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Economic Impacts of Petroleum Industry in States of Pahang and Terengganu

(Impak Ekonomi Industri Petroleum di Negeri Pahang dan Terengganu)

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ABSTRACT

Petroleum industry in Malaysia has created significant contribution to the Malaysian economy as a whole. However, the growth and development of the industry does not necessarily to bring considerable economic linkages to the local and neighboring economies where the industry is located, and thus fail to contribute to the economic diversification of local economies. This paper validates this expectation by examining the economic impacts of petroleum industry in the states of Terengganu and Pahang. Regional input-output model that developed by using location quotient, has been used as the main methodology in this paper. Results are consistent with our expectation that the state of Terengganu does not benefit largely from the petroleum industry but contributes more to the economic diversification for the state of Pahang. One of the explanations to this finding is that petroleum related activities such as petroleum refinery and support services are outsourced to the state of Pahang.

Keywords: Petroleum refinery; regional input-output; location quotient; value added; employment

ABSTRAK

Industri petroleum di Malaysia telah mencipta sumbangan yang signifikan kepada ekonomi negara secara keseluruhannya. Walau bagaimanapun, pertumbuhan dan pembangunan industri tidak semestinya membawa hubungan ekonomi yang besar kepada ekonomi tempatan di mana industri itu terletak, dan dengan itu gagal menyumbang kepada kepelbagaian ekonomi tempatan. Makalah ini mengesahkan jangkaan ini dengan mengkaji kesan ekonomi industri petroleum di negeri Terengganu dan Pahang. Model input-output wilayah yang dibangunkan menggunakan location quotient telah digunakan sebagai metodologi utama dalam makalah ini. Dapatan kajian konsisten dengan jangkaan kami bahawa industri petroleum tidak memberi manfaat besar kepada negeri Terengganu tetapi lebih menyumbang kepada kepelbagaian ekonomi negeri Pahang. Salah satu penjelasan untuk penemuan ini ialah aktiviti berkaitan petroleum seperti penapisan petroleum dan perkhidmatan sokongan telah diagihkan ke negeri Pahang.

Kata kunci: Penapisan petroluem; input-output wilayah; location quotient; nilai ditambah; guna tenaga

INTRODUCTION

Petroleum industry is one of the drivers for the Malaysian economic growth and development. The contribution of this sector to the total value added is considerable, dominating 16% of the total value added in 2005 and 11% in 2012 (in 2005 constant prices)[1]. The contribution to the employment is also significant with the share to the total workforce increases from 0.08% in 2005 to 0.11% in 2012. Integration of this industry with the rest of the industries is largely connected through forward linkages than the backward linkages, implying that this industry plays an important role in supporting growth of other industries (Saari et al. 2016).

In the East Coast region, the petroleum industry concentrated in the state of Terengganu in general and specifically, in the town of Kerteh. Although the petroleum industry is located in this state, it seems to be that the economy of Terengganu does not benefit largely from the production of petroleum industry. In term of employment generation, although the population of Terengganu constitutes 4% of total population, the employment of this state only supplies 3.4% of the total workforce. In addition to that, Terengganu is ranked the

fifth highest poverty rates in Malaysia with 1.7% are poor and 0.2% are hardcore poor in 2012 (Economic Planning Unit 2016). These observations are consistent with the literature that shows the petroleum industry does not contribute a large employment growth in a region but rather widen income inequality (see for example, Munasib & Rickman 2015; Weber 2012).

Narrowing the geographical scopes, it is unlikely that the petroleum industry in Terengganu would have large benefit to neighboring localities such as Gebeng, Kemaman and Dungun (hereafter termed as GKD). This hypothesis can be supported by the two stylized facts: (i) the petroleum industry is capital intensive production and thus the neediness of skilled workers might be one of the factors contributed to the lower income and job creation, and (ii) the industry is highly depended on inputs from other regions and from abroad, and thus creating lower economic spillover effects within the region.

