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DEVELOPING QUANTITY INDICES FOR IMPORTS AND EXPORTS –PROGRESS REPORT ON A NEW OECD PROJECT

Introduction

1. With growing significance of international trade and investments, monitoring the evolution of trade flows is an important statistical task. Detailed yearly Data on exports and imports in countries and at the OECD is typically available in (a) values, i.e., in current currency units of the importing or exporting country, possibly converted to a common currency such as the US dollar. Changes in values reflect the changes of quantities, prices (and possibly exchange rate changes) of a (group of) commodities; (b) physical quantities, i.e., kilograms, tons or units in which a commodity or a group of commodities is traded. Thus, the current information base provides information on the aggregate and by-commodity value of imports and exports and on the physical quantities traded for every detailed commodity. What is missing, however, is a price and/or a quantity index for imports and exports[1].

2. The conceptually correct way of going about the construction of a quantity index for trade flows would be to first compile a true price index[2] and then use the price index to deflate values of imports and exports. Typically, state-of-the-art price indices for exports and imports require survey-based price data with data sources beyond the value and physical quantity information from trade data bases and with methods that can address quality change in traded commodities as well as occurrences of new and disappearing products. In practice, such well-developed price indices are not always available and approximations are made with unit value indices at the national and international level. Unit value indices are derived from trade statistics by dividing total values of a commodity or commodity group by their respective quantities. These Unit Values are price-like variables without, however, being actual prices as they are generally computed at a level of aggregation that mixes up quantity change and changes in the composition of the commodity group and as they do not allow accounting for quality change Despite these shortcomings and the fact that unit value indices are prone to bias, they are regularly used in practice and the present project – for want of true deflators – follows the same route of using unit values as the basis for price and quantity indices of exports and imports. . In trade statistics, the standard unit values (SUV) have a practical aim, namely to estimate the volume of trade when only monetary values are reported and also to provide a benchmark against which the quality of new value and associated volume data can be assessed. The limits of proceeding this way have to

[1] Aggregate volume measures of imports and exports are available from the national accounts databases and, for some countries, from the monthly trade indicators.

[2] See the forthcoming international Manual on Export and Import Price Indices, available from the IMF website: www.imf.org/external/np/sta/tegeipi/

be clearly kept in mind. At the same time, it is hoped that the benefits of approximate price and quantity indices outweigh the inevitable errors due to the use of unit values. One added advantage is that the OECD is in a position to apply the same methodology – although imperfect – to all countries in its ITCS database, thus treating countries symmetrically.

3. The present document describes the approach pursued in this project and reports first results for a single country, Switzerland. More countries will be included in the future. If results appear plausible, it may be possible to compute and publish volume indices on a regular basis

1 The ITCS database as source

4. The 'raw material' for estimating quantity indices of imports and exports can be found in the ITCS database. OECD and UNSD have been working together during the past years to agree on the best statistical treatment of all aspects relating to trade data and to align their respective data processing practice. As a result, both organisations have agreed and implemented a Joint Trade Data Collection and Processing System. Statistical practices have been harmonized in the new database, notably for country codes, commodity codes, conversion to older classifications and quantity units and estimates. The new joint database provides for the first time all quantities in kilograms, and standard unit values (from 2005), which are important for the purpose at hand. In earlier data collections, quantity units changed over time, making it impossible to compile and compare quantity indices.

2. Methodology

2.1 Estimating unit values

5. In principle, computing unit values is a straightforward matter: divide the value of imports or exports of a particular commodity by the number of physical units that have been imported or exported. As mentioned before, some quality and compositional changes of the commodities are included in unit value variations, as well as price changes, and it is not possible to distinguish them. Unit value indices thus reflect changes in the commodities composition as well as pure price movements. In addition, there are a number of other practical difficulties to be overcome:

- First, unit values have to be computed at the most detailed level possible to minimize the bias inherent in using unit values as a proxy for prices. For the purpose at hand, this was done at the 6-digit level of the HS. This level is the most disaggregated level for international comparisons. Data availability across countries and over time did not permit computation at the 8-digit level which would have been preferable in light of compositional changes within the 6-digit level.

