

Final Scientific Report – Enrico Vidale

Cost Action: FP 1203 “European Non-Wood Forest Products Network”
STSM title: International trade network analysis.
Reference: COST-STSM-ECOST-STSM-FP1203-010214-039672
STSM dates: from 01/02/2014 to 28/02/2014
Location: European Forest Institute, Joensuu, Finland
Host: Robert Mavsar (e-mail: robert.mavsar@efi.int)

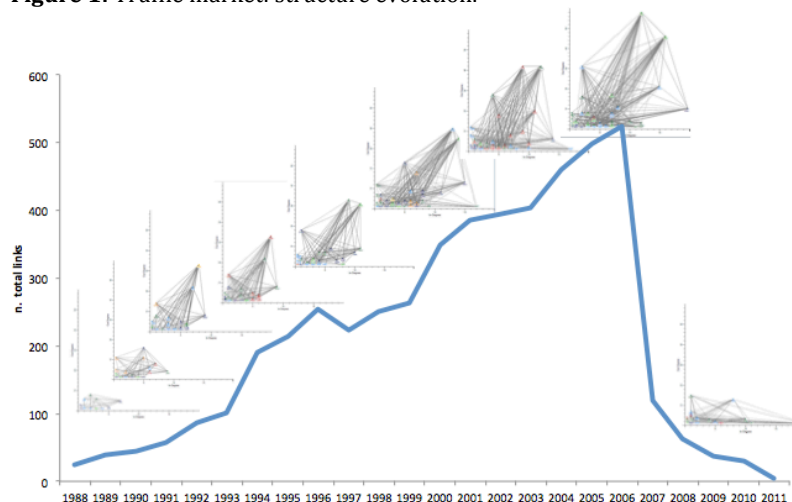
1. Background

The international trade may be analysed through different approaches. The traditional trend analysis is a fundamental tool to understand the trend and orientation of the market, but is generally referred to a certain scale (i.e. the globe or a state). Nonetheless, it provides scarce information on the actors involved in the market. Only recently, the use of new methodologies has allowed to extract more information from the international trade data. Social network analysis (SNA) was originally developed in social science and slowly dragged in other research fields such as medicine, ecology and economics (Borgatti et al. 2009), or more in general, wherever two or more objects create a certain type of relationships forming a network. Some papers have already highlighted the potential of SNA in general economic analysis (Bhattacharya et al. 2007, Butts 2009, Fagiolo 2010) as well applied on specific commodities market models (Bhattacharya et al. 2008), never applied to forest product and more in specifically on non-wood forest product (NWFP).

2. Introduction

The international trade network can be defined as a physical structure of the market in a given timeframe. The market is not a stable environment, both in terms of volume and actors involved. The trend analysis may forecast the market gain or loss in terms of volume, or it simply analyses the past market stock fluctuations, however, no information can be provided on the market structure. The use of social network analysis can help to cover the information gap. In Figure 1, we describe the truffle market evolution both in terms of number of global relationships as well the market structure related for each year.

Figure 1: Truffle market: structure evolution.



Note: Author elaboration on Comtrade Data.

The application of SNA on trade analysis allows to extract more information from the data. Though the Figure 1 is quite small, it shows all the actors (countries) involved in the market and the role they have in the market. For instance, Italy and France represent the core countries of the market, or the historical role of China and the new position of Morocco and Algeria as large supplier, or the target net consumer as Switzerland and Germany. Anyhow, during the preliminary work, my team and I figured out the persistence of a crucial problem on data cleaning that affect also the reliability of the outputs. Consequently, the initial aims have been re-draft in order to solve the problem, as follow:

- 1st week: learning session of the main software and models for network analysis
- 2nd week: development of data cleaning methodology (previously designed for learning of stochastic actor-based models for network dynamics)
- 3rd & 4th weeks: Refining data cleaning methodology and data analysis (previously designed for data analysis and paper writing).

