Regional Input-Output Table: The Case of North Corridor Economic Region (NCER) in Malaysia

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Abstract

Limited studies on the regional input-output model economic performance have been carried out in Malaysia even though the use of input-output model has become important as a planning tool for future economic development. This study attempts to fill the gap by constructing the regional input-output model for NCER. The table will cover nine sectors, which are the main sectors that contributed to the region's GDP. In the case of NCER, it was carried out through applying the non-survey based method, namely RAS technique. Through the backward and forward linkages and multipliers analysis, this study found that manufacturing, other services and finance sectors were the key sectors in NCER that can give a big impact on the economy of this region particularly in accelerating the future economic growth.

Keywords: Regional Input-Output; NCER; Malaysia

1. Introduction

The development of the Northern Corridor Economic Region (NCER) under the Ninth Malaysia Plan has focused on accelerating economic growth and elevating income levels, particularly in the north of Peninsular Malaysia involving the states of Perlis, Kedah, Pulau Pinang, and Northern Perak (districts of Hulu Perak, Kerian, Kuala Kangsar, and Larut Matang-Selama). In this regard, The Northern Corridor Implementation Authority (NCIA) has identified the key economic sectors with a very big investment potential such as agriculture, manufacturing, tourism, and logistics. For example, during the period from 2007 to 2012, the total investment in this region recorded RM29.70 billion, which is about 17 per cent from the total Master Plan target (RM177 billion) and major investments came from the manufacturing and tourism sectors (Economic Planning Unit, 2014). The expansion of investments in NCER also reflected the entire number of employment in this area. In the same period of time, this region recorded 0.42 million jobs or 27 per cent of the total Master Plan target (1.57 million jobs). For the GDP growth, this region recorded 5.9 per cent on average for the period from 2007 to 2012 and Pulau Pinang with the highest GDP growth at 6.1 per cent particularly contributed by the electronics and electrical sector. It is followed by Kedah (5.9 per cent), Perak (5.7 per cent), and Perlis (5.3 per cent) (Economic Planning Unit, 2014). With the current situation, the investment and economic growth in this area are anticipated to expand in achieving the vision to become a world-class economic region by the year 2025. Due to that, the development and improvement in the key economic sectors for this region need to be strengthened in order to give a conducive investment environment to the investors. NCIA as a policymaker at the regional level need to know the potential of each main sector that need to be given more priority. It is because each sector in economy interacting to each other and the information on the interdependency between the sectors in the economy is very useful in the planning process. Thus, because the importance of information on the sectoral level for the economic growth of this area, the policymakers need to have an input-output table, which is explained the flows of the demand and supply for each sector in the economic system. Therefore, the purpose of this paper is to construct the regional input-output table for NCER in Malaysia and its application to the planning process.

By using the non-survey based method RAS technique, the regional input-output table for NCER will develop and provide the calculation on linkages and multipliers analysis. The results obtained give some policy relevance to the development of the region. This paper is outlined as follows. The following two sections present literature review, followed by the basic structure input-output table NCER. The fourth section describes the methodology and data, while the fifth section explains empirical results and discussions. The last part includes conclusions and implications.

2. Literature Review

Various surveys have been done in constructing the regional input-output table with various modifications of the basic procedures as well as their use of data in different type of economies such as Sawyer and Miller (1983), Steven et al. (1983), Pigozzi and Hinojosa (1985), Ralston et al. (1986), Flegg et al. (1995), Flegg and Webber (1997), Junius and Oosterhaven (2003), and Tohmo (2004). In a different non-survey method analysis, Sila and Juvancic (2005) used the modified Generation of Regional Input-Output Table (GRIT) methodology to estimate the regional input-output table and then provided the economic performance of the Eastern Slovenia region by examining relationships between the sectors in the regional economy. This study also examined input and output multipliers derived from the model to identify the key economic sectors in the region. By contrast, Riddington et al. (2006) found unclear significance between the regional input-output tables produced by the survey-based method, utilizing the national data and location quotient tables. The result also raised the observation that utilizing the national data and location quotients produced misleading results. But the gravity model-based approach was found to produce similar result to the survey-based approach. So none of LQ methods seemed to be clearly better than the others.