- Second, not every 6-digit commodity comes with physical quantity information and/or the units of quantity may change over time. The data for Switzerland used in the present test calculations does not suffer from this shortcoming but other countries' data does. One way to overcome this problem is the use of quantities that have been estimated via Standard Unit Values (see box), essentially the average unit value (in dollars) of the same commodity of those countries for which values and quantities are available.

- Third, it is well known that there are differences between the values of the sums of sub-aggregates and of aggregates in exports and imports, due for example to confidential data. The consequence is that the index across the most detailed components is not equal to an index across indices of subcomponents.

Box 1: Standard Unit Value estimation

The United Nations Statistical Division has set up a method to estimate missing quantity data when these are not reported by countries. Estimation is achieved by applying Standard Unit Values (SUVs) to the dollar values of import or export flows. An SUV is defined as the median of the sample derived from all the records sent by all available reporters to all partners (except the whole world) in a year, after several transformations and a process to exclude outliers from the set of unit value observations.

SUVs are estimated only if the sample of unit values on which it is based fulfills the following reliability criteria (UNSD 2006; *Unit Value: Report by Commodity*)

-- The data must come from at least two reporting countries/regions;

-- There must be at least 50 observations in the sample;

-- The relative standard deviation must be less than or equal to one, or it must be between one and two provided that its multimodality index is less than two;

-- The relative interquartile range must be less than two;

-- The trade value corresponding to outliers must be less than 50% of the total trade value.

A descriptive analysis of the unit value data carried out by UNSD showed that:

-- Unit value data for most commodities exhibit high degree of variability.

-- The distribution of unit values is usually asymmetric around its mean (skewness is usually positive).

-- The data is affected by the presence of outliers.

-- A log-transformation of the unit value data significantly reduces asymmetry, and therefore is more appropriate to construct confidence intervals and rejection thresholds for outliers. Using this criterion, about 4.7% of the observations in the unit value samples were diagnosed as outliers and disregarded from further calculations to obtain Standard Unit Values.

SUVs will be available in the ITCS database starting with the reporting year 2005.

Further information about the computation of SUVs can be found in UNSD (2006); *Unit Value: Report by Commodity*.

2.2 Estimating quantity indices

6. Given unit values, values and quantities for several periods and for each of the 6-digit HS commodities, the next step is aggregation of quantity changes to higher levels of the HS. In so doing, we proceed with the computation of a chained Laspeyres, Paasche and Fisher quantity index across the 6-digit commodities.

2.2.1 Laspeyres Quantity Index

7. The Laspeyres quantity index is an arithmetic mean of quantity changes for which the weighting system describes the structure of the base period values. It is the most commonly used price index formula but Laspeyres quantity index numbers are also common, in particular in the national accounts. They compare the quantities of a bundle of goods in the year t valued at prices

of a base period with the prices and quantities in the base period. Put differently, they answer the question what it would cost to purchase today's quantities at yesterday's prices. Period t quantities are weighted by prices in the base period. In its chained form, the quantity observations in the year t, Q_t, are valued at the preceding year's prices P_{t-1}. In the present context, prices are measured as unit values and quantities in physical units, typically kilograms. The Laspeyres quantity index between years t and t-1 is then defined as

$$L_{t/t-1}(Q) = \frac{\sum P_{t-1} * Q_t}{\sum P_{t-1} * Q_{t-1}}$$

8. The advantage of the Laspeyres Index is perhaps that short-or medium-term comparisons are possible since index numbers are comparable with each other. Its disadvantage may be that price developments may be overestimated and that with increasing distance from the base year overestimation increases.

