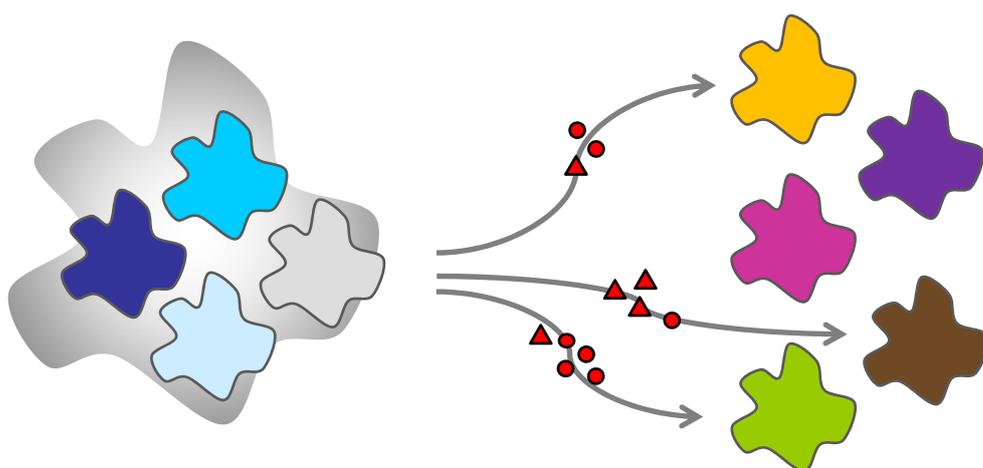




Estimation of trade flows related to export-controlled dual-use items

Data sources, methodology and tools

Cristina Versino and Giacomo G.M. Cojazzi



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O. Abstract

Dual-use items are goods and technologies that have both civil and military uses. In the European Union their export is controlled and governed by an EC regulation since the year 2000. Its implementation, in terms of legislation, export authorisations and customs controls, remains the responsibility of each of the 27 Member States. For reasons linked to the non-proliferation of weapons of mass destruction, competition in trade and free market rules, it is '*desirable to achieve a uniform and consistent application of controls throughout the EU in order to promote EU and international security and to provide a level playing field for EU exporters*' – as stated in the regulation.

How far is the goal? Hard to say since no official data about the trade of dual-use items are shared among Member States, nor with the European Commission, Directorate General Trade, in charge of the dual-use regulation.

This report presents sources of generic, statistical trade data and a methodology to *create an approximate picture of extra-EU trade flows of dual-use items*. The data stem from goods' declarations made by exporters to customs authorities as part of the normal export process for any commodity. The data are collected at national level, aggregated by categories of goods, and made public in web data services on trade. The data are referred to a commodity classification system, the Combined Nomenclature (CN), in use for customs controls in the EU. However the CN is only indirectly related to dual-use items. Correspondence tables exist that map dual-use items to CN descriptors, but they introduce approximations in the description of the items traded. For this reason the CN trade data provide, in the general case, upper bounds to the real trade volume of dual-use items.

Notwithstanding this limitation, the CN trade data may prove useful for some assessments needed for export controls. One example is presented in this report. It concerns the estimation of extra-EU trade flows for dual-use chemicals under consideration for inclusion in a Union General Export Authorisation (EU GEA). EU GEAs define a framework valid in all EU Member States whereby the export of selected categories of dual-use items to specific destination countries with a low risk of diversion is automatically authorised. An analysis of the volume of exports based on CN trade data allows estimating the impact expected on EU exporters by including given dual-use chemicals in an EU GEA.

To facilitate the estimation of extra-EU trade flows, it is proposed to develop a dedicated Information Technology tool merging lists of export-controlled items with correspondence tables of CN items' descriptors and export data. Such a tool can become a design and evaluation instrument to assess the economic impact of alternative policy options to regulate the European dual-use trade.

1. European Regulations on the export of dual-use items

Dual-use (DU) items are goods and technologies that can be used for both civil and military purposes [1]. In the European Union (EU) the export of dual-use items is governed since the year 2000 by Council Regulation *EC Reg 1334/2000* [2] and amendments, the regulation in force since 2009 being *EC Reg 428/2009* [3], very recently amended by *EC Reg 1232/2011* [4].

The regulation embeds internationally agreed dual-use controls including the Wassenaar Arrangement (WA) [5], the Missile Technology Control Regime (MTCR) [6], the Nuclear Suppliers' Group (NSG) [7], the Australia Group (AG) [8] and the Chemical Weapons Convention (CWC) [9].

1.1. Key facts about the dual-use regulation

Are as follows:

- Annex I to EC Reg 428/2009 identifies a *single list* of dual-use items (built from lists published by the above controls) whose export is to be controlled by EU Member States (MS). Exporting items listed in Annex I requires prior *authorisation*¹ by national licensing authorities.
- Exception is made for the export of certain items to 'low risk' destination countries (as per Annex II) under the *Union General Export Authorisation*² (EU GEA) framework whereby no authorisation is needed. EU GEAs are an EU-wide generalisation of national GEAs implemented by some MS (e.g., France, Germany, Greece, Italy, Sweden, the Netherlands, and the UK). EU GEAs are meant to facilitate the trade of dual-use items when the 'risk of diversion is low' (given the destination country) and the extra-EU trade flow is significant in terms of volume (value and/or quantity). At present, six EU GEA are defined [4][10]:
 - EU001: Export of most Annex I items to Australia, Canada, Japan, New Zealand, Norway, Switzerland, and the United States
 - EU002: Export of certain dual-use items to certain destinations
 - EU003: Export after repair/replacement
 - EU004: Temporary export for exhibition or fair
 - EU005: Telecommunications
 - EU006: Chemicals
- Due to the common market and the free movement of goods within the EU territory, *intra-community transfers* are not regulated, except for strategic dual-use items listed in *Annex IV*. Transfers within the EU of these items need to be authorised³.
- Authorisation shall also be required for the export of certain dual-use items not listed in Annex I, to all or certain destinations, when deemed necessary by MS⁴ on grounds of non-proliferation or security concerns. These cases include so-called '*catch-all*' controls, i.e. controls on items besides those listed in Annex I.
- Besides EC Reg 428/2009, other regulations restrict the export of specific items to given destinations to implement i.a. resolutions by the United Nations Security Council. This is the case with the Council regulation on restrictive measures against Iran *EC Reg 423/2007* [11] and amendments, the current regulation being *EC Reg 961/2010* [12]. This regulation lists items whose export to Iran is either prohibited or requires authorization. Another example is the regulation on restrictive measures against the Democratic People's Republic of Korea, first published as *EC Reg 329/2007* [13], presently amended by *EC Reg 567/2010* [14].

¹ EC Reg 428/2009 Article 3(1).

² EU GEAs were named Community General Export Authorisations (CGEAs) in EC Reg 428/2009. See EC Reg 428/2009, Article 9(1).

³ EC Reg 428/2009, Article 22(1).

⁴ EC Reg 428/2009, Articles 4(1), 8(1).

1.2. The need for harmonisation

The dual-use regulation states:

'It is desirable to achieve a uniform and consistent application of controls throughout the EU in order to promote EU and international security and to provide a level playing field for EU exporters⁵.

While the 27 MS retain the responsibility of implementing export controls at national level (in terms of legislation, licensing and customs controls), DG TRADE in the European Commission is responsible for managing the dual-use regulation and to favour the harmonisation of export controls in the EU. Activities in this direction include [15]:

1. Promoting the definition and use of EU GEAs which apply to all MS equally (instead of national GEAs).
2. Chairing the Dual-Use Coordination Group⁶ participated by MS to examine questions concerning the application of the regulation.
3. Organising peer-review visits in MS to exchange practices in export controls.
4. Launching of a training programme on EU export controls for licensing and customs officials.

Related to harmonisation issues, it is noted that these are hard to assess in a factual way as presently *no data about the export of dual-use items (e.g. licenses or actual exports) are shared among MS nor with the Commission*. Knowing these data would help informing the EU policy-making on dual-use trade, especially regarding points 1. and 2. above. Specifically:

- Data about the past exports of dual-use items would help configure EU GEAs by groups of items where *significant* exports exist in terms of value or quantity traded towards low risk destination countries.
- Recent trade flows would allow monitoring the impact of implemented EU GEAs in comparison with the *status quo*.
- A picture of EU exports by MS, dual-use item and destination country would help framing discussions on the practical application of export controls in MS in meetings of the Dual-Use Coordination Group.

In the next Section we introduce *generic, statistical trade data sources that can help creating an approximate picture of extra-EU trade flows of dual-use items*. This approach is proposed as currently no better data are available to support assessments on the harmonisation of export controls in the EU as a whole.

2. Web data services on global trade

Data services on global trade ([16]) referred to hereafter are *open source*, meaning that the data are available to anyone either for free or by a subscription fee.

In contrast to other sources on trade (such as news and specialized press on trade), the information provided by trade data services has a *regulatory origin* as it stems from declarations made by traders to *customs* authorities. Customs data are collected at national level and, by decision of individual States, published in *transactional* or *statistical* format in web data services [16]. The data are published respecting confidentiality requirements whose definition is country-specific.

⁵ EC Reg 428/2009, Preamble (18).

⁶ EC Reg 428/2009, Article 23(1).

2.1. Transactional trade data

Transactional data are close to declarations made by importers/exporters to customs. The scope of transactional data services can be national or multi-national. They are offered mostly by private companies against subscription fees. The geographical coverage of transactional trade data is uneven as not all countries in the world allow for their publication. Concerning the EU, no transactional data are available for EU27 MS [16]. For this reason, transactional data will not be further addressed in this report.

2.2. Statistical trade data

Statistical data are derived by aggregating transactional data by country, trade flow (import or export), period of time (months, years) and product categories as specified by the Harmonized System (HS, see Section 3) [17] and its subdivisions.

A typical statistical data record includes:

- Reporting country (the exporting or the importing country);
- Partner country in trade;
- Trade flow (import or export);
- Category of commodities (Harmonized System or a country-specific subdivision of HS);
- Time period (months or years);
- Cumulative value of the trade for the above fields;
- Cumulative quantity of trade for the above fields.

Statistical trade data are offered by international organizations, governmental organizations and national statistical offices, often for free or for limited fees. Private companies provide access to these data as pay services. The cost of the service is justified by valuable combinations of data sets, advanced interfaces to search and retrieve the data, meta-data information, and additional or more timely data.

The scope of statistical data services is in most cases multi-national. As an example, COMTRADE [18], by the United Nations Organisation, offers freely the largest geographical coverage, including 150 reporting countries with annual series of data. COMEXT [19] (Figure 1), by Eurostat (the Statistical Office of the European Union), is a second example. Focused on European reporting countries, COMEXT provides, freely, monthly and annual records on EU trade. GTA [20] (Figure 2), by Global Trade Information Services, offers for subscription fee monthly and annual records for about 80 reporting countries, including all EU countries.

For the purpose of estimating extra-EU trade flows of dual-use items we will use EU statistical data available from COMEXT and GTA.

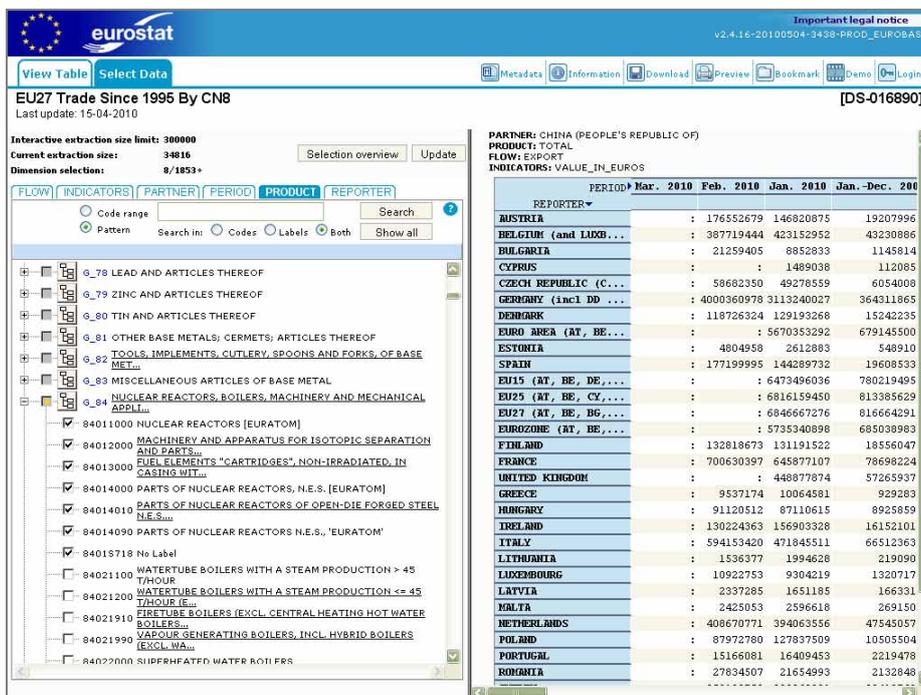


Figure 1 – Setting query parameters in COMEXT External Trade Database.

