | 0 | FISHERY CODE: DROP |

Moreover, some of the original codes in the HS-FCL mapping can be better mapped to another FCL code: the mapping table has a `correction_fcl` (not shown in the previous example in order to save space) that can be used to override the original `fcl` variable. This feature was requested by Team B/C that is responsible for these corrections.

8. Information of the FCL units is added, i.e, to each FCL code its final unit of measurement is assigned.

Table 11: Subset of FCL units

| fcl | fclunit |
|---|---|
| 1096 | heads |
| 1068 | 1000 heads |
| 521 | mt |
| 1083 | 1000 heads |
| 1150 | heads |
| 44 | mt |
| 840 | mt |
| 1098 | mt |
| 1181 | number |
| 1126 | heads |

9. Data conversion of units of measurements are applied to meet FAO standards, where all weights are reported in tonnes, animals in heads or 1000 heads and, for some commodities, just the value is provided. For example, if the originally-reported quantity is "units" and the FAO unit is "1000 heads", the quantity is divided by 1000.

10. Non-livestock commodity specific conversions are added. This is done by taking the ratio of the reported weight and quantity (divided by 1000), computing the median of this ratio by FCL and the originally reported unit of measurement, and finally multiplying it by the reported quantity. To make this clear an example could be useful: suppose that a country does not report the weight of eggs, but reports units, in this case, we compute the median of the weight/quantity/1000 ratio for all countries where both weight and quantity are reported and then apply this median in order to have an idea of how many tonnes the reported quantities of that country weighs. [Probably a weak point of this procedure is that not in all countries eggs weigh the same, thus a more realistic approach would be to compute regional medians (e.g., for Thailand use the Asian median of the weight/quantity/1000 ratio). The first-best approach, in any case, would be to have speficic tables derived from external sources. This is currently under investigation.] This procedure is not applied to livestock: in this case, a country/item specific datatable exists where weights of livestock are present.

#### 1.2.2.2 Eurostat

1. Eurostat classifies areas in their "geonomenclature". These codes are converted in FAO country codes using a specific conversion table, stored in the SWS, provided by Team B/C.

Table 12: Subset of geonom (Eurostat) to FAO codes mapping

| code | faostat | active | name |
|---|---|---|---|
| 1 | 68 | 68 | France |
| 2 | 15 | 15 | Belg.-Luxbg |
| 3 | 150 | 150 | Netherlands |
| 4 | 79 | 79 | Fr Germany |
| 5 | 106 | 106 | Italy |
| 6 | 229 | 229 | Utd. Kingdom |
| 7 | 104 | 104 | Ireland |
| 8 | 54 | 54 | Denmark |
| 9 | 84 | 84 | Greece |
| 10 | 174 | 174 | Portugal |

Area codes not mapping to any FAO country code are reported and the records for these area codes are

removed. All countries mapping to code 252 (which corresponds to undefined areas) are mapped to the 896 M49 code ("Other nei").

2. Commodity codes are reported in CN8 codes (*Combined Nomenclature 8 digits*). The codes are converted in FCL (*FAO Commodity List*) codes. This step is performed using the same HS to FCL mapping table as for UNSD Tariff line. If a specific record has a CN8 code not mapping to any specific FCL code, then it is stored, sent to Team B/C for mapping and re-incorporated after the link has been updated. If a country is not included in the mapping table for that specific year, all the records for the reporting country are removed, and will be mirrored in a subsequent step.
3. Information of the FCL units is added. This step is straightforward since for Eurostat the units are for the vast majority the same as FAO units.
4. Some commodity specific conversions are needed as Eurostat reports the figures in a different unit with respect to FAO. With respect to UNSD data, this is only needed for few commodities, namely: 1057, 1068, 1072, 1079, 1083, 1140, 1181.
5. Values are converted from EUR to USD using a table, stored in the SWS, with the official EUR/USD exchange rate for each year provided by Team B/C.