Yu, et al. (2007) generated two regional input-output (IO) tables by using location quotient technique and cross industry location quotient, and then develops an extended IO model of water consumption for South East of England and North East of England. Another approach based on mixed survey and non-survey based method have become popular instead of using survey-based method in particular. Applying the recent method of constructing the regional input-output table, Flegg and Tohmo (2010) have conducted the study in regional input-output tables and the FLQ formula: a case study of Finland. They are using data for 20 Finnish regions, ranging in size from very small to very large for 1995, which identify 37 separate sectors. In addition, this study is focused on the LQ-based method (including FLQ, SLQ, CILQ and AFLQ). The finding states that the differences between regional and national ratios of intermediate to primary inputs being of much fewer concerns. Moreover, the AFLQ was found to be very similar indeed to those for the FLQ, in terms of both accuracy and the pattern of errors. The finding very helpful to any regional analyst who is contemplating making use of the FLQ formula to generate initial sets regional input-output coefficients. Future more, these coefficients could be used either as part of the RAS procedure or as the non-survey foundations of a hybrid model.

3. Basic Structure Input-Output Table NCER

The 120 intermediate demand sectors of the Malaysian input-output table (2005) were first aggregated into 9 sectors with the available data and with the hope this aggregation would reflect the economy of the NCER region for that particular year. This aggregation was also on the importance of the sectors to the NCER economy as well as based on the contribution to the gross domestic product. Basically, the structures of the regional input-output tables for NCER is similar to that of the national table. The first quadrant or intermediate demand quadrant is represented by the matrix of 9 industry rows and columns. The second quadrant (final demand) is represented by 9 industry rows and five columns of final demand sector (private consumption, government consumption, change in inventory, gross fixed capital formation and exports). Quadrant three is the primary quadrant which includes taxes, import and value added. The fourth quadrant comprises six rows of primary input sector and five columns of final demand sector.

Table 1: Structure of Single-Region Input-Output Table for NCER

			Intermediate demand								Final demand							
															Export			
			1	.	.	*j*	.	.	*9*	Total intermediate demand	Private consumption	Government consumption	Change in inventory	Gross fixed capital formation	Foreign	Inter-regional	Total final demand	Total output
Intermediate demand		*1*	Quadrant 1 Intermediate demand								Quadrant 2 Final demand							
		.																
		.																
		i																
		.																
		.																
		9																
		Total intermediate demand																
Primary inputs		Purchases from abroad	Quadrant 3 Primary inputs								Quadrant 4 Primary inputs to final demand							
		Domestic Services																
		Taxes of commodity (import)																
		Taxes of commodity (domestic)																
	Import	Foreign																
		Inter-regional																
		Value added																
		Total primary inputs																
		Total inputs																

Notes: 1=Agriculture, 2=Mining and quarrying, 3=Manufacturing, 4=Construction, 5=Utilities, 6=Wholesale and retail trade, 7=Finance, 8=Other services, 9=Government services
Source: Miller and Blair (2009)

4. Methodology and Data

In this study, the construction of regional input-output table for NCER used the non-survey method. The main sources of data were taken from the Departments of Statistics, Malaysia, for the development of the regional input-output tables with the national input-output table used as a reference. Actually, none of the non-survey based methods such as RPC, GRIT, SLQ, CILQ, and FLQ produces results similar to a survey-based method. So, in constructing the regional input-output models with the most accurate figures, some sectors needed the full range of superior data, especially for the key sectors (Lahr, 1993).

