DEPOCEN

Working Paper Series No. 2008/31

COMPILATION OF AN MULTI-REGION INTER-REGIONAL INPUT-OUTPUT FRAMEWORK TABLE FOR THE VIETNAM'S ECONOMY

Bui Trinh *
Duong Manh Hung **
Francisco T. Secretario ***
Kwang Moon Kim ****

* Member of AREES, trinhcan@hotmail.com
** Vietnam GSO, dmhung74@yahoo.com
*** Member of AREES, ftsecret@yahoo.com
**** Member of AREES

COMPILATION OF AN MULTI-REGION INTER-REGIONAL INPUT-OUTPUT FRAMEWORK TABLE FOR THE VIETNAM'S ECONOMY

Bui Trinh[1] Duong Manh Hung[2] Francisco T. Secretario[3] Kwang Moon Kim[4]

Abstract:

This paper presents a technique on compiling multi-regional input-output framework. The main objective of the research is to provide an adequate & reliable I-O database that could effectively serve as bases in the conduct of intra-regional as well as inter-regional economic and environmental studies. We also show the result of the research as annex in this paper.

I. INTRODUCTION

This progress paper presents the initial output of a research project entitled "Compilation of an Inter-regional Input-Output (I-O) Table for the Vietnam's Economy".

The main objective of this research is to provide an adequate & reliable I-O database that could effectively serve as bases in the conduct of intra-regional as well as inter-regional economic and environmental studies.

In Vietnam has 3 national I-O tables, these are I-O, 1989, 1996 and 2000 with competitive – import type compiled by Vietnam General Statistical Office, moreover, there was some intra-regional and interregional IO tables, these tables compiled by private research group sponsored by some Japan consultant companies and some Organizations. The data on Vietnam multi-region inter-regional input-output framework will be attached by excel file as annex 1.

II. OVERVIEW OF REGIONAL IO COMPILATION & STUDY IN VIETNAM

The VIRIO research project has already produced two (2) types of regional IO tables since 1996. The initial output of the project came out in the form of a single-region IO table for the Ho Chi Minh City. The 2000 Ho Chi Minh IO table is of the static, open type of traditional IO models that accounts, in its compact form, the intra-regional, inter-industry transactions of products or goods and services for some 45 productive sectors representing the region's economy. As one of the salient features of regional IO tables, the region's external trade, foreign and domestic alike, is highlighted. An illustration of the accounting framework of the intra-regional IO model is replicated in this Report as Annex A.

[1] Member of AREES, trinhcan@hotmail.com
[2] Vietnam GSO, dmhung74@yahoo.com
[3] Member of AREES, ftsecret@yahoo.com
[4] Member of AREES

A technical paper on the structural analysis of the Ho Chi Minh economy based on the 1996's IO table was presented in a seminar/workshop held in early November 2001 at Hanoi, Vietnam sponsored by NISSAN Science Foundation.

Last time of the VRIO project involved the construction of a 2-region inter-regional IO table, with the national territory delineated into two broad economic regions, namely: (1) Ho Chi Minh City and (2) Rest of the Vietnam (ROV). The main objective was to be able to measure inter-regional economic interdependencies that are not captured in single-region IO tables such as the Ho Chi Minh intra-regional table in last time. It is thus capable of quantifying the generally perceived spillover and feedback effects due to inter-regional trade.

To carry out this activity, the intra-regional IO framework was extended into a bi-region inter-regional IO model highlighting, among others, inter-industry outflows/inflows of products between Ho Chi Minh and ROV. Also, the sector classification scheme was expanded from the 45-industry/product grouping to a manageable 51-sector classification system for the general purpose of enhancing the analytical capability in terms of increased sector coverage. The sector reclassifications involved the creation of additional IO sectors for existing vital industries in the ROV economy but were not purposely highlighted in the Ho Chi Minh table, these industries being non-existent in the Ho Chi Minh economy. The resulting VIRIO I thus contains an inter-regional IO matrix in 102 x 102 (=2 regions x 51sectors) dimension.

A technical paper based on the **VIRIO I** table was presented in a symposium held at the National University, Hanoi in November 2001.

AREES have also compiled a Multi-region inter-regional IO table by expanding the area coverage of VIRIO I from 2 to 3 regions between Danang-Ho Chi Minh City and rest of Vietnam This work was finished in August, 2005

III. TERMS OF REFERENCE

(1) IO Model: Multi-region Inter-Regional IO Model **[Izard Type]**

(2) Geographic and sector Reclassification

In accord with the area coverage of this project, Vietnam is subdivided into 8 geographic regions and 10 sectors, as follows:

REGIONS	SECTORS
Reg 1: Red river Delta: Reg 2: Northern Uplands Reg3: North central coast Reg 4: Central Coast Reg 5: Central high–land Reg 6: Southeast	1. Crops 2. Other Agricultural activities 3. Mining 4. Food processing 5. Light manufactures 6. Heavy manufactures 7. Machinery

Reg 7: Mekong River Delta	8. Utility 9. Construction 10. Services

The detail of region will be attached in annex 2

(3) Size of Table: (Refer to Annex B – Sector Classification)

a) Number of Production Sectors: 10
b) Number of Value Added Sectors: 4
c) Number of Final Demand Sectors: 3

(3) Reference Year: CY 2000

(4) This work was implemented by private researcher group

(5) For easy reference, the generated 7-region, 10-sector inter-regional IO table is acronymic in this Report as VIRIO IV. The resulting VIRIO IV table is a 70x70 (=7 regions X 10 sectors) matrix of input-output transactions, excluding equally comprehensive sub-matrices for (foreign) import and final demand transactions that were part and parcel in the whole compilation process

IV. CONCEPUTAL FRAMEWORK

(1) ACCOUNTING FRAMEWORK

Similar to the **"VIRIO I table"** (Ex; Ho Chi Minh – ROV) and **"VIRIO II tables"** (3 Regions inter-regional IO table; Danang—Ho Chi Minh—ROV), **"VIRIO III"** (HAIDEP-VIRIO), **"VIRIO IV"** (7-region interregional IO table) is also of the static, open type of regional IO models with CY 2000 as the same reference period. CY 2000 was chosen as the reference year in this VRIO research study to synchronize the resulting regional tables with the available mother national table for 2000. Numerical consistency is thus maintained and makes comparative analysis of results feasible.

