TERMS OF TRADE EFFECT IN NATIONAL ACCOUNTS*

By YOSHIMASA KURABAYASHI**

1. In what follows we shall discuss the presentation of terms of trade effect within the framework of national accounts. The issue has been taken up by R. C. Geary and G. Stuvel. Based on the method proposed by the Technical Working Group the secretariat of the United Nations has once calculated national gains or losses due to changes in terms of trade for major countries. After a brief review of principal features of these works a more systematic and symmetrical approach will be proposed. Subsequently numerical examples compiled from national accounts statistics for numbers of countries and calculated by this new approach will be shown.

2. The network of national and international transactions is conveniently summerized in the following inter-flow matrix.\(^3\)

\[
\begin{array}{ccc}
(1) & (2) \\
C_1 & I_1^* & U_{12} & C_{12} \\
Y_1 & Y_{12} & G_{12} \\
D_1 & S_1 & B_{21} \\
U_{21} & C_{21} & C_2 & I_2^* \\
Y_{21} & G_{21} & Y_2 & \cdot \\
B_{12} & D_2 & S_2 & \cdot \\
\end{array}
\]

Note: (1) indicates the domestic economy, while (2) stands for the rest of the world.

Notations appeared in this matrix are listed below:

- \(C_1\): current expenditure on goods and services within the domestic economy.
- \(I_1^*\): gross domestic capital formation in the domestic economy

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$Y_1$: factor income accrued within the domestic economy and paid to its normal residents

$D_1$: capital consumption in the domestic economy

$S_1$: saving in the domestic economy

$U_{12}$: flows of intermediate products from the domestic economy to the rest of the world

$C_{12}$: flows of goods and services for consumption from the domestic economy to the rest of the world

$Y_{12}$: factor income accrued in the rest of the world and paid to the domestic economy

$G_{12}$: income transfer from the rest of the world to the domestic economy

$B_{21}$: increase of lending of the rest of the world to the domestic economy

$U_{21}$: flows of intermediate products from the rest of the world to the domestic economy

$C_{21}$: flows of goods and services for consumption from the rest of the world to the domestic economy

$Y_{21}$: factor income accrued in the domestic economy and paid to the rest of the world

$G_{21}$: income transfer from the domestic economy to the rest of the world

$B_{12}$: increase of lending of the domestic economy to the rest of the world

$C_2$: current expenditure on goods and services for consumption within the domestic economy

$I^*_2$: gross domestic capital formation in the rest of the world

$Y_2$: factor income accrued in the rest of the world and paid to the rest of the world

$D_2$: capital consumption in the rest of the world

$S_2$: saving in the rest of the world

Consolidating relevant international transactions into one row and column respectively, the national accounts for the domestic economy are represented in the matrix form as follows:

\[
\begin{bmatrix}
Y_1 & D_1 & U_{12} + C_{12} \\
C_1 & I_1^* & U_{12} + C_{12} \\
Y_{21} & S_1 & B_{21} \\
U_{21} + Y_{21} & C_{21} + G_{21} & B_{12} \\
\end{bmatrix}
\]

\[
\begin{align}
(1) & \quad M_1 + D_1 + Y_1^d = X_1 + I_1^* + C_1^n \\
& \quad M_1 = U_{21} + C_{21}, \quad Y_1^d = Y_1 + Y_{21} \\
& \quad X_1 = U_{12} + C_{12}, \quad C_1^n = C_1 + C_{21} \\
(2) & \quad C_1^* + S_1 + G_1 = Y_1^d + Z_1 \\
& \quad Z_1 = Y_{12} - Y_{21}, \quad G_1 = G_{21} - G_{12} \\
(3) & \quad I_1^* + L_1^n = D_1 + S_1 \\
& \quad L_1^n = B_{12} - B_{21} \\
(4) & \quad X_1 + Z_1 = M_1 + G_1 + L_1^n
\end{align}
\]