2.2.2 Paasche Quantity Index

9. The Paasche quantity index is a harmonic mean of quantity changes with a weighting system that describes the structure of the values in the present period t. It compares how much it would have cost to purchase yesterday's quantities at today's prices and compares this to today's quantities at today's prices:, it is hence a "current weight index"

$$P_{t/t-1}(Q) = \frac{\sum P_t * Q_t}{\sum P_t * Q_{t-1}}$$

2.2.3 Fisher Quantity Index

10. The above definitions showed that the difference between the Laspeyres and the Paasche quantity indices lie in the weighting structure: in the first case, prices of the base period are used to value quantities, in the second case, prices of the present period are used for this purpose. Both weighting schemes are equally plausible but each weighting scheme will yield different results. It is therefore plausible to use an average weighting scheme or more precisely a geometric average of the Laspeyres and the Paasche quantity indices, the Fisher quantity index[3]:

$$F_{t/t-1}(Q) = \sqrt{P_{t/t-1}(Q) * L_{t/t-1}(Q)}.$$

[3] Besides being plausible, the Fisher index number formula has a number of other desirable properties and remains one of the preferred index numbers from a theoretical view for most purposes. See for example INTERNATIONAL LABOUR ORGANISATION, INTERNATIONAL MONETARY FUND, ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, UNITED NATIONS COMMISSION FOR EUROPE, THE WORLD BANK (2004); *Consumer Price Index Manual, Theory and Practice*, Washington, D.C..

2.2.4 Price indices

11. Associated with each of the above quantity indices is a price index, i.e., the index number formula that yields an index of values when multiplied by the quantity index. The price index associated with the Laspeyres quantity index is the Paasche price index $P_{t/t-1}(P)$ and the price index associated with the Paasche quantity index is the Laspeyres price index $L_{t/t-1}(P)$. Along with the Fisher quantity index comes the Fisher price index $F_{t/t-1}(P)$

$$L_{t/t-1}(P) = \frac{\sum P_t * Q_{t-1}}{\sum P_{t-1} * Q_{t-1}}$$

$$P_{t/t-1}(P) = \frac{\sum P_t * Q_t}{\sum P_{t-1} * Q_t}$$

$$F_{t/t-1}(P) = \sqrt{P_{t/t-1}(P) * L_{t/t-1}(P)}$$

12. In principle, thus, the empirical implementation can directly proceed with the computation of a quantity index or first compute a price index and a quantity index by deflation, i.e., by dividing the price index into the value index. For a complete set of data, and when the Fisher index formula is used, both avenues will yield identical results. When the quantity index is based on a Laspeyres formula (to mimic, for example, current practice in the national accounts), the relations above show that a Paasche price index would have to be used for deflation to ensure identical results.

13. There is, however, a practical argument that may privilege the computation of price indices for deflation over the computation of direct quantity indices. It has to be remembered that in the present context 'prices' are actually unit values, computed at the six-digit level of the HS. As was pointed out earlier, this practice runs the risk of mis-reading compositional changes and quality changes of products within the six-digit group as price changes. Sometimes this is very obvious, when unit values exhibit high volatility and change, for example, by several hundred percent between adjacent years. When 'price indices' are computed, such variations become apparent which is not the case with direct quantity indices and procedures can be implemented to deal with outliers in the computation. Also, when unit values are missing for certain product groups, for example because quantity information is not available, standard unit values (see box) may provide an estimate for missing unit values and can directly feed into the computation of a price index. In particular the construction of confidence intervals and rejection thresholds for outliers would improve the validity of this process. It should also be pointed out that unit value indices do not require additional, specific surveys – a considerable advantage taking into account the thousands of traded commodities under observation! Practicality is, therefore, an important argument in this context.

14. A UNSD report to the Task Force on International Trade Statistics in 2000 summarized national compilation practice on index numbers of international trade as follows[4]:

- 60 countries confirmed that they compile index numbers
- All compiling calculate unit value (66%) or price (34%) indices, about 70% calculate volume indices
- The Paasche formula is used by 40% of countries, Fisher by 34% and Laspeyres by 11%
- As to encountered problems, the countries reported inconsistencies and errors in raw data, changes in the structure of traded commodities, heterogeneity of commodity groups and qualitative changes in goods as well as frequent changes in commodity classifications.