Shown below is a generalized framework for multi-region inter-regional IO accounting that was being adopted in constructing **"VIRIO III"**. It is actually an extension of the bi-region inter-regional model taking into consideration the increase in the spatial coverage.

Figure 1. GENERALIZED FRAMEWORK for VRIO Table

FROM \ TO		INTERMEDIATE DEMAND	FINAL DEMAND			GROSS OUTPUT
		REGION **S**	REGION **S**	ROW		
		1 2 … j … 10	1……k…...4	E	M	
REG **R**	1 : i : 10	$\mathbf{X_{ij}^{RS}}$	$\mathbf{{}^{D}Y_{ik}^{RS}}$	$\mathbf{E_i^{RW}}$	**0**	$\mathbf{X_i^{R}}$
ROW	1 : i :	$\mathbf{X_{ij}^{WS}}$	$\mathbf{{}^{D}Y_{ik}^{WS}}$	**0**	**($\mathbf{M_i}$)**	**0**

	10					
G V A	1 : p : 4	$\mathbf{V_{pj}^{S}}$	**0**	**0**	**CDT**	**GDP**
GROSS INPUT		$\mathbf{X_{j}^{S}}$	$\Sigma\ ^{D}\mathbf{Y}$	Σ **E**	Σ **M**	

ABBREVIATIONS:

ROW: Rest of the world (foreign countries)

GVA: Gross Value Added

E : Exports

M : Imports

^{D}Y : Domestic Final Demand

CDT: Customs Duties and Import Taxes

GDP: Gross Domestic Product

MATRIX NOTATIONS:

X_{ij}^{RS} : value of product i produced in region R consumed in production by industry j in region S where: (R = S = 1, 2 … 8) and (i = j = 1, 2,…16)

X_{ij}^{WS} : value of import of product i consumed by industry j in region S

V_{pj}^{S} : value added p generated by industry j in region S (p = 1…4)

Y_{ik}^{RS} : value of region R's product i consumed by final demand k in region S (k = 1…4)

Y_{ik}^{WS} : value of import of product i consumed by domestic final demand k in region S.

E_{i}^{RW} : vector of exports of product i produced in region R

(M_i) : vector of total imports of product i (recorded as negative entries)

X_{i}^{R} : vector of gross outputs of product i produced in region R

X_{j}^{S} : vector of gross inputs of industry j in region S

Figure 1 shows the division of the VRIO table into blocks or quadrants, each block explicitly describing a distinct type of IO transaction. In its blown-up format, the number of intermediate or input-output blocks is equal to $m^2 = 49$, where m is the number of regions. There are 7 blocks to account for intra-regional IO transactions and the remaining 42 blocks for inter-regional transactions on outflows/inflows. Each intermediate demand block is in 10 x 10-sector dimension.

Similarly, there are also 49 blocks for final demand transactions, broken down into 7 for intra-regional and 42 for inter-regional transactions. Each final demand block is in 10 x 4-sector dimension. Moreover, 10 separate blocks are allocated that explicitly record regional transaction with the ROW (imports). All in all, a total of 105 blocks that makes up the whole VIRIO IO Accounts.

(2) BASIC EQUATIONS

The region's total output of product *i* is equal to the region's total input of producing product *j*, i.e.

$$X_{i}^{R} = X_{j}^{S} \quad R=S=1, 2, \ldots 7)\ (i = j = 1, 2,\ldots 10) \qquad (1)$$

The region's total value added is equal to the region's total final demand, i.e.

$$V_{pj}^{S} + CDT = \Sigma\ [^{D}Y_{ik}^{RS} + E_{i}^{RW} + {}^{D}Y_{ik}^{WS} + (M_i) + CDT] \qquad (2)$$

Or in national accounts terminology: Gross Regional Domestic Product = Gross Regional Domestic Expenditure

From the inter-regional accounting framework as illustrated above, the balance equation for the output of sector i in region R is given by, in its generalized form:

$$X_i^{R} = X_{ij}^{RS} + {}^{D}Y_{ik}^{RS} + E_i^{RW} \quad (3)$$

(R=S=1,2,…7); (i = j =1,2,…10); (k = 1, 2,…4)

OR in disaggregated form:

$$X_i^{R1} = [X_{ij}^{R1S1} + X_{ij}^{R1S2} + \ldots\ldots + X_{ij}^{R1S7}] + Y_{ik}^{R1S} + E_i^{R1W} \quad (4)$$

$$X_i^{R2} = [X_{ij}^{R2S1} + X_{ij}^{R2S2} + \ldots\ldots + X_{ij}^{R2S7}] + Y_{ik}^{R2S} + E_i^{R2W} \quad (5)$$

$$X_i^{R3} = [X_{ij}^{R3S1} + X_{ij}^{R3S2} + \ldots\ldots + X_{ij}^{R3S7}] + Y_{ik}^{R3S} + E_i^{R3W} \quad (6)$$

$$X_i^{R4} = [X_{ij}^{R4S1} + X_{ij}^{R4S2} + \ldots\ldots + X_{ij}^{R4S7}] + Y_{ik}^{R4S} + E_i^{R4W} \quad (7)$$

$$X_i^{R5} = [X_{ij}^{R5S1} + X_{ij}^{R5S2} + \ldots\ldots + X_{ij}^{R5S7}] + Y_{ik}^{R5S} + E_i^{R5W} \quad (8)$$

$$X_i^{R6} = [X_{ij}^{R6S1} + X_{ij}^{R6S2} + \ldots\ldots + X_{ij}^{R6S7}] + Y_{ik}^{R6S} + E_i^{R6W} \quad (9)$$

$$X_i^{R7} = [X_{ij}^{R7S1} + X_{ij}^{R7S2} + \ldots\ldots + X_{ij}^{R7S7}] + Y_{ik}^{R7S} + E_i^{R7W} \quad (10)$$