Table 13: EUR/USD exchange rates

| eusd_year | eusd_exchangerate |
|---|---|
| 2006 | 1.25565 |
| 2007 | 1.37064 |
| 2008 | 1.47171 |
| 2009 | 1.3928 |
| 2010 | 1.32689 |
| 2011 | 1.39141 |
| 2012 | 1.28557 |
| 2013 | 1.32816 |
| 2014 | 1.32884 |
| 2015 | 1.109625 |

### 1.2.3 Pre-processing reports

The module generates various indicators/statistics on the raw data that are combined into different pre-processing reports (PPRs). The following PPRs are available in the "trade-reports" SWS domain:

1. Reporters by year
2. Non-reporting countries
3. Number of records by reporter/year
4. Missing data by report
5. Check qty and value included
6. Import and export content check

For a detailed explanation of what the PPR contain and how to update them, see the document "Trade Module: Plug-in Pre-Processing Report". Note that these tables are *not* saved automatically to SWS, but need to be uploaded by using the `pre_processing_report` plugin.

### 1.2.4 Unified Official Trade Flows Dataset

UNSD Tariff line and Eurostat datasets are ready to be merged together. Thus, the resulting table has all the countries worldwide.

### 1.2.5 Standardization, editing and outlier detection

#### 1.2.5.1 Unit Values computation

For each record having both quantity and value (thus excluding all commodity reported just as value), the unit value ($uv$) is computed as following:

$$uv = \frac{value}{quantity}$$

#### 1.2.5.2 Missing Quantities Imputation

For records where the commodity has to be reported in quantity and the quantity is missing and the value is present, the corresponding quantity is imputed dividing the corresponding value by a median unit value:

$$quantity = \frac{value}{uv_{median}}$$

The median unit value ($uv_{median}$) is obtained in a specific-to-generic fashion (in all cases, the unit values are calculated separately for imports and exports). A first attempt is done by calculating unit values at the most specific HS level (i.e., the one at which the quantity is expressed). If the number of partners for which this unit value can be calculated is greater than a certain threshold (currently 10) the median unit value across partner is calculated and used for imputation. If the first attempt fails (i.e., it is not possible to calculate a unit value at the most specific HS level), then the same approach is used by taking into account more generic HS levels, in particular at eight and six digits, and the most generic level for which a sufficient number of partners (at least 10) is available is used for calculating the median unit value. Usually a suitable median can be calculated at the 8-digit level or, at least, at the 6-digit level. However, if the previous strategies fail (which implies that there is not a sufficient number of partners in order to calculate the median) two attempts at calculating a non reporter-specific median unit values (i.e., median unit values valid for all reporters) are sequentially undertaken: by HS and by FCL. In most cases it should be possible to calculate the median unit value by HS, thus that the FCL level is used as the strategy of last resort. Actually, for completeness sake, the very last *fallback* is the median unit value by flow. This is the most generic unit value that can be used for imputation and is calculated just for precaution, as it is very unlikely that an appropriate more specific median unit value can not be calculated.

In short, the first one of the following median unit values that can be calculated is used for imputation (import and export unit values are always calculated separately):

1. most specific HS code, across partners;
2. 8-digit HS level, across partners;
3. 6-digit HS level, across partners;
4. most specific HS code, across reporters/partners;
5. FCL code of the most specific HS code, across reporters/partners;
6. by flow (without taking into account any commodity code; this is very unlikely to be applied).

#### 1.2.5.3 Outlier Detection and Imputation

In the current version of the module, **no automatic outlier imputation is carried out**. The reason is that by comparing the results of the module by correcting outliers and previous FAOSTAT data, the two different datasets presented remarkable differences. Indeed, it was found that the *uncorrected* data was on average more similar to previous FAOSTAT data. For this reason, **automatic** correction is not currently being used, relying on a semi-automatic (guided) correction workflow that is done through an external validation tool. The steps of the guided validation are the following:

1. a validation plugin for total trade is used that indicates which `reporter / commodity / flow / year` combination is likely to be an outlier. It computes various outlier detection routines on the data and assigns scores based on how many times a transaction has been found to be an outlier. This information is displayed on SWS by increasing levels of colouring that go from pale yellow to red, the last one being the one that indicates that a particular transaction has been found to be an outlier by all methods.
2. analysts select the series with outliers (by going from the most to the least severe cases) and use an interactive validation tool that allows to dig into the composition of total trade flows as it uses bilateral data. The tool displays the outliers, allows to use different methods for correcting them, and stores the correction that the analyst deemed required in a `corrections` dataset that is integrated into subsequent runs of the `complete_tf_cpc` trade module. In order to have more information on this topic, please see the validation tool documentation.

