A. TARIFF AGGREGATION METHODS – WHAT ARE THE IMPLICATIONS

WHY ARE AGGREGATES NEEDED?

A major part of statistical work consists of summarizing, for the sake of analysis and description, micro-level information - survey results, administrative or business related data – to manageable macro-level information. Researchers have developed various descriptive statistics, indexes and many other tools with the main objective being to extract and identify specific characteristics of the underlying datasets.

For any meaningful statistical analysis, it is important that it is based on statistical units that can be compared and aggregated. Aggregation needs to be consistent when done at different levels so that lower level aggregations can easily be "added up" to higher levels of aggregation. The unit of measurement is crucial in this context. Many economic statistics can be easily compared and summed up by just referring to their commercial value. For example, imports and exports are measured at customs on the basis of individual transactions in terms of value in national currency and quantity units of measure such as weight together with a range of additional indicators. The value of imports or exports can easily be added up by sector, provenance, destination or just total trade – national, regional and even world - because the unit of measure is a monetary unit. For exchange rates, there are market-based conversion factors that can be used. But doing the same exercise on quantities is normally not feasible because different units of measure are used for different products. Some of these are convertible to a common denominator but others are not. If the units of measure do not lend themselves to easy aggregation, one needs to apply weightings schemes or conversion factors. These are meant to transpose measures that are not directly comparable into equivalent units.

TARIFF DUTIES ARE SPECIAL

Duties are normally measured in terms of *ad valorem* rates that are assigned at the level of national tariff lines.[1] These are defined as subdivisions of the internationally accepted Harmonized System nomenclature, which defines products at the level of HS six-digit product codes. Since different countries have different requirements, the product coverage of individual tariff lines is not the same in different national nomenclatures. Under each national tariff line there may be a lot, a little or no imports. This depends on: (1) the detail of the tariff line breakdown; (2) the level of the duties; (3) the actual domestic demand at a given price for the products covered by the tariff line; and last, but often not least important, (4) non-tariff measures.

There is obviously a need to choose some kind of equalizing or standardizing weighting scheme in order to arrive at meaningful tariff aggregates. This does not mean that there can only be one best set of weights. Different weighting schemes usually serve different purposes and should be used only for the purpose for which they have been designed and where it makes most sense.

1 Duties can be expressed in *ad valorem* terms as per cent of duty per value of imports or in non-*ad valorem* terms. The latter entails specific conversions, which are addressed in part B of the technical annexes. The following analysis assumes that all duties are expressed in *ad valorem* terms.

One concern that needs to be taken into account is cross-country comparability. While many statistical measures based on national standards may make perfect sense and suit national needs very well, it should not be forgotten that international comparison is important even from a national point of view.

THE HARMONIZED SYSTEM NOMENCLATURE

Nearly all national tariff nomenclatures follow the Harmonized System (HS), which is maintained by the World Customs Organization. Its member countries, which are mostly also Members of the WTO, have agreed to adopt the HS product classification as their international standard nomenclature. The HS product classification is broken down by Sections, Chapters, Headings and, at its most detailed level, Subheadings (HS six-digit codes). The HS product classification is logically structured and supported by rules and definitions to achieve uniform classification. The HS was developed as an extension of the former four-digit Customs Co-operation Council Nomenclature (CCCN) heading to the six-digit HS heading and was amended in 1992, 1996, 2002 and 2007.

NATIONAL TARIFF LINE BREAKDOWNS

To suit their national requirements, Members usually break down the HS six-digit standard nomenclature into more detail (8-10 or more digits) for their nation customs classification. One can therefore observe a wide variety in the number of tariff line codes and product descriptions that are used by national customs administrations. This can be seen in the summary tables. Nevertheless, a large majority of countries uses less than 10,000 tariff lines, less than double the international standard number of 5,224 lines (HS 2002).

COMMON MEASURES OF AGGREGATION

Four measures of tariff averages are introduced, two of which are simply based on tariff duties and two that take into account trade weights. The discussion focuses on the calculation of MFN tariff averages. The notation used is as follows:

T	Tariff duty
Ta	Tariff duty average
M	Import value of the reporting country
TRADE	Exogenously defined trade shares
i	Index referring to national tariff line i
hsj	Index referring to HS standard subheading j

(1) Simple average of all tariff line duties

The simple average of all tariff line duties is probably the most commonly used indicator. It is defined as follows:

$$Ta(1) \quad = Sum(T_i) / Count(T_i)$$

Each tariff line (Ti) has exactly the same weight irrespective of its economic importance. The relative weight of a HS subheading depends on the number of individual tariff lines in that subheading compared to the overall number of national tariff lines. It may thus vary from one country to the other because the national nomenclatures vary in their detailed breakdown.