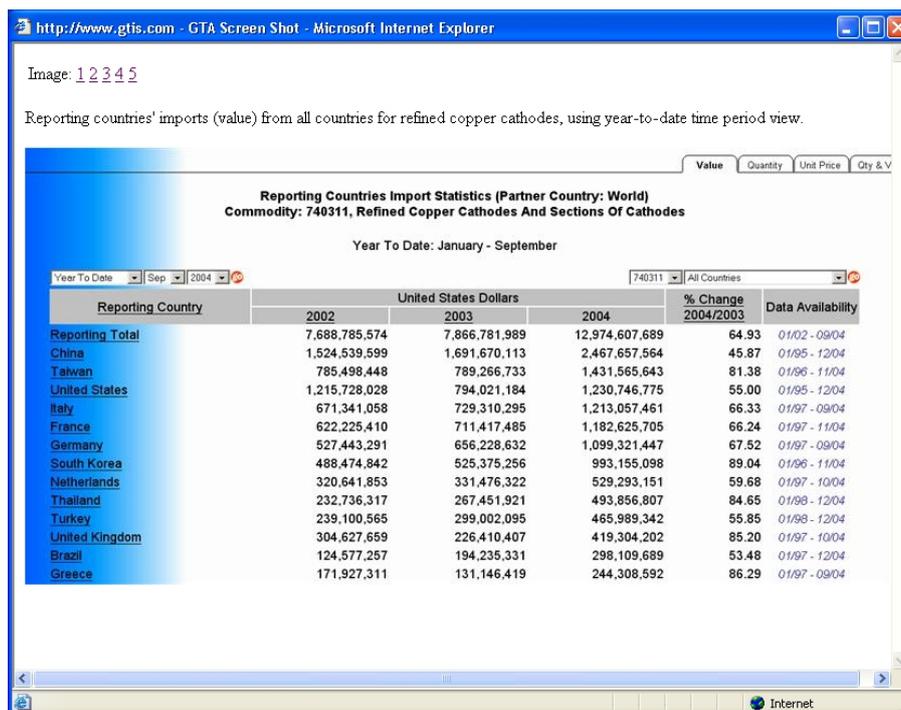


Figure 2 – Report from the Global Trade Atlas.

3. Methodology for the estimation of trade flows for dual-use items

Hereby we consider how to relate items listed for export controls with descriptors needed for retrieving trade data from web services. To estimate extra-EU trade flows of DU items, we are interested in *linking items in Annex I of EC Reg 428/2008 to Harmonized System descriptors* (or its subdivisions) used in web data services on global trade. We use an example to illustrate this process.

3.1. Structure of EC Reg 428/2009 Annex I

Items are presented in Annex I as a single list merging several control lists originated from the Wassenaar Arrangement [5], the Missile Technology Control Regime [6], the Nuclear Suppliers' Group [7], the Australia Group [8] and the Chemical Weapons Convention [9].

The structure of Annex I mirrors the structure of the Wassenaar lists. Items are grouped in 10 categories, numbered 0 to 9 (Table 1). Each category contains 5 sub-categories named by letters A to E (Table 2). Within subcategories, items are identified by a 3-digit number, and eventually by subdivisions indicated by letters alternated with numbers separated by dots. Except for Category 0, the first digit to the left indicates the origin of the control as follows:

- 0: Wassenaar Arrangement
- 1: Missile Technology Control Regime
- 2: Nuclear Suppliers Group
- 3: Australia Group
- 4: Chemical Weapons Convention.

The second and third digits are to number items. An item is identified in Annex I by a *DU code* (Figure 3) obtained by concatenating its category, sub-category, 3-digit number, dot letter dot number etc. The DU code is followed by a textual description of the item, possibly including notes and technical notes. Table 1 indicates the number of DU items per category on Annex I. The total number of items is 2231 [21] when counting the most detailed codes.

<i>Category</i>	<i>Title</i>	<i>Nr. of items</i>
0	NUCLEAR MATERIALS, FACILITIES, AND EQUIPMENT	148
1	SPECIAL MATERIALS AND RELATED EQUIPMENT	560
2	MATERIALS PROCESSING	270
3	ELECTRONICS	254
4	COMPUTERS	39
5	TELECOMMUNICATIONS AND 'INFORMATION SECURITY'	128
6	SENSORS AND LASERS	427
7	NAVIGATION AND AVIONICS	123
8	MARINE	104
9	AEROSPACE AND PROPULSION	176
	<i>ALL ANNEX I</i>	<i>2231</i>

Table 1 – Categories of EC Reg 428/2009 Annex I.

<i>Sub-category</i>	<i>Title</i>
A	Systems, Equipment and Components
B	Test, Inspection and Production Equipment
C	Materials
D	Software
E	Technology

Table 2 – Sub-categories of EC Reg 428/2009 Annex I.

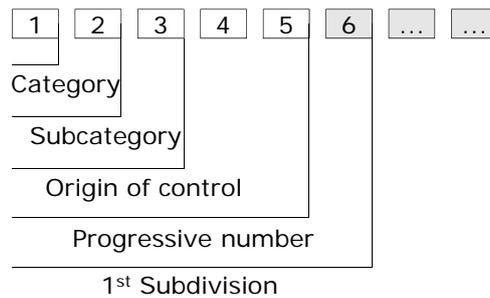


Figure 3 – Structure of Dual-Use (DU) codes in EC Reg 428/2009 Annex I.

Example. Chemicals which may be used as precursors for toxic chemical agents are listed as item 1C350 in Annex I of EC Reg 428/2009 (Figure 4). They are part of Category 1 on 'SPECIAL MATERIALS AND RELATED EQUIPMENT', and sub-category C on 'Materials'.

Item 1C350 includes 63 chemicals (numbered 1. to 63.). Each chemical is listed by its name (not unique) and the CAS (Chemical Abstracts Service) Registry Number [22], a numeric identifier designating only one substance.

1C350 items are drawn from the Australia Group list on chemical weapons precursors. Some – not all – are also listed by the Chemical Weapons Convention which groups them by three 'Schedules' (numbered 1 to 3). Schedules give an indication of a chemical's 'proliferation risk' [23]:

- Schedule 1 toxic chemicals have little or no peaceful commercial or industrial use (e.g., 1C350.4. Methyl phosphonyl difluoride).
- Schedule 2 precursors are produced in limited quantities for non-prohibited commercial uses (e.g., 1C350.1. Thiodiglycol), such as the production of insecticides, herbicides, lubricants, flame retardants and pharmaceuticals.
- Schedule 3 precursors are produced in significant quantities because they have several commercial uses (e.g., 1C350.2 Phosphorus oxychloride).

29.5.2009	EN	Official Journal of the European Union	L 134/75
1C350	Chemicals, which may be used as precursors for toxic chemical agents, as follows, and "chemical mixtures" containing one or more thereof:		
	N.B.: SEE ALSO MILITARY GOODS CONTROLS AND 1C450.		
	1. Thiodiglycol (111-48-8);		
	2. Phosphorus oxychloride (10025-87-3);		
	3. Dimethyl methylphosphonate (756-79-6);		
	4. SEE MILITARY GOODS CONTROLS FOR Methyl phosphonyl difluoride (676-99-3);		
	5. Methyl phosphonyl dichloride (676-97-1);		
	6. Dimethyl phosphite (DMP) (868-85-9);		
	7. Phosphorus trichloride (7719-12-2);		

Figure 4 – First 7 chemicals listed under item 1C350 in Annex I of EC Reg 428/2009.

3.2. Structure of the Harmonized System and subdivisions

The Harmonized System (HS) [17] is the reference taxonomy for commodities adopted by States adhering to the World Customs Organisation (WCO), trade associations and statistical offices in the majority of world countries.

HS is based on about 5,000 commodity groups organized within 22 Sections in a hierarchy made up of:

- Chapters,
- Headings
- Subheadings.

Each level in the hierarchy is identified by an HS code and an explanatory note. Codes are 2-digit for Chapters, 4-digit for Headings and 6-digit for Subheadings (Figure 5).

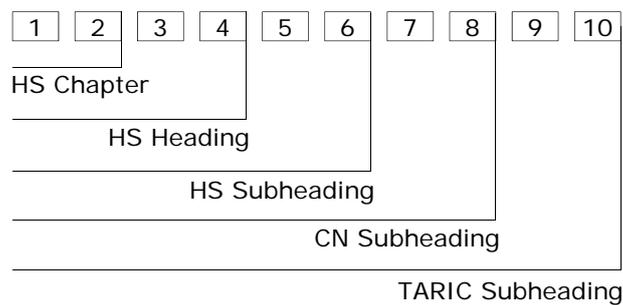


Figure 5 – Structure of the Harmonized System code and its CN and TARIC subdivisions valid in the EU.

Beyond the HS, national subdivisions of the HS exist of 8, 10, digits or more to describe goods at a finer level of detail.

EU MS use the 8-digit subdivision named Combined Nomenclature (CN) [24] [25] and the 10-digit subdivision named TARIC (for 'Online customs tariff database') [26]. The CN is made of 9500 Subheadings. TARIC includes 22300 Subheadings. In what follows we will consider the CN subdivision because trade data of interest is published at this level of detail for EU MS.

Example. Chlorides and chloride oxides are described in HS by the sequence of codes 28 → 2812 → 2812.10 and the explanatory notes given in Table 3. Further subdivisions of the HS lead to more specific categories that are country-specific. In this example the 8-digit code reported in Table 3 (2812.10.11) is a CN code valid in the EU for Phosphorus trichloride oxide “phosphoryl trichloride”.

CODE	EXPLANATORY NOTE
28	INORGANIC CHEMICALS; ORGANIC OR INORGANIC COMPOUNDS OF PRECIOUS METALS, OF RARE-EARTH METALS, OF RADIOACTIVE ELEMENTS OR OF ISOTOPES.
2812	Halides and halide oxides of non-metals.
2812.10	Chlorides and chloride oxides.
2812.10.11	Phosphorus trichloride oxide “phosphoryl trichloride”.

Table 3 – Codes and explanatory notes for Chapter (2-digit), Heading (4-digit) and Subheading (6-digit) leading to a HS category for chlorides and chloride oxides. A further subdivision leads to a more detailed CN category valid in the EU for phosphorus trichloride oxide “phosphoryl trichloride”.

3.3. Correspondence tables

Since EU trade data are reported by the CN, a condition to access relevant data is to relate items of interest with CN codes. Generally two approaches are possible. The *first* is to browse the CN guided by its hierarchical structure or through a textual search on keywords. This approach requires specific expertise and technical knowledge of the commodities for which the CN code is sought. The *second* approach is to consult correspondence tables compiled by experts associating CN codes to items of interest. In our context, tables of interest are those relating items listed in EC Reg 428/2009 Annex I to CN codes. Two such tables exist:

- **The EU Correlation Table (EU CT)** [27] – Developed by DG TAXUD, this table maps 572 unique DU codes to 981 unique CN codes. The EU CT was developed to inform EU exporters about goods that *could* fall within the scope of EC Reg 428/2009 Annex I. To this goal the EU CT is embedded in the TARIC database [26].
- **Umschlüsselungsverzeichnis (UV)** [28] – The German export control authority BAFA publishes on its web site a correspondence table intended to inform German exporters about restrictions that apply to the trade of dual-use items. It is a PDF document organized by sections of the HS. The document can be searched only by text. While the privileged order of consultation of the table is in the direction: CN codes → DU codes, a full text search can be run on the set of PDF documents to derive the converse: DU codes → CN codes. The UV maps 380 unique DU codes to 880 unique CN codes.

The EU Correlation Table and the Umschlüsselungsverzeichnis were developed independently and are different. A detailed comparative table is presented in [29]. The comparative table is ordered by dual-use codes followed by their meaning, the list of associated CN codes, with their meaning, and the table of origin for the association DU → CN, which can be either the EU CT, the UV, or both. A part of this table for some dual-use chemicals is shown in Table 6.

In general, any mapping between export-controlled items and CN items is many-to-many. A DU item may be related to several CN items, and viceversa. CN items introduce a degree of approximation in the description of export-controlled items. For this reason, *any trade volume estimated by CN-based data has to be read in general as an upper-bound of the real export-controlled trade.*

Example 1. *The export-controlled chemical 1C350.2., Phosphorus oxychloride, is related to one HS 6-digit code (2812.10), and, more specifically, to one CN code (2812.10.11) as in Table 3. The CN explanatory note identifies 1C350.2 quite precisely. Hence trade data indexed by this CN should portrait EU exports of 1C350.2. with good accuracy.*

Example 2. *The export-controlled chemicals 1C350.49., Diethylaminoethanol, and 1C350.53., Triethanolamine hydrochlorid, are related to the same three CN codes reported in Table 4. Trade data related to these CN codes will describe EU exports of 1C350.49. and 1C350.53. as an upper bound of the real trade.*

CN CODE	CN EXPLANATORY NOTE
2922.13.90	Salts of triethanolamine
2922.19.80	Amino-alcohols, their ethers and esters; salts thereof (other than those containing > one kind of oxygen function and excl. monoethanolamine, diethanolamine, triethanolamine, dextropropoxyphene "INN" and their salts, and N-ethyl-diethanolamine and 2,2"-methyliminodiethanol "N-methyl-diethanolamine")
2922.50.00	Amino-alcohol-phenols, amino-acid-phenols and other amino-compounds with oxygen function (excl. amino-alcohols, amino-naphthols and other amino-phenols, their ethers and esters and salts thereof, amino-aldehydes, amino-ketones and amino-quinones, and salts thereof, amino-acids and their esters and salts thereof)

Table 4 – CN codes and explanatory notes related to 1C350.49., diethylaminoethanol, and 1C350.53., triethanolamine hydrochlorid.

4. Case study on a EU GEA on dual-use chemicals

This Section presents a case study on extra-EU trade flows of dual-use chemicals. The study supported DG TRADE in the preparation of E006 [4], the Union General Export Authorisation for exports of chemicals to the following destinations:

- Argentina
- Croatia
- Iceland
- South Korea (ROK)
- Turkey
- Ukraine.

A set of 41 chemicals drawn from AG [8] and CWC [9] control lists were considered grouped as follows (Table 5):

- G01: Weapon precursors listed only by the AG (i.e., not listed by the CWC).
- G02: Weapon precursors listed by the AG and corresponding to Schedule 3B of the CWC.
- G03: Toxic chemicals corresponding to Schedule 3A of the CWC.
- G04: Toxic chemical precursor corresponding to Schedule 3B of the CWC.

For each chemical Table 5 indicates its GROUP, DU CODE and textual description (DU MEANING) as per EC Reg 428/2009 Annex I.