4.1 RAS Technique

RAS technique is the best adjustment to the basic matrix to stabilize and improve over the rows and columns. In the context of input-output matrix is frequently the basis of direct and residual coefficient matrix is a vector of demand and intermediate inputs. In this study, we applied the model used by Saari and Rashid (2009). This method can be explained using the following equation:

$$RAS = C^* \quad (1)$$

where R and S is a diagonal matrix, and A and C^* are respectively direct coefficient matrix of national and state levels.

The matrix C^* of state direct coefficient matrix in equation (l) is formed as a result of pre-and post-multiplication of a matrix by a diagonal matrix. This implies that each element a^*_{ij} matrix C^* obtained from any element a_{ij} matrix A as the following equation:

$$a^*_{ij} = r_i \; a_{ij} s_j \quad (2)$$

Since equation (2) shows all the elements of the matrix A and C^* are the same, then the dimensions of the two matrices are also similar. Each element of R must be equal to the number of lines A and C^*, while the number of column A and C^* determining the number of elements of S.

In each row of the RAS technique elements R and a^*_{ij} are formed by multiplying each element of the row, I matrix A with the same R factor. When all operating lines for matrix A is finished, it will create a matrix D:

$$D = R\,A \tag{3}$$

or equivalent:

$$d_{ij} = r_i\, a_{ij} \tag{4}$$

The final process to form the matrix C* is multiplying every element j column of the matrix D with each element of column j factor S. This will create a matrix DS

$$DS = R\ \ A\ S\ =\ C^* \tag{5}$$

Where,

$$a^*_{ij}\ = c_{ij}s_j = \ r_i\ a_{ij}\ s_j \tag{6}$$

4.2 Linkages Analysis

In the input-output analysis, the linkages analysis is used to measure the interaction or relationship between one sector and other sectors in an economy. Basically, there are two commonly utilized forms of linkages, which is the forward and backward linkage. The forward linkage is to explain the relationship between the industry column and to inform which column industries row industry i sells its output and the value of each sale, whereas the backward linkage industries is used to explain the relationship between row and to tell us from which row industries column industry j purchases inputs and the value of each purchase. The effect of linkage analysis is that it utilizes the inverse Leontief matrix technology that reveals the structure of interdependence between sectors of economic production. Index of backward linkage and forward linkage effects, can be achieved by the following equation.

4.3 Backward Linkages

Backward linkage effects are related to derived demand, which is the provision of input for a given activity. The effects on supporting sectors reflect the backward linkages in the economy as firms will be buying from and selling to one another.

$$\sum_i U_{ij} = \frac{\frac{1}{n}\sum_{i=1}^{n} b_{ij}}{\frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}} \tag{7}$$

Where:

n: the number of industry

$\sum b_{ij}$: the column sum of the Leontief inverse matrix for the particular sector

$\sum_i \sum_j b_{ij:}$ denoting the sum of the Leontief inverse matrix for the total industry.

4.4 Forward Linkages

Forward linkage effects are related to output utilization, the outputs from a given activity will induce attempts to use this output as inputs in some new activities.

$$\sum_i U_{\ ij} = \frac{\frac{1}{n}\sum_{j=1}^{n} b_{ij}}{\frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}} \tag{8}$$

Where, $\sum b_{ij}$: the row sum of the Leontief inverse matrix for the particular sector.

4.5 Output Multiplier

The simple output or type I multiplier for a particular sector is defined as the total amount of production in all sectors of the whole economy that is necessary in order to satisfy a dollar's worth of final demand for sector j's output. The measurement of value for simple output multiplier of a sector is given by the formula;

$$OM_j = \sum_{i=1}^{n} b_{ij} \quad (9)$$

where OM_j is a simple output multiplier for sector i and b_{ij} is an element in the Leontief inverse matrix (regional).

4.6 Employment Multiplier

The simple employment multiplier explains the amount of employment generated in the region for each additional ringgit of final demand for the sector's output. This is useful for policymakers or economists to see the employment impacts of a particular sector expansion in their region. The measurement for the employment multiplier is shown as follows:

$$EM_j = \sum_{i=1}^{n} E_{n+1,i} b_{ij} \quad (10)$$

where EM_j is a simple employment multiplier sector j, E_{n+1}, i is a employment coefficient sector i and b_{ij} is an element in the Leontief inverse matrix (regional).

