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ECONOMIC COMMISSION FOR LATIN AMERICA
Office for the Caribbean

THE CONSTRUCTION OF INDEX NUMBERS OF TRADE (VOLUME AND VALUE)

A PROPOSED METHODOLOGY

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QUANTUM AND AVERAGE UNIT VALUE INDEXES OF EXTERNAL TRADE

BACKGROUND

1. An evaluation of the statistics in the West Indies Associated States in 1972 observed the following:

> ....."As mentioned above, external trade statistics, vital statistics and government revenue and expenditure data are the most comprehensive and readily available. External trade statistics data are available on a fairly detailed basis, but in some cases, the details have proved inadequate, for example, many countries are still experiencing difficulty in furnishing statistics on imports and exports of the 22 items of the Agricultural Marketing Protocol to the CARIFTA Agreement. It is of course difficult to provide information on all the possible detailed commodities that might be required for various purposes. A number of other useful trade data are not computed, for example, indexes of prices and quanta and designation of imports by importers, that is, whether personal, government, industry, commercial, etc." 1/

2. Since the territories are basically primary producers and very dependent on foreign trade, it is desirable for policy makers to quantify the terms of trade that exist between their primary products and the manufactured goods imported from the rest of the world. The quotation in para.1. above is equally apt for more developed countries of the CARICOM, they being basically primary producers, and relatively weak in terms of statistical organization, coverage and reporting.

3. If the need for statistics is recognized, then two decisions must be implemented. The first is that suitable expertise must be obtained to work in the local situation; and the second, that steps be taken to train local staff and upgrade their statistical skills.

1/ Vide ECLA/POS 72/11 - The Situation of Statistics in the West Indies Associated States.

4. Despite the fact that in some islands most of the statistical effort is directed towards the elaboration of trade data, the very trade data are themselves underutilized.[2/] Trade indexes could be used to throw light on a number of areas that are now subject to mere description without supporting quantification. It is only by means of an average unit value index that one can attempt to quantify the increase in the price of exports of primary products with an increase in the price of manufactured imports and thus set the stage for a quantification of the change in the terms of trade. The terms of trade argument is employed at various negotiations between developed and developing countries. In many instances the edge of the argument is dulled by the lack of statistical data to support the claim.

5. An index number is one that, as the name implies, indicates the direction and relative magnitude of change of a variable that is not capable of accurate measurement in itself, or of direct valuation in practice. No one can accurately measure the price level, for example. An index number seeks to give an indication of the relative increase in "the price level" through the measurement of the change in the prices of several commodities (and services in the case of the Retail Price Index) that are determinants of the level of prices, taking into consideration the relative importance of the several items selected for pricing.

6. Trade indexes of volume and value are measures of the movements in relative terms of the volumes or quanta of goods passing in international trade, as well as a similar measurement of the movement of the average unit values (prices) of a representative cohort of commodities. The indexes so produced enable the researcher to see behind the value figures of trade, and isolate price effects from quantity effects. In the case of a primary producing island economy that is very dependent on trade with the rest of the world, these index numbers may be used to shed light on the terms of trade as they affect the local economy.

2/ Vide Dudley Seers' article: "The usefulness and accessibility of Trade Statistics in an underdeveloped area." - Social and Economic Studies, Vol. 4, No. 2, 1955.

The Link between the proposed methodology and the various classification systems

7. This methodology has been designed to provide indexes that can be derived from disaggregated quantity and value components, defined and classified according to standard definitions and classification systems. Aggregation can be accomplished in ways that respect or cut across the boundaries of standard classifications and take advantage of input-output relationships.

Price vs. Average Unit Value

In the Caribbean, export values are recorded f.o.b. while imports are recorded on a c.i.f. basis. The c.i.f. valuation distorts the recording of price data. In many cases it is exceedingly difficult to separate the elements of insurance and freight. The result is that the compiler of the index must use the next approximation to price - average unit value.

Formulation of the Indexes

8. The index observes two weighting systems - a set of base year weights, and a set of current year weights. In the case of the base weighted index, the general formulation is of the Laspeyre's type -

$$L_{I_p} = \frac{\sum_{i=1}^{n} p_n q_0}{\sum_{i=1}^{n} p_0 q_0}$$

and

$$L_{I_q} = \frac{\sum_{i=1}^{n} p_0 q_n}{\sum_{i=1}^{n} p_0 q_0}$$

where

L_{I_p} = Laspeyre's Price Index

L_{I_q} = Laspeyre's Quantity Index

p_n = Price or average unit value in the current period

q_n = Quantity in current period

p_o = Price or average unit value in the base period

q_o = Quantity in the base period

9. Since relatives are being computed at the item level to facilitate disaggregations for analytical purposes, the summation is over one item, i.e. $\sum_{i=1}^{n}$ refers to the case where $n=1$. Therefore a simple exposition of $\frac{p_n}{p_o} \times 100$ would yield the required item price relative. However, for purposes of checking one could utilize the aggregative method which observes the summation signs and the base year data. The aggregative method will yield a result identical to that of the average of ratios method, provided that base year prices and quantities are used as weights.

