CHAPTER 3

MEASUREMENT OF TERMS OF TRADE

A. Data Availability

This study will use the data from Foreign Trade Statistic of Thailand reported by the Department of Customs. The data are reported in six digit commodity classification of the BTN (Brussels Tariff Nomenclature) code. The import items are reported in C.I.F. value and export items in F.O.B. value. This is under the assumption that shipment of both imports and exports are operated by the third countries (not relating to Thailand and Trading countries of Thailand). In the case of productivity index number, this study will use the data from Agricultural Statistics of Thailand reported by Division of Agricultural Economics. The data that will be used are the average yield of some crops (major exports of Thailand).

B. Unit Value

The practical difficulty is that the data to be used in this study are incomplete since they lack information of the actual prices. This is because the statements on Foreign Trade Statistic of Thailand report only the merchandise value and quantity of import and export. The way out of this difficulty is to use a substitute estimator for prices. The substitute estimator for prices in this study will be the unit value (the proxy for prices). This unit value can be calculated by dividing the value by its quantities.

C. Criteria For Selection of Data

When we calculate price index number (for calculation terms of trade, we will face the problem about the coverage and homogeneity. This is because homogeneity and coverage are two conflicting condition although each of them is important in an attempt to measure on accurate price index number.

Homogeneity means that each of commodity iterms included in the calculation is of the same kind while the coverage is the share of value of commodity items included in the calculation to the total value. The more homogeneous the commodities, the more accurate unit value would be, as a representative of the prices of commodities in question. Yet coverage is also important to obtain and accurate result. Higher coverage is better than lower, and more homogeneity is better than less.[1]

Criteria for selection of data in this study will consider both coverage and homogeneity. This study will use six-digit commodity classification of BTN code to calculate terms of trade. This is because it is homogeneous enough to using unit value as the proxy for prices. In the case of productivity index, this study will use only yield of some crops to calculate productivity index.

In the case of primary products and manufactures, the group of primary products will be the chapter 1-27 of BTN code and the group of manufactures will be the chapter 28-99 of BTN code.

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[1] C.P. Kindleberger, The Terms of Trade: A European Case Study (New York: John Wiley & Sons, Inc., 1956), p. 361.

The commodity items which show very much difference in unit value from one period to other will be omitted because there must be some mistakes in the recording process or change in quality or composition over time. This study will also omit the commodity items that cannot be adjusted into the same unit code as the unit code changes from one period to other. Nor will it include those items whose reporting is not continuous.

D. Unit Code Adjustment

Unit code of some commodity items may not be the same in some binary years because their quantities trading change every much. Unit code may be changed from kilogram (unit code 03) in this year to metric ton (unit code 04) in next year. Thus, this study has to adjust unit code into the same unit code as the unit code changes.

E. Index Number

Mostly, this study will concern with index number (price index number, quantity index number, and productivity index number), which will be mentioned as follow.

There are two kinds of index numbers: unweighted and weighted. Unweighted index number will be used when all commodities included in the calculation are equally important while weighted index number will be used when all commodities are not equally important. In reality, commodities are not equally important in the calculation of index number, so the weighted index number will be used in this study. Generally, the weighted index number for economists can be seperated as follows:[2]

The Laspeyres index number. This the weighted index number which is weighted by the base period weights:

$$P_{o/n} = \frac{\sum_{i=1}^{r} p_{in} q_{io}}{\sum_{i=1}^{r} p_{io} q_{io}}$$

$$Q_{o/n} = \frac{\sum_{i=1}^{r} q_{in} p_{io}}{\sum_{i=1}^{r} q_{io} p_{io}}$$

where P = the price index number

Q = the quantity index number

n = given period

o = base period

p_i = the price of commodity i

q_i = the quantity of commodity i

r = the number of total commodity items corresponding

This index number can be interpreted as the average ratio of given period prices (or quantities) to base period prices (or quantities), which can be derived from arithmetic mean and weighted by the base period value as follows:

$$P_{o/n} = \frac{\sum_{i=1}^{r} \frac{p_{in}}{p_{io}} v_{io}}{\sum_{i=1}^{r} v_{io}} \quad (v_i = \text{value of commodity } i)$$

[2] R.G.D. Allen, Index Number in Theory and Practice, (London: The Macmillan Press Ltd., 1975), p. 50.