4.7 Income Multiplier

This is expressed as the ratio of the direct plus indirect income change to the direct income change resulting from a unit increase in final demand for any given industry. So, the measurement for the income multiplier is shown as follows:

$$IM_j = \sum_{i=1}^{n} E_{n+1,i} b_{ij} \quad (11)$$

where IM_j is a simple income multiplier sector j, E_{n+1}, i is a income coefficient sector i and b_{ij} is an element in the Leontief inverse matrix (regional).

4.8 Data

In this study, two sets of data were employed. Firstly, Malaysia's input-output table for 2005 published by the Department of Statistics, Malaysia and perhaps gives the most accurate information about the interindustry relations and structure of the economy with a 120 x 120 sectors. The sector was aggregated into 9 x 9 sectors by emphasizing on the main sectors in NCER. This table was compiled by using the new industrial classification of the Malaysian Standard Industrial Classification (MSIC) on the basis of the 1993 System of National Accounts (SNA). This is the latest international standard for compiling I-O as proposed by the United Nation. Secondly, the final demand and primary inputs components. Basically, the final demand component includes private consumption (household expenditure), government consumption, gross fixed capital formation, changes in inventory and export (foreign and inter-regional). For the construction of the final demand quadrant, the Departments of Statistics, Malaysia (DOSM) provided complete data for the national account, external trade statistics and yearbook for each region. The components for primary input included commodity taxes (domestic), commodity taxes (import), imports (foreign and inter-regional) and value added. On the construction of primary input for commodity taxes (domestic), the Departments of Statistics, Malaysia (DOSM) provided figures at the aggregate level as control values.

5. Empirical Results

The total contribution of the main sectors in the generation of output is analyzed based on the 2005 regional input-output table for NCER that have been developed for the purposes of this study (Table 2). NCER recorded a total output of RM208,508 million in year 2005 and manufacturing appeared to be the most important activity in terms of output generation with value of RM101,351 million (48.61 per cent). Wholesale and retail trade; and finance were ranked the second and third most important sectors in NCER with values of RM28,110 million (13.48 per cent) and RM26,015 million (12.48 per cent) respectively. Government services, construction, agriculture and utilities and merged as the least important output generating sectors.

Table 2: Contribution of Each Sector to the Gross Outputs in NCER, 2005

Sector	RM million	Percentage (%)
Agriculture	7,159	3.43
Mining and quarrying	11,297	5.42
Manufacturing	101,351	48.61
Construction	7,977	3.83
Utilities	3,951	1.90
Wholesale and retail trade	28,110	13.48
Finance	26,015	12.48
Other services	13,320	6.39
Government services	9,329	4.47
Total	208,508	100.00

Source: Authors' calculations

Table 3 shows the values of backward and forward linkages for the nine major sectors in NCER for year 2005. The linkages analysis will describe which sectors have greater impact on the development in NCER. Manufacturing (1.2268), other services (1.1589), utilities (1.1510), and construction (1.0154) sectors have greater backward linkages which are more than 1 compared to the other sectors. This is shows, these sectors have a strong interdependence between the sectors in NCER economy particularly in purchasing input from other sectors. The expansion in final demand in these sectors will result the additional output in its own sectors and other sectors in economy as well. With respect to forward linkages, wholesale and retail trade (1.8193), manufacturing (1.7033), finance (1.3346), and other services (1.0685) sectors showed strong values of forward linkages (more than 1). The higher values of forward linkages explain that output of these sectors will be used as an input in the others sectors in economy.