3. Purpose of the STSM

The aim of the brief visit was to gain knowledge about network models applied to international trade of NWFP. In agreement with the host institution, we plan a first learning session to fill up our knowledge gap on three main topics:

- Overview of the present market knowledge on NWFP in Europe about some key products (provided by me to the host institution).
- Overview of the information and data contained in the international database (provided by me to the host institution)
- Overview of the SNA model applicable to economic data (provided by the host institution to me)

Filling the knowledge gap was a prerequisite for the research group to understand macro-idea of the work: study the international market structure evolution for a set of commodities. The application of social network models on international trade required a deep data cleaning and data preparation; hence, we defined three new aims:

- select the most representative NWFP among the one reported in the harmonized system (HS) code system (six digit code), according the NWFP market scale (at least one NWFP only produce within EU28 and one globally produced) and the percentage of wild NWFP contained in the code (at least one non domesticated or simply wild harvested and at least one mixed with domesticated product);
- define the best data cleaning methodology for Comtrade data
- and finally, design a protocol to prepare the dataset for network modelling.

The data analysis has been only the last step of the work. Due to the lack of time, we decided to test only few models, while data analysis was postpone after the STSM.

4. Work description

The STSM took place in Joensuu (Finland) at European Forest Institute (EFI) between the 1st and the 28th of February 2014. The work description will follow the time schedule we re-drafted with the host institution.

4.1. Learning session of the main software and models for network analysis (1st week)

Several NWFP are traded globally. The general understanding of the number and the species (or group) traded in the international market has been the first argument the research group discussed. In total I found more than 110 codes referred to NWFP, but only 66 of them were also produced in Europe (see Annex 1). However, the commodity codes are revised every 5 year, hence some codes can be merged, created or modified according to the observation collected by the World Custom Organization (WCO), so for some products there is only a limited time series of data. Unfortunately, for the period 2007 to 2012, the coding comparison table has been released on the 21st of February (see UNSTAT [link](#)), period in which, the research group and I were concentrated on the data cleaning. The preliminary selection is reported in Table 1.

Table 1: Selected NWFP for the STSM.

Ecological classification	NWFP type	NWFP	Comtrade HS6 Codes	Considered in the analysis
Products of the stem, leaves or tree reproductive system	Stem-based Products (<i>tree is cut</i>)	Christmas tree		no
		Fibre	460191	no
		bio-refining		no
		Tar	380300; 380700	no
		Tanning	320110; 320120; 320130; 320190; 330210; 330290;	yes
	Leaf based products (<i>branches are removed</i>)	Sorbitol	290544; 382460	no
		Essential oils	330129; 330190	no
		Phytochemical	293990; 293999	no
		Pigments	320417	no
		Foliage	060491; 060499	yes
	Extracted from tree (<i>tree is alive</i>)	Sap	130219*	no
		Natural gums	130120; 130120; 130190; 380630	no
		Exudate	330130; 380510; 380520; 380590; 380610; 380690	no
		Bark	Bark products 450110; 450190; 450200; 450310; 450390; 450410; 450490	yes
		Tree flowers		no
Fruits & flowers	Fruits	81090	no	
	Edible nuts	080212; 080221; 080222; 080231; 080232; 080240; 080250; 080290	yes	
	Wild mushrooms	070951; 070959; 071159; 071232; 071233; 071239; 200310; 200390	yes	
Tree dependent species	Products based on species hosted by tree	Truffles	070959; 200310	yes
		Honey & Bee Prod	040900; 152190	no
Forest understory products	Berries	Berries	081010; 081020; 081030; 081040; 081090; 081110; 081120; 081190; 081340; 200880; 200899	yes
	Forest plants	Live tree/plants	060210; 060220; 060491; 060499	no
		Medicinal and aromatic plants	090950; 091020; 091040; 091099; 121190; 130219*	no
		Mosses & lichens	60410	yes

Note: The HS6 code need a further revision with the lastly released HS6 code system.