To map these chemicals to CN descriptors we consulted⁷ both the EU Correlation Table (EU CT) and the Umschlüsselungsverzeichnis (UV) (Table 6). Out of 48 DU CODE/CN CODE pairs, the EU CT and the UV agree on 30 pairs (62.5% agreement). The agreement is on DU chemicals for which an exact CN description exists (e.g., 1C350.7, 1C350.38, 1C350.52, ...), but not exclusively (e.g., see 1C350.14, 1C350.16, 1C350.20, ...). As noted earlier, for DU chemicals with a precise CN description one can expect the estimated trade flow to be close to real exports. For the other cases, the data are to be read as upper bound of the real EU exports.

The total number of unique CN codes identified in Table 6 is 36. We queried GTA [20] on these codes for EU27 exported quantities towards the six destination countries of interest over three years (2007-2009). Results are presented in Figure 6, Figure 7, and Figure 8.

Figure 6 shows the exported quantities over time. The table is sorted by 2009 decreasing quantities. To ease the reading of the data, CNs are put in correspondence with the DU chemicals concerned. The Figure shows that:

- Exports are non-null for 28 CNs out of the 36 CNs queried.
- For some of these 28 CNs the export is marginal (only few tons per year).
- With respect to the chemicals' groups, most traded are G01 and G02. Exports on G03 and G04 are marginal.
- Over the years there is a slight increase in exports, but the main categories of trade remain stable.
- Two categories that increased are Sodium Cyanide (28271100) and Thionyl dichloride thionyl chloride (28121095).
- Other two CNs categories that appear to have increased (29055998 and 29211985) did not exist in the Combined Nomenclature classification before 2009. This means that trade in these categories was previously declared under other CNs.

⁷ The two tables have been used as they are. A review of these correspondences is out of the scope of this report.

Figure 7 shows the 2009 data detailing the destination countries. The main importers stand out: ROK, Argentina and Turkey.

Figure 8 details for 2009 data the EU exporting countries with respect to chemicals and destinations. Strictly speaking this level of detail is not required for the design of Union General Export Authorisations. It is reported here to illustrate that this information can be made available when relevant. One such an endeavour could be the Dual-Use Coordination Group when discussing the practical application of export controls in the EU Member States.

GROUP	DU CODE	DU MEANING
G01	1C350.10.	3-Hydroxy-1-methylpiperidine (3554-74-3);
	1C350.14.	Potassium fluoride (7789-23-3);
	1C350.15.	2-Chloroethanol (107-07-3);
	1C350.16.	Dimethylamine (124-40-3);
	1C350.20.	Dimethylamine hydrochloride (506-59-2);
	1C350.24.	Hydrogen fluoride (7664-39-3);
	1C350.25.	Methyl benzilate (76-89-1);
	1C350.37.	3-Quinuclidone (3731-38-2);
	1C350.39.	Pinacolone (75-97-8);
	1C350.40.	Potassium cyanide (151-50-8);
	1C350.41.	Potassium bifluoride (7789-29-9);
	1C350.42.	Ammonium hydrogen fluoride or ammonium bifluoride (1341-49-7);
	1C350.43.	Sodium fluoride (7681-49-4);
	1C350.44.	Sodium bifluoride (1333-83-1);
	1C350.45.	Sodium cyanide (143-33-9);
	1C350.47.	Phosphorus pentasulphide (1314-80-3);
	1C350.48.	Di-isopropylamine (108-18-9);
	1C350.49.	Diethylaminoethanol (100-37-8);
	1C350.50.	Sodium sulphide (1313-82-2);
	1C350.53.	Triethanolamine hydrochloride (637-39-8);
1C350.58.	Triisopropyl phosphite (116-17-6);	
1C350.60.	O,O-Diethyl phosphorothioate (2465-65-8);	
1C350.61.	O,O-Diethyl phosphorodithioate (298-06-6);	
1C350.62.	Sodium hexafluorosilicate (16893-85-9);	
G02	1C350.2.	Phosphorus oxychloride (10025-87-3);
	1C350.6.	Dimethyl phosphite (DMP) (868-85-9);
	1C350.7.	Phosphorus trichloride (7719-12-2);
	1C350.8.	Trimethyl phosphite (TMP) (121-45-9);
	1C350.9.	Thionyl chloride (7719-09-7);
	1C350.19.	Diethyl phosphite (762-04-9);
	1C350.30.	Triethyl phosphite (122-52-1);
	1C350.38.	Phosphorus pentachloride (10026-13-8);
	1C350.46.	Triethanolamine (102-71-6);
	1C350.51.	Sulphur monochloride (10025-67-9);
	1C350.52.	Sulphur dichloride (10545-99-0);
	1C350.59.	Ethyldiethanolamine (139-87-7);
G03	1C450.a.4.	Phosgene: Carbonyl dichloride (75-44-5);
	1C450.a.5.	Cyanogen chloride (506-77-4);
	1C450.a.6.	Hydrogen cyanide (74-90-8);
	1C450.a.7.	Chloropicrin: Trichloronitromethane (76-06-2);
G04	1C450.b.8.	Methyldiethanolamine (105-59-9)

Table 5 – List of chemicals under consideration for EU GEA E006. For each chemical the Table indicates the dual-use code (DU CODE) and its definition (DU MEANING) as reported in the EC Regulation.

<i>GROUP</i>	<i>DU CODE</i>	<i>DU MEANING</i>	<i>CN CODE</i>	<i>CN EXPLANATORY NOTE</i>	<i>EU CT</i>	<i>UV</i>
G01	1C350.10.	3-Hydroxy-1-methylpiperidine (3554-74-3)	29333999	Heterocyclic compounds with nitrogen hetero-atom[s] only, containing an unfused pyridine ring, whether or not hydrogenated, in the structure (excl. pyridine, piperidine, alfentanil INN, anileridine INN, bezitramide INN, bromazepam INN, difenoxin INN, diph ...)	X	
	1C350.14.	Potassium fluoride (7789-23-3)	28261990	Fluorides (excl. of ammonium, sodium, aluminium and mercury)	X	X
	1C350.15.	2-Chloroethanol (107-07-3)	29055998	Halogenated, sulphonated, nitrated or nitrosated derivatives of acyclic alcohols (excl. 2,2-bisbromomethylpropanediol and ethchlorvynol INN)		X
	1C350.16.	Dimethylamine (124-40-3)	29211100	Methylamine, dimethylamine or trimethylamine and their salts	X	X
	1C350.20.	Dimethylamine hydrochloride (506-59-2)	29211100	Methylamine, dimethylamine or trimethylamine and their salts	X	X
	1C350.24.	Hydrogen fluoride (7664-39-3)	28111100	Hydrogen fluoride hydrofluoric acid		X
			29211100	Methylamine, dimethylamine or trimethylamine and their salts	X	
	1C350.25.	Methyl benzilate (76-89-1)	29181985	Carboxylic acids with additional oxygen function and their anhydrides, halides, peroxides and peroxyacids; their halogenated, sulphonated, nitrated or nitrosated derivatives (excl. lactic acid, tartaric acid, citric acid, gluconic acid, cholic acid, 3-alp ...)	X	X
	1C350.37.	3-Quinuclidone (3731-38-2)	29333999	Heterocyclic compounds with nitrogen hetero-atom[s] only, containing an unfused pyridine ring, whether or not hydrogenated, in the structure (excl. pyridine, piperidine, alfentanil INN, anileridine INN, bezitramide INN, bromazepam INN, difenoxin INN, diph ...)	X	
	1C350.39.	Pinacolone (75-97-8)	29141990	Acyclic ketones without other oxygen function (excl. acetone, butanone methyl ethyl ketone, 4-Methylpentan-2-one Methyl isobutyl ketone and 5-methylhexan-2-one)	X	X
	1C350.40.	Potassium cyanide (151-50-8)	28371900	Cyanides and cyanide oxides (excl. sodium and mercury)	X	X
	1C350.41.	Potassium bifluoride (7789-29-9)	28261990	Fluorides (excl. of ammonium, sodium, aluminium and mercury)	X	X
	1C350.42.	Ammonium hydrogen fluoride or ammonium bifluoride (1341-49-7)	28261910	Fluorides of ammonium or of sodium	X	X
	1C350.43.	Sodium fluoride (7681-49-4)	28261910	Fluorides of ammonium or of sodium	X	X
	1C350.44.	Sodium bifluoride (1333-83-1)	28261910	Fluorides of ammonium or of sodium	X	X
	1C350.45.	Sodium cyanide (143-33-9)	28371100	Sodium cyanide	X	X
	1C350.47.	Phosphorus pentasulphide (1314-80-3)	28139010	Phosphorus sulphides, incl. commercial phosphorus trisulphide	X	X

Table 6 – Correspondence between chemicals of interest and Combined Nomenclature descriptors according to the EU Correlation Table (EU CT) and the Umschlüsselungsverzeichnis (UV).

GROUP	DU CODE	DU MEANING	CN CODE	CN EXPLANATORY NOTE	EU CT	UV
G01	1C350.48.	Di-isopropylamine (108-18-9)	29211985	Acyclic monoamines and their derivatives; salts thereof (excl. methylamine, dimethylamine, trimethylamine, diethylamine, and their salts, and 1,1,3,3-tetramethylbutylamine)	X	X
	1C350.49.	Diethylaminoethanol (100-37-8)	29221390	Salts of triethanolamine		X
			29221980	Amino-alcohols, their ethers and esters; salts thereof (other than those containing > one kind of oxygen function and excl. monoethanolamine, diethanolamine, triethanolamine, dextropropoxyphene INN and their salts, and N-ethyl-diethanolamine and 2,2"-meth ...	X	X
			29225000	Amino-alcohol-phenols, amino-acid-phenols and other amino-compounds with oxygen function (excl. amino-alcohols, amino-naphthols and other amino-phenols, their ethers and esters and salts thereof, amino-aldehydes, amino-ketones and amino-quinones, and salt ...		X
	1C350.50.	Sodium sulphide (1313-82-2)	28301000	Sodium sulphides	X	X
	1C350.53.	Triethanolamine hydrochloride (637-39-8)	29221390	Salts of triethanolamine	X	X
			29221980	Amino-alcohols, their ethers and esters; salts thereof (other than those containing > one kind of oxygen function and excl. monoethanolamine, diethanolamine, triethanolamine, dextropropoxyphene INN and their salts, and N-ethyl-diethanolamine and 2,2"-meth		X
			29225000	Amino-alcohol-phenols, amino-acid-phenols and other amino-compounds with oxygen function (excl. amino-alcohols, amino-naphthols and other amino-phenols, their ethers and esters and salts thereof, amino-aldehydes, amino-ketones and amino-quinones, and salt ...		X
	1C350.58.	Triisopropyl phosphite (116-17-6)	29209085	Esters of inorganic acids of non-metals and their salts; their halogenated, sulphonated, nitrated or nitrosated derivatives (excl. esters of hydrogen halides, phosphoric esters, sulphuric esters, carbonic esters and thiophosphoric esters phosphorothioates)		X
	1C350.60.	O,O-Diethyl phosphorothioate (2465-65-8)	29201900	Thiophosphoric esters phosphorothioates and their salts; their halogenated, sulphonated, nitrated or nitrosated derivatives (excl. parathion [ISO] and parathion-methyl [ISO] [methyl-parathion])		X

Table cont. – Correspondence between chemicals of interest and Combined Nomenclature descriptors according to the EU Correlation Table (EU CT) and the Umschlüsselungsverzeichnis (UV).

GROUP	DU CODE	DU MEANING	CN CODE	CN EXPLANATORY NOTE	EU CT	UV
G01	1C350.61.	O,O-Diethyl phosphorodithioate (298-06-6)	29201900	Thiophosphoric esters phosphorothioates and their salts; their halogenated, sulphonated, nitrated or nitrosated derivatives (excl. parathion [ISO] and parathion-methyl [ISO] [methyl-parathion])		X
	1C350.62.	Sodium hexafluorosilicate (16893-85-9)	28269080	Fluorosilicates, fluoroaluminates and other complex fluorine salts (excl. sodium hexafluoroaluminate synthetic cryolite, dipotassium hexafluorozirconate and inorganic or organic compounds of mercury)		X
G02	1C350.2.	Phosphorus oxychloride (10025-87-3)	28121011	Phosphorus trichloride oxide "phosphoryl trichloride"	X	X
	1C350.6.	Dimethyl phosphite (DMP) (868-85-9)	29209020	Dimethyl phosphonate dimethyl phosphite	X	X
	1C350.7.	Phosphorus trichloride (7719-12-2)	28121015	Phosphorus trichloride	X	X
	1C350.8.	Trimethyl phosphite (TMP) (121-45-9)	29209030	Trimethyl phosphite trimethoxyphosphine	X	X
	1C350.9.	Thionyl chloride (7719-09-7)	28121095	Thionyl dichloride thionyl chloride	X	X
	1C350.19.	Diethyl phosphite (762-04-9)	29209040	Triethyl phosphite		X
			29209050	Diethyl phosphonate diethyl hydrogenphosphite diethyl phosphite	X	
	1C350.30.	Triethyl phosphite (122-52-1)	29209040	Triethyl phosphite	X	
			29209050	Diethyl phosphonate diethyl hydrogenphosphite diethyl phosphite		X
	1C350.38.	Phosphorus pentachloride (10026-13-8)	28121016	Phosphorus pentachloride	X	X
	1C350.46.	Triethanolamine (102-71-6)	29221310	Triethanolamine	X	X
	1C350.51.	Sulphur monochloride (10025-67-9)	28121091	Disulphur dichloride	X	X
	1C350.52.	Sulphur dichloride (10545-99-0)	28121093	Sulphur dichloride	X	X
1C350.59.	Ethyldiethanolamine (139-87-7)	29221910	N-Ethyldiethanolamine		X	
G03	1C450.a.4.	Phosgene: Carbonyl dichloride (75-44-5)	28121094	Phosgene carbonyl chloride	X	X
	1C450.a.5.	Cyanogen chloride (506-77-4)	28530050	Cyanogen chloride	X	X
	1C450.a.6.	Hydrogen cyanide (74-90-8)	28111920	Hydrogen cyanide hydrocyanic acid	X	X
	1C450.a.7.	Chloropicrin: Trichloronitromethane (76-06-2)	29049040	Trichloronitromethane chloropicrin	X	X
G04	1C450.b.8.	Methyldiethanolamine (105-59-9)	29221920	2,2''-Methyliminodiethanol N-methyldiethanolamine	X	X

Table cont. – Correspondence between chemicals of interest and Combined Nomenclature descriptors according to the EU Correlation Table (EU CT) and the Umschlüsselungsverzeichnis (UV).