Initially, the principle aims of this study are twofold. The first aim is to examine the economic implications of the petroleum industry on GKD economies. The second aim is to analyze the impact of petroleum output growth and shocks on various sectors in GKD economies. Among the relevant research questions that the study intends to answer are: (i) how do the development and growth of petroleum industry in Kerteh impacted the value added and employment in GKD region?, and (ii) to what extent does the lower regional economic spillover effects can be explained by leakages and production intensities of the petroleum industry?

The major contribution of this paper to the literature is the development of inter-industry analytical framework at regional level. It is important to note that examining the economic impacts of oil and gas industry on local economies requires a comprehensive model that incorporates production chains for all industries in a single framework. Thus, the first part of this study is to develop a model which is designed to provide a general equilibrium framework for investigating the potential impacts of petroleum industry on local economies. The data that are necessary to empirically implement such a model are given in a regional input-output table (RIOT). Once the RIOT is completed, the second part of this study is to model economic impacts of petroleum industry through multiplier and linkage measures.

It is important to note that the construction of RIOT for GKD region is totally depending on the data quantity and quality. These two factors constraint our work. For example, economic data by districts are less accurate to be used because methodologies for the Economic Census that developed by the Department of Statistics Malaysia (DOSM) are applied at a state level only. Economic data for a specific district can be obtained by running a specific survey and this surely cannot be materialized due to cost-intensive. Thus, taking into these considerations, we generalize our observation on the economic impacts of petroleum industry on local economies by looking at state levels.

This paper is structured into six sections. Next to the Introduction, Section 2 provides our main contribution to the scientific knowledge by reviewing relevant literature. Section 3 presents methodologies for the construction of RIOT for the states of Terengganu and Pahang. Section 4 describes data requirements and sources for the construction of RIOT. Section 5 shows the main findings that derived from the multiplier and linkage measures. Section 6 provides concluding remarks and some policy reflections.

LITERATURE REVIEW

A range of empirical studies have been conducted on the macroeconomic and environmental impacts of oil and gas industry. The scope of studies ranges from the national economy as a whole to specific regional and local economies. In term of petroleum industry itself, Dutch disease, boom and price shocks are commonly found in the empirical findings from studies all over the world, especially for the oil-exporting countries (see for example, Dülger et al. 2013; Hasanov 2013). This includes the study of economic phenomenon known as "resource curse" (see for example, Doraisami 2015). The dynamic relationship between economic variables concludes that petroleum industry plays significant role in the economy.

This section provides several important findings from the literature which in turn inform us the research gap in the area of regional impacts of petroleum industry. Based on our literature survey, we observe that there are two main research gaps, which provide the novelty aspects of our study. First, literature survey does not find any study that analyzes the economic impacts of petroleum industry at regional level in general and on the states of Pahang and Terengganu in specific. Second, regional studies in Malaysia are mostly concentrated on the application of partial equilibrium techniques such as the econometric models. For the development and industrial planning, input-output model that captures general equilibrium analysis, is more appropriate to be applied.

In the case of Malaysia, the recent studies on petroleum industry include the works of Khalid and Liwan (2012), Solaymani et al. (2014), Solarin and Shahbaz (2015) and Saari et al. (2016). These are the national-level studies that emphasize on national crude oil reserve, oil subsidy reforms and natural gas consumption respectively. To the best of our knowledge, studies on petroleum industry are concentrated on the national economy and no studies have been found that analyze specifically on regional impacts. As a result of this literature gaps, we are unable to provide useful insights for the economic impacts of petroleum industry at regional or local economies.

In other countries, empirical evidences for the impacts of petroleum industry for its own industry and other industries at regional economies is vast. These include the works of Papyrakis and Gerlagh (2007), James and Aadland (2011), Weber (2012), Brasier et al. (2014), Haggerty et al. (2014), Maniloff and Mastromonaco (2014), Munasib and Rickman (2015) and Paredes et al. (2015). Among the studies, Papyrakis and Gerlagh (2007) and James and Aadland (2011) have revealed a negative link between economic growth and natural resources across regions in United States. The findings seem to be consistence with that of Paredes et al. (2015) which shows that income spillover effects of natural resources at the regional level is minimal.