In the same way the national accounts matrix for the rest of the world is given below:
3. Geary's argument is presented in a summarized way as follows. For the simplicity of argument the system of national accounts of the domestic economy (1)–(4) is rewritten so that $G_1$ may be included in relevant terms in the accounts (2) and (4).

\begin{align*}
(1) & \quad M_1 + D_1 + Y_1^d = X_1 + I_1^* + C_1^n \\
(2) & \quad C_1^n + S_1 = Y_1^d + Z_1 \\
(3) & \quad I_1^* + L_1^n = D_2 + S_2 \\
(4) & \quad X_1 + Z_1 = M_1 + G_1 + L_2^n 
\end{align*}

Reflection will show that the replaced system of national accounts (i)–(iv) can be transformed into a system of national accounts in real terms if an appropriate deflator is selected for $Z_i$. His argument is concerned chiefly with the account (iv). Suppose the account (iv) is expressed in real terms whose deflations are separately made by individual deflectors. The balance of the account (iv) is apparently disturbed by these deflations. Facing this situation two questions must be solved simultaneously. The first is a selection of deflator for the $Z_i$. And the second is to discover the method of restoring the balance of the account (iv) in real terms. Geary's rule for the selection of $Z_i$'s deflator answers the first question. It is put forward below, putting

$$CS_i = X_i - M_i = N_i - Z_i \quad \text{or} \quad N_i = CS_i + Z_i.$$  

(Case 1) If $CS_i < 0$ and $Z_i > 0$ then $Z_i$'s deflator is $p_2$, where $p_2$ is the export price of the rest of the world.

(Case 2) If $CS_i > 0$ and $Z_i < 0$ then $Z_i$'s deflator is $p_1$, where $p_1$ is the export price of the domestic economy.

(Case 3) If $CS_i > 0$ and $Z_i > 0$ then $Z_i$'s deflator is $p_1$ and $p_1$ is also the deflator of $N_1$.

\footnote{In particular, see R. Stone, \textit{Quantity and Price Indexes in National Accounts}, Paris 1956, pp. 90–93.}
(Case 4) If $CS_1<0$ and $Z_1<0$ then $Z_1$'s deflator is $p_2$ and $p_2$ is also the deflator of $N_1$.

Similar argument is applied to the national accounts for the rest of the world which is written by the following form:

\begin{align*}
(i)' & \quad M_1 + D_1 + Y_1^d = X_1 + I_1^* + C_1^* \\
(ii)' & \quad C_1^* + S_1^* = Y_1^d + Z_1 \quad (S_1^* = S_1 + G_1) \\
(iii)' & \quad I_2^* + N_2 = S_2^* + D_2 \\
(iv)' & \quad X_2 + Z_2 = M_2 + N_2 \quad (N_2 = L_2^n + G_2)
\end{align*}

Putting

$$CS_2 = X_2 - M_2 = N_2 - Z_2 \quad \text{or} \quad N_2 = CS_2 + Z_2,$$

hence

$$CS_2 = M_1 - X_1 = -CS_1, \quad N_2 = -(CS_1 + Z_1) = -N_1,$$

the rule for the selection of $Z_2$'s deflator follows:

(Case 1') If $CS_2<0$ and $Z_1>0$ (or $CS_1>0$ and $Z_1<0$) then $Z_2$'s deflator is $p_1$ ($Z_1$'s deflator is $p_1$).

(Case 2') If $CS_2>0$ and $Z_1<0$ (or $CS_1<0$ and $Z_1>0$) then $Z_2$'s deflator is $p_2$ ($Z_1$'s deflator is $p_2$)

and $p_2$ is also the deflator of $N_2$ ($p_2$ is also the deflator of $N_1$).

(Case 3') If $CS_2<0$ and $Z_1>0$ (or $CS_1>0$ and $Z_1<0$) then $Z_2$'s deflator is $p_2$ ($Z_1$'s deflator is $p_2$)

and $p_2$ is also the deflator of $N_2$ ($p_2$ is also the deflator of $N_1$).