CN CODE	CN EXPLANATORY NOTE	GROUP	DU CODES	DU MEANING	UNIT	2007 EU EXPORT	2008 EU EXPORT	2009 EU EXPORT
29221980	Amino-alcohols, their ethers and esters; salts..	G01	1C350.49., 1C350.53.	Diethylaminoethanol; Triethanolamine hydrochloride	Tons	15,198	15,198	15,198
29225000	Amino-alcohol-phenols, amino-acid-phenols ..	G01	1C350.49., 1C350.53.	Diethylaminoethanol; Triethanolamine hydrochloride	Tons	10,000	10,000	10,000
28301000	Sodium sulphides	G01	1C350.50.	Sodium sulphide	Tons	5,000	5,000	5,000
29333999	Heterocyclic compounds with nitrogen hetero..	G01	1C350.10., 1C350.37.	3-Hydroxy-1-methylpiperidine; 3-Quinuclidone	Tons	5,000	5,000	5,000
29209085	Esters of inorganic acids of non-metals and t..	G01	1C350.58.	Triisopropyl phosphite	Tons	5,000	5,000	5,000
29055998	Halogenated, sulphonated, nitrated or nitros..	G01	1C350.15.	2-Chloroethano	Tons	5,000	5,000	5,000
28111100	Hydrogen fluoride hydrofluoric acid	G01	1C350.24.	Hydrogen fluoride	Tons	5,000	5,000	5,000
29181985	Carboxylic acids with additional oxygen funct..	G01	1C350.25.	Methyl benzilate	Tons	5,000	5,000	5,000
28371100	Sodium cyanide	G01	1C350.45.	Sodium cyanide	Tons	5,000	5,000	5,000
28121095	Thionyl dichloride thionyl chloride	G02	1C350.9.	Thionyl chloride	Tons	5,000	5,000	5,000
28269080	Fluorosilicates, fluoroaluminates and other co..	G01	1C350.62.	Sodium hexafluorosilicate	Tons	5,000	5,000	5,000
29211985	Acyclic monoamines and their derivatives; sa..	G01	1C350.48.	Di-isopropylamine	Tons	5,000	5,000	5,000
29211100	Methylamine, dimethylamine or trimethylami..	G01	1C350.16., 1C350.20.	Dimethylamine; Dimethylamine hydrochloride; Hydrogen fluoride	Tons	5,000	5,000	5,000
29141990	Acyclic ketones without other oxygen functio..	G01	1C350.39.	Pinacolone	Tons	5,000	5,000	5,000
29221310	Triethanolamine	G02	1C350.46.	Triethanolamine	Tons	5,000	5,000	5,000
29201900	Thiophosphoric esters phosphorothioates and..	G01	1C350.60., 1C350.61.	O,O-Diethyl phosphorothioate; O,O-Diethyl phosphorodithioate	Tons	5,000	5,000	5,000
28261910	Fluorides of ammonium or of sodium	G01	1C350.42., 1C350.43., 1C350.44.	Ammonium hydrogen fluoride or ammonium bifluoride; Sodium fluoride; Sodium fluoride	Tons	5,000	5,000	5,000
28261990	Fluorides (excl. of ammonium, sodium, alumi..	G01	1C350.14., 1C350.41.	Potassium fluoride; Potassium bifluoride	Tons	5,000	5,000	5,000
29221920	2,2"-Methyliminoethanol N-methyldiethano..	G04	1C450.b.8.	Methyldiethanolamine	Tons	5,000	5,000	5,000
28371900	Cyanides and cyanide oxides (excl. sodium a..	G01	1C350.40.	Potassium cyanide	Tons	5,000	5,000	5,000
29221910	N-Ethyldiethanolamine	G02	1C350.59.	Ethyldiethanolamine	Tons	5,000	5,000	5,000
28111920	Hydrogen cyanide hydrocyanic acid	G03	1C450.a.6.	Hydrogen cyanide	Tons	5,000	5,000	5,000
29209020	Dimethyl phosphonate dimethyl phosphite	G02	1C350.6.	Dimethyl phosphite (DMP)	Tons	5,000	5,000	5,000
29221390	Salts of triethanolamine	G01	1C350.49., 1C350.53.	Diethylaminoethanol; Triethanolamine hydrochloride	Tons	5,000	5,000	5,000
29209050	Diethyl phosphonate diethyl hydrogenphosph..	G02	1C350.19., 1C350.30.	Diethyl phosphite; Triethyl phosphite	Tons	5,000	5,000	5,000
29209040	Triethyl phosphite	G02	1C350.19., 1C350.30.	Diethyl phosphite; Triethyl phosphite	Tons	5,000	5,000	5,000
29209030	Trimethyl phosphite trimethoxyphosphine	G02	1C350.8.	Trimethyl phosphite (TMP)	Tons	5,000	5,000	5,000
28121094	Phosgene carbonyl chloride	G03	1C450.a.4.	Phosgene; Carbonyl dichloride	Tons	5,000	5,000	5,000

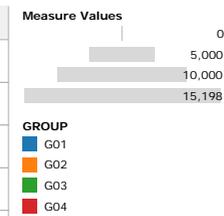


Figure 6 – EU exported quantities of selected chemicals over three years (2007-2009) to all destination countries in EU GEA 006. The table is sorted by 2009 decreasing exports.

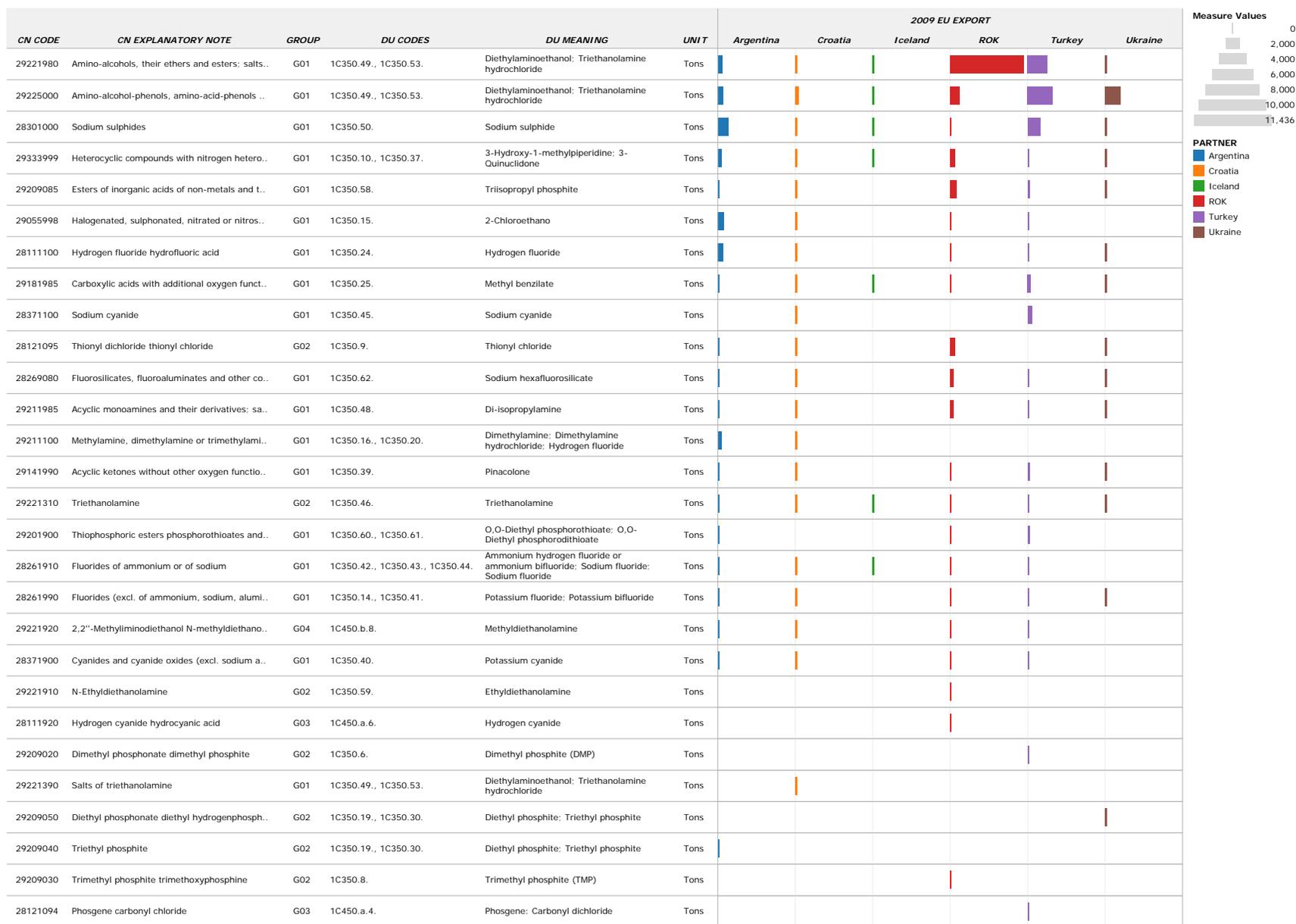


Figure 7 – EU exported quantities of selected chemicals in 2009 to each destination country in EU GEA 006.

5. Setting-up a prototype tool for the estimation of trade flows

The case study in the previous Section highlighted the steps necessary for the estimation of extra-EU trade flows for export-controlled items:

1. Select items of interest in EC Reg 428/2009 Annex I and identify them by their DU codes.
2. Map DU codes to CN codes by means of correspondence tables (such as the EU CT or the UV) or by browsing and searching directly the Combined Nomenclature.
3. Retrieve the trade data (expressed as quantity and/or value of trade) by querying a web data service on CN codes, EU MS as exporting countries, and destinations and time frames of interest.
4. Format, visualise and analyse the trade data.

Currently this procedure is to be run manually for each case study at hand. Generally the most costly steps in terms of work required are steps 3. and 4.

The number of queries in step 3. depends on (i) how queries on the web data service are set-up and on (ii) the level of trade detail sought.

For example, when using GTA it is convenient to:

- Define as a *product group* the CN codes of interest. GTA allows including up to 500 CN codes in a group.
- Restrict the reporting country scope to the EU27 MS: this excludes all other GTA reporting countries from the trade statistics.
- Define as a *country group* the destination countries of interest and activate the filter that shows the trade statistics for those recipient countries only.

In this way one can get by a single query the cumulative trade quantity (or value) of EU MS exports for the product group to the destination country group, as illustrated in Table 7 for the case study on EU GEA on dual-use chemicals. However, to get a detailed view on which products are traded the most, or to which destination countries, or by which EU MS, this requires extracting the data by *multiple queries*. For example, for the case study on chemicals to get the most detailed trade data it requires:

$$27 \text{ (EU MS)} \times 1 \text{ (product group of 36 CN codes)} \times 6 \text{ (destination countries)} = 162 \text{ queries}$$

Each query generates a table of data that must be downloaded individually and which looks like Table 8. All tables are then concatenated and formatted (as illustrated in Table 9) to enable the required data visualisation and analysis. Further, it is desirable to relate explicitly DU items to the query results which are expressed in terms of CN codes. This requires using the correlation tables in backward mode, i.e. from CN codes to DU codes.

The above steps would be speeded-up by the existence of an IT tool dedicated to the estimation of extra-EU trade flows of export-controlled dual-use items. The building blocks for such a tool would be:

- a. A tabular format of EC Reg 428/2009 of Annex I identifying DU items by DU codes and their textual description (as illustrated in Table 10). One such a table was developed by JRC for its The Big Table tool [21]. It can be re-used for the present purpose.
- b. A tabular format of the Combined Nomenclature identifying items by CN codes and their explanatory note (as illustrated in Table 11). Yearly revisions of the Combined Nomenclature are available in tabular format for download from Eurostat [25].
- c. A correspondence table relating DU items and CN items. These can be the EU CT and/or the UV (as illustrated in Table 12).
- d. Tabular trade data for extra-EU exports (in terms of quantity and value) by EU MS, for all CN items of interest, to all destinations and for several years measured at monthly level. Table 9 gives a simplified example of such a table. These trade data are available in codified format from Eurostat's bulk download site [30].

These tables would then be joined in a relational database by common fields to create new useful tables. For example, the trade data (Table 9) can be related to the DU CODEs in the correspondence table (Table 12) via the CN CODEs. In this way one can see the trade data w.r.t. to the DU CODE reference instead of the CN CODE reference. Further, this new table can be augmented by joining the DU CODEs with the DU MEANINGS from Table 10 to make it readable.

A demonstrator in this direction was developed as a proof of concept using the Tableau commercial software [31]. Tableau creates workbooks that connect to external user-prepared tables of data, imports them in a relational data extract, and makes the data available for visualisation, filtering, analysis. Tableau is highly interactive. The user can re-organize on the fly the way the tabular data is organized and displayed. The end-user of a Tableau workbook can either open it as a personal desktop copy using the freeware Tableau Reader, or access it over the web (via login) if the workbook is published with Tableau Server.

The Tableau workbook demonstrator (Figure 9) is on extra-EU exports to a selected destination country for all EC Reg 428/2009 Annex I items. We used the EU CT to relate DU items (about 500 distinct items) and CN items (about 1000 distinct items). The trade data (value of exports) was extracted for six years (2005-2010) by querying GTA. We defined two groups of CN codes of about 500 items each (the maximum allowed) and filtered the destination countries to show only the destination country related data. With this set-up, the data was extracted by:

$$27 \text{ (EU MS)} \times 2 \text{ (product group of 500 CN codes)} \times 1 \text{ (destination country)} = 54 \text{ queries}$$

Note that this step will no longer be required when all the trade data of interest are downloaded in bulk (see point c. above) and kept updated over time.