A training session on the market knowledge was given as roundtable discussion for each product during the second part of the first week. Among all the products revised, we selected only three group of product for the data cleaning methodology we develop till the end of the STSM; hence we considered:

- All the codes referred to mushrooms (cultivated and wild) both traded as raw or processed (fresh and frozen, dry and preserved);
- All the codes referred to cork (raw, in pieces, stopper and panel)
- And all codes referred co tannins (quebracho, wattle, oak and chestnut, other tanning)

The choice on the three product groups has been done by purpose. Mushrooms was selected because the coding system allows to describe the majority of the products traded in the different mushrooms supply chains at international level (global market for producers and consumers); the choice of cork was done for the limited quantity of producers (producers oligopoly market); finally the tannings has

been selected for the substitution effect of competitive product like quebracho and wattle tanning towards oak and chestnut one.

4.2. Development of data cleaning methodology (2nd week)

Among the main problems we face on data cleaning, the lack of data reporting is surely the main one. In theory, every country should report the trade flows that “come in” or “go out” from the national boundaries; in reality not all the custom units reports the incoming and outgoing flows in the same quantity and economic values (double check). If only one custom office (instead of two) reports quantity and value, we have to take the information as such at this stage. On the contrary, they may report different quantity or values as it occur quite frequently. In example let's suppose to have two countries "A" and "B", which they declared following information:

- A reports 1000 kg of import from B with a value of 10000 USD
- B reports 120 kg of export to A with a value of 9000 USD

What record is right? Nobody, except the custom officers, can answer it. So in trade data analysis we need to use a certain process to clean the data and avoid double counting. According (UN-ESCAP 2009), there are no formal approach to clean the data, and the researcher can use its own approach. The suggestion proposed by (UN-ESCAP 2009) are:

- The use all the data (very difficult, not applicable for network analysis)
- The use an average of the reported data from each source;
- The use import data in preference to export data; the rationale is that many countries are much more strict in regulating imports than exports, and hence records are likely to be better;
- The use data from developed economies in preference to data from developing economies, or large economies in preference to small economies; this may be justified on the basis of assumed better reporting practices, or the law of large numbers;

However, the proposed approaches are not applicable in all cases (see Table 2).