(2) Simple average of tariff lines with pre-aggregation

This indicator is a slight variation of the previous one as it uses the HS standard nomenclature at the HS six-digit level as standardizing factor. It is defined as:

$$Ta(2) \quad = Sum(T_{hsj}) / Count(T_{hsj})$$

where $T_{hsj} = Sum(T_i) / Count(T_i)$ is the tariff duty average in subheading hsj

The intention is to give each HS subheading the same weight in the overall tariff average. This in turn will ensure that the same subheading weights are used across countries since the number of subheadings is the same for all. Therefore, any given subheading always has the same weight irrespective of how many national tariff lines there are in that subheading and overall in the entire schedule.

(3) Trade weighted tariff average using imports

By taking into account the actual trade flows, one associates an economic weight to the tariff line duties and thus detaches the measure completely from the underlying nomenclature breakdown. It is defined as follows:[2]

$Ta(3) \quad = Sum(T_i \times M_i) / Sum(M_i)$ where M_i = imports of product i subject to duty T_i

The trade-weighted average is the average rate of duty per imported value unit. It is normally lower than the simple average duty because high duties are normally less attractive for importers than low duties. High duties tend to deflect imports and thus lower the trade weighted tariff average. This measure is often discredited as not truly reflecting the level of protection. However, it has some use in assessing revenue implications of duty rate changes.

2 An alternative way of calculation is can be defined as tariff revenue divided by import value. This would take into account all preferences and exceptions as they have been actually applied. It reflects better the revenue implications but on the other hand it does not allow to assess MFN averages when some of the imports come in under preferential duties.

In the absence of tariff line trade flows, one can also use as an approximation HS six-digit trade flows that are often more easily available. One would have to rely on an initial pre-aggregation to HS six-digit averages (like in method 2 above) to which the HS six-digit trade flows are then applied. This is likely to lead to a slight overestimation because low tariff line duties within a subheading are likely to attract a more than proportional share of trade flows.

(4) Trade weighted tariff average using standard weights

In order to correct the bias arising from the use of the country's own imports, one can make use of a set of standard weights based on trade flows that typically reflect other countries' export interest and/or capabilities. Since other countries' trade is often defined in nomenclatures that differ at the tariff line level from that of the importer, the set of standard weights can only be defined at the level of HS subheadings. It therefore requires a preliminary aggregation to the six-digit level before any weighting scheme can be applied (as in method 2).

Using standard weights the tariff average can be defined as follows:

$$Ta(4) \quad = Sum(T_{hsj} \times TRADE_{hsj}) \,/\, Sum(TRADE_{hsj})$$

where $TRADE_{hsj}$ = standard trade weights by HS subheading hsj

The choice of the weighting scheme is crucial and affects the outcome significantly. If one intends to evaluate the protective effects of developed markets vis-à-vis developing country exporters one could for example use the export structure of the latter as weighting scheme. However, again one is faced with two caveats: (1) If this export structure is based on simple aggregations of all developing country exports, one is likely to reflect the structure of the major 5-10 exporters and not necessarily that of the majority of developing countries. (2) It is likely that the developing countries' export structure is already conditioned by existing preference schemes and may thus not reflect their true potential.

COMPARISON

To illustrate the implication that different nomenclatures and different aggregation measures may have on the resulting averages, a small theoretical example is used. Table A.1 shows four sample schedules. They are based on a standard nomenclature of only five codes shown in the first column (j). The second column (i) indicates if at the national level there is a further breakdown. This presentation attempts to reflect the situations of HS six-digit vs. national tariff lines breakdown. Schedule A shows five tariff lines following the standard breakdown. Schedule B has a further breakdown but with the same duty rates within each standard group. Schedule C has the same breakdown as schedule B and the same HS six-digit averages but a different protection at the detailed tariff line level. Schedule D has the same protection as schedule C but the low duties in groups (j) 20 and 30 are collapsed into only one national tariff line, respectively. The import structure is the same at the level of the five standard groups but with more detail in schedule B. There is also a column with standard trade weights.