Using Leontief's assumption of linearity in production cost functions, i.e. $a_{ij}=X_{ij} / X_j$, a set of 49 input structural equations are regionally-defined, as follows:

(a1-1) $a_{ij}^{R1S1} = X_{ij}^{R1S1} / X_j^{S1}$, (a4-1) $a_{ij}^{R4S1} = X_{ij}^{R4S1} / X_j^{S1}$, (a7-1) $a_{ij}^{R7S1} = X_{ij}^{R7S1} / X_j^{S1}$,

(a1-2) $a_{ij}^{R1S2} = X_{ij}^{R1S2} / X_j^{S2}$, (a4-2) $a_{ij}^{R4S2} = X_{ij}^{R4S2} / X_j^{S2}$, (a7-2) $a_{ij}^{R7S2} = X_{ij}^{R7S2} / X_j^{S2}$,

(a1-3) $a_{ij}^{R1S3} = X_{ij}^{R1S3} / X_j^{S3}$, (a4-3) $a_{ij}^{R4S3} = X_{ij}^{R4S3} / X_j^{S3}$, (a7-3) $a_{ij}^{R7S3} = X_{ij}^{R7S3} / X_j^{S3}$,

(a1-4) $a_{ij}^{R1S4} = X_{ij}^{R1S4} / X_j^{S4}$, (a4-4) $a_{ij}^{R4S4} = X_{ij}^{R4S4} / X_j^{S4}$, (a7-4) $a_{ij}^{R7S4} = X_{ij}^{R7S4} / X_j^{S4}$,

(a1-5) $a_{ij}^{R1S5} = X_{ij}^{R1S5} / X_j^{S5}$, (a4-5) $a_{ij}^{R4S5} = X_{ij}^{R4S5} / X_j^{S5}$, (a7-5) $a_{ij}^{R7S5} = X_{ij}^{R7S5} / X_j^{S5}$,

(a1-6) $a_{ij}^{R1S6} = X_{ij}^{R1S6} / X_j^{S6}$, (a4-6) $a_{ij}^{R41S6} = X_{ij}^{R4S6} / X_j^{S6}$, (a7-6) $a_{ij}^{R7S6} = X_{ij}^{R7S7} / X_j^{S7}$,

(a1-7) $a_{ij}^{R1S7} = X_{ij}^{R1S7} / X_j^{S7}$, (a4-7) $a_{ij}^{R4S7} = X_{ij}^{R4S7} / X_j^{S7}$, (a7-7) $a_{ij}^{R7S7} = X_{ij}^{R7S7} / X_j^{S7}$,

(a2-1) $a_{ij}^{R2S1} = X_{ij}^{R2S1} / X_j^{S1}$, (a5-1) $a_{ij}^{R5S1} = X_{ij}^{R5S1} / X_j^{S1}$,

(a2-2) $a_{ij}^{R2S2} = X_{ij}^{R2S2} / X_j^{S2}$, (a5-2) $a_{ij}^{R5S2} = X_{ij}^{R5S2} / X_j^{S2}$,

(a2-3) $a_{ij}^{R2S3} = X_{ij}^{R2S3} / X_j^{S3}$, (a5-3) $a_{ij}^{R5S3} = X_{ij}^{R5S3} / X_j^{S3}$,

(a2-4) $a_{ij}^{R2S4} = X_{ij}^{R2S4} / X_j^{S4}$, (a5-4) $a_{ij}^{R5S4} = X_{ij}^{R5S4} / X_j^{S4}$,

(a2-5) $a_{ij}^{R2S5} = X_{ij}^{R2S5} / X_j^{S5}$, (a5-5) $a_{ij}^{R5S5} = X_{ij}^{R5S5} / X_j^{S5}$,

(a2-6) $a_{ij}^{R2S6} = X_{ij}^{R2S6} / X_j^{S6}$, (a5-6) $a_{ij}^{R5S6} = X_{ij}^{R5S6} / X_j^{S6}$,

(a2-7) $a_{ij}^{R2S7} = X_{ij}^{R2S7} / X_j^{S7}$, (a5-7) $a_{ij}^{R5S7} = X_{ij}^{R5S7} / X_j^{S7}$,

(a3-1) $a_{ij}^{R3S1} = X_{ij}^{R3S1} / X_j^{S1}$, (a6-1) $a_{ij}^{R6S1} = X_{ij}^{R6S1} / X_j^{S1}$,

(a3-2) $a_{ij}^{R3S2} = X_{ij}^{R3S2} / X_j^{S2}$, (a6-2) $a_{ij}^{R6S2} = X_{ij}^{R6S2} / X_j^{S2}$,

(a3-3) $a_{ij}^{R3S3} = X_{ij}^{R3S3} / X_j^{S3}$, (a6-3) $a_{ij}^{R6S3} = X_{ij}^{R6S3} / X_j^{S3}$,

(a3-4) $a_{ij}^{R3S4} = X_{ij}^{R3S4} / X_j^{S4}$, (a6-4) $a_{ij}^{R6S4} = X_{ij}^{R6S4} / X_j^{S4}$,