Table 2: Cases of double reporting

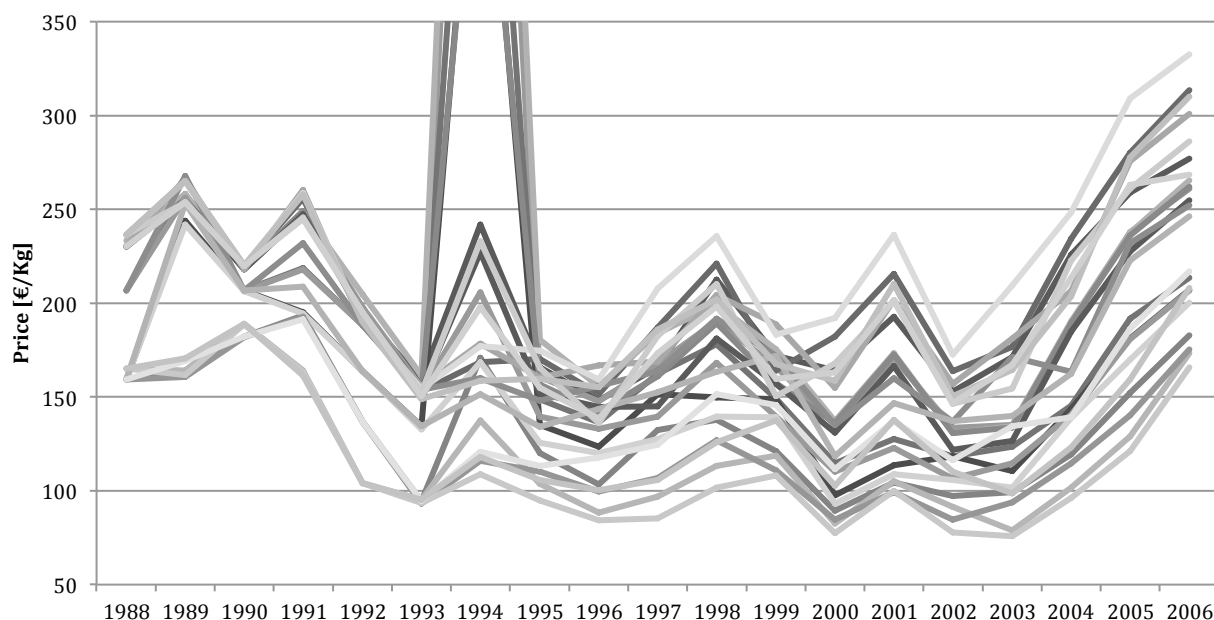
Case	Id	Flow	Reporter	From	To	Quantity (Kg)	Value (USD)	Price	Reliable?	Problem of selection?
1	32	Import	AUS	AUS	FJI	7372	60582	8.22	yes	yes - theories 2 and 3 may hold
	33	Export	FJI	AUS	FJI	157	1190	7.58	yes	
2	35	Import	AUS	AUS	IDN	4300	16161	3.76	yes	no - theory 3 hold
	36	Export	IDN	AUS	IDN	1390	17660	12.71	no	
3	125	Import	FRA	BGR	FRA	75	2426	32.35	no	yes - none of the four theories holds
	126	Export	BGR	BGR	FRA	12846	64204	5.00	yes	

In order to tackle the issues we tested different approaches:

- Select the record that report more quantity;
- Select the record that report more economic value;
- Select the record that report lower quantity;
- Select the record that report lower economic value;
- Create a new record based on the mean of quantity and economic value;
- Create a record based on the selection of the maximum quantity an values between the two records;
- Create a record based on the selection of the minimum quantity an values between the two records;
- Select one of the two records at random

We used the price, as it is the most important market indicator to compare the different approaches. The output showed a large variability on price (see Figure 2) that need further analysis in order to define and select the best approach (third and fourth week of the STSM)

Figure 2: International price of truffles calculated



4.3. Refining data cleaning methodology and data analysis (3rd & 4th weeks)

Finally we select the best approach using the annual standard deviation of the price. Among all the approaches the one that consider the record with higher Kg decrease the annual standard deviation (see Table 3).

Table 3: Selection of the best approach according St.Dv. calculation.

Model	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	Total
Record Import declaration	280	390	205	331	403	389	438	264	249	319	409	373	368	431	317	458	488	467	574	420
Max Kg & USD	280	389	205	331	409	388	3727	263	248	373	375	366	297	396	330	341	421	447	546	785
Min Kg & USD	285	397	206	342	404	389	278	254	237	362	444	353	396	450	321	403	466	473	598	420
Mean Kg & USD	279	388	206	331	427	400	4050	327	265	419	379	397	301	399	300	335	412	443	551	841
Mean Kg & USD (Kg>0)	281	389	206	331	405	387	2023	247	226	328	373	354	301	398	300	335	412	443	547	528
Record Max Kg	280	390	205	331	403	388	435	240	247	301	364	360	296	394	283	332	418	441	546	381
Record Max USD	280	397	205	348	402	388	267	246	267	337	396	385	334	432	348	485	438	477	581	416
Record Min Kg	285	397	206	347	404	389	285	260	242	391	464	369	406	480	324	517	490	500	616	446
Record Min USD	285	390	206	329	405	389	462	255	218	360	435	342	378	449	305	380	457	471	585	415
Record Exporter declaration	285	397	206	346	404	389	275	235	241	376	422	357	344	450	338	412	402	480	592	412
Record Developed Countries	280	390	206	329	405	389	356	237	223	355	386	362	362	443	303	425	459	473	557	408

Note: Data source (Comtrade 2014), our elaboration

The approach hold also in term of price, compared with two key actor of the international market (see Table 4).