Table A.1
Sample schedules

Schedule A					Schedule B					Standard weight
TL codes		Duties	Pre-aggregation	Imports	TL codes		Duties	Pre-aggregation	Imports	
j	i	T	T_{hs}	M	j	i	T	T_{hs}	M	TRADE
10	0	10	10	200	10	1	10	10	50	20%
					10	2	10		150	
20	0	20	20	100	20	1	20	20	50	10%
					20	2	20		20	
					20	3	20		30	
					20	4	20		0	
30	0	10	10	1000	30	1	10	10	500	20%
					30	2	10		100	
					30	3	10		400	
40	0	0	0	500	40	0	0	0	500	10%
50	0	5	5	400	50	0	5	5	400	40%

Schedule C					Schedule D					Standard weight
TL codes		Duties	Pre-aggregation	Imports	TL codes		Duties	Pre-aggregation	Imports	
j	i	T	T_{hs}	M	j	i	T	T_{hs}	M	TRADE
10	1	15	10	50	10	1	15	10	50	20%
10	2	5		150	10	2	5		150	
20	1	10	20	50	20	1	10	30	100	10%
20	2	10		20						
20	3	10		30						
20	4	50		0	20	4	50		0	
30	1	5	10	500	30	1	5	12.5	900	20%
30	2	5		400						
30	3	20		100	30	3	20		100	
40	0	0	0	500	40	0	0	0	500	10%
50	0	5	5	400	50	0	5	5	400	40%

The summary statistics in Table A.2 show the results for the four methods applied to the four schedules. Although the level of protection is the same in schedules A and B as well as C and D, respectively, the summary statistics do not always give the same results for the two pairs of schedules. Only Method 3, the import trade weighted average, gives the same results for both pairs of schedules. In fact, tariff line import trade weighted averages remain invariant to national nomenclature breakdown because the trade weights make up for the changes in nomenclature. It also yields lower averages because lower duties normally attract higher imports.[3] Methods 2 and 4 lead to the same results for schedules A, B and C because the averages at the level of the five standard tariff lines are identical. These methods are robust as to variations in detailed national tariff nomenclature breakdown.

Table A.2
Summary statistics for aggregation methods

Method		Schedule			
		A	B	C	D
1	Simple average	9.00	12.27	12.27	13.75
2	Simple average with pre-aggregation	9.00	9.00	9.00	11.50
3	Import trade-weighted	7.27	7.27	5.00	5.00
4	Standard trade-weighted	8.00	8.00	8.00	9.50

Table A.3 shows some country examples to illustrate the different outcomes resulting from different averaging methods with actual tariff schedules. It shows the tariff averages which are obtained using methods 1 and 2, for some of the most extreme cases.[4] If one looks at the complete sample one can observe that there are many more countries for which the tariff line approach (method 1) gives higher averages than the approach using HS six-digit pre aggregation (method 2). While there are more than 40 countries for which the tariff line aggregation is more than one percentage point higher, there are only five countries - all of them in Latin America - where the tariff line aggregation is more than one percentage point lower. The data reveal that, on average, highly protected sectors are broken down into more detailed tariff lines than less protected sectors.

3 Some individual exporters may nevertheless specialise in higher value added products in spite of relatively high duties.
4 Simple averages are more easily calculated and more frequently used than the trade-weighted averages.

Table A.3
Differences in duty averages for selected countries

Country	Year	Average over all products		Difference
		Method 1	Method 2	
Switzerland	2006	13.4	7.6	5.7
Tunisia	2006	31.8	26.8	5.0
Norway	2006	12.4	8.6	3.8
Uruguay	2006	9.2	10.6	-1.4
Brazil	2006	10.6	12.3	-1.7
Paraguay	2006	8.1	9.9	-1.8

In this publication method 2, i.e. simple averages with pre-aggregation, was used as the main method in the summary tables and also in the country tables. In addition, trade weighted averages, based on HS six-digit pre-aggregations, are presented in Part A.1 of the country pages. In Part B import trade-weighted averages are based on bilateral tariff line trade flows, taking also into account preferential treatment as applicable. In the bilateral context, it appears quite appropriate and very relevant to focus on traded tariff lines. In the absence of prohibitive market access conditions, these tariff lines are of interest from an exporter's perspective. The difference between MFN and preferential trade-weighted duties gives an indication of the preferential rent.

B. METHODOLOGY FOR THE ESTIMATION OF NON-*AD VALOREM* TARIFFS

Countries use various types of tariffs in their currently applied or in their bound tariff schedules. In most cases, tariffs are expressed in *ad valorem* terms, i.e., as a simple percentage of the value of the imported product. However, some countries express some or even a substantial number of tariffs in non-*ad valorem* terms as classified in Box 1.[5]

Box B.1
Typology of non-ad valorem duties

• **Specific duties:** The customs duty is not related to the value of the imported goods but to its weight, volume, surface, etc. The specific duty stipulates how many units of currency are to be levied per unit of quantity (e.g. 2.00 Swiss Francs/kg).
• **Compound duties:** The customs duty is a tariff comprising an *ad valorem* duty to which is added or subtracted a specific duty (e.g. 10 per cent plus US$2.00/kg; 20 per cent less US$2.00/kg).
• **Mixed duties**: The customs duty is based on a conditional choice between an *ad valorem* duty and a specific duty, subject to an upper (ceiling) and/or a lower (floor) limit.
• **Technical duties**: The customs duty is determined by complex technical factors such as alcohol content, sugar content or the value of the imported product (e.g. 8.2 per cent + T1, where T1 refers to a specific formula duty based on the agricultural component).