In Malaysia, regional studies for other than petroleum industry have been conducted. For example, Gazi et al. (2014) conducted a survey-based study on economic benefits of artificial reefs in Terengganu. Similar to that Teh et al. (2011) quantified the socio-economic contribution of small-scale fisheries in Sabah by using an input-output analysis. Also, Jamal et al. (2014) assessed the economic value of health impacts of transboundary smoke haze pollution in Kuala Lumpur and adjacent areas in the state of Selangor, Malaysia.

From the methodological point of view, the application of regional input-output model in Malaysia is limited, with the exception of Saari (2014). Almost all of the petroleum studies in Malaysia applied econometric models which include the works of Abeysinghe (2001), Park and Yoo (2014) and Badeeb et al. (2016). None of the studies used a regional input-output model to examine the impacts of petroleum industry on state economies of Terengganu and Pahang. This constitutes another area of literature gap that this paper contributes to the scientific knowledge.

REGIONAL INPUT-OUTPUT ANALYSIS

The methodologies that are developed in this section specifically to determine the economic impacts of petroleum industry in the states of Terengganu and Pahang. Input-output model, the technique that widely used in the literature of regional studies, has been utilized. Section 3.1 provides the methodologies for the estimation of RIOT for the states of Terengganu and Pahang. By using the RIOT, Section 3.2 discusses impact assessment of petroleum industry that derived based on multipliers and linkages.

ESTIMATION OF REGIONAL INPUT-OUTPUT

Input-output analysis is an economic modelling technique that aims to understand the interactions among production sectors. Specifically, it shows the interrelations among different production sectors which purchase goods and services from other sectors as production inputs and which in turn produce goods and services which are sold to other sectors and consumers. The ability of input-output analysis to capture the whole production interdependencies leads to the wide application of the model for regional analysis (see for example, Miller & Blair 2009).

In Malaysia, most of the applications of the input-output model are made at a national level. The interest in extending the application of the same framework to spatial units different from the country (usually, sub-national regions) led to some modifications in the national model, originating a set of regional input-output models. There are two specific characteristics referring to the regional dimension which make evident and necessary the distinction between national and regional input-output models. First, the productive structure of each region is specific, probably being very different from the national one; second, the smaller the focusing economy, the more it depends on the exterior world (this including the other regions of the same country and other countries), making exports and imports becoming more important in determining the region's demand and supply.

There are three most commonly techniques used for the construction of regional input-output table, survey-based, semi-survey and non-survey techniques. The survey-based technique associates with higher degree of accuracy but with higher cost and is time-consuming through a careful compilation of data from nationally representative survey or census. In contrast, the semi-survey and non-survey based may associate with lower degree of accuracy but, can offer reliable estimates with the limited data and less cost. Given the limited data availability and cost-effective, this study applies the non-survey approach by adapting the Simple Location Quotient (SLQ). Empirical evidences show that the SLQ provides a good approximation for the estimation of "true" regional input-output table (see for example, Miller & Blair 2009; Morrissey 2014).

The rationale for using the SLQ is examined in Richardson (1972), Mayer and Pleeter (1975), Round (1983), Miller and Blair (2009), and Habibullah and Radam (2009) for Malaysia. This technique is used to adjust the national input-output coefficients from the **A** matrix to consider the potential for local demands to be satisfied locally. As an illustration of the technique, let us denote state of Terengganu as *T* and regional coefficients for *T* can be defined as;

$$a_{ij}^{TT} = LQ_i^T\left(a_{ij}^N\right) \tag{1}$$

where a_{ij}^{TT} is the regional input-output coefficient, LQ_i^T is the location quotient for demonstrating the importance of sector *i* in the local economy relative to the national economy, a_{ij}^N is the national input-output coefficient.