An adjustment term which indicates changes in terms of trade should be inserted for restoring the balance of the account (iv) in real terms of the domestic economy or the rest of the world. The term is expressed by $T_1$ for the domestic economy and by $T_2$ for the rest of the world. The account (iv) in real terms of the domestic economy is written by

$$X_1 + Z_1 + T_1 = \overline{N}_1 + \overline{M}_1,$$

where the barred variables stand for the deflated values obtained from the rule stated above.

Similarly for the rest of the world, the account (iv)' in real terms is

$$X_2 + Z_2 + T_2 = \overline{N}_2 + \overline{M}_2.$$

The following property for $T_1$ and $T_2$ is easily derived:

1. $T_1 + T_2 = 0$ or $T_2 = -T_1$.

$T_1$ or $T_2$ is called the real gain or loss due to changes in terms of trade for the domestic economy or the rest of the world, and the resulting real gain or loss for the domestic economy is expressed below.

$$\begin{cases}
\text{if } X > M & \text{then } T_1 = -\frac{X}{P_1} \left(1 - \frac{P_1}{P_2}\right) = -\overline{X} \left(1 - \frac{P_1}{P_2}\right), \\
\text{if } X < M & \text{then } T_1 = -\frac{X}{P_1} \left(1 - \frac{P_1}{P_2}\right) = -\overline{X} \left(1 - \frac{P_1}{P_2}\right),
\end{cases}$$

where \(\frac{1}{P_1} - \frac{1}{P_2}\) or \(\left(\frac{P_1}{P_2} - 1\right)\) stands for the unit real gain.

4. As a point of departure for his argument Stuvel divides each entry of a system of national accounts (i)–(iv) by a common deflator $P$ which stands for the general price level. The following system of national accounts in real terms is derived by this deflation:

$$\begin{align*}
8) & \quad \overline{M}_1 + \overline{D}_1 + \overline{F}_1^d = \overline{X}_1 + \overline{I}_1^* + \overline{C}_1^* \\
9) & \quad \overline{C}_1^* + \overline{S}_1^* = \overline{Y}_1^d + \overline{Z}_1 \\
10) & \quad \overline{I}_2^* + \overline{N}_2 = \overline{S}_2^* + \overline{D}_2 \\
11) & \quad \overline{X}_2 + \overline{Z}_2 = \overline{M}_2 + \overline{N}_2
\end{align*}$$

where
Putting
\[ \hat{I}_1^* = \frac{I_1^*}{P_1} \quad \text{and} \quad \tilde{C}_1^w = \frac{C_1^w}{P_w}, \]

(8)-(11) are rewritten as
\[ \begin{align*}
(12) & \quad \bar{D}_1 + \bar{Y}_1 - \bar{M}_1 + (\bar{M} - \bar{M}_1) = \bar{X}_1 + (\bar{X}_1 - \bar{X}_1) + \hat{I}_1^* + (\tilde{I}_1^* - \hat{I}_1^*) + \tilde{C}_1^w + (\tilde{C}_1^w - \bar{C}_1^w) \\
(13) & \quad \bar{C}_1^w + (\bar{C}_1^w - \bar{C}_1^w) + \bar{S}_1^* = \bar{Y}_1^* + \bar{Z}_1 \\
(14) & \quad \hat{I}_1^* + (\tilde{I}_1^* - \hat{I}_1^*) + \tilde{N}_1 = \bar{S}_1^* + \bar{D}_1 \\
(15) & \quad \bar{X}_1 + (\bar{X}_1 - \bar{X}_1) + \bar{Z}_1 = \bar{M}_1 + (\bar{M} - \bar{M}_1) + \tilde{N}_1
\end{align*} \]

