Economic Integration : A Systemic Measure in I-O Framework

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(Abstract)

Countries are linked through trade. For mutual benefit they are grouped and consequently economic regions are formed in some form or other. Examples are SAARC, ECM, EFTA etc. Depending upon the form and nature of grouping, trade relations among countries vary from regions to regions. The pattern and volume of trade of countries are hence different. Such differences cause differences in the impact of trade on growth and development. Over time the nature of integration of the countries also changes. It is thus of interest to examine the strength of integration of economic regions so as to make a comparative analysis for regions. For this what is required is a systemic measure of integration. In this paper such a measure is developed in the Input-Output framework.

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Economic Integration : A Systemic Measure in I-O Framework

Countries are linked through trade. For mutual benefit they are grouped and consequently economic regions are formed in some form or other. Examples are SAARC, ECM, EFTA etc. Depending upon the form and nature of grouping, trade relations among countries vary from regions to regions. The pattern and volume of trade of countries are hence different. Such differences cause differences in the impact of trade on growth and development. Over time the nature of integration of the countries also changes. It is thus of interest to examine the strength of integration of economic regions so as to make a comparative analysis for regions. For this what is required is a systemic measure of integration. In this paper such a measure is developed in the Input-Output framework. The measure is used to examine the changing nature of integration among the SAARC countries. Section 1 presents the measure. Estimates of the integration index for SAARC are explained in Section 2.

Section 1. Methodology

Let S be the set of m countries which form an economic association called SA. S^c be the set of countries not belonging to SA. X_i, D_i, M_i and E_i be the GDP, domestic consumption, import and export of country $i \in S$. Then it follows from the national income identity

$$X_i + M_i = D_i + E_i \quad . \quad \ldots\ldots\ldots (1).$$

Let M_i^S and M_i^c be respectively the total imports of country $i \in S$ from the (union) countries in S and from the rest of the countries in S^c. Then

$$M_i^S + M_i^c = M_i \quad \ldots\ldots\ldots (2).$$

Similarly, exports are divided as:

$$E_i^s + E_i^c = E_i \qquad \ldots\ldots\ldots (3).$$

Substitution of (2) and (3) in (1) yields:

$$X_i + M_i^s + M_i^c = D_i + E_i^s + E_i^c$$

or $$D_i - M_i^s + E_i^s + E_i^c = X_i + M_i^c \qquad \ldots\ldots\ldots (4).$$

Let E_{ij}^s be the the export of country $i \in S$ to country $j \in S$. Then

$$E_i^s = E_{i1}^s + \ldots\ldots\ldots\ldots + E_{im}^s \,,\, E_{ii}^s = 0 \qquad \ldots\ldots\ldots (5).$$

Obviously, E_{ji}^s be the import of country $i \in S$ from country $j \in S$. Then it follows that

$$M_i^s = E_{1i}^s + \ldots\ldots\ldots\ldots + E_{mi}^s,\ E_{ji}^s = 0 \qquad \ldots\ldots\ldots (6).$$

From (4) and (5)

$$(D_i - M_i^s) + E_{i1}^s + \ldots\ldots\ldots\ldots + E_{im}^s + E_i^c = X_i + M_i^c = Z_i \qquad \ldots\ldots\ldots (7).$$

For i= 1,2…….,m and using $E_{ii}^s = 0$, $\forall i$, (7) yields :

$$\begin{aligned}
&(D_1 - M_1^s) + E_{12}^s + \ldots\ldots\ldots + E_{1m}^s + E_1^c = Z_1 \\
&E_{21}^s + (D_2 - M_2^s) + \ldots\ldots\ldots + E_{2m}^s + E_2^c = Z_2 \\
&\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad \ldots\ldots\ldots (8). \\
&\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\
&E_{m1}^s + E_{m2}^s + \ldots\ldots\ldots + (D_m - M_m^s) + E_m^c = Z_m
\end{aligned}$$

Define $e_{ij}^s = E_{ij}^s / Z_j$

and $$d_{ii} = \frac{D_i - M_i^s}{Z_i} \quad i, j = 1,2, \ldots\ldots m \qquad \ldots\ldots\ldots (9).$$

e_{ij}^s is the amount of export of country $i \in S$ to country $j \in S$ per unit of later's supply(exclusive of M_i^s). In other words, it is the amount of import country $j \in S$ has from country $i \in S$ per unit of its supply. d_{ii} is the amount of net domestic consumption of country i per unit of its supply (exclusive of M_i^s).

Using (9) in (8), we get :

$d_{11}Z_1 + e_{12}{}^{s}Z_2 + \ldots\ldots\ldots\ldots\ldots + e_{1m}{}^{s}Z_m + E_1{}^{c} = Z_1$

$e_{21}{}^{s}Z_1 + d_{22}Z_2 + \ldots\ldots\ldots\ldots\ldots . + e_{2m}{}^{s}Z_m + E_2{}^{c} = Z_2$

