Journal of Contemporary Management

Submitted on 05/May/2013

Article ID: 1929-0128-2013-04-11-10

Vietnam Inter-Regional Input-Output Analysis: The Bi-regional and 8-regional Cases of Vietnam

Dr. *Bui Trinh* (Correspondence author)
Vietnam National Accounts Department, General Statistics Office
1 Lieu Gia, Badinh, Hanoi, VIETNAM
Tel: +84-939-198-586 E-mail: buitrinhcan@gmail.com

Duong Manh Hung
Vietnam National Account Department, General Statistics Office
6b Hoangdieu, Badinh, Hanoi, VIETNAM
Tel: +84-904821628 E-mail: dmhung74@yahoo.com

Dr. *Nguyen Van Huan*
Researcher Centre for Sustainable Development Policy Studies,
Vietnam Academy of Social Sciences
1 Lieu Gia, Badinh, Hanoi, VIETNAM
Tel: +84-913-542-528 E-mail: huan.nguyenvan58@gmail.com

Abstract: The Leontief's input-output system was developed to the inter-regional input-output model by Isard in 1951. The idea of the inter-regional input-output model was specified by Richardson and it is considered as an important tool in researching of regional economy. The inter-regional input-output model describes not only the relationship between sectors but also the relationship between regions based on trading flows among regions and the trading flows between regions and foreign countries. This research develops two types of inter-regional input-output tables of Vietnam: the inter-regional input-output table with two regions, and the inter-regional input-output table with eight regions.

JEL Classifications: C13, C32, C51

Keywords: Inter-region, Input-output, Multiplier, Southern key economic region, Vietnam economy

1. Introduction

By a simple calculation, a farmer can know how to use horses or tractors efficiently for the farm work. But he or anyone else in the world cannot calculate the impact of replacing horses by tractors to the market price of these horses or tractors, or how much the agricultural produce increases when the consumer benefits from the reduction of expenses due to the replacement.

In an economy, whatever people do will impact accidentally or intentionally on the interest of other individuals. In 1906, when Pareto wrote the above statement, indeed, there was no

quantitative method that could calculate the reciprocal influence of the changes caused by one or more factors, inside or outside the economy. Until 1936, when the first I-O models invented, researchers could do it. It was thanks to I-O models that people could begin to bind the economic statistics and data with the economic theory. And finally, it analyzes the economy comprehensively as a whole.

The I-O model is the quantitative analysis tool basing on I-O table. I-O table originated from the ideas in the book "Capitalism" by Marx when he found out the direct relationships in technical rules between elements involved in the production. His ideas then have been developed by Wassily Leontief (Nobel prize, 1973), by mathematizing of the relationship between supply and demand in the whole economy. Leontief considered every production technology as a linear relationship between the volume of manufactured products and the input cost of material products and services. This relationship is represented by a system of linear functions in which the coefficients are decided by the technical process. With this idea, the first I-O tables built by Leontief for the U.S were 1919 and 1929 I-O tables in 1936; in 1941, this work was published under the name "The Structure of the U.S Economy". Today, the I-O model is considered as the centrer the system of national accounts of the United Nations (SNA) published in 1968 and 1993.

The I-O system of Leontief was developed to the inter-regional input-output model by Isard (1951), the idea of the inter-regional input-output model was specified by Richardson and it was considered as an important tool in studying of regional economy. The inter-regional input-output model describes not only the relationship between sectors but also the relationship between regions basing on trading flows among regions and the trading flows between regions and foreign countries. The inter-regional model has been then developed by Chenery-Moses (also known as Chenery-Moses model) and Miller-Blair (1985).

The inter-regional input-output model was first built in European countries such as Austria (Fritz and Authors, 2006), Finland (Piispala, 2000), Italy (Penvenuti and Panicia, 2003) and Spain (Verdura, 2000). In Japan, the inter-regional input-output model was strongly applied and developed in analyzing and assessing the economy and the environment, this model was used to analyze the impact of the earthquake in Hanshin (Japan). In recent years, researches that based on the inter-regional I-O model have been increasing in Asian countries such as Japan (Mishikawa and Miyazi, 2004); China (Okamoto, 2005 and Okuda, 2004); The Phillipines (Francisco T. Secretario, 1994 and 2002); Vietnam (Bui Trinh, Francisco T. Secretario, Kwang Moon Kim, 1996; Bui Trinh Francisco T. Secretario, Kwang Moon Kim and Duong Manh Hung, 2000; and Bui Trinh, Duong Manh Hung and Henning, 2005).