Figure 10 to Figure 20 show how the workbook is constructed and used.

First the trade data table is imported (Figure 10) in an empty workbook (Figure 11). This step joins the trade data with the EU Correlation Table (via CN CODEs) and with the EC Reg 428/2009 Annex I (via DU CODEs).

The workbook table is then built by dragging to the row and column shelves the dimensions of interest (e.g. REPORTERS as columns and CN CODEs and CN EXPLANATORY NOTES as rows, as in Figure 12 and Figure 13).

Now the table content can be defined by dragging the trade data into it (Figure 14, Figure 15). The data can be displayed as numbers (default) or by a visualisation modality of choice (e.g., the 'line' format in Figure 16).

The data is dynamically re-organised when new table dimensions are dragged on the row or column shelves. As an example, Figure 17 shows the trade data re-organized by DU CODEs and DU MEANING.

At this stage the table includes all trade data for all DU items, all CN items, all EU MS. It can be browsed as is, or it can be filtered on its dimensions or values. For example, Figure 18 shows the table filtered by matching a string on DU MEANING ('flow-forming machine'). Figure 19 shows the effect of filtering on CN MEANING (on the string 'laser'). Figure 20 shows filtering on a given EU REPORTER.

<i>EU REPORTING COUNTRIES EXPORT STATISTICS (PARTNER COUNTRIES: EU GEA E006-DESTINATION COUNTRIES)</i>				
<i>COMMODITY: CHEMICALS EU GEA E006</i>				
<i>ANNUAL SERIES: 2007 - 2009</i>				
<i>EU REPORTING COUNTRY</i>	<i>UNIT</i>	<i>QUANTITY</i>		
		<i>2007</i>	<i>2008</i>	<i>2009</i>
Austria	T	120	84	26
Belgium	T	870	773	2462
Bulgaria	T	0	0	2
Czech Republic	T	2	87	29
Denmark	T	382	191	305
Estonia	T	9	10	0
Finland	T	6	0	0
France	T	610	382	322
Germany	T	7201	7383	7480
Greece	T	7	13	9
Hungary	T	56	913	1231
Ireland	T	61	43	56
Italy	T	547	638	677
Latvia	T	0	0	0
Luxembourg	T	0	0	0
Malta	T	0	0	0
Netherlands	T	913	815	686
Poland	T	90	318	24
Portugal	T	0	0	0
Romania	T	0	0	1
Slovakia	T	897	1690	1244
Slovenia	T	44	16	16
Spain	T	1815	2428	3226
Sweden	T	820	864	669
United Kingdom	T	884	1044	1560

Table 7 – EU MS cumulative exported quantities for a group of products to a group of destination countries.

GERMANY EXPORT STATISTICS TO ARGENTINA					
COMMODITY: CHEMICALS EU GEA E006					
ANNUAL SERIES: 2007 - 2009					
CN CODE	UNIT	CN EXPLANATORY NOTE	QUANTITY		
			2007	2008	2009
28111100	T	Hydrogen Fluoride "Hydrofluoric Acid"	295	565	726
28121095	T	Thionyl Dichloride "Thionyl Chloride"	0	0	25
28269080	T	Fluorosilicates, Fluoroaluminates And Other Comple	0	1	1
28301000	T	Sodium Sulphides	0	280	158
29181985	T	Carboxylic Acids With Additional Oxygen Function A	89	165	2
29201900	T	Thiophosphoric Esters "Phosphorothioates" And Thei	4	2	1
29209040	T	Triethyl Phosphite	0	1	0
29209085	T	Esters Of Inorganic Acids Of Non-Metals And Their	158	1	2
29221310	T	Triethanolamine	32	21	6
29221980	T	Amino-Alcohols, Their Ethers And Esters; Salts The	145	176	156
29225000	T	Amino-Alcohol-Phenols, Amino-Acid-Phenols And Othe	35	22	4
29333999	T	Heterocyclic Compounds With Nitrogen Hetero-Atom[S	123	87	12

Table 8 – A single MS exported non-null quantities for detailed products to a specific destination country.

CN CODE	UNIT	CN EXPLANATORY NOTE	QUANTITY			REPORTER	PARTNER
			2007	2008	2009		
28111100	T	Hydrogen Fluoride "Hydrofluoric Acid"	9	5	0	Austria	Croatia
28261990	T	Fluorides (Excl. Of Ammonium, Sodium, Aluminium An	0	0	1	Austria	Croatia
28301000	T	Sodium Sulphides	101	64	16	Austria	Croatia
29141990	T	Acyclic Ketones Without Other Oxygen Function (Exc	0	0	1	Austria	Croatia
29181985	T	Carboxylic Acids With Additional Oxygen Function A	0	9	0	Austria	Croatia
29211985	T	Acyclic Monoamines And Their Derivatives; Salts Th	0	0	3	Austria	Croatia
29221310	T	Triethanolamine	1	0	3	Austria	Croatia
29221980	T	Amino-Alcohols, Their Ethers And Esters; Salts The	5	3	1	Austria	Croatia
29225000	T	Amino-Alcohol-Phenols, Amino-Acid-Phenols And Othe	1	1	1	Austria	ROK
29141990	T	Acyclic Ketones Without Other Oxygen Function (Exc	3	1	0	Austria	Turkey
29209085	T	Esters Of Inorganic Acids Of Non-Metals And Their	0	0	1	Austria	Turkey
28269080	T	Fluorosilicates, Fluoroaluminates And Other Comple	30	15	0	Belgium	Argentina
29055998	T	Halogenated, Sulphonated, Nitrated Or Nitrosated D	0	0	796	Belgium	Argentina
29141990	T	Acyclic Ketones Without Other Oxygen Function (Exc	0	0	3	Belgium	Argentina
...

Table 9 – Overall trade data table stemming from multiple queries after formatting.

DU CODE	DU MEANING
0	NUCLEAR MATERIALS, FACILITIES, AND EQUIPMENT
0A	Systems, Equipment and Components
0A001	"Nuclear reactors" and specially designed or prepared equipment and components therefor, as follows: ...
0A001.a.	"Nuclear reactors".
0A001.b.	Metal vessels, or major shop-fabricated parts therefor, including the reactor vessel head for a reactor pressure vessel, specially designed or prepared to contain the core of a "nuclear reactor".
0A001.c.	Manipulative equipment specially designed or prepared for inserting or removing fuel in a "nuclear reactor".
0A001.d.	Control rods specially designed or prepared for the control of the fission process in a "nuclear reactor", support or suspension structures therefor, rod drive mechanisms and rod guide tubes.
0A001.e.	Pressure tubes specially designed or prepared to contain fuel elements and the primary coolant in a "nuclear reactor" at an operating pressure in excess of 5,1 MPa.
0A001.f.	Zirconium metal and alloys in the form of tubes or assemblies of tubes in which the ratio of hafnium to zirconium is less than 1:500 parts by weight, specially designed or prepared for use in a "nuclear reactor".
0A001.g.	Coolant pumps specially designed or prepared for circulating the primary coolant of "nuclear reactors".
...	...

Table 10 – Tabular format of EC Reg 428/2009 of Annex I.

CN CODE	CN EXPLANATORY NOTE
...	...
84011000	Nuclear reactors [Euratom]
84012000	Machinery and apparatus for isotopic separation and parts thereof, n.e.s. [Euratom]
84013000	Fuel elements cartridges, non-irradiated, in casing with handling fixtures, for nuclear reactors [Euratom]
84014000	Parts of nuclear reactors, n.e.s. [Euratom]
84020000	Steam or other vapour generating boilers (excl. central heating hot water boilers capable also of producing low pressure steam); superheated water boilers; parts thereof
84021100	Watertube boilers with a steam production > 45 t/hour
84021200	Watertube boilers with a steam production <= 45 t/hour (excl. central heating hot water boilers capable also of producing low pressure steam)
84021900	Vapour generating boilers, incl. hybrid boilers (excl. central heating hot water boilers capable also of producing low pressure steam)
84021910	Firetube boilers (excl. central heating hot water boilers capable also of producing low pressure steam)
84021990	Vapour generating boilers, incl. hybrid boilers (excl. watertube boilers, firetube boilers and central heating hot water boilers capable also of producing low pressure steam)
...	...

Table 11 – Tabular format of the Combined Nomenclature.

<i>DU CODE</i>	<i>CN CODE</i>	<i>CORR. TABLE</i>
0A001	84011000	UV
0A001	84014000	UV
0A001	84136080	UV
0A001	84195000	UV
0A001	84199085	UV
0A001.a.	84011000	EU CT
0A001.b.	84014000	EU CT
0A001.c.	84261100	EU CT
0A001.c.	84261100	UV
0A001.c.	84261900	EU CT
0A001.c.	84261900	UV
0A001.c.	84269900	EU CT
0A001.c.	84269900	UV
0A001.c.	84289090	UV
0A001.c.	84289095	EU CT
...

Table 12 – Correspondence table between DU and CN codes, merging the EU CT and the UV.

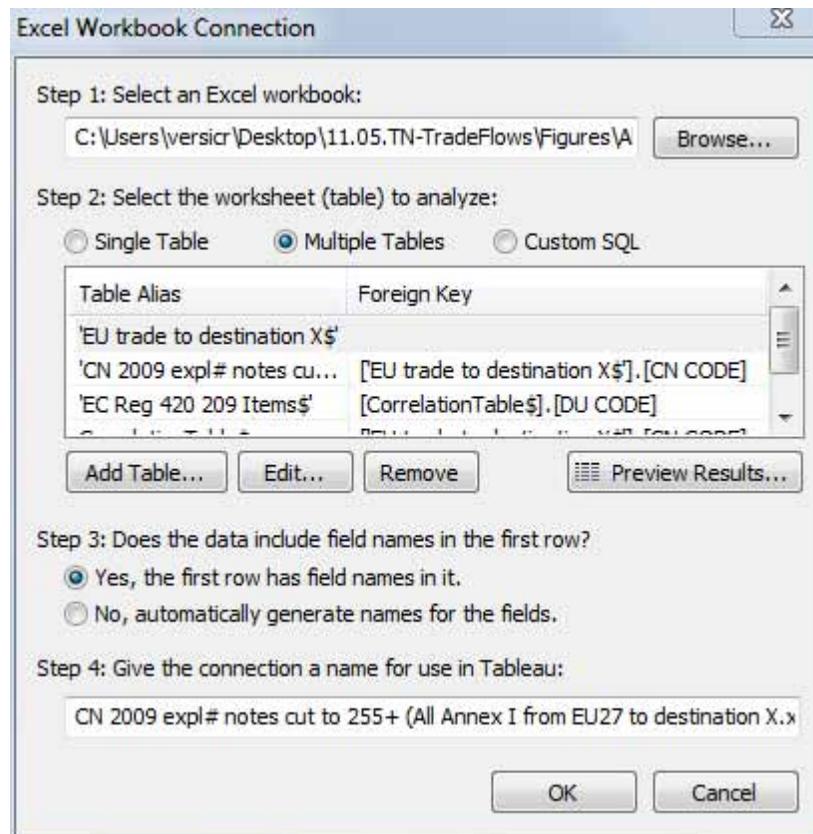


Figure 10 – Importing in Tableau three Excel worksheets containing the trade data, the list of EC Reg 428/2009 Annex I items and the EU Correlation Table. The original tables are joined in Tableau by the CN CODEs and the DU CODEs.

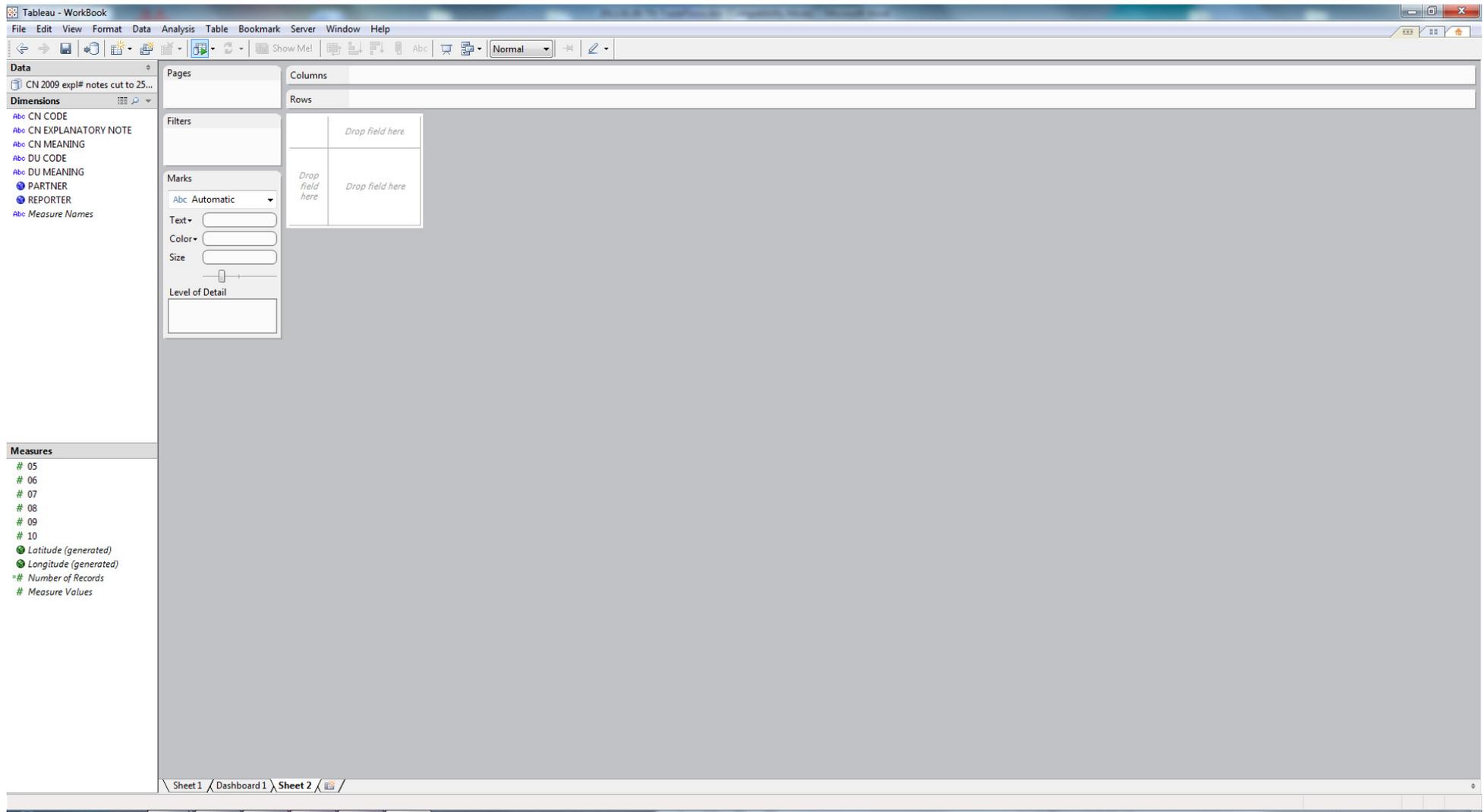


Figure 11 – The initial Tableau workbook is an empty table with dimensions and measures (the trade values) defined by the import operation at previous step.