The proliferation of non-*ad valorem* duties (NAVs) is partly due to the tariffication process for agricultural products undertaken during the Uruguay Round, whereby quantitative restrictions and variable levies applicable to agricultural products were converted into tariffs and tariff rate quotas. This tariffication process resulted in the adoption of specific duties, often combined with quotas, rather than pure *ad valorem* tariffs. The co-existence of *ad valorem* and non-*ad valorem* tariffs makes the comparison of countries' tariff profiles difficult, hence the need to calculate *ad valorem* equivalents for the non-*ad valorem* tariffs.

There is a general, albeit incorrect, perception that NAVs are used only by developed countries. In reality, NAVs are applied by 68 out of the 151 countries shown in this publication including several LDCs (see the summary tables). The use of these tariffs varies strongly from country to country from 80% of tariff lines in Switzerland to only one tariff line in Tanzania. Out of the 68 countries that use such tariffs, 19 apply them to more than 10 per cent of their agricultural tariff lines – among them are Switzerland, Norway, Thailand and the United States with over one third of their subheadings with NAVs. In the case of non-agricultural tariff lines, the incidence of NAVs is much lower but there are over 10 countries that use these tariffs for more than 200 of their tariff lines - among them are Switzerland, Thailand, Russia, India and Argentina.

5 WTO document TN/MA/S/10.

One of the peculiarities of NAVs resides in the fact that even if they are applied to a limited number of tariff lines, the products concerned are often classified as sensitive, either because governments collect significant tariff revenues, e.g. cigarettes and alcoholic drinks, or for protecting domestic products against lower priced imports. These highlight the importance of analysing NAVs. In order to compare the level of protection among products and across countries, the different NAVs applied by a country have to be "normalized" and treated homogeneously.

This "normalization" is most commonly done by converting these different measures into *ad valorem* equivalents (AVEs). An AVE is an estimate of *ad valorem* effect that a NAV duty has on the imports. It has to be kept in mind that AVEs are only "imperfect" estimates because the *ad valorem* equivalent of a specific tariff at a given date will remain equivalent only as long as the price of the imported goods remains unchanged.[6]

AD VALOREM EQUIVALENTS BASED ON UNIT VALUES

There are two main methods of AVE estimation that were used in the GATT/WTO context: revenue collected divided by the value of imports, and unit values based on import values divided by import quantities.

The revenue method will not be discussed further because it has more serious limitations in its use than the unit value method. In particular, it requires that MFN dutiable trade has taken place in the reference period. The unit value method is relatively easier to apply to situations with no trade flows and/or situations with multiple preferential rates.

The unit value method requires that the value of imports is first divided by the import volume (quantity) to derive the import unit value (UV). The AVE is then calculated as the specific part of the NAV divided by the UV and the result is presented as a percentage.[7] For example, if the import value is US$10,000 and the corresponding import volume is 100 tonnes, the unit value would be US$100/tonne. A specific duty of US$10/tonne expressed as a percentage of the resulting unit value (US$100/tonne) would give an AVE of 10 per cent.

6 Analogously, AVEs will diverge when the price of a product varies. It can be observed that specific tariffs tend to discriminate against exports from low-income countries, whose producers often specialize in the lower price-quality segment of export markets. In addition, the price decrease for many commodities in recent years has further penalized many least developed countries, as the AVE of specific duties for these commodities increased correspondingly. For example, the protection is equal between a US$20/tonne specific tariff and a 20 per cent *ad valorem* tariff, when the price equals US$100/tonne. If the price falls to US$50/tonne, however, the same specific tariff is equivalent to a 40 per cent protection level.

7 For compound duties the *ad valorem* part is then added or subtracted to arrive at one AVE value. For mixed duties the AVE of the specific part is then subject to the conditional choice expressed in the duty.

The calculation of the AVE of a simple specific tariff can be formalized by the following formula:

$$AVE = \left(\frac{SP}{UV} \times XR \right) \times 100$$

AVE: *Ad valorem* equivalent (per cent)

SP: Monetary value of duty per unit of imports

UV: Import unit value

where UV = V / Q

V = Value of imports

Q = Quantity of imports

XR: Currency exchange rate, where appropriate

The key parameter for the AVE calculation is the import UV. There are, however, different possible product specific UVs to choose from, including those based on bilateral trade flows, on the country›s imports from the world or from a reference group of countries, at the tariff line level or at the six-digit level of the Harmonised System (HS). Depending on the availability and quality of import data, UVs should be calculated at the tariff line level. If tariff line data are not available or do not satisfy certain quality tests which will be introduced later on, HS six-digit level UVs have to be used. In this case the same unit value will be applied to all tariff line products under the same subheading.