In this research, we develop two types of inter-regional input-output tables of Vietnam. The first is inter-regional input-output table of two regions (Southern key economic region and the rest of Vietnam), and the second is inter-regional input-output table of 8 regions.

1.1 An inter-regional I-O model of Vietnam, two regions

This model is based on two regions: the Southern key economic zone, and the rest of Vietnam. Each region is divided into 12 economic sectors (Table 1).

Table 1. List of 12 economic sectors for two-regional I-O model

1	Agriculture, fisheries and forestry	7	Construction
2	Mining	8	Trading
3	Agricultural products processing	9	Transportation and postal

4	Other consumer goods	10	Finance, Real estates
5	Machinery and equipments	11	Government management
6	Electricity and water	12	Personal and public services

1.2 An inter-regional I-O model of Vietnam, eight regions

Different from the two-regional model above, this model is based on eight regions. These eight economic regions are specified as: Red River Delta, Northeast, Northwest, North Central Coast, South Central Coast, Central Highlands, Southern key economic zone, and The rest of the South.

In this model, each region of eight is divided into 27 economic sectors (Table 2).

Table 2. List of 27 economic sectors for eight-regional I-O model

No.	Sector	No.	Sector	No.	Sector
1	Paddy	10	Rice	19	Other industrial processing
2	Other cultivation	11	Other agriculture products processing	20	Construction
3	Livestock	12	Textile and garments	21	Transportation
4	Forestry	13	Paper	22	Post and telecommunications
5	Aquaculture	14	Wood processing	23	Trading
6	Fishing	15	Rubber	24	Financial services
7	Energy	16	Non-metallic Products	25	Government management
8	Other exploitation	17	Means of transportation	26	Hotels and restaurants
9	Fisheries processing	18	Metal Products	27	Other Services

2. Methodology

The model allows us to describe the relationship of inter-regions, inter-sectors. Basic relationship is in the form

$$\boldsymbol{X} = (\boldsymbol{I}-\boldsymbol{B})^{-1}.\boldsymbol{Y}$$

In which: $\boldsymbol{X} = (\boldsymbol{X}_1, \boldsymbol{X}_2,..., \boldsymbol{X}_8)$ and $\boldsymbol{Y} = (\boldsymbol{Y}_1, \boldsymbol{Y}_2,..., \boldsymbol{Y}_8)$, and matrix $\boldsymbol{B}$ consists of sub-matrixes $\boldsymbol{X}_{ij}$; $\boldsymbol{X}_{ij}$ are matrixes of direct cost of region j in using products of region i; when i = j, the matrix is intermediate cost matrix that directly uses internal regional products.

The inter-regional I-O model goes further than basic I-O models; in the basic I-O models, assumption is that only the final demand factors (consumption, investment and export) influence the production. In inter-regional I-O model, the production depends not only on the final demand factors of the region, but also on the final demand factors of other regions. This could be understandable by the economic theory, any changes in the final demand factors of a specific region will lead to the changes of production value of that region. These changes are followed by changes in other regions because the production of one region uses the products of the others as the input costs. These impacts are shown by input-output multipliers. These ideas seem to be like “The Law of Cause and Effect” in the Buddha theory and it is shown as the figure below.