When no statistical-based imputation seems appropriate, analysts can "force" some values (e.g., obtained by consulting external sources) by overwriting the values saved on SWS and using "protected" flags. When the modules are run, these protected figures will not be overwritten by any figure generated by the module. The list of protected flags is shown in the following table ("BLANK" stands for an empty flag).

Table 14: Protected flags

| flagObservationStatus | flagMethod |
|---|---|
| E | c |
| E | f |
| E | h |
| I | c |
| M | - |
| T | - |
| T | h |
| T | p |
| BLANK | - |
| BLANK | p |
| BLANK | q |

The previous set of flags is a subset of the protected flags in `faoswsFlag::flagValidTable`. The difference is that as trade is concerned, the **(BLANK, c)**, **(BLANK, h)**, and **(T, c)** are flags actually given by the module, thus they should not be considered protected.

### 1.2.6 Mirroring

The module generates the list of non-reporting countries: these are the countries present as partners but missing as reporters. For these countries the mirroring routine is applied: the corresponding trade of the non-reporting countries are extracted from the partners, inverting the flows. The quantities are the same while the values are corrected by a factor of 12% due to the CIF/FOB (Cost, Insurance and Freight / Free on Board) conversion (i.e., original imports are divided by 1.12, while original exports are multiplied by 1.12).

There is also another condition for which mirroring is applied: when a flow is completely missing for a country when it is a reporter. For instance, if in a given year Tanzania did not report any flow as export, but did so for imports, the mirroring procedure will be used for exports.

## 1.3 Flags

The module assigns two types of flags ("Observation Status" and "Method") once some conditions are met.

The first flags that all data are given are a "BLANK" Observation Status flag and an "h" Method flag. They indicate that data are official and were harvested, respectively. After these, the different kind of flags, and the conditions that should be met in order to assign them, are reported in the document "Flag Management in the Trade module".

An observation can have multiple Observation Status flags and Method flags associated with it. The final flag is the "weakest" flag: the `flagWeightTable` table contains the weights that should be assigned to all flags, and the one with the lowest value prevails over the other flags. For instance, if two official transactions at the HS level are aggregated in one CPC code, then the "s" (for aggregation) Method flag will prevail over the two "h" (for harvested) Method flags of each transaction.

## 1.4 Conversion to FAO SWS standards

At this point data is almost ready to be saved in the SWS. Additional mapping and aggregation are necessary in order to respect the SWS standards:

- Conversion of FCL into CPC codes. This conversion is based on the table of conversion 2.1 expanded. If some FCL codes are not mapped to CPC, the corresponding records are filtered out. Since the mapping between FCL and CPC is one-to-one there is no aggregation at this point. The routine just adds the corresponding CPC code.
- Conversion from FAO country code to M49.
- Each row of the final output must be either quantity- or value-specific, while so far the module keeps this information in one row. The information is therefore split in two separate rows.

The first submodule saves the final output in the `completed_tf_cpc_m49` dataset, within the `trade` domain.

## 1.5 Use validation corrections

If corrections for the year for which the module is run exits, they will replace the data generated by the module. For instance, if the module generated 2 million tonnes for some item in some country, but in the validation process it was found that this figure suffers from an "order of magnitude" problem, because it was saved as tonnes while it should have actually be kilograms so that it got replaced by 2 thousand tonnes, 2 millions will be replaced by 2 thousand in the data that is processed. When values are replaced by validated figures, they get the **(I, e)** flags combination. Moreover, if a mirror flow exists it will be changed accordingly (in this case, the flags combination will be set to **(T, e)**).

The "corrections" mechanism was designed so that if the original figure that will be replaced is different from what the analyst corrected, the correction will be dropped. This can happen for different reasons, among which: raw data changed and pre-existing errors were corrected; the mapping table of a commodity was modified; etc.

Metadata for corrected figures is generated and will be saved on SWS.