It is easily shown that the following system of national accounts in real terms can be derived if and only if \( P \) is identical with the GDP deflator:
\[ \begin{align*}
(12)' & \quad \bar{D}_1 + \bar{Y}_1 = \bar{X}_1 + (\bar{X}_1 - \bar{X}_1) + \hat{I}_1^* + (\tilde{I}_1^* - \hat{I}_1^*) + \tilde{C}_1^w + (\tilde{C}_1^w - \bar{C}_1^w) \\
(13)' & \quad \bar{C}_1^w + \bar{S}_1^* = \bar{Y}_1^* + \bar{Z}_1 + \Delta \bar{C}_1^w \\
(14)' & \quad \hat{I}_1^* + \tilde{N}_1 = \bar{S}_1^* + \bar{D}_1 \\
(15)' & \quad \bar{X}_1 + \bar{Z}_1 = \Delta \bar{X}_1 = \bar{M}_1 + \tilde{N}_1
\end{align*} \]

where
\[ \Delta \bar{C}_1^w = (\bar{C}_1^w - \bar{C}_1^w), \quad \Delta \hat{I}_1^* = (\tilde{I}_1^* - \hat{I}_1^*), \quad \Delta \bar{M}_1 = (\bar{M} - \bar{M}_1), \quad \Delta \bar{X} = (\bar{X} - \bar{X}_1) \]

In fact, the relation (17) is held if and only if \( P \) is the GDP deflator of the domestic economy.

\[ \begin{align*}
(17) & \quad (\bar{D}_1 + \bar{Y}_1^*) - (\bar{D}_1 + \bar{Y}_1^*) - \frac{D_1 + Y_1 - \hat{I}_1^* + \tilde{C}_1^w + X - M}{P} \quad \frac{P_1}{P_2}
\end{align*} \]

The system of national accounts in real terms (12)'-(15)' and (16) immediately follows from the system (12)-(15) if the relation (17) is established.

A particular attention is called to the equation (16), which indicates the transfer of purchasing power due to changes in terms of trade. Trade gain for the domestic economy is written by
\[ \bar{T}_1 = \Delta \bar{M}_1 - \Delta \bar{X}_1 = \bar{M} \left( 1 - \frac{P_1}{P} \right) - \bar{X} \left( 1 - \frac{P_1}{P} \right) \]

In the same way the trade gain for the rest of the world is easily calculated. It is worth while to note that the sum of both gains does not become zero, i.e.
\[ \bar{T}_1 + \bar{T}_2 \neq 0 \quad \text{or} \quad \bar{T}_1 \neq - \bar{T}_2 \]

because no symmetrical or asymmetrical relation is held between the GDP deflator of the domestic economy and that of the rest of the world. (19) amounts to say that the trade gain due to changes in terms of trade of the domestic economy in Stuvel's sense is not necessarily well compensated by the trade loss of the rest of the world suffered from relevant changes in terms of trade.

5. Two arresting features are contained in the preceding arguments. First, it is easily revealed that in Geary's argument the amounts of exports and imports are not taken into account simultaneously for the calculation of the trade gain or loss. In fact, apart from the variable which expresses the terms of trade, the real gain or loss for the domestic economy in (7) is solely determined by the amounts of either imports or exports. On the contrary Stuvel's calculation of trade gain or loss in (18) includes both the amounts of exports and imports. Second, in Stuvel's argument the trade gain appeared in the domestic economy cannot be cancelled out
the equal amounts of the trade loss suffered from the rest of the world. The lack of this kind of symmetrical relation is not observed by the corresponding calculation of trade gain or loss in Geary's argument.

A more systematic and symmetrical approach is consequently required for overcoming these difficulties. Whatever forms of calculation for the trade gain or loss may be selected, the following requirements must be fulfilled:

1. For the calculation of trade gain or loss (a) the trade gain of the domestic economy must be compensated by the equal amounts of the loss on the side of the rest of the world. (b) the amounts of both exports and imports must be simultaneously and explicitly taken into account for the computation of trade gain or loss.

2. For the selection of price deflator \( p_N \), it must be chosen so that the deflated \( N \) of the domestic economy may be counterbalanced by the corresponding deflation of \( N \) of the rest of the world.