Table 3: Backward and Forward Linkages in NCER, 2005

Sector	Backward Linkages	Rank	Forward Linkages	Rank
Agriculture	0.8353	8	0.7612	7
Mining and quarrying	0.7204	9	0.7112	8
Manufacturing	1.2268	1	1.7033	2
Construction	1.0154	4	0.7707	6
Utilities	1.1510	3	0.8193	5
Wholesale and retail trade	0.9373	7	1.8193	1
Finance	0.9902	5	1.3346	3
Other services	1.1589	2	1.0685	4
Government services	0.9647	6	0.6879	9

Source: Authors' calculations

On the other hand, manufacturing and other services sectors were the strategic sectors in accelerating economic development in NCER. This is because these sectors have a strong backward and forward linkages which are more than 1 (backward and forward linkages) and contributing more in purchasing and supplying the output in the economy. A unit change in their final demand will cause the expansion in output for overall sectors in economy.

Table 4: Output Multiplier, Employment Multiplier and Income Multiplier in NCER, 2005

Sector	Output	Employment	Income
Agriculture	1.3721	0.0229	0.7515
Mining and quarrying	1.1834	0.0018	0.8778
Manufacturing	2.0151	0.0230	0.8285
Construction	1.6680	0.0145	0.3921
Utilities	1.8907	0.0221	0.5437
Wholesale and retail trade	1.5396	0.0195	0.7655
Finance	1.6265	0.0136	1.0344
Other services	1.9035	0.0212	0.6774
Government services	1.5846	0.0107	0.5433

Source: Authors' calculations

Table 4 shows the values of sectoral output, employment and income multipliers based on the NCER input-output table. By using the single-region input-output model, NCER recorded the manufacturing sector as having the highest output multiplier. This means that increasing a unit of the final demand would increase the output multipliers of the manufacturing sector by 2.0151. This value of output generated in the NCER economy included direct effects and indirect effects. The other services; and utilities; sectors were the second and third sectors in NCER with the highest output multipliers of 1.9035 and 1.8907 respectively. The manufacturing; other services; and utilities; sectors recorded the highest output multiplier values in the NCER region because these sectors had strong input relations with the other sectors in the economy as shown by values of their backward linkages. So, these sectors should be given more priority by policymakers for future growth and development in this region. Employment multiplier is another important measurement in addition to output and primary multipliers. An employment multiplier shows the amount of employment generated in the region for each additional ringgit of final demand for the sector's output. The manufacturing sector had the highest employment multiplier with value of 0.0230 in NCER. So, increasing a unit of final demand in this sector would increase 0.0230 unit of employment in this region. In NCER, several important sectors contributed to the employment. The agriculture sector was ranked second with value of 0.0229, followed by the utilities (0.0221), other services (0.0212), wholesale and retail trade (0.0195), construction (0.0145) and finance (0.0136) sectors. The government services, and mining and quarrying sectors emerged as the smallest contributors to the employment multipliers with values of 0.0107 and 0.0018 respectively. For the income multiplier, the finance sector recorded the highest income multiplier in NCER with value of 1.0344. This shows that any increase in the final demand of this sector would lead to a big generation of income in the NCER region. The mining and quarrying sector ranked second with value of 0.8778, followed by the manufacturing sector in the third rank with value of 0.8285. These three sectors had the highest values of multipliers (income) because of their capability in generating high values for income.

6. Conclusion

In this paper, regional input-output model was applied to construct the regional input-output table for North Corridor Economics Region (NCER) in Malaysia. Hence, one of the most important contributions of this study is the creation of regional input-output for NCER which provides policymakers a good tool in examining the relationships between economic sectors particularly in linkages and multiplier analysis. In 2005, the manufacturing sector emerged as the main contributor to NCER's output, generating an output amounting to RM101,351 million. The next largest sector was wholesale and retail trade sector with output of RM28,110 million, followed by the finance sector with output of RM26,015 million. Through the linkages and multipliers analysis, the results demonstrate that manufacturing, other services and finance sectors were the main or key sectors that play an important role in the development strategy of NCER economy. Therefore, policymakers will be able to design a better regional planning in future by using the most potential sectors in the region to accelerate the economic growth by stimulating the investment flows.