(a3-5) $a_{ij}^{R3S5} = X_{ij}^{R3S5} / X_j^{S5}$, (a6-5) $a_{ij}^{R6S5} = X_{ij}^{R6S5} / X_j^{S5}$,

(a3-6) $a_{ij}^{R3S6} = X_{ij}^{R3S6} / X_j^{S6}$, (a6-6) $a_{ij}^{R6S6} = X_{ij}^{R6S6} / X_j^{S6}$,

(a3-7) $a_{ij}^{R3S7} = X_{ij}^{R3S7} / X_j^{S7}$, (a6-7) $a_{ij}^{R6S7} = X_{ij}^{R6S7} / X_j^{S7}$, Equations (a1-1), (a2-2), (a3-3), (a4-4), (a5-5), (a6-6), and (a7-7) represent the intra-regional intermediate input coefficients, while the rest account for the inter-regional trade coefficients. Substituting these structural equations into equations (4) through (10), we have:

$$X_i^{R1} = [a_{ij}^{R1S1} X_j^{S1} + a_{ij}^{R1S2} X_j^{S2} + a_{ij}^{R1S3} X_j^{S3} + a_{ij}^{R1S4} X_j^{S4} + a_{ij}^{R1S5} X_j^{S5} + a_{ij}^{R1S6} X_j^{S6} + a_{ij}^{R1S7} X_j^{S7}] + Y_i^{R1} + E_i^{R1W} \quad (12)$$

$$X_i^{R2} = [a_{ij}^{R2S1} X_j^{S1} + a_{ij}^{R2S2} X_j^{S2} + a_{ij}^{R2S3} X_j^{S3} + a_{ij}^{R2S4} X_j^{S4} + a_{ij}^{R2S5} X_j^{S5} + a_{ij}^{R2S6} X_j^{S6} + a_{ij}^{R2S7} X_j^{S7}] + Y_i^{R2} + E_i^{R2W} \quad (13)$$

$$X_i^{R3} = [a_{ij}^{R3S1} X_j^{S1} + a_{ij}^{R3S2} X_j^{S2} + a_{ij}^{R3S3} X_j^{S3} + a_{ij}^{R3S4} X_j^{S4} + a_{ij}^{R3S5} X_j^{S5} + a_{ij}^{R3S6} X_j^{S6} + a_{ij}^{R3S7} X_j^{S7}] + Y_i^{R3} + E_i^{R3W} \quad (14)$$

$$X_i^{R4} = [a_{ij}^{R4S1} X_j^{S1} + a_{ij}^{R4S2} X_j^{S2} + a_{ij}^{R4S3} X_j^{S3} + a_{ij}^{R4S4} X_j^{S4} + a_{ij}^{R4S5} X_j^{S5} + a_{ij}^{R4S6} X_j^{S6} + a_{ij}^{R4S7} X_j^{S7}] + Y_i^{R4} + E_i^{R4W} \quad (15)$$

$$X_i^{R5} = [a_{ij}^{R5S1} X_{ij}^{S1} + a_{ij}^{R5S2} X_{ij}^{S2} + a_{ij}^{R5S3} X_{ij}^{S3} + a_{ij}^{R5S4} X_{ij}^{S4} + a_{ij}^{R5S5} X_{ij}^{S5} + a_{ij}^{R5S6} X_j^{S6} + a_{ij}^{R5S7} X_j^{S7}] + Y_i^{R5} + E_i^{R5W} \quad (16)$$

$$X_i^{R6} = [a_{ij}^{R6S1} X_j^{S1} + a_{ij}^{R6S2} X_j^{S2} + a_{ij}^{R6S3} X_j^{S3} + a_{ij}^{R6S4} X_j^{S4} + a_{ij}^{R6S5} X_j^{S5} + a_{ij}^{R6S6} X_j^{S6} + a_{ij}^{R6S7} X_j^{S7}] + Y_i^{R6} + E_i^{R6W} \quad (17)$$

$$X_i^{R7} = [a_{ij}^{R7S1} X_j^{S1} + a_{ij}^{R7S2} X_j^{S2} + a_{ij}^{R7S3} X_j^{S3} + a_{ij}^{R7S4} X_j^{S4} + a_{ij}^{R7S5} X_j^{S5} + a_{ij}^{R7S6} X_j^{S6} + a_{ij}^{R7S7} X_j^{S7}] + Y_i^{R7} + E_i^{R7W} \quad (18)$$

In matrix form,

$$\begin{bmatrix} X_i^{R1} \\ X_i^{R2} \\ X_i^{R3} \\ \ldots\ldots \\ X_i^{R7} \\ X_i^{R8} \end{bmatrix} = \begin{bmatrix} a_{ij}^{R1S1} + a_{ij}^{R1S2} \ldots\ldots + a_{ij}^{R1S6} + a_{ij}^{R1S7} \\ a_{ij}^{R2S1} + a_{ij}^{R2S2} \ldots\ldots + a_{ij}^{R2S6} + a_{ij}^{R2S7} \\ a_{ij}^{R3S1} + a_{ij}^{R3S2} \ldots\ldots + a_{ij}^{R3S6} + a_{ij}^{R3S7} \\ \ldots\ldots\ldots\ldots\ldots\ldots \\ a_{ij}^{R7S1} + a_{ij}^{R7S2} \ldots\ldots + a_{ij}^{R6S6} + a_{ij}^{R6S7} \\ a_{ij}^{R7S1} + a_{ij}^{R7S2} \ldots\ldots + a_{ij}^{R7S6} + a_{ij}^{R7S7} \end{bmatrix} \begin{bmatrix} X_j^{S1} \\ X_j^{S2} \\ X_j^{S3} \\ \ldots \\ X_j^{S6} \\ X_j^{S7} \end{bmatrix} + \begin{bmatrix} Y_i^{R1} \\ Y_i^{R2} \\ Y_i^{R3} \\ \ldots \\ Y_i^{R6} \\ Y_i^{R7} \end{bmatrix} + \begin{bmatrix} E_i^{R1W} \\ E_i^{R2W} \\ E_i^{R3W} \\ \ldots \\ E_i^{R6W} \\ E_i^{R7W} \end{bmatrix} \quad (19)$$

Let $X = A \quad X + Y + E$

Then **X = AX + [Y+E]** OR **X = (I-A)$^{-1}$ [Y+E]** (20) where: A is a 128 x 128 matrix of technical coefficients; Y is a 128 x 40 matrix of regional final demands; and X is a 128-sector vector of regional outputs.