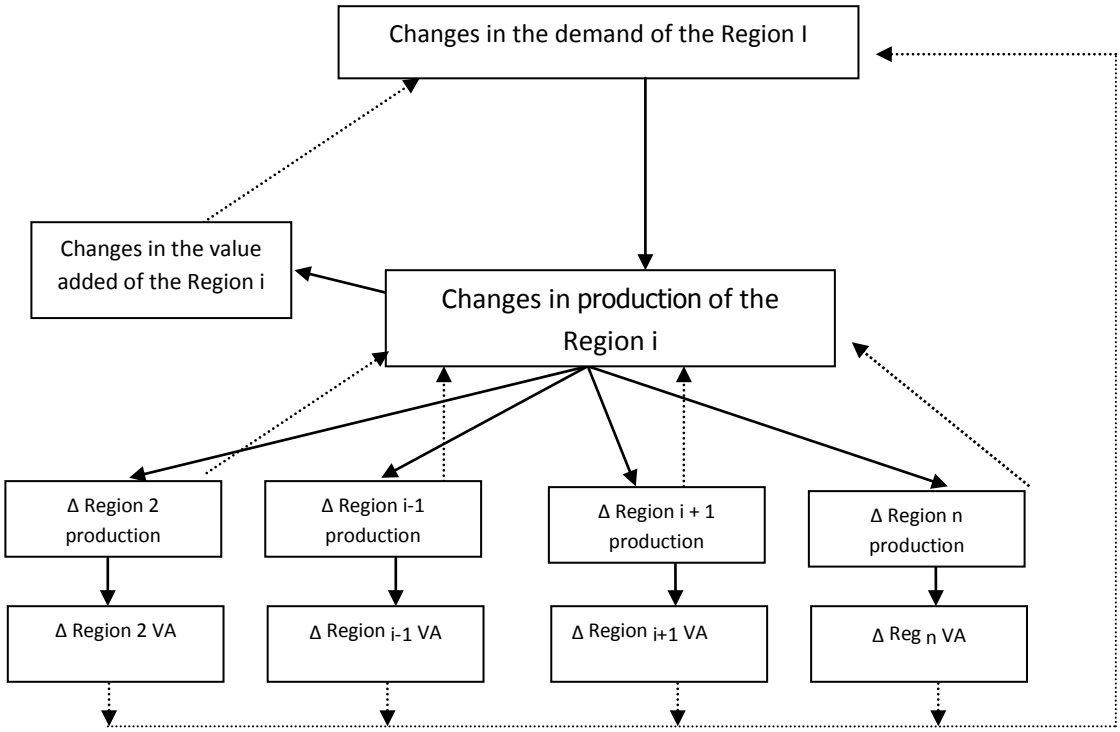


Figure 1. The induced impact and inter-regional feedback effects between 8 regions of Vietnam

2.1 Basic relationships in the inter-regional I-O model

Relationship of a national I-O model or regional I-O model is formed as follows.

$$AX + Y = X \qquad or \qquad (I - A).X = Y \qquad (1)$$

Assuming that there are 2 regions, the coefficient matrix of direct cost is divided into sub-matrixes.

$$A = \begin{pmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{pmatrix}$$

In which: A_{11} and A_{22} are matrixes of internal regional direct cost index.

A_{12} and A_{21} are matrixes of the direct cost index of region 1 to region 2 and vice versa.

Setting X_1 as the vector of production value of region 1 and X_2 as the vector of production value of region 2; Y_1 as the vector of final demand of region 1, Y_2 as the vector of final demand of region 2.

$$X = \begin{pmatrix} X_1 \\ X_2 \end{pmatrix} \quad \text{and} \quad Y = \begin{pmatrix} Y_1 \\ Y_2 \end{pmatrix}$$

From Eq. (1), we get:

$$\begin{pmatrix} I - A_{11} & -A_{12} \\ -A_{21} & I - A_{22} \end{pmatrix} \begin{pmatrix} X_1 \\ X_2 \end{pmatrix} = \begin{pmatrix} Y_1 \\ Y_2 \end{pmatrix} \qquad (2)$$

Relation (2) could be equivalently formed as:

$$(I - A_{11})X_1 - A_{12}X_2 = Y_1 \quad (2a)$$
$$(I - A_{22})X_2 - A_{21}X_1 = Y_2 \quad (2b)$$

The relationship between 2 regions could be shown by:

$$X_2 = (I - A_{22})^{-1}A_{21}X_1 \qquad (3)$$
$$X_1 = (I - A_{11})^{-1}A_{12}X_2 \qquad (4)$$

Basic relations of inter-regions are shown by Miyazawa as follows.

$$(I - A)^{-1} = \begin{pmatrix} \Delta_{11}B_1 & \Delta_{11}P_1B_2 \\ \Delta_{22}P_2B_1 & \Delta_{22}B_2 \end{pmatrix} = \begin{pmatrix} \Delta_{11} & 0 \\ 0 & \Delta_{22} \end{pmatrix} \begin{pmatrix} I & P_1 \\ P_2 & I \end{pmatrix} \begin{pmatrix} B_1 & 0 \\ 0 & B_2 \end{pmatrix} \qquad (5)$$

Equation (5) above represents the Leontief's standard relation which has been disintegrated as follows.