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References

Economic Planning Unit. (2014). Regional Corridor Development in Malaysia. Retrieved July 15, 2014, from http://www.carecprogram.org/uploads/events/2014/CAREC-IMT-Workshop-KL/Presentation-Materials%20/009_134_209_Regional-Corridor-Development-in-Malaysia.pdf

Flegg, A. T., Webber, C. D., and Elliott, M. V. (1995). On the Appropriate Use of Location Quotients in Generating Regional Input-Output Tables, *Regional Studies*, Vol. 29 (6), pp. 547-561.

Flegg, A. T., and Webber, C. D. (1997). On the Appropriate Use of Location Quotients in Generating Regional Input-Output Tables: Reply, *Regional Studies*, Vol.31 (8), pp. 795-805.

Flegg, A. T., and Tohmo, T. (2010). Regional Input-Output Tables and the FLQ Formula: A Case Study of Finland. *Bristol* , pp. 1-49.

Junius, T., and Oosterhaven, J. (2003), The Solution of Updating or Regionalizing a Matrix with both Positive and Negative Entries, *Economic Systems Research*, Vol. 15 (1), pp. 87-96.

Lahr, M. L. (1993). A Review of the Literature Supporting the Hybrid Approach to Constructing Regional Input-Output Models. *Economic Systems Research*, 5(3): 277-293.

Malaysia, Department of Statistics (2005*). Input-Output Tables*. Percetakan Nasional Malaysia Berhad: Kuala Lumpur.

Miller, R. E. (1983). Experiments in Regionalization of National Input-Output Tables, *Environment and Planning A*, 15, pp. 1501-1520.

Miller, R.E., and Blair, P. D. (2009). Input-Output Analysis: Foundations and *Extensions*, 2nd Edition, New York: Cambridge University Press.

Pigozzi, B. WM., and Hinojosa, R. C. (1985). Regional Input-Output Inverse Coefficients Adjusted from National Tables, *Growth and Change*, Vol. 16 (1), pp. 8-12.

Ralston, S. N., Hastings, S. E., and Brucker, S. M. (1986). Improving Regional I-O Models: Evidence Against Uniform Regional Purchase Coefficients Across Rows, *Annals of Regional Science*, Vol. 20, pp. 65-80.

Riddington, G., Gibson, H., and Anderson, J. (2006). Comparison of Gravity Model, Survey and Location Quotients-based Local Area Tables and Multipliers. *Regional Studies*, 40(9): 1069-1081.

Saari, M. Y., and Rashid, Z. A. (2009). Pembangunan Jadual Input-Output Wilayah dan Analisis ke atas Struktur Industri Selangor. *International Journal of Management Studies*, 16: 1-30.

Sawyer, C. H., and Miller, R. E. (1983). Experiments in Regionalization of National Input-Output Tables. *Environment and Planning A*, 15: 1501-1520.

Sila, U., and Juvancic, L. (2005). Regional Input-Output Table-the Case of Eastern Slovenia. *Jahrbuch der Osterreichischen Gesellschaft fur Agrarokonomie*, 13: 121-134.

Stevens, B. H., Treyz, G. I., Ehrlich, D. J., and Bower, J. R. (1983). A New Technique for the Construction of Non-Survey Regional Input-Output Models, *International Regional Science Review*, Vol. 8 (3), pp. 271-286.

Tohmo, T. (2004). New Developments in the Use of Location Quotients to Estimate Regional Input-Output Coefficient and Multipliers, *Regional Studies*, Vol. 38 (1), pp. 43-54.

Yu, Y., Hubacek, K., Guan, D., and Feng, K. (2007). *Construction and Application of Regional Input-Output Models: Assessing Water Consumption in South East and North East of England*. Paper presented at the 16th International Conference on Input-Output Techniques, Istanbul, Turkey, July 2-6.