Figure 1 shows a truncated configuration of the final output of this research. It is a 7-region Inter-regional I-O Table for Vietnam's economy (to be hereafter referred to as VIRIO). The VIRIO table traces the (money) flows of products (or goods and services) between regions and between sectors in the national economy during the reference period. Reading along the rows, it shows the deliveries of one region's products to intermediate & final demand sectors in partner regions and to itself. Reading down the columns, it shows the input structure of production and the expenditure pattern of final demands in each region, further distinguished by source of inputs/expenditures.

Figure 2 shows the division of the VIRIO table into blocks, with each block explicitly describing a distinct type of I-O transaction. In its blown-up layout, the total number of blocks that account for the intermediate transactions in this VIRIO table is equal to $m^2 = 49$, where m is the number of regions (= 7). There are 7 blocks to account for intra-regional I-O transactions and the remaining 42 blocks for inter-regional transactions on intermediate outflows/inflows. With each intermediate block in 10x10-sector dimension, the whole intermediate or input-output quadrant, therefore, is of magnitude

Similarly, there are also 49 blocks for final demand transactions, with each final demand block in 10-product sector x 7-final demand sector dimension. Fig 2 presents detail of VRIO framework as follows:

Fig. 2. GENERAL CONFIGURATION OF 8-REGION VIRIO TABLE

TO / FROM			INTERMEDIATE DEMAND			FINAL DEMAND			M	GROSS OUTPUT
			Region 1	....	Region 7	Region 1	....	Region 7		
			1 2 ... j ... n		1 2 ... j ... n	C G I E		C G I E		
INTERMED INPUTS	REG 1	1 : i : n	Intra-regional Flows of Intermediate Prods X^{11}	....	Inter-regional Flows of Intermediate Prods X^{17}	Intra-regional Flows of Final Prods F^{11}	....	Inter-regional Flows of Final Prods F^{17}	0	$X^{1.}$
	:	:	:	:	:	:	:	:	:	:
	REG 7	1 : i : n	Inter-regional Flows of Intermediate Prods X^{71}	....	Intra-regional Flows of Intermediate Prods X^{77}	Inter-regional Flows of Final Prods F^{71}	....	Intra-regional Flows of Final Prods F^{77}	0	$X^{7.}$
	ROW	1 : i : n	Imports of Intermediate Products X^{W1}	....	Imports of Intermediate Products X^{W7}	Imports of Final Products F^{W1}	....	Imports of Final Products F^{W7}	Total Imports F^{W7}	0
PRIMARY INPUTS		CE PT-S D OS	Value Added V^{P1}	....	Value Added V^{P7}	Value Added 0	....	Value Added 0	Value Added 0	GVA $V^{P.}$
GROSS INPUT			$X^{.1}$	....	$X^{.7}$	$F^{.1}$	....	$F^{.7}$	(M)	

ABBREVIATIONS:

CE: Compensation of Employees
PT-S: Production Tax less Subsidies
C: Private Consumption Expenditures
G: Government Consumption Expenditures

D: Depreciation — **I:** Investment (Gross Domestic Capital Formation)
OS: Operating Surplus — **E:** Exports
GVA: Gross Value Added — **M:** Imports

NOTATIONS:

X^{11} : Matrix of intra-regional flows of intermediate products within Region 1;
X^{17} : Matrix of inter-regional flows of intermediate products between Regions 1 & 7;
F^{11} : Matrix of intra-regional flows of final products within Region 1;
F^{17} : Matrix of inter-regional flows of products between Regions 1 and 7;
X^{W1} : Matrix of imports of intermediate products consumed in Region 1;
F^{W1} : Matrix of imports of final products consumed in Region 1;
(M) : Vector of total imports of national economy, (negative entries)
V^{P1} : Matrix of primary inputs in production (=GVA) in Region 1
$V^{P.}$: Vector of GVA of national economy, where $\sum$GVA = national GDP
$F^{.1}$: Vector of total final demand in Region 1
$X^{1.} = X^{.1}$: Vector of gross outputs in Region1 = vector of gross inputs in Region 1;

V. METHODOLOGY, DATA SOURCES and LIMITATIONS

This section summarizes the general compilation methodology adopted in the project implementation in accordance with its above-mentioned terms of reference. It consists of four (4) main stages undertaken in sequential order, as follows:

Stage I : Compilation of Competitive Intra-Regional I-O tables;
Stage II : Derivation of Non-Competitive Intra-Regional I-O Tables;
Stage III: Estimation of Inter-Regional Domestic Flows; and
Stage IV: Integration of Stage II & III Outputs to Generate VIRIO IV Table

The hybrid or mixed approach of constructing regional IO tables was adopted. The hybrid method starts with the compilation of readily available but limited survey-generated data at the regional level. Non-survey techniques of estimation are then employed to fill-in observed data gaps and deficiencies. In particular, indirect methods were applied in estimating external and domestic trade because foreign and domestic outflows and inflows at the sub-national level are presently inadequate and inappropriate to meet the rigid data requirements of I-O accounting.