## 1.6 Remove non-existent transactions

The module checks whether there are combinations of `reporter` / `partner` / `item` / `element` stored on SWS that is not generated by the module. If there is any, said combination(s) will be removed from SWS. Indeed, the module should generate all possible combinations of those dimensions and combinations that are not generated should not exist. These "non-existing" combinations can be present on SWS because they were generated in the past but they should not have been. Also in this case, possible reasons can be multiple: the module had a bug that got corrected; the mapping table was modified; etc. Given that the SWS R-API does not have an option to check whether some combinations are not going to be overwritten, this needs to be done code-side by performing a set difference on the combinations available in the module and those

generated by the module. Values and flags of the resulting combinations will be set to NA as there is actually no way to remove the observation. In any case result is substantially the same.

## 2 Total trade CPC

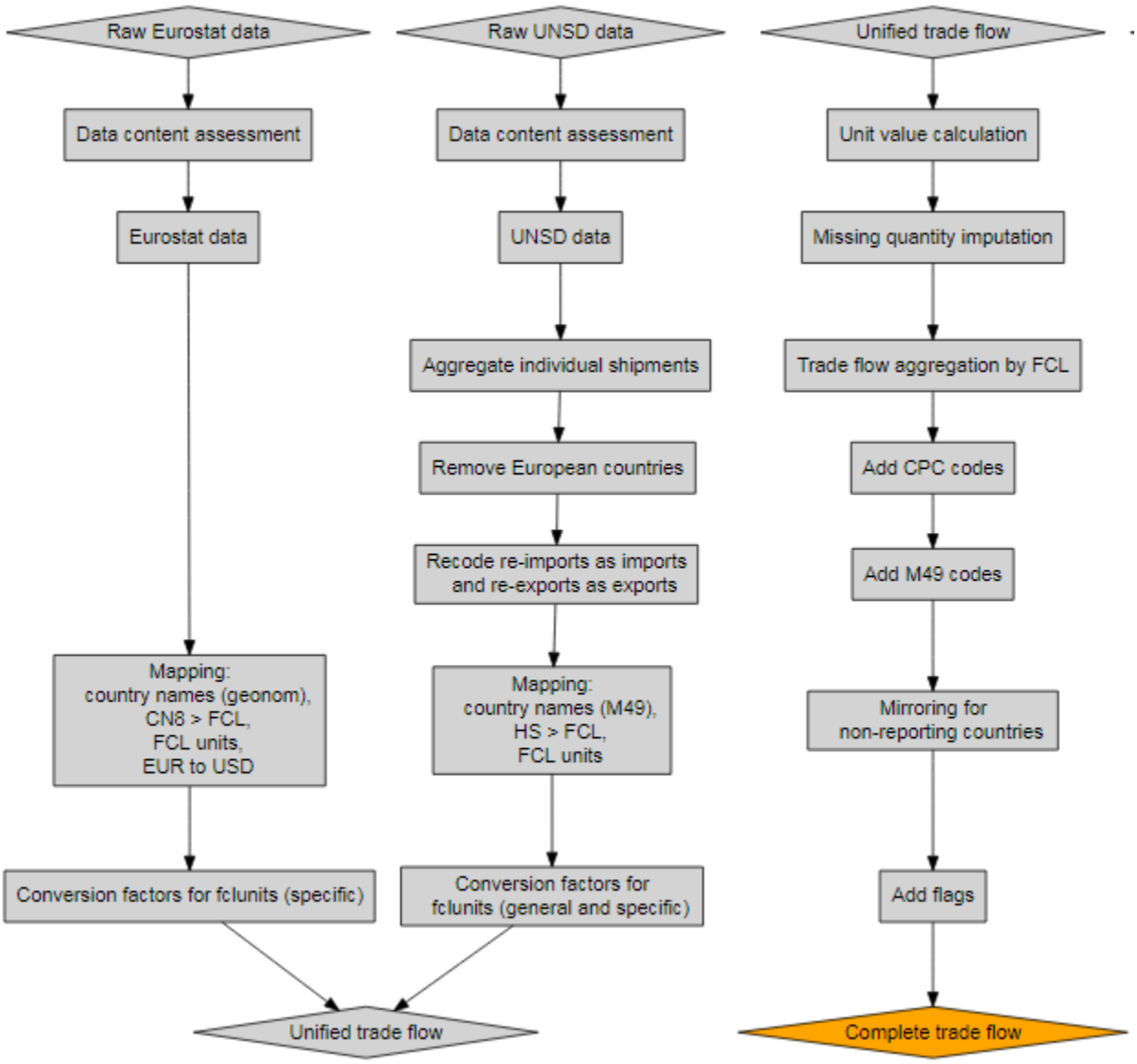
This second submodule uses as input the output of the previous submodule. It aggregates total trade flows by reporting country for partners countries to a single total trade for each unique CPC commodity code. As the previous one, this submodule works by year.