$B_1=(I-A_{11})^{-1}$	Matrix of internal factor of region 1.
$B_2=(I-A_{22})^{-1}$	Matrix of internal factor of region 2.
$P_1 = (I-A_{11})^{-1}.A_{12}$	Matrix of induced impact from region 2 to region 1.
$P_2 = (I-A_{22})^{-1}.A_{21}$	Matrix of induced impact from region 1 to region 2.
$\Delta_{11} = (I - P_1P_2)^{-1}$	External impact of region 1
$\Delta_{22} = (I - P_2P_1)^{-1}$	External impact of region 2

And, $X_1 = B_1.Y_1$
$X_2 = B_2.Y_2$

3. Results of the Research

3.1 Results of the bi-regional model: Southern key economic zone and the rest of Vietnam

Figure 2 and Figure 3 are the results of the calculation of the bi-regional model. Figure 2 presents production's growth of the Southern key economic region of most of the sectors which are stimulated by final demand (includes final consumption, saving and export) of other regions. Thus, the simulation of one region not only affects that region but also promote the production's growth of other regions. However, for the production side, figure 3 shows that the production of the Southern key economic zone has greater impact on other regions than the impact of other regions on the zone. Thus, we can see the cause-effect relationship between economic regions. The demand of the rest of Vietnam stimulates the production of the Southern key economic zone; and production of the Southern key economic zone in turn stimulates the Southern key economic production of the rest of Vietnam.

$$\Delta_{11} = (I - P_1P_2)^{-1} \quad \textit{and} \quad \Delta_{22} = (I - P_2P_1)^{-1}$$

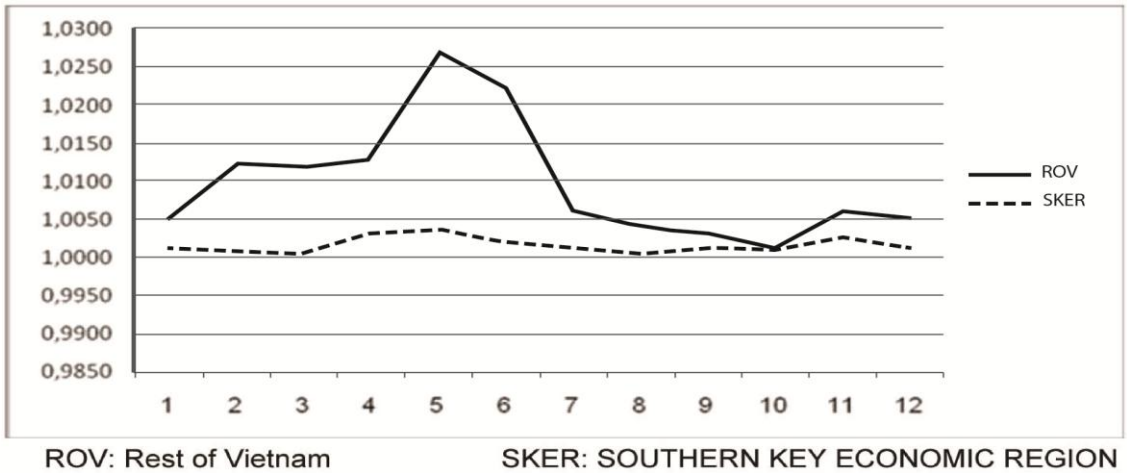


Figure 2. The impact of final demand of one region to the others

$$P_1 = (I - A_{11})^{-1} A_{12} \quad \text{and} \quad P_2 = (I - A_{22})^{-1} A_{21}$$