UVs can be calculated for each partner separately, thus allowing the possibility of capturing the quality specialization of the corresponding trade flow. UVs can also be calculated for a group of countries, i.e. a reference group, identified on the basis of geographical or economic criteria such as GDP per capita, trade openness, total trade, etc. Furthermore, membership in a preferential agreement often affects the trade patterns and thus the UV distribution of imports.

Before calculating UVs, tariff lines without any quantity or value information are excluded because they cannot be used for bilateral UVs and they would distort UVs based on imports from the world or from a reference group. Exchange rates and conversion factors are applied on the raw data to transform values, quantities and units for each of the individual products for each concerned country in the same unit. Once these preliminary steps are completed, several methodologies for calculating UVs for an importing country for a given product k can be considered:

(a) Global UV average: The calculations are based on the sum of all (n) bilateral import flows (i). The import values Vik and the import quantities Q_{ik} registered during the period is first summed up and then the sum of the values is divided by the sum of the quantities.

$$UV_k = \sum_i^n V_{ik} \Big/ \sum_i^n Q_{ik}$$

The drawback of this method is that the result is strongly affected by high value and/or volume transactions.

(b) Weighted UV average: UVs are calculated, for each bilateral trade flow and then a import-weighted average is calculated.

$$UV_k = \frac{\sum_{i=1}^{n}\left[\left(V_{ik}/Q_{ik}\right) * V_{ik}\right]}{\sum_{i=1}^{n}\left[V_{ik}\right]}$$

The drawback of this method is that the result is strongly affected by high value transactions.

(c) Simple UV average: All UVs calculated for each bilateral import trade flow are summed up and divided by the total number of bilateral trade flows

$$UV_k = \frac{1}{n}\sum_{i=1}^{n}\left[V_{ik}/Q_{ik}\right] = \frac{1}{n}\sum_{i=1}^{n}\left[UV_{ik}\right]$$

In this method all UVs are given the same weight in the calculation of the average UV. Small trade transactions are often more numerous and costly per unit and have a tendency to push the average upwards if a minimum trade threshold is not used. Extreme UVs may also unduly affect the result.

(d) Median UV: This approach, also based on individual bilateral UVs, uses the median UVs which is not sensitive to extreme values However, the use of the median is not appropriate in a multimodal structure, i.e. the product covered under a specific tariff line includes two or more quite distinctly priced sub items. In a graphical perspective, one would see a UV distribution with multiple peaks.

To determine which methodology calculates most accurately the UVs required for the estimation of AVEs one needs to test the different methodologies and analyse their sensitivity to variations in the data. It is important to understand and interpret the origin of these variations and to correct them if possible. This would also enable the identification of multimodal UV distributions. The remainder of this paper investigates and elaborates on the problems that can be faced when analysing trade data and it introduces different approaches and methods adopted to overcome these problems in the calculation of AVEs for this publication.

The analysis was done for all of the about 28,000 NAVs that were present in the tariff schedules. For about 15,000 tariff lines UVs were calculated at the tariff line level. For the remainder of the NAVs HS six-digit UVs were used.

IDENTIFICATION AND ELIMINATION OF OUTLIERS

One often finds UVs that seem to be inconsistent with the general characteristics of the sample. Such UVs are either "far too low" or "far too high" compared with the overall distribution of the bilateral UVs; these extreme values are called outliers. They could be a result of niche products, measurement errors or even reporting errors in the data collecting process. Since these outliers may significantly affect the calculation of averages it is important to identify and possibly eliminate such outliers.

Several methods have been developed to exclude extreme UVs, e.g. excluding flows with small import values (e.g less than US$5,000) or excluding UVs which are X time larger or smaller than the median. The method used in this publication consists in retaining successive UVs around the median until the sum of the contributions to total trade reaches 90 per cent or 90 per cent of the observations are covered. For the series to be retained, it must include at least three observations following the elimination of extreme values. Otherwise, the series was omitted and the calculation of the AVE relative to the tariff line was undertaken at the HS six-digit.

To illustrate the issue, the following product 04041006[8], imported by the EU is taken as an example. Before the exclusion of the extreme values, the UVs ranged from 39 US$/tonne to 111,250 US$/tonne with an average of 4,021 US$/tonne. After the elimination of six extreme values, the range reduced to between 39 US$/tonne and 3,212 US$/tonne with an average of 1,282 US$/tonne and a median of 952 US$/tonne.