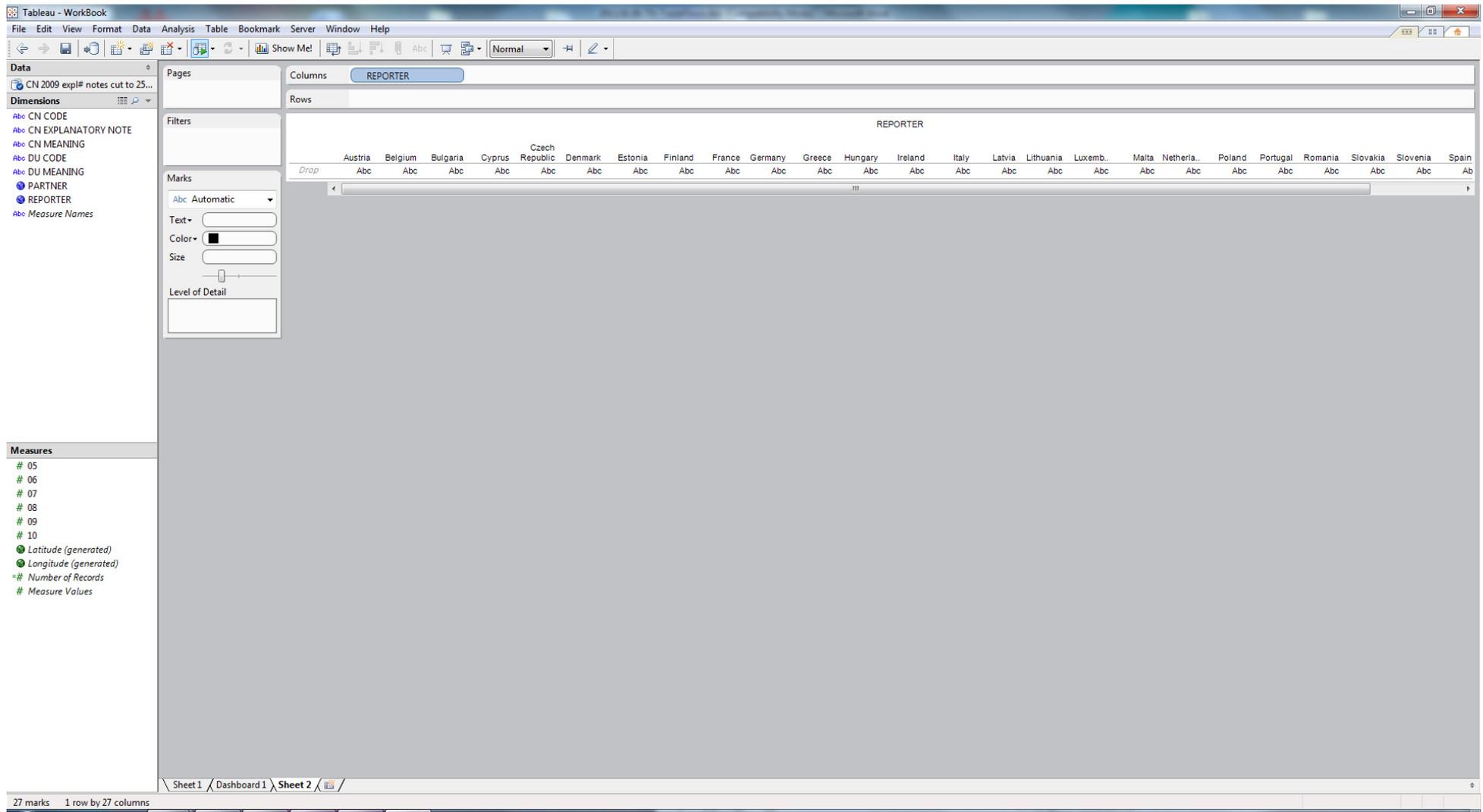


Figure 12 – Dragging EU REPORTERS to columns.

Tableau - WorkBook

File Edit View Format Data Analysis Table Bookmark Server Window Help

Normal

Data

CN 2009 expl# notes cut to 25...

Dimensions

- Abc CN CODE
- Abc CN EXPLANATORY NOTE
- Abc CN MEANING
- Abc DU CODE
- Abc DU MEANING
- PARTNER
- REPORTER
- Abc Measure Names

Columns

REPORTER

Rows

CN CODE CN MEANING

Filters

Marks

Abc Automatic

Text

Color

Size

Level of Detail

CN CODE	CN MEANING	REPORTER																			
		Austria	Belgium	Bulgaria	Cyprus	Czech R..	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Latvia	Lithuania	Luxemb..	Malta	Netherla..	Poland
28042910	Helium									Abc	Abc										Abc
28045010	Boron																				
28046090	Tellurium																				
28051200	Calcium										Abc										
28051990	Alkali Metals (Excl. Sodium)										Abc										
28100090	Oxides Of Boron And Boric Acids (Excl. Dibor..		Abc								Abc				Abc						Abc
28112930	Nitrogen Oxides									Abc	Abc										
28121094	Phosgene "Carbonyl Chloride"																				
28129000	Halides And Halide Oxides Of Non-Metals (E..									Abc	Abc		Abc								
28199090	Chromium Oxides And Hydroxides (Excl. Chr..									Abc	Abc										Abc
28211000	Iron Oxides And Hydroxides			Abc						Abc	Abc				Abc						Abc
28256000	Germanium Oxides And Zirconium Dioxide									Abc	Abc										
28259085	Inorganic Bases And Metal Oxides, Hydroxid..		Abc												Abc						
28261990	Fluorides (Excl. Of Ammonium, Sodium, Alu..										Abc										
28273985	Chlorides (Excl. Ammonium, Calcium, Magne..		Abc	Abc							Abc				Abc						Abc
28274990	Chloride Oxides And Chloride Hydroxides (Ex..										Abc				Abc						
28275900	Bromides And Bromide Oxides (Excl. Of Sodl..		Abc	Abc							Abc										
28289000	Hypochlorites, Chlorites And Hypobromites (..									Abc	Abc										Abc
28299010	Perchlorates		Abc								Abc										
28299080	Bromates And Perbromates (Excl. Potassium..			Abc							Abc				Abc						Abc
28309085	Sulphides, Polysulphides, Whether Or Not Ch..			Abc							Abc										
28322000	Sulphites (Excl. Sodium)														Abc						Abc
28332980	Sulphates (Excl. Of Sodium, Magnesium, Alu..										Abc	Abc			Abc						Abc
28333000	Alums			Abc	Abc						Abc										
28334000	Peroxisulphates "Persulphates"			Abc											Abc						Abc
28341000	Nitrites			Abc											Abc						
28342920	Nitrates Of Barium, Of Beryllium, Of Cadmiu..			Abc				Abc			Abc	Abc									
28342980	Nitrates (Excl. Of Potassium, Barium, Berylli..			Abc				Abc			Abc	Abc									Abc
28351000	Phosphinates "Hypophosphites" And Phosph..			Abc							Abc				Abc						
28352990	Phosphates (Excl. Phosphates Of Triammoni..			Abc				Abc			Abc	Abc			Abc						Abc
28353900	Polyphosphates, Whether Or Not Chemically ..		Abc	Abc							Abc				Abc						Abc
28369917	Carbonates, Commercial Ammonium Carbon..		Abc	Abc							Abc										
28371900	Cyanides And Oxycyanides (Excl. Sodium)			Abc							Abc										
28399000	Silicates, Incl. Commercial Alkali Metal Silicat..			Abc				Abc			Abc				Abc						
28402090	Borates (Excl. Of Sodium, Anhydrous, And Di..		Abc								Abc				Abc						Abc
28403000	Peroxo-borates "Perborates"										Abc										
28429010	Salts, Double Salts Or Complex Salts Of Sele..		Abc								Abc				Abc						
28441090	Compounds Of Natural Uranium; Alloys, Disp..			Abc							Abc										
28443019	Uranium Depleted In U 235; Alloys, Dispersio..										Abc										

6999 marks 878 rows by 27 columns

Figure 13 – Dragging CN CODES and CN MEANING as rows.

CN CODE	CN MEANING	REPORTER											
		Austria	Belgium	Bulgaria	Cyprus	Czech Republic	Denmark	Estonia	Finland	France	Germany	Greece	Hungary
28042910	Helium									0	5,010		
28045010	Boron												
28046090	Tellurium												
28051200	Calcium										200		
28051990	Alkali Metals (Excl. Sodium)										1,040		
28100090	Oxides Of Boron And Boric Acids (Excl. Dibor..		160								26,420		
28112930	Nitrogen Oxides								0		14,500		
28121094	Phosgene "Carbonyl Chloride"												
28129000	Halides And Halide Oxides Of Non-Metals (E..									17,830	668,370		97,370
28199090	Chromium Oxides And Hydroxides (Excl. Chr..									0	0		
28211000	Iron Oxides And Hydroxides		3,030							29,440	0		
28256000	Germanium Oxides And Zirconium Dioxide									0	139,820		
28259085	Inorganic Bases And Metal Oxides, Hydroxid..	1,410											
28261990	Fluorides (Excl. Of Ammonium, Sodium, Alu..										6,810		
28273985	Chlorides (Excl. Ammonium, Calcium, Magne..	1,230	270								136,450		
28274990	Chloride Oxides And Chloride Hydroxides (Ex..										69,150		
28275900	Bromides And Bromide Oxides (Excl. Of Sodl..	120	17,160								2,280		
28289000	Hypochlorites, Chlorites And Hypobromites (..									300	12,630		
28299010	Perchlorates	270									6,510		
28299080	Bromates And Perbromates (Excl. Potassium..		0								40,980		
28309085	Sulphides, Polysulphides, Whether Or Not Ch..		0								47,490		
28322000	Sulphites (Excl. Sodium)												
28332980	Sulphates (Excl. Of Sodium, Magnesium, Alu..									5,460	243,300		
28333000	Alums	120	150								14,640		
28334000	Peroxisulphates "Persulphates"	0											
28341000	Nitrites		240										
28342920	Nitrites Of Barium, Of Beryllium, Of Cadmiu..		180				0			0	5,060		
28342980	Nitrates (Excl. Of Potassium, Barium, Berylli..		740				0			0	37,720		
28351000	Phosphinates "Hypophosphites" And Phosph..		0								124,080		
28352990	Phosphates (Excl. Phosphates Of Triammoni..		297,300				0				135,780		
28353900	Polyphosphates, Whether Or Not Chemically ..	90	170,160								1,089,540		
28369917	Carbonates, Commercial Ammonium Carbon..	330	75,810								150,330		
28371900	Cyanides And Oxycyanides (Excl. Sodium)	0											
28399000	Silicates, Incl. Commercial Alkali Metal Silicat..		0				0				0		
28402090	Borates (Excl. Of Sodium, Anhydrous, And Di..	540									8,010		
28403000	Peroxborates "Perborates"										210		
28429010	Salts, Double Salts Or Complex Salts Of Sele..	110									7,260		
28441090	Compounds Of Natural Uranium; Alloys, Disp..	0											
28443019	Uranium Depleted In U 235; Alloys, Dispersio..										0		
28443090	Thorium Salts												

Figure 14 – Dragging 2010 trade data into the table for display. By default the numerical values are shown.