10. In the case of the current weighted index, the formulation is of the general Paasche type -

$$P_{I_p} = \frac{\sum_{i=1}^{n} p_n q_n}{\sum_{i=1}^{n} p_o q_n}$$

and

$$P_{I_q} = \frac{\sum_{i=1}^{n} p_n q_n}{\sum_{i=1}^{n} p_n q_o}$$

The nomenclature is the same as that above in the exposition of the Laspeyre's index. Usually in index number construction it is not possible to utilize the Paasche formula because of difficulties in the computation of current weights. In the case of trade data, mechanical processing has made this exercise a very feasible one.

11. In the index calculations being proposed, the average of ratios approach to computation will be used. That is the item relatives will be combined with their weights (See paragraph below: "The indexes to be computed").

Scope and Coverage

12. The indexes purport to measure the changes in the average unit values and quantities of goods and services that enter into international trade. So as not to produce spurious indexes, the same commodities are priced over time. There is a fairly high probability that average unit values for a given commodity (except n.e.s. categories) would reflect price changes to a far greater extent than quality changes. Excluded from the index computations would be the standard exclusions from the trade statistics. These are:

(a) Transhipment goods;

(b) Ship and aircraft stores and bunkers for locally registered craft;

(c) Gold coin, bullion, issued coinage and bank notes;

(d) Goods on lease or on loan;

(e) Samples for exhibition or study;

(f) Personal and household effects; and

(g) Military and naval stores.

13. Also to be excluded are items that are subject to violent fluctuations in average unit value or quantity traded over time.[3/] These items are determined heuristically. As a general rule, the n.e.s. categories should be excluded from the index computation because of the theoretical variability of the item composition within any such category. Only where it is established that the same single item within any n.e.s. category is traded over time and that item is important in the trade, should any such item be included.

A number of items that enter into the trade of a given country are so relatively insignificant in value that they cannot influence the index. If these items are included, the time and effort involved

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3/ This would include lumpy capital items that are at best, purchased only occasionally.

in their inclusion would not be compensated for by greater accuracy of the index. It would therefore be advisable for the compiler to establish a "cut-off" point, to be determined by the value of the item traded. Goods whose value fell below a certain level in the base year should be excluded from the list of items to be selected.

The Indexes to be Computed

14. The constructors may compute a whole family of index numbers. The assumption being made all the time is that the processing will be done mechanically. The following would represent the indexes that have been identified.

		General Formula	Working Formula
Base weighted Average Unit Value Index	=	$\frac{\sum_{i=1}^{n} q_o p_n}{\sum_{i=1}^{n} q_o p_o}$	$\frac{\sum_{i=1}^{n} \frac{p_{ni}}{p_{oi}} (w_i)}{\sum_{i=1}^{n} w_i}$
Base weighted Volume Index	=	$\frac{\sum_{i=1}^{n} q_n p_o}{\sum_{i=1}^{n} q_o p_o}$	$\frac{\sum_{i=1}^{n} \frac{q_{ni}}{q_{oi}} (w_i)}{\sum_{i=1}^{n} w_i}$
Current weighted Average Unit Value Index	=	$\frac{\sum_{i=1}^{n} q_n p_n}{\sum_{i=1}^{n} q_n p_o}$	$\frac{\sum_{i=1}^{n} \frac{p_{ni}}{p_{oi}} (w_i)}{\sum_{i=1}^{n} (w_i)}$
Current weighted Volume Index	=	$\frac{\sum_{i=1}^{n} q_n p_n}{\sum_{i=1}^{n} q_o p_n}$	$\frac{\sum_{i=1}^{n} \frac{q_{ni}}{q_{oi}} (w_i)}{\sum_{i=1}^{n} w_i}$

15. Additionally, cognizance can be taken of the three main indexes constructed by the Statistical Office of the United Nations. There will be no additional manual labour involved. The index groups are:

(a) Primary commodities

(b) Non-Ferrous base metals

(c) Manufactured goods.

16. In any developing economy the price and quantity movements of these groups merit study. In the ECCM group of countries (a) and (c) are of primary importance.