Table B.1
Distribution of UVs (US$/tonne)

	Minimum UV	Quartile UV		Maximum UV	Number of observations
		Q_1	Q_3		
With outliers	39	782	2,052	111,250	65
Without outliers	39	769	1,833	3,212	59

Table B.2 shows the resulting UVs for the four methods with and without outliers.

Table B.2
UVs using different methods (US$/tonne)

	Global UV average	Weighted UV average	Simple UV average	Median UV
With outliers	1,115	11,994	4,021	978
Without outliers	964	1,281	1,282	952

8 Whey and modified whey, in powder, granules or other solid forms, without added sugar or other sweetening matter, of a protein content nitrogen content X 6.38' OF <= 15 per cent by weight and a fat content by weight of > 27 per cent.

The elimination of the extreme values has, on the one hand, enabled to bring closer together the estimated UVs, but on the other hand, it has only partially eliminated all the risks associated with dispersion of UVs.

Apart from the identification and elimination of outliers, bilateral UVs may exhibit certain properties that require the use of a different algorithm. The choice of the calculation method depends significantly on the characteristics of the distribution of the bilateral UVs. In an ideal world, a thorough analysis of each sample would be undertaken as a way to better adapt the methodology. Since the volume of data under analysis is significant, it was judicious to come up with an automated methodology.

MEASURES OF DISPERSION AND ASYMMETRY

A very useful and robust measure to describe the dispersion of a data series is the interquartile range ratio, which is the ratio between the lower (Q_1) and upper (Q_3) quartile ($IRR = Q_1/Q_3$). The closer the ratio's value is to 1, the lower and the more stable the dispersion is. A low value of the ratio denotes a high variability of the UVs included in the data series. Moreover, a high variation does not allow the extraction of a representative UV sample. The IRR's sensitivity can in certain instances be caused by inaccuracies in the data set or by the presence of two or more categories or varieties of products in the same tariff line. This phenomenon is more often encountered when the analysis is undertaken at the HS six-digit level because of the aggregation of different products under the same subheading.

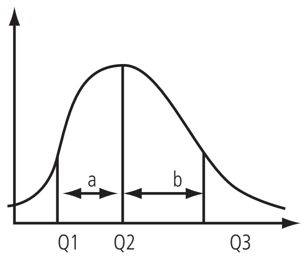
Two levels of sensitivity have been tested. The first one has an IRR greater than 0.5 and the second one has an IRR greater than 0.25. For a stable range, the value of the upper quartile (Q_3) must be at most two times greater (respectively four times) than value of the lower quartile (Q_1).

According to the results of the analysis about 80 per cent of the tariff line UVs satisfy the first level of sensitivity ($IRR>0.25$) and 46 per cent satisfy the second level ($IRR>0.5$). The percentage for the second level can be improved to 66 per cent if outliers are removed as outlined above. While an IRR value of 0.5 can be considered as extremely constraining and inflexible, the thoroughness of the methodology pays off in terms of the increased reliability. If the IRR value is > 0.5, the sample can be considered as stable and its median UV can be considered as the sample's representative value.

Before coming to such a conclusion, one must verify whether this median is also properly centered. To perform this verification, the Bowley's asymmetry coefficient (Bowley Skewness Coefficient: BSC) has been used. It is calculated as follows:

$$BSC = \frac{(Q_3 - Q_2) - (Q_2 - Q_1)}{(Q_3 - Q_2)}$$

Its value ranges from -1 to +1, and it is equal to zero if the median is located exactly in the middle of the interquartile range.



$$\begin{cases} b > a \Leftrightarrow BSC > 0 \\ b = a \Leftrightarrow BSC <= 0 \\ b < a \Leftrightarrow BSC < 0 \end{cases}$$

Over 80 per cent of the tariff line UVs have a BSC between –0.5 and 0.5 and their distribution can be considered as symmetrical. The median UV for these tariff lines has been used for calculating AVEs (as long as the conditions relating to the IRR hold and that there are at least three observations available for the calculation). The remaining lines were treated separately with a different algorithm because of their high dispersion.

Using again the example of product 04041006 imported by the EU, none of the two prerequisite conditions have been met, even though the elimination of extreme values has reduced the dispersion in the sample. The BSC for this product is equal to 0.66 and the IRR is 0.42. As a result, this product was assigned to the group of other products which have not been retained according to this criteria. It would have to go through the UV's additional identification procedures.

In summary, 58 per cent of the tariff lines satisfy the two conditions and among them 42 per cent have a minimum of three observations and have therefore been retained for the calculation of median UVs.