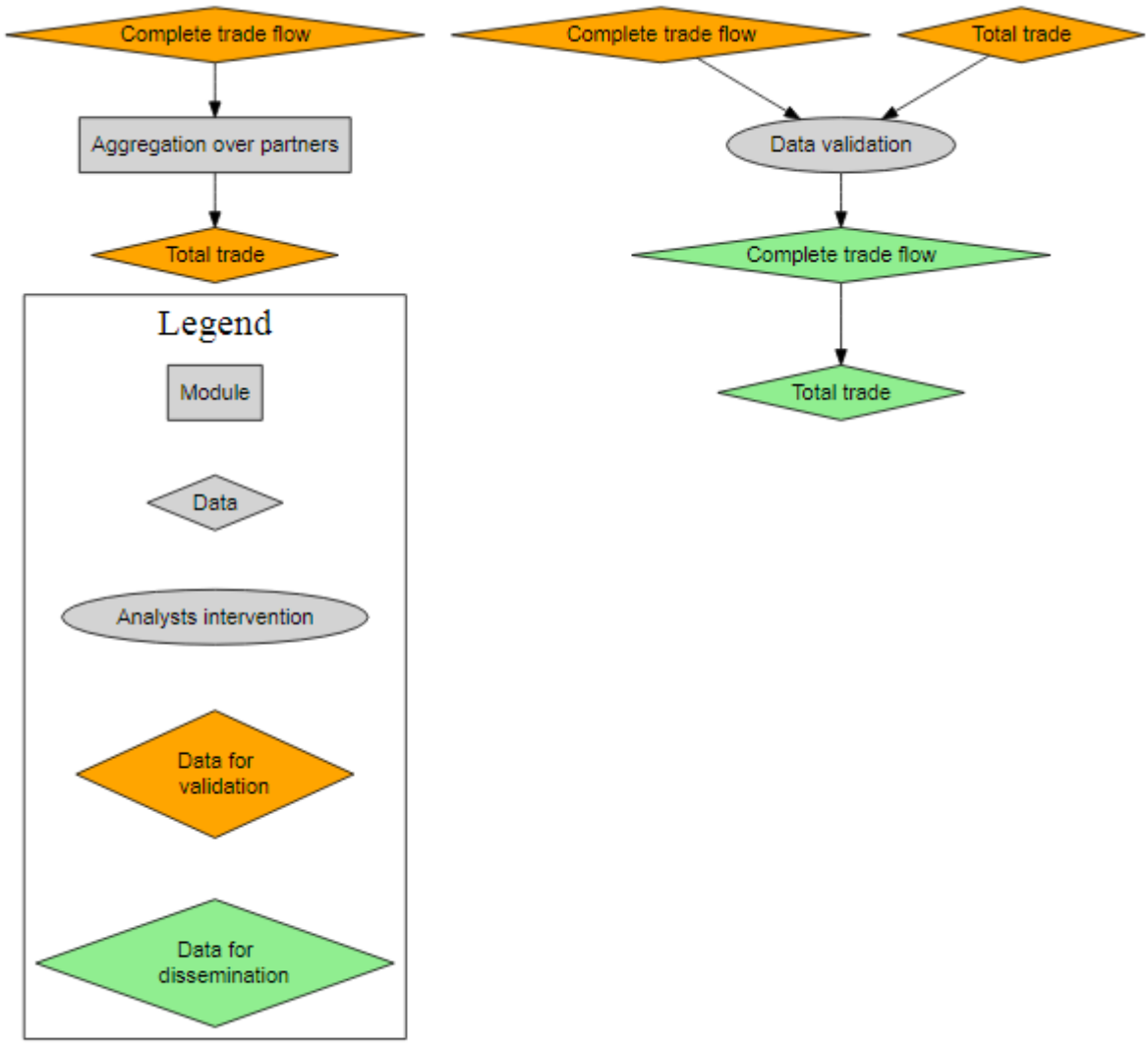
The module saves the output into the dataset `total_trade_cpc_m49`, within the `trade` domain.