$$= \frac{\sum_{i=1}^{r} \frac{p_{in}}{p_{io}} p_{io} q_{io}}{\sum_{i=1}^{r} p_{io} q_{io}} = \frac{\sum_{i=1}^{r} p_{in} q_{io}}{\sum_{i=1}^{r} p_{io} q_{io}}$$

$$Q_{o/n} = \frac{\sum_{i=1}^{r} \frac{q_{in}}{q_{io}} v_{io}}{\sum_{i=1}^{r} v_{io}}$$

$$= \frac{\sum_{i=1}^{r} \frac{q_{in}}{q_{io}} p_{io} q_{io}}{\sum_{i=1}^{r} p_{io} q_{io}} = \frac{\sum_{i=1}^{r} q_{in} p_{io}}{\sum_{i=1}^{r} q_{io} p_{io}}$$

The Paasche index number. This is the weighted index number which is weighted by given period weights:

$$P_{o/n} = \frac{\sum_{i=1}^{r} p_{in} q_{in}}{\sum_{i=1}^{r} p_{io} q_{in}}$$

$$Q_{o/n} = \frac{\sum_{i=1}^{r} q_{in} p_{in}}{\sum_{i=1}^{r} q_{io} p_{in}}$$

This index number can be interpreted as the average ratio of given period prices (or quantities) to base period perices (or quantities) but it is derived from harmonic mean and weighted by the given period value as follows:

$$P_{o/n} = \frac{\sum_{i=1}^{r} v_{in}}{\sum_{i=1}^{r} \frac{p_{io}}{p_{in}} v_{in}}$$

$$= \frac{\sum_{i=1}^{r} p_{in} q_{in}}{\sum_{i=1}^{r} \frac{p_{io}}{p_{in}} q_{in} p_{in}} = \frac{\sum_{i=1}^{r} p_{in} q_{in}}{\sum_{i=1}^{r} p_{io} q_{in}}$$

$$Q_{o/n} = \frac{\sum_{i=1}^{r} v_{in}}{\sum_{i=1}^{r} \frac{q_{io}}{q_{in}} v_{in}}$$

$$= \frac{\sum_{i=1}^{r} p_{in}q_{in}}{\sum_{i=1}^{r} \frac{q_{io}}{q_{in}} p_{in}q_{in}} = \frac{\sum_{i=1}^{r} q_{in}p_{in}}{\sum_{i=1}^{r} q_{io}p_{in}}$$

<u>Statistic relation between Laspeyres and Paasche froms.</u> The Paasche index of price (and of quantity) will be greater than the Laspeyres index of price when movements of prices and quantities tend to be in the same direction. The economic condition is that the market is dominated by suppliers. Examples are exporters selling on a large international market and farmers selling on a market comprising both home produced and imported food stuffs. The Laspeyres index of price (and of quantity) will be greater than the Paasche index of price when prices and quantities tend to move in opposite direction. The economic condition is that demand-dominated market where buyers set the pace, buying less as prices rise and more as prices fall. The leading example is the market for consumer good.[3] The way to prove this can be shown by using coorelation coefficient concept which can be shown as follow.

$$r = \frac{\text{Covariance of x and y}}{\sigma_x \sigma_y}$$

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[3] Ibid., p. 62-64.

$$\text{Covariance of } x \text{ and } y = E(xy) - E(x)\,E(y)$$

$$r = \frac{E(xy)}{\sigma x \sigma y} - \frac{E(x)\,E(y)}{\sigma x \sigma y}$$

where r = correlation coefficient between x and y

$x = \frac{p_n}{p_o}$ (ratio of given period prices to base period prices)

$y = \frac{q_n}{q_o}$ (ratio of given period quantities to base period quantities)

σx = standard deviation of $\frac{p_n}{p_o}$

σy = standard deviation of $\frac{q_n}{q_o}$

$$E(x) = \frac{\Sigma v_o \frac{p_n}{p_o}}{\Sigma v_o} = \frac{\Sigma p_n q_o}{\Sigma p_o q_o} \quad \text{(Laspeyres price index)}$$

$$E(y) = \frac{\Sigma v_o \frac{q_n}{q_o}}{\Sigma v_o} = \frac{\Sigma q_n p_o}{\Sigma q_o p_o} \quad \text{(Laspeyres quantities index)}$$

$$E(xy) = \frac{\Sigma v_o \frac{p_n}{p_o} \frac{q_n}{q_o}}{\Sigma v_o} = \frac{\Sigma v_n}{\Sigma v_o} \quad \text{(value index)}$$

$$= \frac{\Sigma p_n q_n}{\Sigma p_o q_o} = \frac{\Sigma p_n q_n}{\Sigma p_o q_n} \frac{\Sigma q_n p_o}{\Sigma q_o p_o}$$