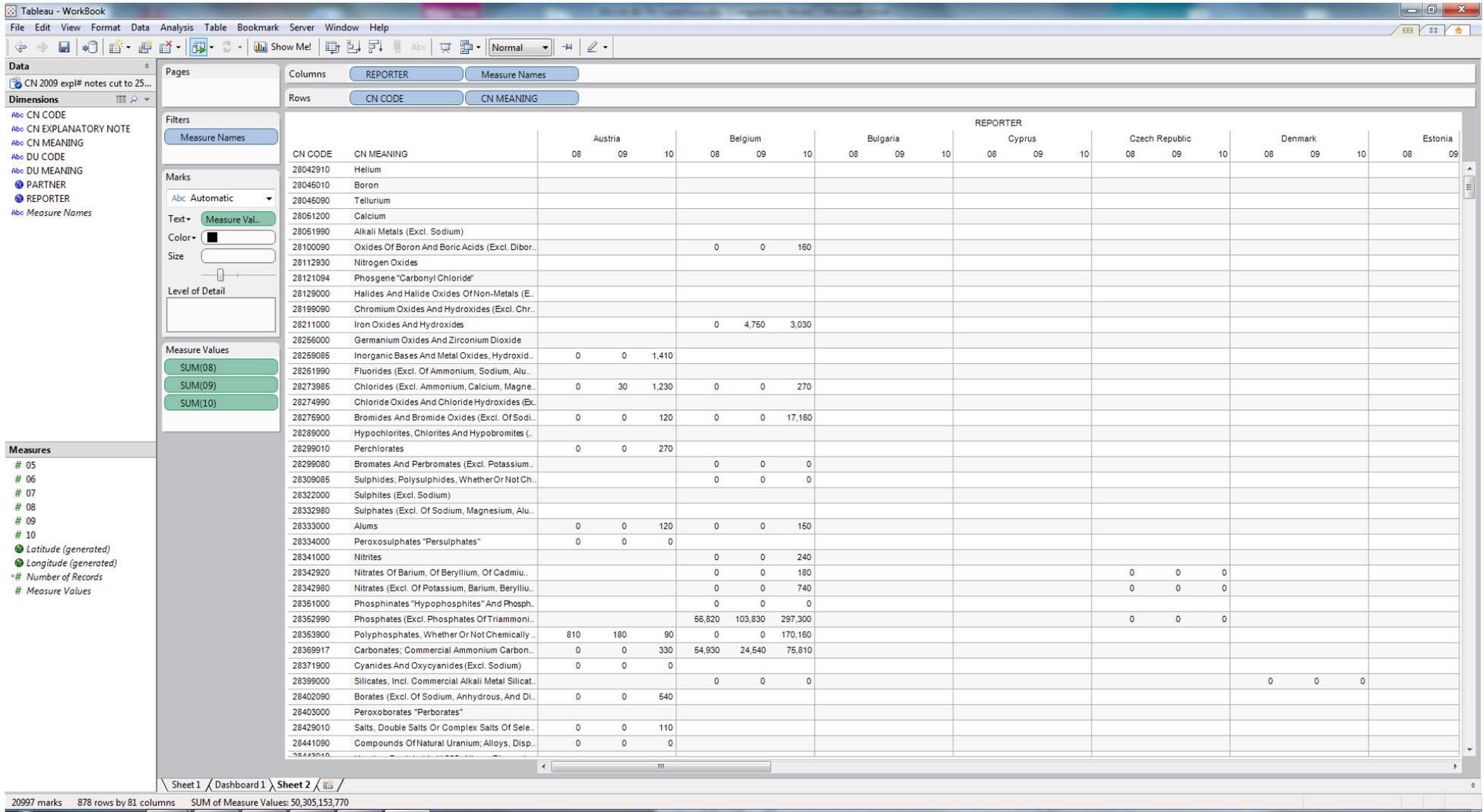


Figure 15 – Dragging more years of data into the table (2008 and 2009 in this Figure).

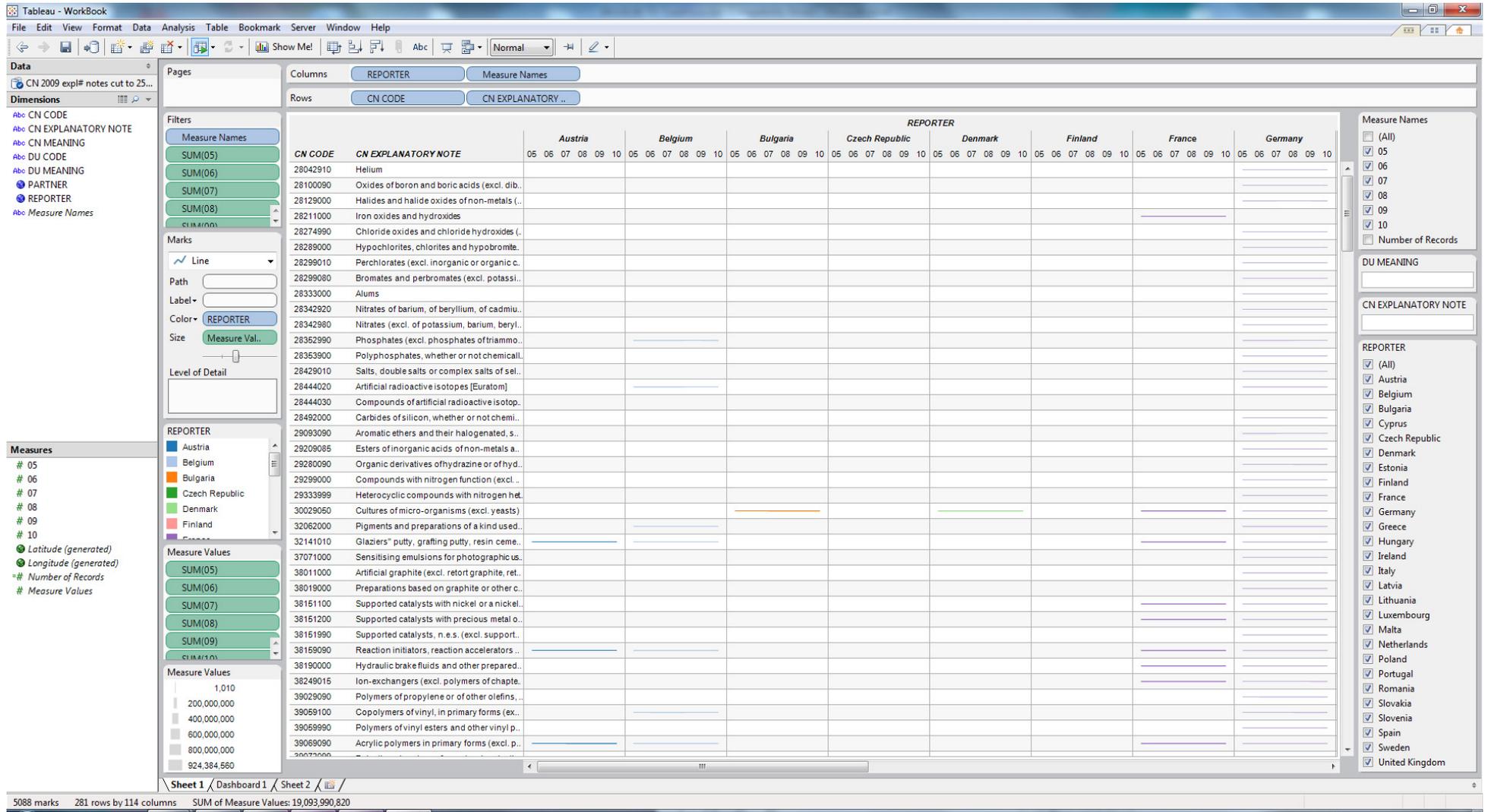


Figure 16 – Showing the trade data as a 'line' chart. All 6 years of data are displayed.

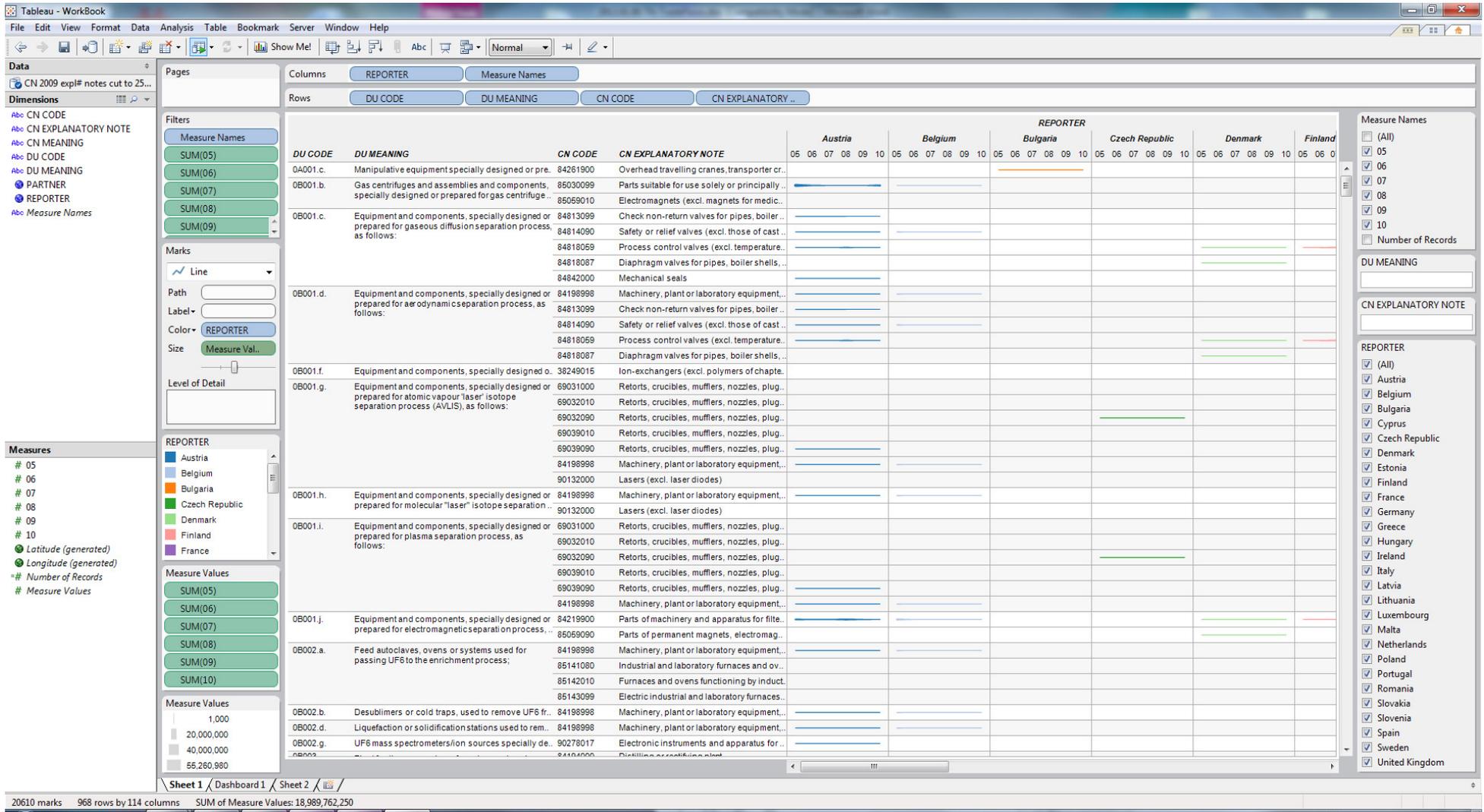


Figure 17 – Adding DU CODES and DU MEANING to rows.

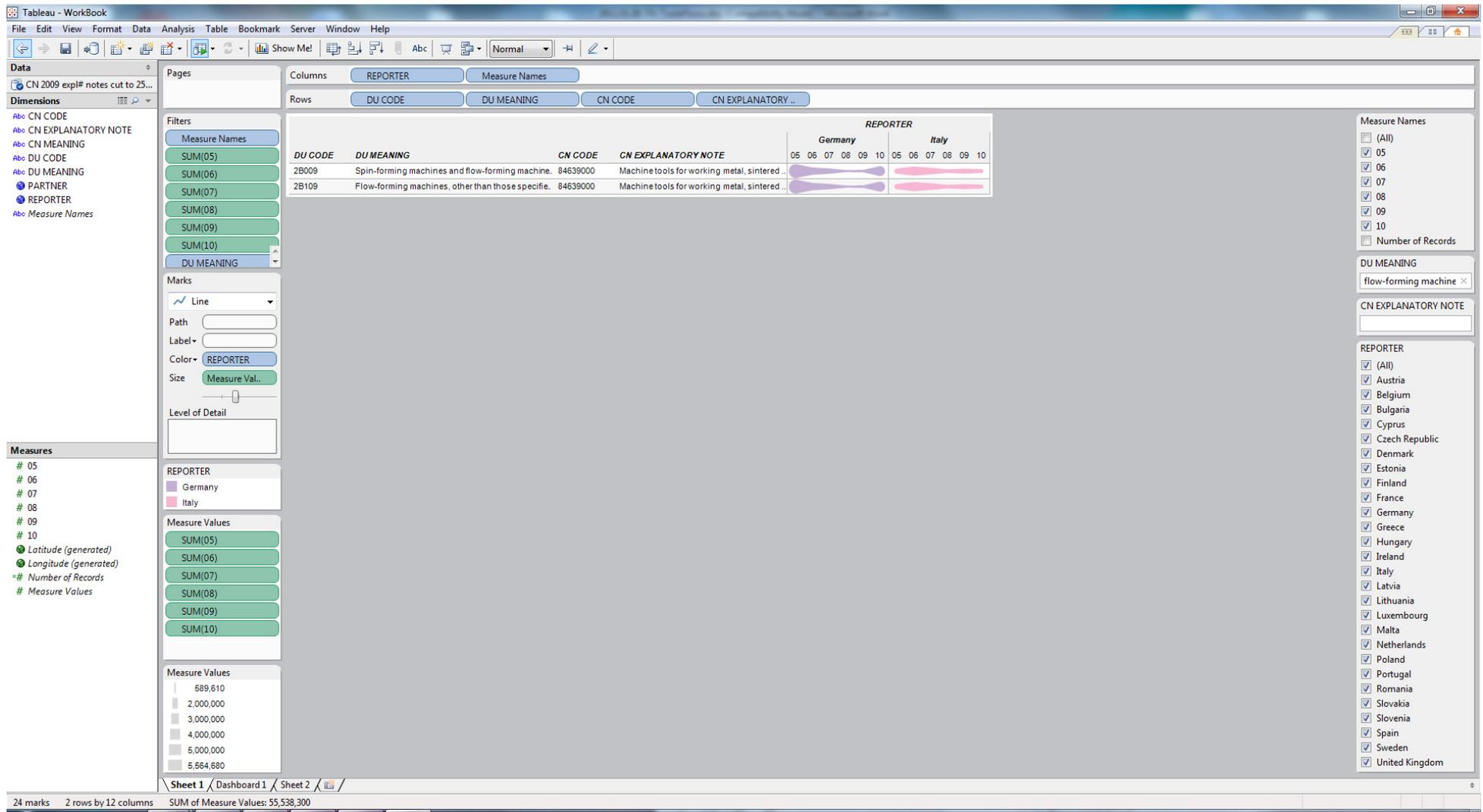


Figure 18 – Focusing on DU MEANING matching a string ('flow-forming machine').