As for the `complete_tf_cpc`, non-existent transactions are removed. In this case, the combinations to compare are composed by `reporter` / `item` / `element`.

## 3 Flow Chart Process

The whole process is displayed in the next flow chart.


Raw Eurostat data
Data content assessment
Eurostat data
Mapping:
country names (geonom),
CN8 > FCL,
FCL units,
EUR to USD
Conversion factors for fclunits (specific)
Raw UNSD data
Data content assessment
UNSD data
Aggregate individual shipments
Remove European countries
Recode re-imports as imports
and re-exports as exports
Mapping:
country names (M49),
HS > FCL,
FCL units
Conversion factors for
fclunits (general and specific)
Unified trade flow
Unified trade flow
Unit value calculation
Missing quantity imputation
Trade flow aggregation by FCL
Add CPC codes
Add M49 codes
Mirroring for
non-reporting countries
Add flags
Complete trade flow




# 4 Future work

## 4.1 Outlier identification/imputation at the bilateral level

Outliers were identified in a previous version of the `complete_tf_cpc` module and imputed automatically by using the median unit value with a specific-to-generic median unit value calculation, as explained above. Results were found to be unsatisfactory, thus automatic imputation was switched off. Said strategy could be supplemented by using information of neighbour or similar countries (e.g., the median unit value of Asian countries for a detailed HS level can be used for imputing an outlier for an Asian country instead of going up to the HS8 or HS6 level for the country itself as attempted in the specific-to-generic approach).

## 4.2 Destination Table

The `complete_tf_cpc` module produces output for all the records passing all the routines and not filtered out. The module does not check if any commodity is missing. A possible solution would be to have a destination table with all the commodities of interest and the module should fill the destination table. In this way the output validation step should be achieved.

## 4.3 CIF/FOB

The CIF/FOB correction for mirroring is, at the time being, set up to 12%. This has been suggested by team B/C. Additional work might be done in order to assess if this estimate is appropriate, but logic suggests that this is a very crude approximation. Indeed, there are different range of percentages for different type of countries and by distance between reporters and partners (e.g., the cost of transportation of a given commodity is definitely different if it is between France and Italy or France and Australia). A study can be conducted on available records on both sides: this means records for which the commodity is reported by the reporter and by the partner.

## 4.4 Re-import and Re-export

All re-imports and re-exports are considered as, respectively, imports and exports. More study might be conducted in order to identify countries more prone to report re-imports and re-exports.

## 4.5 Self Trade Analysis

- A script within the vignette folder, named selftrade.R, has been used to perform some simple analyses on the self trade. The script filter all records for which the reporter and the partner are the same. The script compute the sum of all value across all commodities per country (Figure 1), or the sum of all the value for each commodity across all countries (Figure 2). In this way we can spot out the countries reporting massive self trade as well as which are the main commodities reported in self trade.

  This is an example of the graphical output (still part of the script).

- This might be incorporated in the module and might produce suitable output within the SWS. More documentation is needed.

## 4.6 Pseudo-automatic mapping of commodities

An additional method could be added in the future: the algorithm should try to trim the code not mapped and try to map them with shorter HS codes. If any of shorter codes (from right to left) are then not mapped, we can definitely discard the record. If a specific record has a HS code not mapping to any specific FCL code, then the record is reported and removed.