Table 4: Selection of the best approach according annual average price.

Model	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	Total
Record Import declaration	230	255	218	247	194	159	242	166	148	166	212	172	164	193	153	171	226	259	277	202
Max Kg & USD	230	257	218	248	198	155	760	161	148	168	190	166	135	171	134	135	189	238	261	202
Min Kg & USD	236	265	220	256	190	153	168	170	152	187	221	164	182	216	164	177	234	280	313	213
Mean Kg & USD	233	258	219	249	205	161	868	181	156	184	199	175	137	173	131	134	191	237	265	210
Mean Kg & USD (Kg>0)	230	255	219	249	196	154	486	157	142	161	189	157	136	173	131	134	189	236	262	191
Record Max Kg	230	255	218	247	194	154	227	152	145	145	181	157	131	167	122	126	185	227	255	177
Record Max USD	230	266	218	260	189	155	178	160	167	169	204	189	155	202	157	181	207	276	301	205
Record Min Kg	236	265	220	259	190	154	177	175	159	208	236	183	192	237	173	210	248	309	333	229
Record Min USD	236	254	220	245	195	153	233	166	136	182	210	150	168	201	146	154	223	261	286	200
Record Exporter declaration	236	265	220	258	190	149	159	160	155	186	202	167	159	210	151	165	204	278	310	203
Record Developed Countries	230	254	220	246	195	150	198	155	138	173	198	160	163	202	147	167	214	263	268	197

Note: Data source (Comtrade 2014), our elaboration

Due to the large amount of data, all the analysis took a lot of time to be run. Once we selected the methodology, we cleaned the dataset and we started the data re-shaping to use SNA models. Thus all the record has been put in export direction “from A → to B” with the quantity and values linked to the given trade relationship.

5. Summary of the main results

The results of the STSM has been several; among the most important achievement I did, together with the research group, four are worth to be metioned:

- A detailed methodology to clean the Comtrade data;
- A methodology to prepare the Comtrade data for SNA;
- The structure of two papers for scientific Journals
 - the first concerns with the methodological work made during the STSM period. The draft title is: *“Comparison of the data cleaning procedures for international trade data”*.
 - the second focuses on new challenges in economic networks, with a review of SNA applied International Trade Network, and points to a clear demand on network explanations of economic concepts. The working title is: *“Social Network Analysis as a tool for the analysis of international trade”*.
- Clean dataset that can be used in official portal like FAO-NWFP.

6. Future collaboration

The STSM was an important opportunity to start a permanent cooperation between the University of Padua and EFI headquarter. We will surely try to promote further scientific mission and projects that aim to collect economic information on NWFP, especially on trade: so far the only permanent data source available globally.

7. Bibliography

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Annex 1: NWFP traded in the international market (incomplete list)