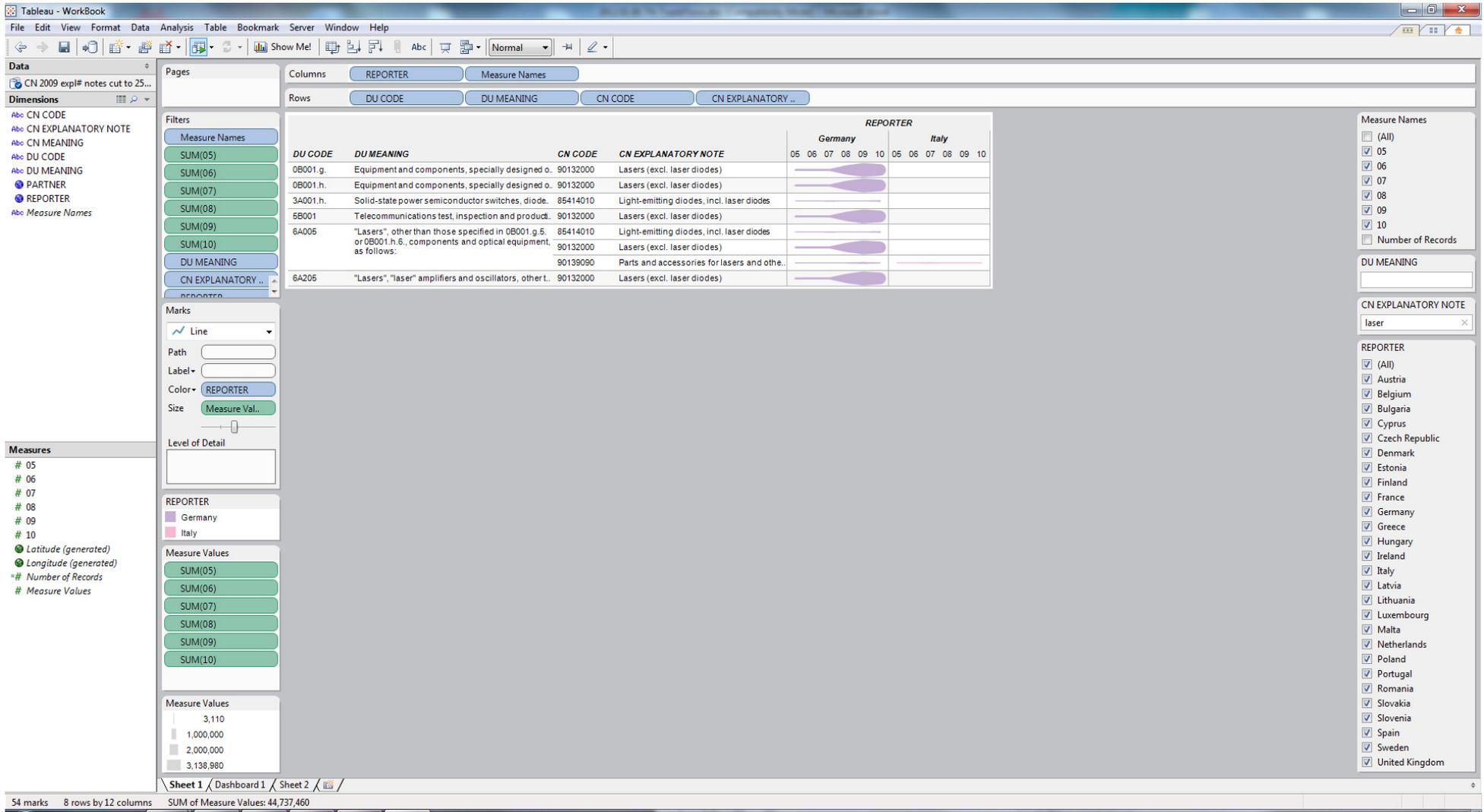


Figure 19 – Focusing on CN MEANING matching a string ('laser').

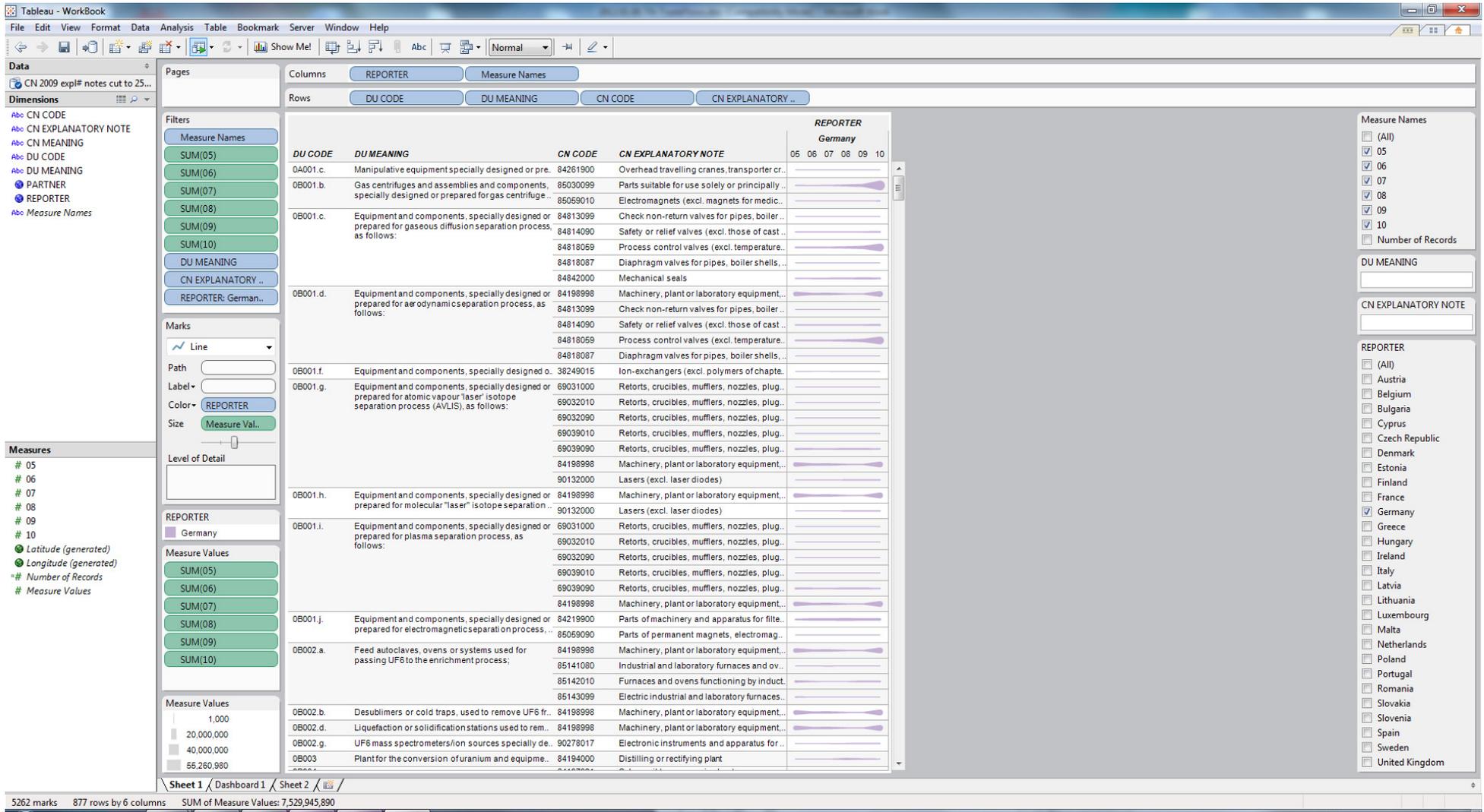


Figure 20 – Profiling of a REPORTER's exports.

6. Discussion

The EU single market and the consequent free movement of goods within the EU territory makes it necessary to harmonise the controls of the export of dual-use items in 27 Member States. Harmonisation means same rules and a consistent implementation across Member States both in licensing and customs controls.

To date there are no official data published by Member States on the trade of dual-use items. It is therefore difficult to assess progress towards an effective EU export control 'system' because of its distributed nature.

In this report we overviewed some sources of generic, statistical trade data that can be used to estimate extra-EU trade flows of dual-use items. Since these data refer to export-controlled items through non-specific descriptors, they can provide only upper bounds of the real dual-use trade.

Still, since trade is *sparse* (in the sense that not *all* items are traded towards *all* destinations) using these data can prove useful to *profile* the European dual-use trade. Which items are traded the most, towards which destinations? And: which items are *not traded* or are exported only in limited quantity? This profiling exercise can simplify the picture of the export of dual-use items which *a priori* (i.e. before seeing any data) is complex given the very high number of items listed for controls. Trade data can aid focussing the attention where required.

A possible application of statistical trade data analysis is the estimation of dual-use trade flows to inform the design of Union General Export Authorisations, as illustrated in this report. To this goal we make use of correlation tables that map items listed for export controls to descriptors indexing the statistical trade data. To harness the potential of these data we need to design and develop an information technology tool *to ease* the estimation and visualisation of trade of flows for any item listed for export controls.

Other possible uses of trade analysis include assessments related to the application of sanctions. For example, one could estimate upper bound volumes of items under embargo to:

- Assess trade flows of controlled items *before* and *after* the embargo.
- Assess the economic impact of the embargo on EU exporting countries.
- Detect deflection of trade (re-exports to embargo countries of EU items from non EU MS).

Estimates of dual-use exports could improve if EU Member States would publish license-related data (e.g. which item categories are traded towards which destinations). Few Member States and EU regions do already publish these data (e.g., [32][33]). A larger adoption of this practice by Member States would inform policy making for an effective European export controls system.

Acknowledgments

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Appendix 1: Acronyms

- **AG:** Australia Group [8].
- **CN :** Combined Nomenclature [24].
- **CAS :** CAS Registry Number [22].
- **CWC:** Chemical Weapons Convention [9].
- **EU CT:** EU Correlation Table [27].
- **DU:** Dual-Use.
- **EU:** European Union.
- **EU GEA:** EU General Export Authorisation.
- **EU MS:** EU Member States.
- **HS:** Harmonized System [17].
- **MTCR:** Missile Technology Control Regime [6].
- **NSG:** Nuclear Suppliers Group [7].
- **TARIC:** Integrated Tariff of the European Communities [26].
- **UV:** Umschlüsselungsverzeichnis [28].
- **WA:** Wassenaar Arrangement [5].
- **WCO:** World Customs Organisation [17].
- **WMD:** Weapons of Mass Destruction.

Appendix 2: Glossary

- **Web data service on global trade:** Web service providing open source data on world trade. The data originate from goods' declarations made by exporters and importers to customs authorities [16].
- **Harmonized System:** Taxonomy of goods designed and maintained by the World Customs Organisation [17]. Goods are identified by a 6 digit *Code* and an *Explanatory Note*. The Harmonized System is used by exporters and importers to declare goods to customs authorities.
- **Combined Nomenclature:** A 8 digit subdivision [24] of the Harmonized system adopted by EU Member States.
- **TARIC:** Database on EU trade legislation concerning tariff suspensions, quotas, import/export prohibitions, surveillance, restrictions, etc. It identifies goods by TARIC Codes, a 10 digit subdivision [26] of the Combined Nomenclature.
- **Correspondence table:** Table identifying related items appearing in two taxonomies. The table is a list of pairs. Each pair connects items in the two taxonomies by their identifying *Codes*.
- **EU Correlation Table:** Correspondence table [27] developed by DG TAXUD linking the Combined Nomenclature with Annex I of COUNCIL REGULATION (EC) No 428/2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items (recast) [3].
- **Umschlüsselungsverzeichnis:** Correspondence table [28] developed by BAFA linking the Combined Nomenclature with Annex I of COUNCIL REGULATION (EC) No 428/2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items (recast) [3].

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Abstract

Dual-use items are goods and technologies that have both civil and military uses. In the European Union their export is controlled and governed by an EC regulation since the year 2000. Its implementation, in terms of legislation, export authorisations and customs controls, remains the responsibility of each of the 27 Member States. For reasons linked to the non-proliferation of weapons of mass destruction, competition in trade and free market rules, it is *'desirable to achieve a uniform and consistent application of controls throughout the EU in order to promote EU and international security and to provide a level playing field for EU exporters'* – as stated in the regulation.

How far is the goal? Hard to say since no official data about the trade of dual-use items are shared among Member States, nor with the European Commission, Directorate General Trade, in charge of the dual-use regulation.

This report presents sources of generic, statistical trade data and a methodology to *create an approximate picture of extra-EU trade flows of dual-use items*. The data stem from goods' declarations made by exporters to customs authorities as part of the normal export process for any commodity. The data are collected at national level, aggregated by categories of goods, and made public in web data services on trade. The data are referred to a commodity classification system, the Combined Nomenclature (CN), in use for customs controls in the EU. However the CN is only indirectly related to dual-use items. Correspondence tables exist that map dual-use items to CN descriptors, but they introduce approximations in the description of the items traded. For this reason the CN trade data provide, in the general case, upper bounds to the real trade volume of dual-use items.

Notwithstanding this limitation, the CN trade data may prove useful for some assessments needed for export controls. One example is presented in this report. It concerns the estimation of extra-EU trade flows for dual-use chemicals under consideration for inclusion in a Union General Export Authorisation (EU GEA). EU GEAs define a framework valid in all EU Members States whereby the export of selected categories of dual-use items to specific destination countries with a low risk of diversion is automatically authorised. An analysis of the volume of exports based on CN trade data allows estimating the impact expected on EU exporters by including given dual-use chemicals in an EU GEA.

To facilitate the estimation of extra-EU trade flows, it is proposed to develop a dedicated Information Technology tool merging lists of export-controlled items with correspondence tables of CN items' descriptors and export data. Such a tool can become a design and evaluation instrument to assess the economic impact of alternative policy options to regulate the European dual-use trade.

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