= Paasche price index X Laspeyres quantities index

$$\therefore \; r = \frac{PP_{o/n} \; QL_{o/n}}{\sigma x \sigma y} - \frac{PL_{o/n} \; QL_{o/n}}{\sigma x \sigma y}$$

where PP = Paasche price index number

PL = Laspeyres price index number

QL = Laspeyres quantities index number

and QP = Paasche quantities index number

$$\therefore r = \frac{PL_{o/n} \times QL_{o/n}}{x\,y} \left(\frac{PP_{o/n}}{PL_{o/n}} - 1\right)$$

$$\frac{PP_{o/n}}{PL_{o/n}} = 1 + r \frac{\sigma x \sigma y}{PL_{o/n}\; QL_{o/n}}$$

and $$\frac{PP_{o/n}}{PL_{o/n}} = \frac{QP_{o/n}}{QL_{o/n}}$$

$$\therefore \frac{PP_{o/n}}{PL_{o/n}} = \frac{QP_{o/n}}{QL_{o/n}} = 1 + r \frac{\sigma x \sigma y}{PL_{o/n}\, QL_{o/n}}$$

In the final equation, x, y, $PL_{o/n}$, $PP_{o/n}$, $QL_{o/n}$ and $QP_{o/n}$ will always be positive sign. But, r will be positive when movements of prices and quantities tend to be in the same direction and vice versa. The Paasche index will be greater than the Laspeyres index when $r > 0$ and vice versa.

Both Paasche index and Laspeyres index are not good in statistical sense, because they do not statisfy the properties of good index number in statistical sense. The properties are time reversal property, circular property, and factor-reversal property.

Time-reversal property: $P_{o/n} = \frac{1}{P_{n/o}}$ of $Q_{o/n} = \frac{1}{Q_{n/o}}$

Circular property : $P_{o/n} \times P_{n/t} = P_{o/t}$ or $Q_{o/n} \times Q_{n/t} = Q_{o/t}$

Factor-reversal property: $P_{o/n} \times Q_{o/n} = V_{o/n}$

where t = other period

V = the value index number

The index number that is the geometric mean between the Laspeyres and Paasche forms will satisfy with Time-reversal property and Factor-reversal property. This index number is called Fisher index or 'ideal' index.

In economic sense, the Laspeyres index measures all changes of price (or quantity) forward from base period to current period while the Paasche index measures it backward from current period to base period.[4] This study will cover the Laspeyres index, Paasche index, and Fisher index.

There are serious limitations from an economic point of view.[5] In binary comparisons, the index for period n depends only on prices of quantities of the base period (prices or quantities between the base period and period n is completely ignored). Economic common sense would suggest that (e.g.) a consumer price index in period n would be influenced by prices before period n as well as prices in period n. Moreover, from the statistical sense, the binary comparison is inefficient in that it does not make full use of all the data as they unfold over time. According to the above problem, the study has to use the chain index number because this index will make full use of all the data and will satisfy with economic sense. The chain index number can be applied to Laspeyres index number, Paasche index number, Fisher index number, so this

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[4]Ibid., p. 25-26.

[5]Ibid., p. 145-146.

study will use the chain price (or quantity) index number for calculation of the terms of trade. The process of the chain Laspeyres (or Paasche or Fisher) price index number which can be derived from the Laspeyres (or Paasche or Fisher) price index number can be shown as follows:

$$\bar{P}_{73/74} = P_{73/74}$$

$$\bar{P}_{73/75} = P_{73/74}\, P_{74/75}$$

$$\bar{P}_{73/76} = P_{73/74}\, P_{74/75}\, P_{75/76}$$

$$\bar{P}_{73/77} = P_{73/74}\, P_{74/75}\, P_{75/76}\, P_{76/77}$$

$$\bar{P}_{73/78} = P_{73/74}\, P_{74/75}\, P_{75/76}\, P_{76/77}\, P_{77/78}$$

$$\bar{P}_{73/79} = P_{73/74}\, P_{74/75}\, P_{75/76}\, P_{76/77}\, P_{77/78}\, P_{78/79}$$

where $\bar{P}$ = the chain Laspeyres (or Paasche or Fisher) price index

73 = year 1973

74 = year 1974

75 = year 1975

76 = year 1976

77 = year 1977

78 = year 1978

79 = year 1979

P = the Laspeyres (or Paasche or Fisher) price index

This study concerns not only the price index number to be calculated but also the quantity index number. The quantity index will be calculated from price index and value index. This is because the quantity of different commodity items are reported in different units i.e. the unit codes of different commodities are different. Hence, it is more accurate to find the quantity index from the value index and the price index:

$$\bar{Q}_{73/74} = \frac{V_{73/74}}{\bar{P}_{73/74}}$$

$$\bar{Q}_{73/75} = \frac{V_{73/75}}{\bar{P}_{73/75}}$$

$$\bar{Q}_{73/76} = \frac{V_{73/76}}{\bar{P}_{73/76}}$$

$$\bar{Q}_{73/77} = \frac{V_{73/77}}{\bar{P}_{73/76}}$$

$$\bar{Q}_{73/78} = \frac{V_{73/78}}{\bar{P}_{73/78}}$$

$$\bar{Q}_{73/79} = \frac{V_{73/79}}{\bar{P}_{73/79}}$$

where $\bar{Q}$ = the chain quantity index number

The chain quantity index derived from the chain Fisher price index is called the chain Fisher quantity index. This is because the chain Fisher index satisfies with factor-reversal property. The chain quantity index derived from the chain Laspeyres (or Paasche) price index is called the chain Paasche (or Laspeyres) quantity index. This is because the chain Laspeyres (or Paasche) index does not satisfy with factor-reversal property. The value index will equal to the chain Laspeyres (or Paasche) price index multiplied by the chain Paasche (or Laspeyres) quantity index as follows:

Suppose there are three year: 0, 1, 2.

and $\overline{PP}$ = the chain Paasche Price index number

$\overline{PL}$ = the chain Laspeyres price index number

$\overline{QP}$ = the chain Paasche quantity index number

$\overline{QL}$ = the chain Laspeyres quantity index number

$$\overline{PP}_{o/2}\overline{QL}_{o/2} = \left(\frac{\Sigma p_1q_1}{\Sigma p_1q_1} \times \frac{\Sigma p_2q_2}{\Sigma p_1q_2}\right)\left(\frac{\Sigma q_1p_o}{\Sigma q_op_o} \times \frac{\Sigma q_2p_1}{\Sigma q_1p_1}\right)$$

$$= \frac{\Sigma p_2q_2}{\Sigma p_2q_2} = V_{o/2} .$$

$$\therefore \quad \overline{QL}_{o/2} = \frac{V_{o/2}}{\overline{PP}_{o/2}}$$

$$\overline{PL}_{o/2}\overline{QP}_{o/2} = \left(\frac{\Sigma p_1q_o}{\Sigma p_oq_o} \times \frac{\Sigma p_2q_2}{\Sigma p_1q_2}\right)\left(\frac{\Sigma q_1p_1}{\Sigma q_op_1} \times \frac{\Sigma q_2p_2}{\Sigma q_1p_2}\right)$$

$$= \frac{\Sigma p_2q_2}{\Sigma p_oq_2} = V_{o/2}$$

$$\therefore \quad \overline{QP}_{o/2} = \frac{V_{o/2}}{\overline{PL}_{o/2}}$$

In the case of productivity index number, this study will concentrate only on land productivity. Land productivity can be found by total output devided by total land used and land productivity index comes from land productivity in given period devided by land productivity in base period. Hence, the single factoral terms of any major export of Thailand will measure the capacity to import per rai of land used in that major export production.

The terms of trade will be calculated from the price indices, the quantity indices of both export and import side, and land productivity index of that major export production. This calculation is not difficult and can be shown as follows:

$$N_{o/n} = \frac{(\bar{P}_x)_{o/n}}{(\bar{P}_m)_{o/n}}$$

$$G_{o/n} = \frac{(\bar{Q}_m)_{o/n}}{(\bar{Q}_x)_{o/n}}$$

$$I_{o/n} = \frac{(V_x)_{o/n}}{(\bar{P}_m)_{o/n}}$$

$$S_{o/n} = \frac{(\bar{P}_2)_{o/n} \, (R_g)_{o/n}}{(\bar{P}_m)_{o/n}}$$

where N = the net barter terms of trade

G = the gross barter terms of trade

I = the income terms of trade

S = the single factoral terms of trade

x = the export side

m = the import side

g = the major export of Thailand

R = the land productivity index number

F. Error in Empirical Measurement of Terms of Trade

This study use the data of exports which are collected by Department of Customs in F.O.B. value and the data of imports are collected in C.I.F. value. Thus, the movement of unit value of imports may result from the movement of freight rate. The declining of freight rate over time will over estimate the terms of trade situation of the poor countries when they are calculated from the data of themselves, and underestimate when they are calculated from the data of developed countries. When the terms of trade is made from the point of view of poor countries themselves, the terms of trade will not be unfavorable as much as those calculated by the developed countries. Moreover, increase in unit value may result from increase in quality of innovation of new products of manufactures. Thus, international situation of the poor countries may not be so bad as it has been calculated.