17. (a) Primary commodities: These would include goods listed in Sections 0 to 4 of the SITC (R_2), with the exception of Manufactured foods, beverages and tobacco (from Sections 0 and 1), synthetic rubber and waste and scrap of primary commodities (from Section 2) and petroleum products (from Section 3). Because of their unique position in international trade, ores and concentrates of precious metals (SITC R_2 289) are also excluded. Annex II contains a detailed list of the exclusions.

18. (b) Non-ferrous base metals: The metals included in the index for non-ferrous base metals are: copper, nickel, aluminium, lead, zinc and tin (SITC (R_2) groups 682, 683, 684, 685, 686 and 687).

19. (c) Manufactured goods: This group includes all manufactured goods as are included in Sections 5 to 8 of the SITC (R_2). At present indexes can be computed for Sections 5 to 8 of the SITC R_2, or for any other Section of the SITC R_2.

Economic End-use: When trade data by broad economic category become available, it would be possible for indexes to be calculated on this basis, simply by regrouping the items and using their respective absolute weights. Some space allocation should be reserved for inserting these codes at a later date.

Weighting

20. The relative importance of the items, groups, divisions and sections of the trade must be taken cognizance of in the construction of the index. One can identify two weighting diagrams which should yield the same result, but which differ in the extent to which they lend themselves to disaggregation and regrouping according to any classification, e.g. according to Sections as opposed to end-use.

Method I

21. Section base weights may be computed in the following manner:

$$\frac{\sum_{i=1}^{n} (p_0 q_0)_i}{\sum_{s=0}^{9} \sum_{i=1}^{n} (p_0 q_0)_i} \times 10,000$$

where i = the i^{th} selected item in any Section of the SITC (R_2) and
$\sum_{i=1}^{n} (p_0 q_0)_i$ = the base values of the selected items in the s^{th} section.

22. The item weights are additive to the Section weights which in turn add up to 10,000. If, for example, the weight of Section 0 is 6050, then

$$\frac{\sum_{i=1}^{n} (p_0 q_0)_i^{0}}{\sum_{s=0}^{9} \sum_{i=1}^{n} (p_0 q_0)_i} \times 10,000 = 6050$$

and the sum of the item weights in Section 0 = 6050.

Method II

23. Section base weights may also be computed in the following manner:

$$\frac{\sum_{i=1}^{n} (p_0 q_0)_i}{\sum_{\text{Sec. 0}}^{q} \sum_{i=1}^{n} (p_0 q_0)_i} \times 1,000$$

and the sum of the item weights in any given section could be made to total 1,000. In this case, in Section 0, say, the weight for the item would be:

$$w_i = \frac{(p_0 q_0)_i}{\sum_{i=1}^{n} (p_0 q_0)_i} \times 1,000$$

24. In this manner one would achieve the sum of the item weights within any given Section being additive to 1,000 while the sum of the weights at the Section level is 1,000. To combine the Section Indexes in this example, it would be necessary first to establish Section Indexes, then to combine them with Section weights.

25. Both methods have their good points and their limitations. In the case of Method II, the convenient summation of item weights within any given Section to 1,000 facilitates division, since only a decimal point moves. This operation is at the level of the computation of Section Indexes, after which it would be necessary to combine the Section Indexes with the Section weights which are part values of 1,000. The drawback of this weighting diagram is that if indexes according to end-use or any other criterion are to be constructed, the derivation of weights to join the sub-indexes becomes roundabout.

26. The weighting diagram as suggested by Method I is a fully integrated one as it is additive at every stage, with a total weight of 1,000 (or 10,000 or whatever absolute value is arrived at according to the magnitude of the individual values). One advantage of this weighting diagram is that it establishes in a very simple and direct manner the relative importance of any one item vis-à-vis any other. This is the method that utilizes absolute weights. In this case, the construction of indexes according to end-use or any other criterion becomes a simple exercise in multiplication, accumulation and division. Method I seems to commend itself to use.

Unit of Measurement

27. The units of measurement for previous years are imperial units. The recent moves towards metrication will pose problems if a switch was made in mid-stream. It might be better to establish a base file in metric units, and manually convert the past data to metric. Conversely, and perhaps more reasonably, we could compute the indexes for 1970 to 1975 in imperial units and publish only indexes, to the exclusion of absolute data on average unit values. The post 1975 series should make use of metric units of measurement. The indexes would be the same as those computed on a metric base, given that units of measurement do not change (e.g. from pounds to numbers).