PROCESSING NON COMPLIANT LINES

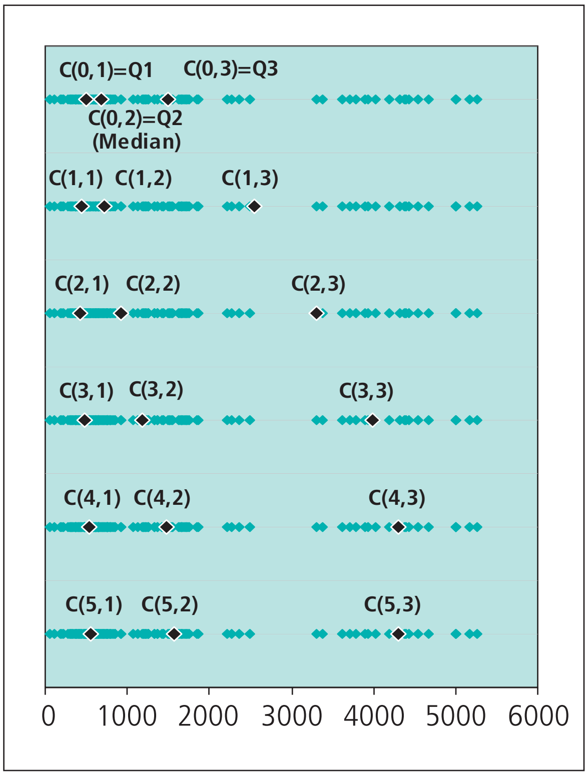
For those series which have a significant dispersion and/or dissymmetry, the median cannot be used as a representative UV and an alternative solution has been identified. It consists in calculating an average that takes into account the presence of different product categories. Hence, for each series, one identifies the central points around which the observations gravitate. The relative weight and number of observations associated with each central point can then be used in the calculation of the series› average representative UV. Hence, use is made of an aggregation algorithm around moving centres. For a good functioning of the algorithm, it is necessary to have a suitable number of observations in the identified series. Therefore, series with less than ten observations were treated using HS six-digit data.[9]

9 A minimum of 10 observations was selected to ensure a reasonably robust result. A sensitivity analysis, which had been undertaken beforehand, had shown that there would only be a loss of 25 per cent of series compared to a threshold set at 5 observations.

The starting point is a partition where each interval is represented by an initial central value(C(0,1), C(0,2) and C(0,3)). The starting values for the current algorithm are the three quartiles: Q_1, Q_2 (Median) and Q_3. After several rounds of successive iterations, the gaps between the different observations and their previous centre of gravity are reduced until a set of stable partitions is found.[10] Once stability has been reached an average UV is calculated by weighing the final partitions' UVs with their partitions' relative weights and number of observations.

To illustrate the process the product 04041004[11] imported by the EU is taken as an example. Without outliers, the data series contains 169 observations, ranges from 54 US$/tonne to 5,259 US$/tonne and has an average of 1,348 US$/tonne and a median of 680 US$/tonne. With a BSC of 0.63 and an IRR of 0.336, neither the asymmetry, nor the dispersion conditions are respected. Since the number of observations is higher than ten, it is possible to use the algorithm. The weighting of each of the initial central values with its number of observation and its trade weight leads to an average UV of 881 US$/tonne.

Graph B.1



10 The number of classes can decrease along the way.

11 Whey and modified whey, in powder, granules or other solid forms, without added sugar or other sweetening matter, of a protein content "nitrogen content x 6.38" of <= 15% by weight and a fat content, by weight, of > 1,5 and <= 27%

Graph B.1 shows how after five successive iterations a stable partition is obtained. In this final partition, the first central value goes from C(0,1)=500 US$/tonne to C(5,1)=547 US$/tonne for 109 observations and 23 million US$ of trade. The second value goes from C(0,2)=680 US$/tonne to C(5,2)=1,562 US$/tonne for 39 observations and 38 million US$ of trade and the third central value goes from C(0,3)=1,488 US$/tonne to C(5,3)=4,304 US$/tonne for 21 observations and 35 million US$ of trade. The average weighted UV calculated using these three values is 1,246 US$/tonne which is nearly two times higher than the median.

Out of the series included in this process, 24 per cent have a minimum of 10 observations. The remaining series were disregarded and treated using HS six-digit (see table B.3).

Table B.3
Distribution of tariff line UV by UV method

Method	Share of tariff lines in per cent
Median	42
< 3 observations for Median	16
Algorithm	24
< 10 observations for Algorithm	18

PROCESSING LINES USING HS SIX-DIGIT DATA

International trade at the level of HS six-digit subheadings is an aggregation of a group of products covered under the respective subheading. The contribution of each product's weight varies from one country to another. The product's contribution is greatly affected by the tariff imposed on it. The higher the tariff, the less the product is imported. This implies that at the HS six-digit aggregation, there are combinations of products dominated by those products facing low tariffs, or those having relatively higher UVs, leading to an underestimation of a given country's protection level.