$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$

$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$

$e_{m1}{}^{s}Z1 + e_{m2}{}^{s}Z_2 + \ldots\ldots\ldots\ldots\ldots + d_{mm}Z_m + E_m{}^{c} = Z_m$

which becomes in matrix from as

$$\begin{pmatrix} d_{11} & e^{s}_{11} & e^{s}_{1m} \\ e^{s}_{21} & d_{22} & e^{s}_{2m} \\ & & \\ e^{s}_{m1} & e^{s}_{m2} & d_{mm} \end{pmatrix} \begin{pmatrix} Z_1 \\ Z_2 \\ \\ Z_m \end{pmatrix} + \begin{pmatrix} E_1{}^{c} \\ \\ \\ E_m{}^{c} \end{pmatrix} = \begin{pmatrix} Z_1 \\ Z_2 \\ \\ Z_m \end{pmatrix}$$

or $eZ + E^{c} = Z$ where $e = (e_{ij})$, $\quad e_{i\,i} = d_{ii}$

$e_{ij} = e_{ij}^{s} \quad i \neq j,$

$$Z = (Z_j) \quad \text{and} \quad E^{c} = (E_j{}^{c}) \qquad \ldots\ldots (10)$$

The matrix e is of interest to us. It may be called the matrix of intra trade- flow coefficients for the countries in S: row-wise it indicates the coefficients of exports of the member countries to the member countries; column – wise it indicates the coefficients of imports of the member countries from the member countries. Two-way inter-country trade relationships are embodied in the trade-flow matrix. The diagonal terms indicate intra- country trade coefficients (coeffient of net domestic consumption). All the entries of e matrix are non-negative and less than unity. The sum of each column is also less than unity since for column j, say,

$s_j = e^{s}_{1j} + \ldots.. + e^{s}_{jj} + \ldots\ldots + e^{s}_{mj}$

$= e^{s}_{jj} + \sum_{i=1,\, i \neq j}^{m} e^{s}_{ij}$

$= (D_{jj} - M_j{}^{s})/ Z_j + M_j^{s}/ Z_j$ [using (6)]

$= D_{jj}/z_j < 1.$

The matrix e is hence well-behaved in the sense of Solow and hence $(I - e)^{-1}$ exists. From equation (10) we get:

$$Z = (I - e)^{-1} E^c \qquad \ldots\ldots\ldots\ldots\ldots\ldots (11)$$

We consider the following cases in respect of the matrix e :

(1) When $e_{ij}^s = 0 , \forall i,j ,$

then $e = \text{diag}\ (d_{11}.....d_{mn}) = \text{diag}\ (D_1/Z_1, \ldots\ldots.., D_2/Z_2)$

and $(I - e) = \text{diag}\ [(1- D_1/Z_1]. \ldots . (1- Dn/Zn)]$

so that $|I\text{-}e| = (1- D_1/Z_1) \ldots . (1- Dn/Zn) < 1$, since $(1- D_i/Z_i) < 1, \forall\ i \qquad \ldots\ldots\ldots (12)$

This case corresponds to the situation when there are no trade flows among the member countries of the association.

(2) When $e_{ij}^s \neq 0, \forall\ i, j$

then e is a non-diagonal matrix and (I-e) is non-singular having determinant $|I\text{-}e| > 0$.

It is Solovian. This case corresponds to the situation where the member countries trade among themselves. And $|I\text{-}e|$ (with trade flows among member countries) is greater than $|I\text{-}e|$ (with no trade flows among the member countries). Below is given a heuristic proof for a 2×2 case:

$$|I\text{-}e| = (1\text{-}d_{11})(1\text{-}d_{22}) - e_{12}^s e_{21}^s$$

$$= [1\text{-}(D_1\text{-}M_1^s)/Z_1][1\text{-}(D_2\text{-}M_2^s)/Z_2] - e_{12}^s e_{21}^s$$

$$= (1- D_1/Z_1)(1- D_2Z_2) + \{(1- D_1/Z_1)(M_2^s/Z_2) + (1- D_2/Z_2)(M_1^s/Z_1) + (M_1^s/Z_1)(M_2^s/Z_2) - e_{12}^s e_{21}^s\} \qquad \ldots\ldots\ldots\ldots (13)$$

Term in {} is obviously positive. Hence using (12), we get:

$|I-e|$ = $|I-e|$ (with no trade flows) + positive amount so that $|I-e|$ (with trade flows among the member countries) is greater than $|I-e|$ (with no trade flows among the member countries).

It thus follows from the above that $|I-e|$ may be taken as an index of trade integration among the countries which form the union (association). Higher (lower) the value of the determinant of (I-e), higher (lower) the degree of integration among the member countries. The intertemporal movement in the extent of integration may hence be judged by means of $|I-e|$.

Section 2. Index of Integration for SAARC

Six countries – India, Pakistan, Nepal, Sri Lanka, Bangladesh and Maldives formed the South Asian Association of Regional Cooperation (SAARC) in 1985. Almost 25 years have passed so far. It is time to examine whether SAARC has consolidated over time and increased the strength of integration among its member countries.

Based on trade data taken from Directorate of Trade Statistics Yearbook, the Index of Integration has been computed for the period 1975-98. The period 1975-85 is pre to the formation of SAARC while 1985-98 is the post –SAARC period. The index which was .000000529 in 1975 came down to .000000117 in 1980. In 1985 it went up to .000000138. In 1990 it rose to .00000305. In 1995 it substantially went up to .0000128 and slightly decreased to .0000114 in 1998. On the whole, the index has revealed a rising trend, which is indicative of increasing integration among the countries in SAARC.