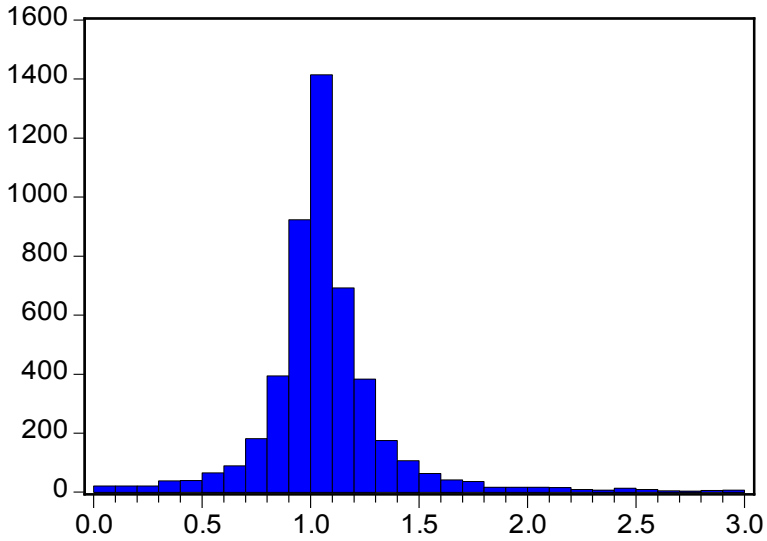
3. An example with data for Switzerland

15. Swiss import data was chosen to carry out a first test for the computation of quantity indices of trade flows, because there exists a complete time series of data in consistent values and quantities (net weight in kilograms for all commodities) since 1999. It was thus possible to compute price and quantity indices for the 1999 to 2005 period with different index number formulae without having to deal with additional problems like missing values or physical units for commodities that change over time.

16. Indices were computed for 4-digit and 2-digit groups as well as for total imported goods. As the number of items within the 4 digit groups is variable, several such groups were composed of only one commodity, implying that Laspeyres, Paasche and Fisher indices collapse into a single number. Some high values of quantity indices could also be observed due to the irregular importation of some commodities which provoke large variations of the values, especially among the groups composed of one or few commodities like cobalt, precious metal, etc. While such measured quantity changes may reflect actual variations in quantity, very large swings in unit values are indicative not of price changes but of changes in the composition of goods inside a six-digit group. Figure 1 shows the frequency distribution of the changes in unit values between the years 2004 and 2005 for Swiss imports. The maximum ratio shown in the graph is 3, indicating a 300 percent rise in unit values – it is unlikely that this reflects a true price change and it may be advisable to exclude such extreme values from the index number calculations. For the present set of results, this has not yet been the case but, as said before, future implementation will include the exclusion of outliers according to a set of rules established in line with UNSD practice to maximise applicability across countries.

4. Technical Information on Index Numbers of International Trade – a progress report, Paper presented by UNSD at the meeting of the Task Force on International Trade Statistics, Vienna 21-23 March 2000

Figure 1 Frequency distribution of unit value ratios 2005/04
6-digit commodities, imports, Switzerland



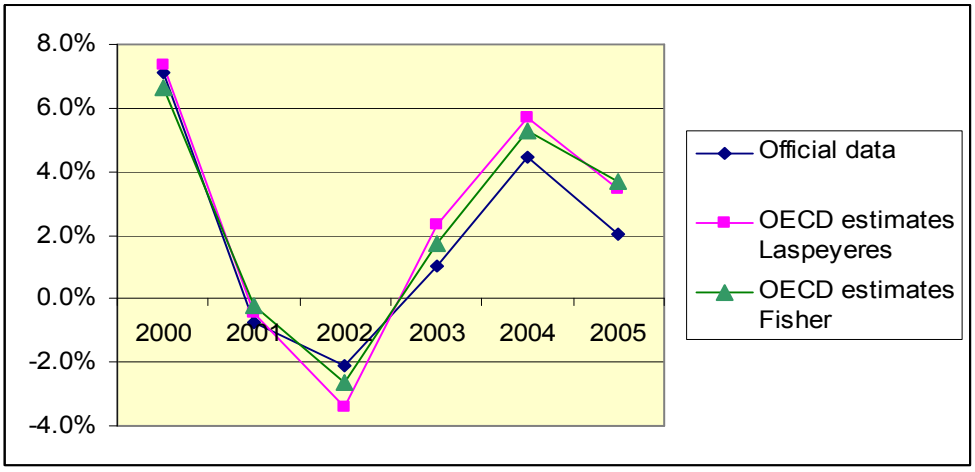
17. Table 1 provides a concrete example for the computation of a quantity index for product group 306 of the HS (0306: Crust w/n in shell, live, fr...; crust in shell ckd in water, w/n chi) for the years 2004 and 2005. From values and physical quantities, unit values are computed and used to revalue quantities (2005 quantities at 2004 UV in the case of the Laspeyres index and 2004 quantities at 2005 UV in the case of the Paasche index). Because quantity and price variations are relatively modest in this commodity group and because chained index numbers have been used, the spread between the Laspeyres and the Paasche quantity index is quite small. For other product groups, this may well be different.