The problem of items that split or amalgamate over time

28. From time to time the situation arises wherein a given item number is sub-divided into more than one number, for the purpose of identification of a sub-commodity that is assuming importance. If the values are above the cut-off point, the problem would be the introduction in the current period of a commodity that has no identifying number in the base period. One of two approaches can be adopted:

(i) Compress the new disaggregations into the previous single item number, thus leaving the base file/listing unchanged. This approach suffers the disadvantage of not being able to reflect movements in the newly identified commodities.

(ii) Reflect the new disaggregations. This means that there will be an alteration in the base file, so as to provide a synthetic figure with which the current disaggregations can be compared. This approach has the advantage of being of greater practical value.

29. The approach (ii) would tend to be the one that would be followed. The base item number and weight will be split in accordance with the relative importance of each of the values of the new items to the total of these values (which constitute the former single item number). This process creates "synthetic" base period disaggregations. This will facilitate the re-allocation of weights. The Average unit value of the single item in the base period would, through lack of knowledge on the part of the complier, have to be attributed to each of the new disaggregated items.

The Selection of a base year and a comparison base within the base period

30. The constructor is urged in the literature, to utilize a "normal" year as a base year, but the word "normal" is question begging, and in fact there is no such thing as a "normal" year. In the case of a price index, it is sufficient to choose as base, a year that was not characterized by major shortages in the supply of commodities. In most cases the base year is chosen on grounds of convenience. From the point of view of convenience and conformity with stated policy regarding new index number series, 1975 should be selected as the base year. The computation of pre-1975 indexes would be a function of resources.

31. The constructor will decide whether or not his resources permit him to use more than one comparison base. If only one can be afforded, it might be advisable to use the average of the four quarters of the base year as the reference base, and compute the indexes on a quarterly basis. The average of the four quarters will eliminate fluctuations in the quantum indexes.

RECOMMENDATIONS

32. The indexes developed must be of maximum use to Government planners, the business community and researchers. Arising out of the present discussion are a number of recommendations. These are now highlighted for consideration with a view to implementation.

33. (i) Average of ratios approach. This provides greatest versatility to the constructor, in that he could re-group the items according to any classification and derive indexes that would represent that particular grouping.

34. (ii) Coverage. The indexes should not include the standard exclusions from trade statistics, nor should they include n.e.s. categories unless the composition of goods in such a commodity is known to be more or less invariate over time.

35. (iii) Weighting diagram. The system of absolute weights should be used in order to facilitate the computation of indexes according to various groupings.

36. (iv) The Establishment of a Metric base file. With the change to metric units of measurement having been instituted as of 1 January 1977, the systems and programming should be done in terms of metric units, so that as of 1977 the indexes would be prepared on the basis of metric reporting. The indexes for the years prior to 1977 should be done manually.

37. (v) The Selection of a base year. The year 1975 should be used as the base year for the series, and indexes can be computed in respect of 1974, 1972 and 1970 working backwards, and forward to 1977. If resources are limited, annual indexes may be computed. If, on the other hand, it is possible to compute the indexes for the "back years" on a quarterly basis, this would be preferable.

38. (vi) The indexes to be computed. The Appendix to this Methodology lists a number of tables that could from time to time be requested. The intention is not that all of the tables as listed should be computed on a quarterly basis. The listing should guide the systems design to cater for such requests as far as possible. Priority should be given to the computation of base weighted Indexes of Volume and indexes of Value, by Section and on an "All Sections" basis. The indexes of Value would be needed to compute the terms of trade indexes. The Current Value of domestic exports, when deflated by the import price index, would yield deflated export values.

39. If the systems are built around the possible data requests as per the Appendix, the result would be a wealth of information of the type that is not at present available to planners and analysts in the region. A fuller utilization of the trade data would assist in the understanding of the working of the economies.

ANNEX I

The following is a list of tables that are likely to be requested:

1. Indexes of Volume by SITC Sections - base weighted, average of 4 quarters 1977 = 100 - IMPORTS

2. Indexes of Volume by SITC Sections - base weighted, average of 4 quarters 1977 = 100 - EXPORTS

3. Indexes of Value by SITC Sections - base weighted, average of 4 quarters 1977 = 100 - IMPORTS

4. Indexes of Value by SITC Sections - base weighted, average of 4 quarters 1977 = 100 - EXPORTS

5. Indexes of Volume by SITC Sections - current weighted, average of 4 quarters 1977 = 100 - IMPORTS

6. Indexes of Volume by SITC Sections - current weighted, average of 4 quarters 1977 = 100 - EXPORTS

7. Indexes of Value by SITC Sections - current weighted, average of 4 quarters 1977 = 100 - IMPORTS

8. Indexes of Value by SITC Sections - current weighted, average of 4 quarters 1977 = 100 - EXPORTS

9-16. Tables as per 1-8 above, with 1st quarter 1977 = 100

17. Indexes of Volume by Broad Economic Category - base weighted, average of 4 quarters 1977 = 100 - IMPORTS

18. Indexes of Volume by Broad Economic Category - base weighted, average of 4 quarters 1977 = 100 - EXPORTS

19. Indexes of Value by Broad Economic Category - base weighted, average of 4 quarters 1977 = 100 - IMPORTS

20. Indexes of Value by Broad Economic Category - base weighted, average of 4 quarters 1977 = 100 - EXPORTS

21. Indexes of Volume by Broad Economic Category - current weighted, average of 4 quarters 1977 = 100 - IMPORTS

22. Indexes of Volume by Broad Economic Category - current weighted, average of 4 quarters 1977 = 100 - EXPORTS

23. Indexes of Value by Broad Economic Category - current weighted, average of 4 quarters 1977 = 100 - IMPORTS

24. Indexes of Value by Broad Economic Category - current weighted, average of 4 quarters 1977 = 100 - EXPORTS

25-32. Tables as per 17-24 above, with 1st quarter 1977 = 100

33. Indexes of Volume, Country within Item within Section - base weighted, average of 4 quarters 1977 = 100 - IMPORTS

34. Indexes of Volume, Country within Item within Section - base weighted, average of 4 quarters 1977 = 100 - EXPORTS

35. Indexes of Value, Country within Item within Section - base weighted, average of 4 quarters 1977 = 100 - IMPORTS

36. Indexes of Value, Country within Item within Section - base weighted, average of 4 quarters 1977 = 100 - EXPORTS

37. Indexes of Volume, Country within Item within Section - current weighted, average of 4 quarters 1977 = 100 - IMPORTS

38. Indexes of Volume, Country within Item within Section - current weighted, average of 4 quarters 1977 = 100 - EXPORTS

39. Indexes of Value, Country within Item within Section - current weighted, average of 4 quarters 1977 = 100 - IMPORTS

40. Indexes of Value, Country within Item within Section - current weighted, average of 4 quarters 1977 = 100 - EXPORTS.

ANNEX II

List of Commodities from Sections 0 to 4 of the Standard International Trade classification Rev. 2. excluded from the computation of the price indexes of primary commodity exports. These items may however be included in the general index depending on their value:

A. Manufactured or semi-manufactured goods excluded

Item	Sub-group	Group	
Section 0			
		014	(Meat canned and meat preparations (Fish preparations and fish in containers
		048	Cereal preparations
		058	Fruit, preserved and fruit preparations
		056	Vegetables, preserved and vegetable preparations
		062	Sugar confectionery and other sugar preparations
	071.2		Coffee extracts, essences, etc.
	072.3		Cocoa butter and cocoa paste
		073	Chocolate and chocolate preparations
	091.4		Margarine
		098	Other food preparations
Section 1			
		111	Non-alcoholic beverages
	112.2		Cider, etc.
	112.3		Beer, etc.
	112.4		Distilled alcoholic beverages
		122	Tobacco manufactures
Section 2			
	233.1		Synthetic rubber and rubber substitutes
		266	Synthetic fibres
Section 3			
		334	Petroleum products
		341	Gas, natural and manufactured
		351	Electric energy

B. Waste and Scrap materials excluded

Item	Sub-group	Group	
		081 except 081.3	Animal feeding stuff apart from oilseed cake and meal
	233.2		Reclaimed and waste and scrap rubber
	268.6		Wool waste
	263.3		Cotton waste
		269	Waste material from textile fabrics
		282	Iron and steel scrap
689.14) 686.33)	288.1) 288.2)		Non-ferrous metal scrap

C. Miscellaneous goods excluded

Item	Sub-group	Group	
	268.3) 268.5)		Miscellaneous animal hair (other than wool)
		289	Gold, silver and platinum ores
		291	Crude animal materials, inedible, n.e.s.
		292	Crude vegetable materials, inedible, n.e.s.

ANNEX III

SITC Section	SITC Division	SITC Item	Value (Base period)	Quantity A (Base period)	Quantity B (Base period)	Average Unit Value (Base)
01						
02						

Value (Current period)	Quantity (Current period)	Average Unit Value (Curr.)	Average Unit Value Relative	Weight (Base)	Weighted Relative Unit (Average Value)	Indexes by Section
						xx
						yy

Value (Current period)	Quantity (Current period)	Average Unit Value (Current period)	Indexes by Section

Value (Current period)	Quantity (Current period)	Quantity Relative	Indexes by Section