(1) Stage I. Compilation of Intra-Regional Tables (Competitive Type)

Stage I refers to the compilation of intra-regional tables of the competitive-imports type. A regional IO table of the competitive-imports type records the value of input-output transactions of products, whether they are regionally produced and/or imported whether from abroad or from other regions of the domestic economy.

Similar to national IO compilation, regional MAKE and USE tables are initially compiled based on processed data obtained from the 2000 IO Survey of Enterprises (IOSE). GRDP and GRDE data by province and by sector were obtained from the GSO, PSO statistical year book which is published every year.

The MAKE or Supply table is an industry x product matrix showing the distribution of the value of IO-classified products produced by IO-classified industries during the reference year. The MAKE matrix at the regional level is constructed based on the 2000 IOSE, given estimated industry outputs. The IOSE is conducted during IO benchmark years to provide more detailed structural indicators on the composition of industry outputs and inputs. The MAKE table is valued in producers' prices while the basic USE table is valued in purchasers' prices.

The derivation of regional industry outputs, as control totals in building the MAKE matrices, is carried out using the following equation:

$$\mathbf{X_j^R = GVA_j^R / GVAR_j^R} \tag{21}$$

Where: X_j^R is estimated output of industry j in region R;

GVA_j^R is estimated GVA of industry j based on GRDP Accounts, GSO/PSO;

$GVAR_j^R$ is calculated GVA ratio based on 2000 CE regional data.

The MAKE matrix is then calculated by multiplying output allocation ratios at the 16-sector level (as derived from the IOSE results) by their respective control totals based on ratio of National IO, 2000, X_j^R.

The USE table is a product x industry table that traces the money flow of IO-classified products used by the intermediate and final demand sectors of the regional economy. The USE table is valued in purchasers' prices. It is constructed column-wise by multiplying computed input structures (based on IOSE data) by their respective industry outputs recorded in the MAKE matrix. That is, for each industry column sector j in Region R:

$$\mathbf{X_{ij}^R = IC_{ij}^R \,.\, X_j^R} \tag{22}$$

Where: X_{ij}^R is the estimated value of product *i* consumed by industry *j* in Region R;

IC_{ij}^R is the derived input coefficient (from 2000 IOSE); and

X_j^R is the estimated industry output (from the MAKE matrix).

Similarly, for each final demand column sector k (except export sector) in Region R:

$$\mathbf{X_{ik}^R = YC_{ik}^R \,.\, YT_k^R} \tag{23}$$

Where: X_{ik}^R is estimated value of product *i* consumed by final demand sector *k*;

YC_{ik}^R is final demand coefficient (derived from Household survey conducted by GSO, IOSE data, etc.)

YT_k^R is total of final demand sector k (based from report of PSO).

The (foreign) export vector in Region R is estimated based on export-revenue indicators derived from the 2000 IOSE (for the manufacturing sectors) and national export-output ratios derived from the national IO table for all the other sectors.

The next process is to revalue the USE table from purchasers' to producers' prices to attain uniformity with the producers' price valuation of the MAKE table. This is carried out using regional trade and transport margin ratios derived primarily from the 2000 IOSE.

The final step in the construction of intra-regional tables of the competitive type is to generate a symmetric IO table, which could either be in industry x industry or product x product table format. A symmetric I-O table is one in which there are the same classifications or units used in both rows and columns. A product-by-product table shows which products are used in the production of which other products. Unlike in the product-by-industry USE table, the symmetric table satisfies the Leontief material balance that total output equals the product of I-O coefficients and total output plus the final demand, i.e. X = AX + Y. The symmetric table therefore provides the effective analytical framework for economic modeling.

There are two ways for aggregating IO model with two assumptions. In this case study, the generation of a symmetric product x product table, that is deemed most useful in IO analysis, involved the merging of the industry x product MAKE and the balanced product x industry USE tables using the following equation, in matrix form:

$$\mathbf{A_{pp} = B_{pi}D_{ip}} \tag{24}$$

With: Industry technology assumption and

$$A_{pp} = B_{pi}D^{-1}{}_{ip} \tag{25}$$

With: Commodity technology assumption

Where: A_{pp} = product-by-product matrix of input coefficients;

B_{pi} = product-by-industry matrix of input coefficients; and

D_{ip} = industry-by-product matrix of MAKE coefficients.

The balanced, symmetric, producers' price tables for the 7 regions in 10-sector dimensions, served as the basic tables in deriving the non-competitive type of intra-regional tables (Stage II).

(2)Stage II: Estimation of Inflows and Derivation of Non-Competitive Tables

It should be noted that, in the initial competitive type of IO table constructed in Stage I, exports and imports are lumped as a single residual vector of net exports, i.e. (XP-MP) where XP is exports to include domestic outflows and MP is imports to include domestic inflows. This accounting limitation emerges because of lack of direct data on regional exports and imports including domestic trade flows. While commodity flow statistics are currently available (from the GSO), their usefulness as direct source of information for compiling inter-regional outflows and inflows within the context of IO accounting remains to be desired. The raw data need further scrutiny to meet the rigid IO concept that goods should be shown as flowing directly from producers to consumers. Shipments via middlemen such as wholesalers and retailers are not considered to be originators or receivers. Moreover, such relevant issues as in-transit flows and cross hauling should be taken into account in the careful evaluation of existing commodity flow data within an inter-regional IO framework.

In view of the above data constraint, an indirect estimation technique was therefore applied in compiling the trade tables. Disaggregating the estimated residual vector on net exports (XP-MP) into its components, we have:

$$(XP - MP)_i = (FXP + DXP)_i - (FMP + DMP)_i$$

$$= FXP_i + DXP_i - FMP_i - DMP_i$$

$$DXP_i = (XP\text{-}MP)_i - FXP_i + FMP_i + DMP_i \qquad (26)$$

Where: DXP_i = total domestic export (outflow) of product i;

(XP-MP)i = next exports obtained from intra-regional I/O table;

FXP_i = estimated foreign export of product *i* (from 2000 CE data);

FMP_i = estimated foreign import of product *i*

DMP_i = estimated total domestic import (inflow) of product *i*.