The first condition of the heading 1. is equivalent to the second condition in the sense that the former implies the latter while the latter implies the former.

6. Suppose that \( p_N \) is expressed in a form of harmonic mean in terms of \( p_1 \) and \( p_2 \):

\[
(20) \quad p_N = \frac{1}{\alpha \frac{1}{p_1} + (1-\alpha) \frac{1}{p_2}} \quad 0 \leq \alpha \leq 1
\]

The following restrictions are reasonably imposed on \( \alpha \):

(1) If there are no exports of the domestic economy, \( p_N \) can be regarded as \( p_2 \). In other words it amounts to say the fact that \( \alpha \) becomes zero. If there are no imports of the domestic economy, \( p_N \) can be regarded as \( p_1 \), in other words it amounts to say the fact that \( \alpha \) is equal to one.

(2) As apparent from the structure of the inter-flow matrix described above, exports of the domestic economy are imports for the rest of the world and vice versa. The selection of \( \alpha \) must be symmetrical form respecting \( X_1 \) and \( M_1 \).

The following argument

\[
(21) \quad \alpha = \frac{X_1}{X_1 + M_1} \quad 0 \leq \alpha \leq 1
\]

is symmetrical with respect to \( X_1 \) and \( M_1 \). It also satisfies the condition (1). Putting (21) into (20), it is easily derived that

\[
(22) \quad p_N = \frac{X_1 + M_1}{X_1 + M_1}
\]

\( \alpha \) is the parameter that indicates the dependence of the domestic economic activities on the international trade. In fact, aside from the international flow of financial claims, the economy may be termed the imports dependent economy if \( 0<\alpha<\frac{1}{2} \). On the contrary, the economy may be termed the exports dependent economy if \( 1>\alpha>\frac{1}{2} \). If \( \alpha=1 \) the economy may be termed the entirely exports dependent economy, while the economy may be termed the entirely imports dependent economy if \( \alpha=0 \). The case in which the domestic economy has no international trade relations is disregarded for this classification.

Supposing that \( p_N \) in (22) is also applied to \( Z_1 \) as a deflator, the rest of the world account for the domestic economy is expressed in the same expression as
\[ X_1 + Z_1 + T_1 = \bar{N}_1 + \bar{M}_1 \]

where \( T_1 \) is the term which indicates the trade gain or loss due to the variation of terms of trade and is easily calculated by the following formula

\[
T_1 = X_1 \left[ \frac{1}{\alpha + (1-\alpha) X_1} - 1 \right] - M_1 \left[ \frac{1}{(1-\alpha) + \alpha X_1} - 1 \right].
\]

As \( p_N \) has a symmetrical property regarding with \( X_1 \) and \( M_1 \), it is shown that \( \bar{N}_1 \) and \( \bar{T}_1 \) derived from (*) and (23) respectively satisfy the conditions of 1. and 2. in the section 5.

Putting

\[
\alpha = \frac{X_1}{X_1 + M_1}, \quad 0 \leq \alpha \leq 1,
\]

if we suppose that \( p_N \) is expressed as a convex linear combination of \( p_1 \) and \( p_2 \),

\[
p_N = \alpha p_1 + (1-\alpha) p_2,
\]

the virtually same conclusion as (22) and (23) can be drawn. But (20) is preferred to (25) as the argument for the deflator of \( p_N \). Being a kind of implicit price deflator, \( p_N \) in its original sense must be expressed as a form of current year weighted harmonic mean of \( p_1 \) and \( p_2 \). \( p_N \) in (25) differs from this expression in that it is a base year weighted arithmetic mean.