In order to minimise this endogeneity bias, one makes use of UVs derived from reference groups with similar economic and trade profiles. Hence, it is no longer the country's import structure which influences the UVs but it is the import structure of the reference group of countries.

Once the reference groups have been established, one needs to calculate respectively the UV at the six-digit level for each group. For this calculation, the same procedure undertaken at the tariff line level (outlier, dispersion, symmetry, number of observations, median and algorithm) was applied at the HS six-digit level. The data series for a HS six-digit product and a given unit includes the overall imports of the countries' reference group for the period 2003-2005.

Box B.2
Method for establishing country reference groups

To establish reference groups for which unit values are calculated, an approach is used that draws on two complementary statistical methodologies: "Principal Component Analysis" and "Hierarchical Clustering Analysis", two major multidimensional exploratory analysis techniques. Factorial analysis is used as a preliminary step because of its powerful filtering capacity. By reducing the initial set of variables to fewer dimensions one can eliminate random fluctuations, which are part of the initial variance. Seven variables have been used.[12] The reference groups enable one to distinguish among countries in terms of: their trade openness (total trade in terms of GDP); their trade structure (share of agricultural and non agricultural products in imports and exports); their relative contribution to world trade; and their GDP in terms of purchasing power per capita.

Results of the Principal Component Analysis (PCA)
The first four factorial axes retained for our analysis account for 88 per cent of the total inertia. The first axis accounts for 47 per cent of the total inertia and groups on one side countries with a high share of non-agricultural exports and those with a high share of agricultural exports. The second axis representing 20 per cent of the total inertia, differentiates among countries importing agricultural and exporting non-agricultural products, with countries exporting agricultural and importing non-agricultural products. The third axis represents 14 per cent of the total inertia and separates countries in terms of their trade openness. The final axis, 7 per cent of the total inertia, contrasts countries according to their income levels.

Hierarchical Clustering Analysis (HCA)
Following the PCA analysis, the HCA is applied to the data rearranged according to the four factorial axes. This classification aggregates groups of elements according to Ward's generalised criteria. These criteria seem to be compatible with the corresponding PCA analysis, since they are based on a similar notion of inertia, which guaranties the results' stability when we group elements with similar profiles.
The hierarchical tree generated by this classification is cut in a way to have the most homogenous classes while still being well separated. Based on the tree, seven groups of countries were defined. The countries not included in the analysis are placed in a residual group.

12 (1) Trade openness; (2) Total exports + imports; (3) GDP purchasing power per capita; (4) Agricultural exports as a share of total exports; (5) Non-agricultural exports as a share of total exports; (6) Agricultural imports as a share of total imports; and (7) Non-agricultural imports as a share of total imports.

The calculation of UVs using reference groups data was done for 57 per cent of the NAVs. The remaining UVs were based on world imports. Even at the world level, the selection procedure of the UVs followed the same stringency. It allowed to cover another two per cent of the NAVs. In the end, for only four per cent of the NAVs no AVEs could be calculated. This was due to the use of undefined units or non-quantifiable technical measures by countries.

Table B.4
Overall distribution of UVs by UV method

Method	Share of tariff lines in per cent
Tariff line UV	38
HS six-digit reference group UV	57
HS six-digit world UV	2
Tariffs with problems	3
Technical duties	1

CONCLUSION

Several approaches can be considered for estimating AVEs. These approaches can lead to different results depending on a number of factors including, inter alia: product disaggregation level used, the preliminary treatment of the data leading to the exclusion of outliers and the choice of reference group or world UV in the absence of reliable national data. Various criteria can be used to identify the risk related to excessive dispersion and to orient the work towards more robust results. The approach used for this publication has emphasized the stability of the resulting UVs and has nevertheless enabled the estimation of AVEs for 96 per cent of all NAVs. The remaining four per cent of tariff lines that could not treated will be looked at more closely in the future and work will continue in collaboration with countries to fix the problem concerning these NAVs.

The following flowchart summarizes the methodology used to achieve the original objective of obtaining one unique unit value by country, product and unit of quantity measure.[13]

13 The same logical path can be followed for the calculation of AVEs at the bilateral level with the advantage of not being obliged to retain only one AVE. Keeping several unit values allows one to highlight the fact that a tariff line position may include products of different quality or type. This is the approach that will be applied to the new version of Market Access Map (www.MacMap.org).

Unit values calculation process