In equation (19), domestic outflows are treated as residuals because it is not presently possible to estimate at this Stage this component, whether directly or indirectly.

Based on equation (19), two types of satellite tables have to be compiled initially, namely:

a) (Foreign) Imports Table (FMP)
b) Domestic Inflow Table (DMP)

Regional (foreign) imports, FMP, were estimated using national import content ratios as proxy indicators on the assumption that regional economies follow the national economy's consumption pattern of imported products, whether for further production or for final consumption. Given the intra-regional IO tables of the competitive type, the import content of product *i* consumed by intermediate sector *j* in region S is estimated, in matrix equation, as:

$$\mathbf{M_{ij}^S = MC_{ij}^N * X_{ij}^S} \qquad (i = j = 1,2,\ldots 16) \qquad (27)$$

Where: M_{ij}^S = matrix of estimated intermediate imported inputs in Region S;
MC_{ij}^N = matrix of national intermediate import coefficients derived from the 2000 national IO table; and
X_{ij}^S = matrix of intermediate input transactions in Region S.

Similarly, the import content of product *i* consumed by final domestic demand sector k (excluding export) in region S is calculated, in matrix equation, as:

$$\mathbf{M_{ik}^S = MC_{ik}^N * Y_{ik}^S} \qquad (28)$$

Where: M_{ik}^S = matrix of estimated final demand imports in region S;
MC_{ik}^N = matrix of national final demand import coefficients; and
Y_{ik}^S = matrix of final demand transactions (excluding exports) in Region S

Similarly, domestic inflows or the region's consumption of goods produced by other regions were estimated using the simple location quotient (SLQ) method. The SLQ approach assumes that the needs of region *r* for output *i* in each industry relative to the needs for output *i* in each of these industries nationally

Are the same as the ratio of the total regional to the total national output. In its equation form, the SLQ is calculated as:

$$l1Q_{ri} / T_r$$

$$SLQ_i = \frac{\qquad}{Q_{ni} / T_n} \quad (29)$$

Where:

Q_{ri} = a measure of the output of industry i in region r;

Q_{ni} = a measure of the output of industry i in the Nation;

T_r = a measure of aggregate economic activity in region r;

T_n = a measure of aggregate economic activity in the Nation.

From equation (30), if SLQ_i is less than unity, the region imports some of product i from elsewhere in the domestic economy. On the other hand, if SLQ_i is greater than 1.0, the region exports some of its industry's output. If SLQ_i is equal to 1.0, the region is viewed as self-sufficient with respect to output i.

In this study, SLQs are applied along the rows of the intra-regional table (net of foreign imports) for sectors with SLQs of less than unity. Sectors with SLQs that are equal or greater than unity are assumed to be self-sufficient and therefore are excluded in the estimation process.

The product of each cell entry multiplied by its corresponding SLQ is the local content with the residual as the domestic inflow requirement that needs to be sourced from other regions. For the intermediate demand quadrant, the domestic inflows are estimated as:

$$DMP_{ij}^R = X_{ij}^R - (SLQ_i^R \,.\, X_{ij}^R) \quad (30)$$

where: DMP_{ij}^R is the domestic inflow of product *i* consumed by industry *j*;

X_{ij}^R is the total value of product *i* consumed by industry *j* (as recorded in the intra-regional symmetric tables)

SLQ_i^R is the regional simple location quotient of product *i*, $(0 \le SLQ_i^R \ge 1)$.

Likewise, for domestic inflows in the final demand sectors,

$$DMP_{ik}^R = Y_{ik}^R - (SLQ_i^R \,.\, Y_{ik}^R) \quad (31)$$

where: DMP_{ik}^R is the domestic inflow of product *i* consumed by final demand sector k,

Y_{ik}^R is the total value of product *i* consumed by final demand sector *k* (as recorded in the intra-regional symmetric tables).

The second term in the right-hand side of both equations accounts for the share of local content or the regionally produced products.

The non-competitive type of intra-regional table is derived by subtracting the resulting satellite tables on imports and domestic inflows from the competitive table as compiled in Stage 1. Thus, in a non-competitive table, inter-sectoral transactions within the region refer only to purely regionally produced products. Product inflows from foreign and other domestic sources are reflected as separate sub-matrices in the table to complete the IO accounts of the non-competitive type.

(3)Stage III: Estimation of Inter-Regional Product Flows

It should be noted that domestic inflow tables generated in Stage II represent the regional economy's requirements for products that need to be sourced from other regions within the domestic national economy. It shows the value of products that comes into the region but it does not show its region of origin. In inter-regional IO models, it is imperative that inter-sectoral transactions between regions in terms of outflows and inflows are compiled to complete the inter-regional IO accounting framework.

The desired number of inter-regional flow tables to be compiled is equal to 2m(m-1) where m is the number of regions. In the 2-region VIRIO I, four (4) inter-regional flow tables were compiled: 2 for intermediate demand and the other 2 for final demand. In this 8-region VIRIO III, a total of 112 sub-matrices of inter-regional flows were estimated, consisting of 56 intermediate and 56 final demand transactions. It can thus be observed that the problem of compiling inter-regional domestic trade flows becomes complicated as the number of regions increases.

As stated earlier, the compilation of product outflows (exports) and inflows (imports) was done employing indirect methods due to data constraints. The first step in estimating product flows between regions is to distribute a region's estimated product outflow to the other 7 recipient regions. The total outflow of product *i* from region R to region S, OF_i^{RS}, is estimated as region R's total outflow of product *i* (as recorded in the noncompetitive table) multiplied by the share of domestic demand in recipient region S to total domestic demand of product i. In equation form,

$$OF_i^{RS} = DXP_i^R * \frac{DD_i^S}{\sum_{S=1}^{7} DD_i^S} \qquad (32)$$

where: DXP_i^R = total domestic outflow of product *i* in region R;
DD_i^S = total domestic demand of product *i* in region S.