## 4.7 Mapping from HS to FCL/CPC

In the module for commodities we have two different mappings. From HS to FCL, using a mapping table produced by team B/C and then from FCL to CPC 2.1. In the future direct mapping from HS to CPC has been asked from management. A possible solution, where adding the column with the one-to-one CPC codes has been sent to Carola (09.06.2016), but anyway this needs revision (link)

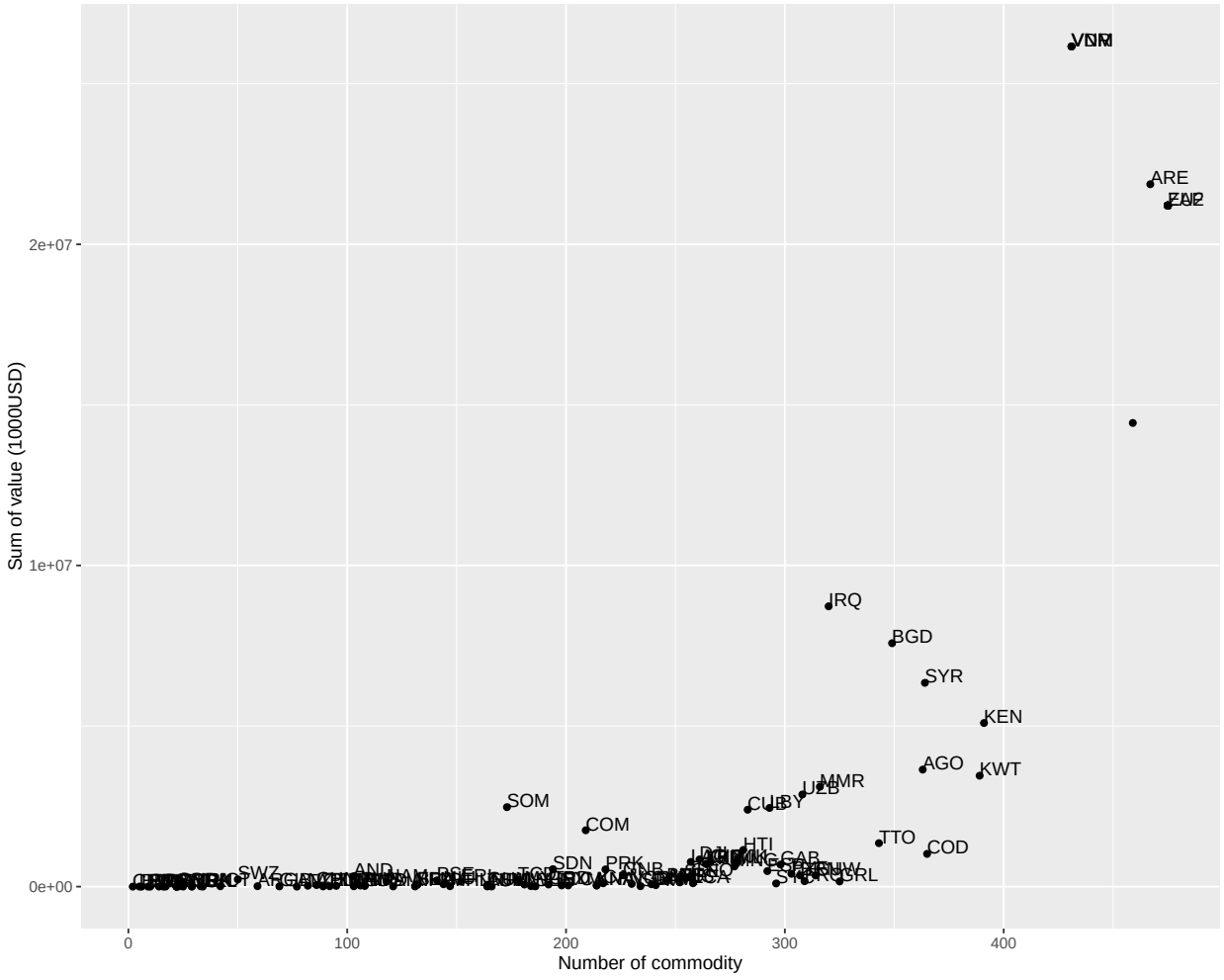



Figure 1: Sum of all self trade records by country.