Output, value added and employment are the indicators that commonly used to derive the location quotient. In this study we use value added to measure the SLQ because of data availability. Let V_i^T and V^T

denote value added of sector i and total value added in region T, and V_i^T/V^T is the share of sector i in regional value added. Similarly, V_i^N and V^N denote value added of sector i and total value added at national economy, and V_i^N/V^N represents the share of sector i in national value added. Based on these definitions, SLQ can be derived as follows,

$$SLQ_i = \left(\frac{V_i^T/V^T}{V_i^N/V^N} \right) \quad (2)$$

SLQ measures the ability of regional industry i to supply demands placed upon it by other industries in the region and by regional final demand. If the SLQ is greater than one (SLQ > 1), this implies that sector i is more concentrated in region T than in the nation as a whole, and the regional input-output coefficient is similar the national input-output coefficient. If the SLQ is less than one (SLQ < 1), it is assumed that the region is being less able to satisfy demand for its output and the national input-output coefficient has to be multiplied by the SLQ for sector i in Region T. Altogether, the regional input-output coefficient is altered based on the following conditions.

$$a_{ij}^{TT} = \begin{Bmatrix} a_{ij}^N (SLQ_i^T) & \text{if} \quad SLQ_i^T < 1 \\ a_{ij}^N & \text{if} \quad SLQ_i^T \geq 1 \end{Bmatrix} \quad (3)$$

There are two main steps involve in the estimation of RIOT for the states of Pahang and Terengganu. First, we compile value added data at sectoral levels for the states of Pahang and Terengganu, and Malaysia as a whole. The published value added data are disaggregated only into 10 broad industries. Based on the data, we calculate SLQ index for 10 broad industries in Table 1 for the states of Terengganu and Pahang.

Recall that SLQ quantifies how "concentrated" an industry is in a region compared to a larger geographic area. If the SLQ < 1, output of the sector is not sufficient to meet the local demand and thus imports are required. While if SLQ > 1, output of the industry is more than sufficient to meet the local demand and the surplus is exporting to other regions. For example, SLQ index for Agriculture and Forestry industry in state of Terengganu is 1.07 implies that the state and the nation are more or less equally specialized in the industry. In addition, the SLQ index for the Petroleum Refinery industry is 23.04 which means that the state has a higher concentration in the industry than the nation. In this case, it informs that the output of Petroleum Refinery industry is more than sufficient to supply products in the state economy and a large of the products is exported to neighboring regions (in our case is the state of Pahang).

The second step is to aggregate the national input-output table from 124 industries into 10 industries, consistent with the SLQ breakdown. Based on the national input-output table, we apply the SLQ in Table 1 to estimate the RIOT for the states of Terengganu and Pahang. Technically, if SLQ < 1, the national input-output coefficient needs to be adjusted downwards by multiplying it by the SLQ. If the SLQ > 1, no adjustment is made for the national input-output coefficient. Using the RIOT, we analyze the economic impacts of Petroleum Refinery industry in the states of Terengganu and Pahang by using multiplier and linkage measures.

We are aware that there are several variants of SLQ that had been proposed in the literature of regional input-output studies. Different technique may produce different outcomes and in our case where the "true" of regional input-output is not available, comparison of different estimation techniques cannot be performed.

TABLE 1. Simple location quotients (SLQ) for Terengganu and Pahang

	Terengganu		Pahang	
	LQ	Implications	LQ	Implications
1. Agriculture and forestry	1.07	Self-sufficient	4.11	Self-sufficient
2. Mining and quarrying	0.03	Imports	0.34	Imports
3. Petroleum Refinery	23.04	Self-sufficient	0.02	Imports
4. Manufacturing	0.61	Imports	1.49	Self-sufficient
5. Building and construction	0.97	Imports	1.13	Self-sufficient
6. Utilities, Transportation and Storage, Information and Communication	1.59	Self-sufficient	0.64	Imports
7. Wholesale and Retail Trade, Hotels and Restaurants	0.56	Imports	1.42	Self-sufficient
8. Banking and financial services	0.30	Imports	0.70	Imports
9. Private services	0.77	Imports	3.19	Self-sufficient
10. Government Services	1.49	Self-sufficient	1.86	Self-sufficient

Notes:
LQ < 1, output of the sector is not sufficient to meet the local demand and thus imports are required.
LQ > 1, output of the sector is more than sufficient to meet the local demand and the surplus is exporting to other regions.