The estimated vectors of product outflows region R to region S, OF^{RS}, serve as the control totals in the succeeding process of allocation to the different using sectors in recipient regions, S. The allocation process is carried out by applying inter-regional trade coefficients that are calculated as follows:

$$TC_i^{RS} = \frac{OF_i^{RS}}{DD_i^S} \qquad (33)$$

where: TC_i^{RS} = trade coefficient of product *i* between region R and S;
OF_i^{RS} = total outflow of product *i* from region R to region S; and

DD_i^S = total domestic demand of product *i* in region S,

$$= \sum_{S=1}^{7} X_i^S + \sum_{S=1}^{7} Y_i^S - E_i^S$$

where X is intermediate demand, Y is final demand and E is (foreign) export.

It should be noted here that the estimation of TCs between regions was carried out for all products including the services sectors. These TCs were applied along their respective row sectors in each of the 8 intra-regional tables of the non-competitive type.

(4)Stage IV: Integration and Calculation of Coefficient Tables

The final stage is the consolidation of the outputs of Stage II (intra-regional USE tables, noncompetitive) and Stage III (inter-regional domestic flows) following the multi-region inter-regional accounting framework in its disaggregated format as illustrated in Figure 1 and Figure 2.

The empirical study presented as working paper on www.deponcenwp.org

REFFERENCE

[1]Isard, W. and Cumberland, J.H, "Interregional and Regional Input-Output Techniques" in Isard, W. (ed.), "Methods of Regional Analysis: An Introduction to Regional Science" MIT PRESS 8: pp309-371,1960.

[2] F.SECRETARIO, K.KIM "The Metro-Manila Inter-Regional Input-Output Table: Its attempt of compilation based on the Hybrid Approach" Research paper to be presented at the 14th International Conference on Input-Output Techniques, Montreal, Canada, October 2002.

[3]BUI TRINH, K.KIM, F.SECRETARIO, "Economic Environmental Impact Analysis Based on a Bi-region Interregional I-O Model for Vietnam" presented at 15th IO conference of IIOA at Beijing, 2005.

[4] BUI TRINH, Demographic-Economic modeling based on Vietnam SAM, 2000" accepted by program committee for presentation at PAPAIOS conference at Yokohama National University – Japan(Will be presented).

[5]K.KIM, BUI TRINH, S.FRANCISO, HUNG, "Interregional input – output analysis: The case of HoChiMinh City and Rest of Vietnam economies" Vietnam's Socio-Economic Development- A Social Science Review – No.43, Summer 2005.

[6]K.KIM, Comparative Analysis of the Economies of Asian MEGA Cities Based on the Inter-Regional Input-Output Model: Tokyo, Manila, and Ho Chi Minh, Vietnam" presented at 15th IO conference of IIOA at Beijing, 2005.

[7] Benson Sim, Francisco T. Secretario, Eric Suan "Devoloping an interregional input-output table for cross-border economies: An application to Lao people's democratic republic and Thailand" ADB, ERD occasional statistical paper series No.1, 2007

[8] Research and economic analysis division, department of Business, economic development and tourism – State of Hawaii " The Hawaii Inter-county Input-output study: 2002 Benchmark report" March 2007. www.hawaii.gov

ANNEX 1:
IN XLS file

ANNEX 2.

List of province in regional

Red River Delta
Hà Nội
Vĩnh Phúc
Bắc Ninh
Hà Tây
Hải Dương
Hải Phòng
Hưng Yên
Thái Bình
Hà Nam
Nam Định
Ninh Bình
Northern Upland
Hà Giang
Cao Bằng
Bắc Kạn
Tuyên Quang
Lào Cai
Yên Bái
Thái Nguyên
Lạng Sơn
Quảng Ninh
Bắc Giang
Phú Thọ
Điện Biên
Lai Châu
Sơn La
Hòa Bình
North Central Coast
Thanh Hóa
Nghệ An
Hà Tĩnh
Quảng Bình
Quảng Trị
Thừa Thiên - Huế
South Central Coast
Đà Nẵng
Quảng Nam
Quảng Ngãi
Bình Định
Phú Yên
Khánh Hòa
Central Highlands
Kon Tum
Gia Lai
Đắk Lắk
Đắk Nông
Lâm Đồng
South East
Ninh Thuận
Bình Thuận

Bình Phước
Tây Ninh
Bình Dương
Đồng Nai
Bà Rịa - Vũng Tàu
TP. Hồ Chí Minh
Mekong River Delta
Long An
Tiền Giang
Bến Tre
Trà Vinh
Vĩnh Long
Đồng Tháp
An Giang
Kiên Giang
Cần Thơ
Hậu Giang
Sóc Trăng
Bạc Liêu
Cà Mau

ANNEX 3.

SECTOR CLASSIFICATION SCHEME

PRODUCTION SECTORS:		**FINAL DEMAND SECTORS:**	
01		16	HOUSEHOLD CONSUMPTION EXPENDITURES
02		17	GOVERNMENT CONSUMPTION EXPENDITURES
03		18	FIXED CAPITAL FORMATION
04		19	CHANGE IN INVENTORIES
05		20	FOREIGN EXPORTS
06		21	DOMESTIC EXPORTS
07		22	FOREIGN IMPORTS
08		23	DOMESTIC IMPORTS
09			
10		**VALUE ADDED SECTORS:**	
		24	COMPENSATION OF EMPLOYEES
		25	PRODUCTION TAX
		26	DEPRECIATION
		27	OPERATING SURPLUS