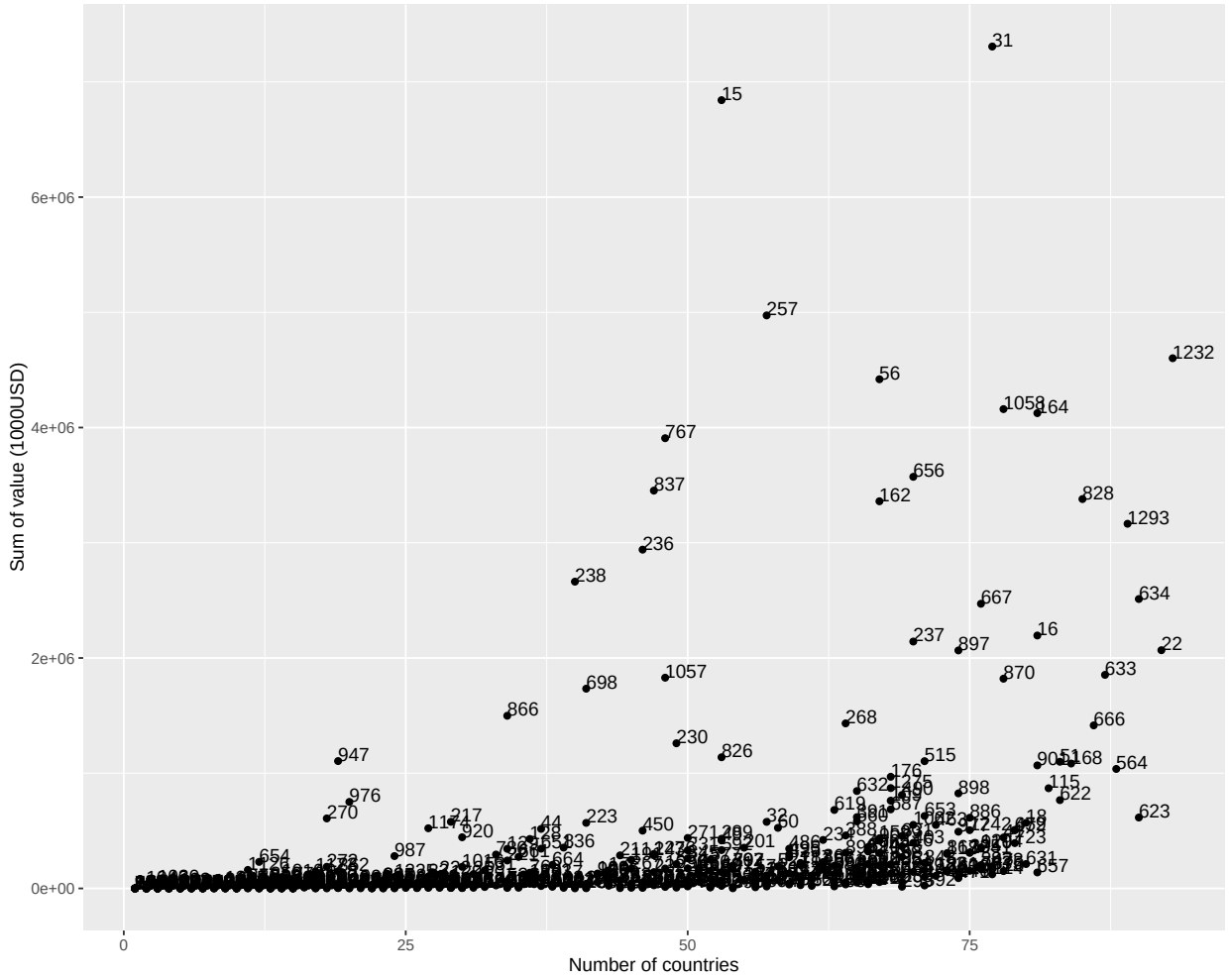



Figure 2: Sum of all self trade records by commodity. Codes in FCL.

### 4.8 Mapping from Comtrade M49 and Geonomenclature directly to M49

The country codes, as the commodity ones, have two steps of mapping. This results in higher risk of data loss due to unsolved mapping. A direct map from Comtrade M49 (Tariff line UNSD) to M49 and from Geonomenclature (Eurostat) to M49 would be ideal.

### 4.9 Food-aid

This has to be incorporated also to understand the trend in a time series analysis. This needs special study to understand if we can get the data just from the exports not reported as imports in the partner.

## Disclaimer