id	HS6	Brief description	Description (Comtrade)	nwfp	wild	raw
1	010690	Deers, Bees and other little animals	Live animals, n.e.s.	2	1	1
2	030760	Terrestrial snails	Snails (excl. sea snails)	1	1	1
3	040900	Honey	Natural honey	1	2	1
4	060200	Mushroom spawn	Other live plants (including their roots), cuttings and slips; mushroom spawn.	2	2	1
5	060290	Mushroom spawn	Live plants, n.e.s., incl. their roots; mushroom spawn	2	3	1
6	060313	Orchids	Fresh orchids	2	3	2
7	060410	Mosses & lichens	Mosses & lichens	2	1	1
8	070959	Mushrooms and truffles	Mushrooms&truffles (excl. of 0709.51), fresh/chilled	2	2	1
9	071159	Wild Mushrooms	Mushrooms other than of the genus Agaricus, provisionally preserved	2	2	2
10	071232	Wild Mushrooms	Wood ears (Auricularia spp.), dried, whole/cut/sliced/broken/in powder but not further prepared	1	2	3
11	071233	Wild Mushrooms	Jelly fungi (Tremella spp.), dried, whole/cut/sliced/broken/in powder but not further prepared	1	2	3
12	071239	Wild Mushrooms	Mushrooms (excl. of 0712.31-0712.33) & truffles, dried, whole/cut/sliced/broken/in powder but not further prepared	2	2	2
13	080221	Hazelnut	Hazelnuts/filberts (Corylus spp.), in shell	1	3	1
14	080222	Hazelnut	Hazelnuts/filberts (Corylus spp.), shelled	1	3	2
15	080231	Walnuts	Walnuts, in shell	1	3	1
16	080232	Walnuts	Walnuts, shelled	1	3	2
17	080240	Chestnuts	Chestnuts (Castanea spp.)	1	2	1
18	080250	Pistachios	Pistachios	1	2	1
19	080290	Pine nut (with several other nuts)	Nuts, n.e.s. in 08.01 & 08.02, fresh/dried, whether/not shelled/peeled	2	2	3
20	081010	Strawberries	Strawberries, fresh	1	3	1
21	081020	Raspberries, blackberries, mulberries & loganberries	Raspberries, blackberries, mulberries & loganberries, fresh	2	3	1
22	081040	Cranberries, bilberries & other fruits of the genus Vaccinium	Cranberries, bilberries & other fruits of the genus Vaccinium, fresh	2	2	1
23	081090	Sorbus spp (i.e. rowanberry), Arbutus unedo (tree-strawberry)	Fresh fruit, n.e.s. in Ch. 8	2	2	1
24	081110	Strawberries	Strawberries, uncooked/cooked by steaming/boiling in water, frozen, whether/not containing added sugar/other sweetening matter	1	3	2
25	081120	Raspberries, blackberries, mulberries & loganberries	Raspberries, blackberries, mulberries, loganberries, black/white/red currants & gooseberries, uncooked/cooked by steaming/boiling in water, frozen, whether/not containing added sugar/other sweetening matter	2	3	2
26	090910	Seeds of anise/badian	Seeds of anise/badian	2	3	1
27	090920	Seeds of coriander	Seeds of coriander	1	3	1
28	090930	Seeds of cumin	Seeds of cumin	1	3	1
29	090950	Seeds of fennel; juniper berries	Seeds of fennel; juniper berries	2	2	1