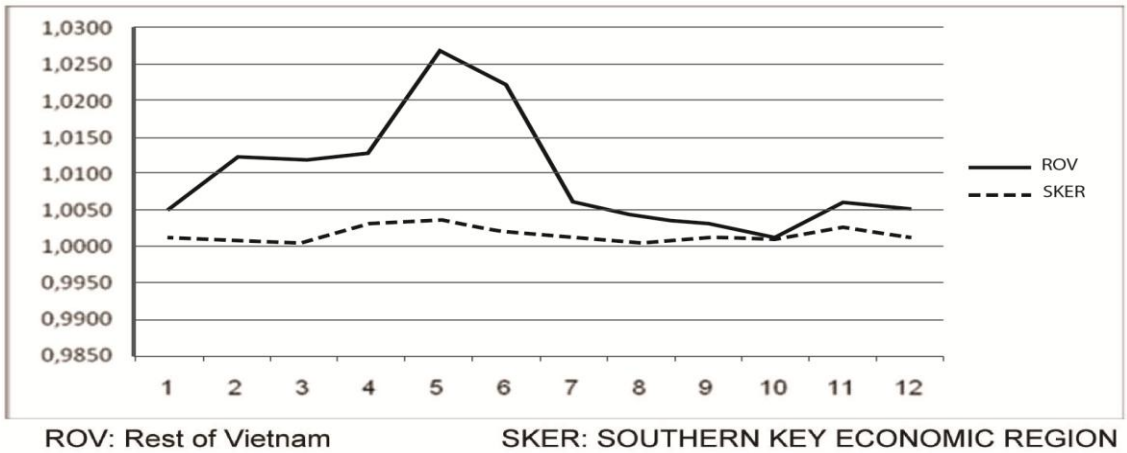
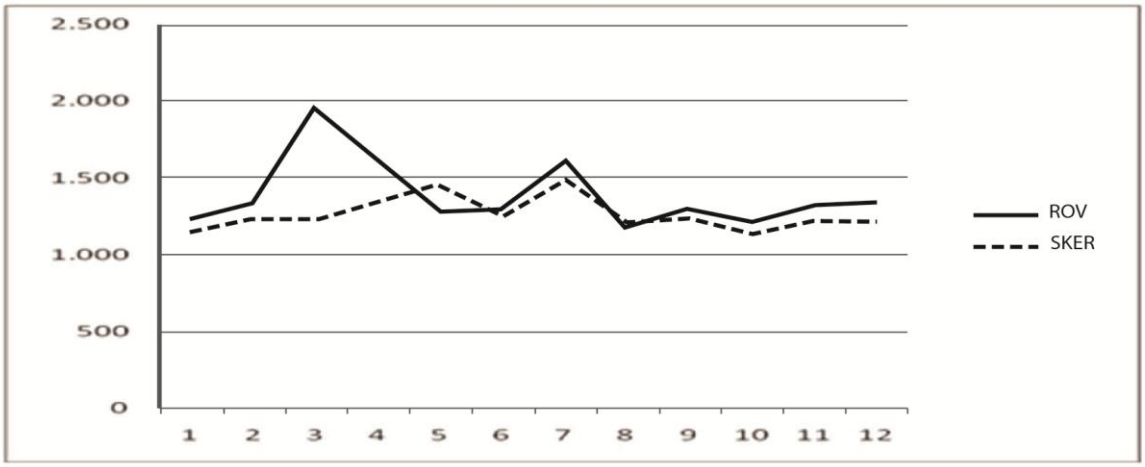


Figure 3. The impact of production of one region to the others

In term of the total impacts, the agriculture, agricultural products processing and consumer goods production sectors of the rest of Vietnam are extremely impressive. Sectors of machinery, equipment and trade in the Southern key economic zone have greater impact than the rest of Vietnam. This result could be used by policy makers in making regional economic structuring policy.



ROV: Rest of Vietnam SKER: SOUTHERN KEY ECONOMIC REGION

Figure 4. Total impact of the Southern key economic zone and the rest of Vietnam

3.2 Results of the multi-regional I-O model (8 regions)

When the final demand factors of each region change, it may lead to the change in the induced impacts including direct impact, indirect impact and the induced impact; the induced impact consists of (1) Changes in the final demand of other regions that lead to changes in production of themselves then have induced impact on the production of this region; (2) The use of products of one region for the final demand by other regions will finally impact the production of that region.