18. As a final point, we shall compare the overall quantity index derived from the present unit value method for the years 1999 to 2005 with the official volume data for imports into Switzerland for the same period. Three time series are shown in Figure 2: the official data produced by Switzerland and the Laspeyres and Fisher quantity indices produced by the OECD. Clearly, the series are highly correlated although for the later years, discrepancies rise. At the same time it has to be noted that the OECD calculations presented here made no correction for outliers in unit value changes which might bring the two series closer.

Table 1: Computation of quantity indices for a 4-digit commodity group

	Value (current USD) 2004		Quantities (kg)		Unit value			2005 quantities at 2004 UVs	Laspeyres quantity index	2004 quantities at 2005 UVs	Paasche quantity index	Fisher quantity index
	2004	2005	2004	2005	USD 2004	USD 2005	Ratio 2005/04		2005/04		2005/04	2005/04
	A	B	C	D	E=A/C	F=B/D	G=F/E	H=D*E	I=H/A	J=C*F	K=B/J	L=(I*K)$^{0.5}$
30611	1189299	618615	43838	20814	27.13	29.72	1.0955308	564671.5		1302914		
30612	670686	738592	27062	27954	24.78	26.42	1.0661082	692792.71		715024		
30613	32285002	32737755	3248639	3301716	9.94	9.92	0.9977226	32812482		32211477		
30614	462024	812092	38880	63408	11.88	12.81	1.0777621	753498.4		497952		
30619	4059116	4708845	216727	237925	18.73	19.79	1.0567101	4456136.9		4289309		
30621	29478	158360	919	5437	32.08	29.13	0.9080372	174398.13		26767		
30622	3923563	4257895	208256	208024	18.84	20.47	1.0864216	3919192.1		4262644		
30623	356421	388197	25030	24586	14.24	15.79	1.1088221	350098.55		395207		
30624	713450	586852	118045	92115	6.04	6.37	1.0541011	556732.15		752048		
30629	597428	609433	33167	31340	18.01	19.45	1.079562	564518.75		644961		
Total	44286467	45616636						44844521	1.013	45098302	1.011	1.012

Figure 2: Quantity indices for imports, Switzerland
Percentage change over preceding year



4. Next steps

19. The present report served to present the basic methodology for the estimation of price and quantity indices for exports and imports and to show a first example of results. Next steps in the process will include:

- Defining an algorithm for the treatment of missing values. Most likely, this will draw on standard unit values as defined and produced by UNSD and could result in another Inter-Agency co-operation project yielding comparable results across countries;

- Dealing with outliers in unit value changes to eliminate the most flagrant cases of changes in commodity composition and commodity quality; here, too, co-operation with UNSD is planned

- Testing the possibilities of calculating means amongst similar countries and compare the results. For instance, one could assume that German exports to OECD countries are of higher quality than those to, say, Africa. This would entail analysis of bilateral trade flows and comparing the values obtained for the different market segments might allow developing a better proxy for quality.

- Extending test calculations to additional OECD countries and, more generally, identifying commodity groups that could be sufficiently well approximated through unit value indices (relationship with import/export price indices) considering the law of one price, primary commodity groups could fall under such a category.

- Proposing a more harmonised methodology based upon information obtained from countries and other International Organisations.

- Defining and implementing a suitable database structure and data processing routines to add this new data as regularly updated and available part of the range of OECD trade data.

20. ***Delegates are invited to comment on the usefulness of such data, the proposed methodology and the next steps outlined above.***