id	HS6	Brief description	Description (Comtrade)	nwfp	wild	raw
30	091020	Saffron	Saffron	1	3	1
31	121190	Pyrethrum (Chrysanthemum cinerariifolium)	Plants & parts of plants, incl. seeds & fruits, of a kind (excl. of 1211.20 - 1211.40) used primarily in perfumery/pharmacy/for insecticidal/fungicidal/similar purposes, fresh/dried, whether/not cut/crushed/powdered	2	2	1
32	130120	Gum Arabic	Gum Arabic	1	2	1
33	130190	Natural gums	Lac; Natural gums (excl. of 1301.20), resins, gum-resins & oleoresins (e.g., balsams)	2	2	1
34	130212	Liquorice (Glycyrrhiza glabra)	Saps & extracts of liquorice	1	3	2
35	130213	Hops (Humulus lupulus)	Saps & extracts of hops	1	3	2
36	152190	Beeswax	Beeswax, other insect waxes & spermaceti, whether/not refined/coloured	1	1	2
37	200390	Wild Mushrooms	Mushrooms other than of the genus Agaricus, prepared/preserved othw. than by vinegar/acetic acid	2	2	2
38	200880	Strawberries	Strawberries, prepared/preserved, whether/not containing added sugar/other sweetening matter/spirit, n.e.s.	1	3	2
39	293919	Opium	Alkaloids of opium (excl. of 2939.11) & their derivatives; salts thereof	1	3	2
40	320190	Tanning	Tanning extracts of vegetable origin other than quebracho extract/wattle extract; tannins & their salts, ethers, esters & other derivatives	2	2	2
41	320417	Pigments	Pigments & preparations based thereon	2	2	2
42	330112	Essential Oils	Essential oils of orange	1	3	2
43	330113	Essential Oils	Essential oils of lemon	1	3	2
44	330119	Essential Oils	Essential oils of citrus fruit, other than of orange/lemon	2	3	2
45	330124	Essential Oils	Essential oils of peppermint (Mentha piperita)	1	3	2
46	330125	Essential Oils	Essential oils of mints other than peppermint	2	2	2
47	330129	Essential Oils	Essential oils other than those of citrus fruit (excl. of 3301.24 & 3301.25)	2	2	2
48	330130	Resinoids	Resinoids	2	2	2
49	330190	Essential Oils	Essential oils (terpeneless/not), including concretes & absolutes(excl. of 3301.12-3301.29);extracted oleoresins; concentrates of essential oils in fats, in fixed oils, in waxes/the like, obtained by enfleurage/maceration; terpenic by-products of the deterpenation of essential oils; aqueous distillates & aqueous solutions of essential oils	2	2	2
50	330210	Odoriferous substance	Mixtures of odoriferous substance & mixtures (incl. alcoholic solutions) with a basis of one/more of these substance, of a kind used in the food/drink industries	2	2	2
51	330290	Odoriferous substance	Mixtures of odoriferous substance & mixtures, incl. alcoholic solutions, with a basis of one/more of these substance, of a kind used as raw materials in industry other than food/drink industries	2	2	2
52	380300	Tall	Tall oil, whether/not refined	2	1	2
53	380510	turpentine	Gum/wood/sulphate turpentine oils	2	1	2
54	380590	Terpenic oils	Terpenic oils produced by the distillation/other treatment of coniferous woods; crude dipentene; sulphite turpentine&other crude para-cymene; pine oil containing alpha-terpineol as the main constituent.	2	1	2
55	380610	Rosin & resin acids	Rosin & resin acids	1	1	2
56	380630	Ester gums	Ester gums	2	1	2
57	380690	Rosin & resin acids	Derivatives of rosin/resin acids (excl. of 3806.2); rosin spirit & rosin oils; run gums	2	1	2
58	380700	Tar	Wood tar; wood tar oils; wood creosote; wood naphtha; vegetable pitch; brewers' pitch & similar preparations based on rosin/resin acids/vegetable pitch	1	1	2

id	HS6	Brief description	Description (Comtrade)	nwfp	wild	raw
59	382460	Sorbitol	Sorbitol other than of 2905.44	2	1	2
60	450110	Cork	Natural cork, raw/simplely prepared	1	1	1
61	450190	Cork	Waste cork; crushed/granulated/ground cork	1	1	3
62	450200	Cork	Natural cork, debacked/roughly squared/in rectangular (incl. square) blocks/plates/sheets/strip (incl. sharp-edged blanks for corks/stoppers)	1	1	3
63	450310	Cork	Corks & stoppers, of natural cork	1	1	3
64	450390	Cork	Articles of natural cork other than corks & stoppers	1	1	3
65	450410	Cork	Blocks, plates, sheets & strip, of agglomerated cork; tiles of any shape, of agglomerated cork; solid cylinders, incl. discs, of agglomerated cork	1	1	3
66	450490	Cork	Agglomerated cork (with/without a binding substance) & other articles of agglomerated cork (excl. of 4504.10)	1	1	3

Notes: Codes of colum "nwfp": 1=single NWFP, 2=two or more NWFP together, 3=NWFP with other products. Code of colum "wild": 1=wild, 2=wild and domesticated, 3=domesticated. Code of colum "raw": 1=raw, 2=processed, 3= raw and processed. The HS6 codes are referred to the period 2007-2012.