7. In order to show numerically the trade gain or loss due to changes in terms of trade national accounts data are collected and compiled for as many countries as possible. The data are entirely collected from the United Nations' *Yearbook of National Accounts Statistics*. The data for each individual country are arranged according to major expenditure components of GDP and compiled into the list of tables which are itemized by the expenditure components of GDP in current prices and constant prices respectively. The expenditure components of GDP expressed in national currency unit are converted into the U. S. $ by means of the official exchange rate. The list of countries for which the national accounts data are compiled is shown in the end of this paper as appendices. Those countries are divided into two major categories, i.e. developing countries and developed countries. So-called the centrally planned countries are entirely excluded from this compilation. Developing countries are further broken down according regions. Same principle for breaking down of countries is applied to developed countries aside from the fact that the western European countries are subdivided by EEC and EFTA regions.

Utilizing the national accounts data thus compiled for each individual country the results of computation concerning the trade gain due to changes in terms of trade in the fifties are listed in Tables 1, 2 and 3. Table 1 is calculated from the formula (7) and indicates the trade gain in Geary's sense. Table 2 is calculated from the formula (23) which is proposed by the author. Table 3 is calculated by means of (18). According to (17), the GDP deflator of individual country is used for \( P \) in (18). Table 3 indicates the trade gain in Stuvel's sense.

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4 It should be noted that \( p_N \) defined in (20) or (23) does not possess the property of an implicit price deflator in the strict sense, for (20) or (23) is by no means subject to any accounting relation. But the mere fact that \( p_N \) in (20) or (23) is expressed either as a harmonic mean of \( p_1 \) and \( p_2 \) or as an arithmetic mean of \( p_1 \) and \( p_2 \) states that \( p_N \) in our argument is derived from \( p_1 \) and \( p_2 \).

Although M. R. Courbis has proposed (23) for the formula of selecting \( p_N \) in his elaborate analysis of the national accounts in real terms, it appears that he has paid little attention to this property of price deflator above pointed out. For this matter, see M. R. Courbis, "Comptes Économiques À Prix Constants", *Études et Conjoncture*, Juillet 1964, pp. 5-76.
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Table 2: Terms of trade effect in national accounts

unit: million dollars in 1960 prices
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**unit:** million dollars in 1960 prices
Comparing these results more closely it is observed that no marked differences of results arise between Table 1 and Table 2. Certain reservation is still required for insisting that there exists a fairly good coincidence of results between Table 1 or 2 and Table 3. Although more detailed analysis is required for drawing definite conclusions from the results, it may be tentatively pointed out that in the fifties developing countries as a whole have not suffered from such significant losses due to changes in terms of trade that necessitate compensatory international aids by developed countries.

APPENDIX 1. Country Breakdown for Developing Countries

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   102 Brazil
   103 Chile
   104 Colombia
   105 Costa Rica
   106 Ecuador
   107 El Salvador
   108 Guatemala
   109 Honduras
   110 Mexico
   111 Nicaragua
   112 Panama
   113 Paraguay
   114 Peru
   115 Venezuela
   116 Other Latin America

200 Africa
   201 Algeria
   202 Morocco
   203 Sudan
   204 United Arab Republic
   205 Kenya
   206 Tanganyika
   207 Uganda
   208 Congo (Leopold Ville)
   209 Ghana
   210 Nigeria
   211 Mauritius
   212 Rhodesia and Nyasaland
   213 Other Africa

300 Far East
   301 Burma
   302 Ceylon
   303 China (Taiwan)
   304 India
   305 Pakistan
   306 Philippines
   307 Republic of Korea
   308 Thailand
   309 Other Far East
APPENDIX 2. Country Breakdown for Developed Countries

000 Western Europe
010 EEC
  011 Belgium
  012 France
  013 Luxembourg
  014 Federal Republic of Germany
  015 Italy
  016 Netherlands
020 EFTA
  021 Austria
  022 Denmark
  023 Norway
  024 Portugal
  025 Sweden
  026 Switzerland
  027 United Kingdom
030 Other Western Europe
  031 Finland
  032 Greece
  033 Iceland
  034 Ireland
  035 Spain
  036 Turkey
040 North America
  041 United States
  042 Canada
051 Japan
060 Australia, New Zealand and South Africa
  061 Australia
  062 New Zealand
  063 South Africa