An impressive thing is that in all 8 regions, the Group of agricultural and fisheries processing sectors (including rice processing, fisheries processing and other agriculture processing sectors) has the highest induced impact. Thus, these sectors are key economic sectors of the region as well as the Nation; we can also see that the Southern key economic zone is the region that consists of the greatest induced impact, then the Northeast; there are a few sectors in the Northwest and the North Central with the induced impact greater than 1.

This may lead to some conclusions as follows.

(1) The grow of the Group of agricultural and fisheries processing sectors will lead to economic stimulus in all regions;

(2) In the Southern key economic zone, there are a lot of key sectors that their growing would lead to economic stimulus in the region. Some sectors, such as fisheries processing, rice, other agricultural products processing, paper, wood processing, textile, rubber, transportation, metal products, other processing sectors and construction, all have the induced impact greater than 1;

(3) The induced impact level of the Group of agricultural and fisheries processing sectors of the Southern key economic zone is greater than other regions, such as the fisheries processing sector of the Southern key economic zone is 1.34, equal to that of the Red River Delta, while the index of region 5, the next highest, is only 1.33; The induced impact of the rice processing sector of the Southern key economic zone is similar to that of the Red River Delta (1.395 and 1.397).

Table 3. Total impact of 27 sectors in 8 regions (OM: Output multiplier; BL: Backward linkage)

	1		2		3		4		5		6		7		8	
	OM	BL	OM	BL	OM	BL	OM	BL	OM	BL	OM	BL	OM	BL	OM	BL
1	1.280	0.836	1.272	0.831	1.252	0.818	1.230	0.804	1.198	0.783	1.249	0.816	1.356	0.886	1.202	0.785
2	1.124	0.734	1.121	0.733	1.086	0.710	1.095	0.715	1.100	0.719	1.128	0.737	1.180	0.771	1.077	0.703
3	1.424	0.930	1.379	0.901	1.361	0.889	1.301	0.850	1.303	0.851	1.339	0.875	1.523	0.995	1.326	0.866
4	1.185	0.774	1.152	0.752	1.128	0.737	1.053	0.688	1.186	0.775	1.124	0.735	1.382	0.903	1.111	0.726
5	1.418	0.927	1.382	0.903	1.438	0.940	1.360	0.889	1.368	0.894	1.395	0.911	1.469	0.960	1.395	0.911
6	1.308	0.855	1.335	0.873	1.210	0.791	1.225	0.800	1.240	0.810	1.196	0.782	1.490	0.973	1.111	0.726
7	1.271	0.830	1.275	0.833	1.171	0.765	1.108	0.724	1.044	0.682	1.062	0.694	1.282	0.837	1.166	0.762
8	1.259	0.822	1.515	0.990	1.287	0.841	1.293	0.845	1.207	0.789	1.228	0.802	1.394	0.911	1.158	0.756
9	1.801	1.177	2.051	1.340	1.963	1.282	1.940	1.268	2.035	1.330	1.791	1.170	2.051	1.340	1.971	1.288
10	2.138	1.397	2.115	1.382	2.090	1.366	2.060	1.346	2.016	1.317	2.048	1.338	2.135	1.395	2.062	1.347
11	1.725	1.127	1.615	1.055	1.504	0.983	1.505	0.983	1.562	1.021	1.474	0.963	1.814	1.185	1.573	1.028
12	1.277	0.834	1.275	0.833	1.867	.....	1.355	0.886	1.247	0.814	1.453	0.949	1.812	1.184	1.144	0.747
13	1.686	1.101	1.556	1.016	1.471	0.961	1.424	0.931	1.669	1.090	1.318	0.861	1.831	1.196	1.441	0.942
14	1.669	1.090	1.717	1.122	1.495	0.976	1.526	0.997	1.499	0.979	1.567	1.024	1.756	1.147	1.440	0.941
15	1.518	0.992	1.408	0.920	1.615	.....	1.209	0.790	1.391	0.909	1.356	0.886	1.713	1.119	1.208	0.789
16	1.308	0.855	1.268	0.829	1.206	0.788	1.231	0.804	1.244	0.813	1.159	0.757	1.417	0.926	1.150	0.752
17	1.487	0.972	1.560	1.019	1.305	0.853	1.294	0.845	1.512	0.988	1.416	0.925	1.952	1.275	1.127	0.736
18	1.464	0.956	1.474	0.963	1.264	0.826	1.236	0.808	1.294	0.845	1.271	0.830	1.751	1.144	1.157	0.756
19	1.509	0.986	1.466	0.958	1.236	0.808	1.205	0.788	1.248	0.815	1.243	0.812	1.782	1.164	1.125	0.735
20	1.433	0.936	1.371	0.895	1.241	0.811	1.202	0.785	1.196	0.781	1.185	0.774	1.599	1.045	1.131	0.739
21	1.439	0.940	1.386	0.906	1.269	0.829	1.247	0.815	1.261	0.824	1.268	0.829	1.514	0.989	1.198	0.783
22	1.213	0.792	1.189	0.777	1.160	0.758	1.132	0.740	1.129	0.738	1.124	0.735	1.262	0.825	1.124	0.735
23	1.290	0.843	1.354	0.885	1.268	0.828	1.265	0.826	1.297	0.847	1.324	0.865	1.506	0.984	1.191	0.778
24	1.358	0.887	1.345	0.879	1.301	0.850	1.212	0.792	1.187	0.775	1.199	0.783	1.306	0.854	1.210	0.791
25	1.358	0.887	1.401	0.916	1.363	0.890	1.332	0.870	1.362	0.890	1.327	0.867	1.512	0.988	1.317	0.860
26	1.500	0.980	1.552	1.014	1.472	0.962	1.369	0.894	1.396	0.912	1.328	0.868	1.504	0.983	1.408	0.920
27	1.289	0.842	1.271	0.830	1.221	0.798	1.205	0.787	1.217	0.795	1.170	0.764	1.38	0.9	1.166	0.762

Table 4 shows the changes in the induced impact of the production value of 27 sectors by region when there is a change in final demand. Recently, scientists and policy makers often mention an idea of "demand stimulus". Total demand includes three main factors, i.e. final consumption, investment, and export; Detailed factors are the final household consumption, the government's consumption, investment by types (such as investment by other economic members, investment of the government) and export. Hence, when talking about "stimulus", we need to specify where to stimulate among total demand's factors. This is often quantified in factors of total demand such as consumption's factors, investment's factors, export's factors. These factors present how much the production grows when we increase one unit of a factor of demand. Usually, when a factor of total demand increases by one unit, it will stimulate the production by more than one unit. Table 4 shows the factors of total demand of 8 regions.

Calculations in table 4 show that the investment in almost every region is not effective. The government's investments in 7 regions are not effective, except for the Southern key economic zone; The investment of private sectors is not effective in 6 regions, but the Southern key economic zone and the Red River Delta; Notably, the investment in three regions (Northwest, Highlands and the South Central) has very low efficiency. In the Southern key economic zone, all factors of the total demand bring along a very impressive element, especially in export and the government's investment. In every region, export is a factor of production's stimulus, especially in the Southern key economic zone, the rest of the South, the Red River Delta and the Northeast.

Another notable point is that the level of induced impact of fixed assets investment from the Government's capital is higher than that from private sector in all 8 regions (this is really different from the results of simple ICOR researches recently); especially this index in the Southern key economic zone is very impressive and remarkably higher than that of other regions, 1.51 as compared to 1.30 of the second highest (region 1). The induced impact of the private sector on fixed assets investment of the Southern key economic zone is also the highest among 8 regions (1.25), though it is lower than that from the Government's capital (1.25 as compared with 1.51). Another interesting thing is that the induced impact of the investment on current assets in all 7 regions spread is lower than 1, while that of the Southern key economic zone is still much greater than 1, even higher other factors of the total demand such as final consumption. However, the induced impact of export to production of the Southern key economic region is the highest (1.566).

Table 4. Output requirement induced by factors of final demand

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
PCE	1.184	1.180	1.209	1.085	1.065	1.061	1.260	1.007
GCE	1.344	1.389	1.350	1.317	1.282	1.282	1.365	1.230
Gov. GFCF	1.304	1.250	1.145	1.163	1.155	1.121	1.506	1.056
Pr.GFCF	1.120	1.223	1.063	1.048	1.037	0.943	1.248	0.791
Gov. CI	0.928	0.909	0.398	0.654	0.533	0.529	1.405	0.659
Pr.CI	1.017	0.969	0.595	0.997	0.469	0.735	1.383	0.814
FXP	1.434	1.413	1.301	1.314	1.366	1.201	1.566	1.430

Notes: PCE= Private Consumption Expenses; GCE= The Government's Consumption Expenses; Gov. GFCF= The Government's investment on fixed assets; Pr. GFCF= Non-government sectors' Investment on fixed assets; Bov. CI= The Government's investment on current assets; Pr. CI= Non-government sectors' Investment on current assets; FXP= Export.

4. Conclusions

This study is an attempt to obviously reveal through the linkages and multipliers analysis of inter-regional input – output system. It focuses on impacts of southern key economic region to other regions, and inter-regional feedback effects of other regions to southern key economic region as "The Law of Cause and Effect" of the economy. From the research we can see that

(1) The growth of the Group of agricultural and fisheries processing sectors will lead to economic stimulus in all other regions;

(2) In the Southern key economic zone, there are a lot of key sectors that their growth would lead to economic stimulus in the region. Some sectors, such as fisheries processing, rice, other agricultural products processing, paper, wood processing, textile, rubber, transportation, metal products, other processing sectors and construction, all have the induced impact greater than 1;

(3) The research shows that each region has a unique economic structure, so each region need a unique policy, this point is important for sustainable development not only for the region but also for the country, this recommendation seems to be different from the policies of Vietnam now a day (general policy apply for all over the country).

Acknowledgments: We would like to thank Mr. Bui Can, Mr. Binh Phan and Nguyen Thao for their supports on this research.

References

[1] Batey P. W. J., & Madden M. (1983), "The Modeling of Demographic-economic Change Within the Context of Regional Decline: Analytical Procedures and Empirical Results", *Socio-Economic Plan*, 17(5): 315-328. http://dx.doi.org/10.1016/0038-0121(83)90038-1

[2] Bui Trinh, Francisco T. Secretario, et al.(2005), "Economic-Environmental impact analysis based on a Bi-region inter-regional I-O model for Vietnam", Working paper presented at 15th IIOA conference, 2005. website: www.iioa.org

[3] Francisco T. Secretario, et al.(2007) "Developing an interregional input-output table for cross border economies: An application to Laos people's democratic republic and Thailand", ADB statistics paper No. 1, 2007

[4] Geoffrey J.D., Hewings, Michael Sonis, Moss Madden and Yoshio Kimura (1999), *Introduction - Understanding and Interpreting Economic Structure*, Heidelberg: Springer-Verlag.

[5] Isard Walter (1951), "Interregional and regional input-output analysis: A model of a space-economy", Review of Economics and Statistics, 33(4): 318-328.

[6] Miller, R., & P. Blair. (1985), "Input-Output Analysis: Foundations and Extensions", Chapter 7 (pp. 236-260*), Environmental Input-Output Analysis*, Prentice-Hall.

[6] Miyazawa, K. (1976), "Input-Output Analysis and the Structure of Income Distribution", *Lecture Notes in Economics and Mathematical Systems*, Berlin: Springer-Verlag. [On-line] http://dx.doi.org/10.1007/978-3-642-48146-8

[7] Pyatt, G., & Roe, A.N. (1977), *Social Accounting for Development Planning with Special Reference to Sri-Lanka*, Cambridge: Cambridge University Press.

[8] Pyatt, G., & J.I. Round (eds) (1985), *SAMs: A Basis for Planning*. Washington, D.C.: World Bank.

[9] Sonis M., & Hewings, G. J. D. (1999), "Miyazawa's contributions to understanding economic structure: interpretation, evaluation and extensions", *Understanding and Interpreting Economic Structure*, Springer, ISBN 3540660453. Pp13-51.

[10] Vietnam GSO (2005), Statistical Year Book, 2005. Vietnam Statistics Publishing House.

[11] Vietnam GSO(2000), Vietnam Input-output Table, 2000. Vietnam Statistics Publishing House.