MULTIPLIER AND LINKAGE MEASURES

For each state, Table 2 illustrates the regional input-output table in the form of matrix representation. Total output consists of intermediate and final goods. The ($n \times n$) matrix **Z** denotes the intermediate deliveries and each element of z_{ij} indicates the amount of commodity sector *i* used by sector *j* to produce final goods. Final goods are sold to the ($n \times k$) vector of **f** represents final demand consumers—which consists of private consumption (**c**), investment (**s**), public consumption (**g**) and exports (**e**)[2]. To produce output for final demand consumers, production requires also primary inputs—the ($1 \times n$) vector *m* gives the sectoral imports and ($1 \times n$) vector **v** shows value added[3].

Based on the structure of Table 2, the independencies among production activities can be shown based on the following material balance equation;

$$\mathbf{x = Zi + (c + s + g + e) = Zi + f} \quad (4)$$

where **x** is the vector for gross output, **Zi** is the summation vector of matrix intermediate deliveries and **f** is the vector for final demand. Equation (4) simply shows that total output of sectors is equal to intermediate deliveries and final demand. Treating the intermediate deliveries as endogenous component and final demand as exogenous component, (4) can be transformed into a standard input-output model as follows:

$$\mathbf{x = Ax + (c + s + g + e) = Ax + f} \quad (5)$$

where **A** ($\mathbf{A = Z\hat{x}^{-1}}$) is known as the input-output coefficient. The input-output coefficients show the amounts of inputs that a sector purchased from other sectors per unit of its own output. Solving for **x**, we obtain total production delivered to final demand:

$$\mathbf{x = (I - A)^{-1}f} \quad (6)$$

where **I** is the identity matrix, and $(\mathbf{I - A})^{-1}$ is known as the Leontief inverse matrix. The Leontief inverse matrix representing the total production every sector must generate to satisfy the final demand. In other words, the coefficients are the amount by which sector *i* must change its production level to satisfy an increase of one unit in the final demand from sector *j*. Thus, each element of the Leontief inverse matrix contains the direct and indirect requirements of an industry to meet its final demand.

In this study, we estimate the economic impacts of oil and gas industry by looking at the impacts on value added and employment. These two macroeconomic indicators are the most commonly used in assessing economic impacts of an industry for regional studies. Now, let us expands the standard input-output model in equation (6) to capture the impacts on value added and employment. Introducing a vector of value added coefficient **h**, which is derived by dividing the amount of value added **v** of the *j*th sector by total input to that sector x_j. In matrix notation, **h** becomes:

$$\mathbf{h = v\hat{x}^{-1}} \quad (7)$$

Each element of value added coefficient indicates value added per unit produced of output for each sector. Introducing (7) into (6), we obtain the amount of value added **v** that is used to produce output for final demand components.

$$\mathbf{v = \hat{h}(I - A)^{-1}\, c + s + g + e = \hat{h}(I - A)^{-1}f} \quad (8)$$

The similar modeling procedures are used for employment effects. Denoting a vector of employment coefficient **w**, which is derived by dividing the number of employment **u** of the *j*th sector by total input to that sector x_j. In matrix notation, **w** can be derived as follows:

$$\mathbf{w = u\hat{x}^{-1}} \quad (9)$$

It is straightforward that the employment effects can be derived as follows;

$$\mathbf{u = \hat{w}(I - A)^{-1}\, c + s + g + e = \hat{w}(I - A)^{-1}\, f} \quad (10)$$

TABLE 2. Simplified input-output table in current prices

	Intermediate demand							Final demand				Total output
	S1	S2	S3	.	.	.	Sn	**c**	**s**	**g**	**e**	
Sector 1 (S1)												
Sector 2 (S2)												
Sector 3 (S3)												
.				**Z**					**f**			**x**
.												
.												
Sector (Sn)												
Imports				**m**								
Value added				**v**								
Total input				**x'**								

The importance of a sector to an economy is commonly identified based on two measures, that is, linkages and multipliers. Equations (8) and (10) only deal with the multipliers for value added and employment. The multipliers must be used complementarily with the backward and forward linkages.

Backward and forward linkages measure the level of dependencies between intermediate input purchases and intermediate input sales for a given sector. A sector may have large backward and forward linkages, but that it does not inform the policy makers, whether that sector is passively receiving impulses from other sectors or actively sending impulses to other sectors. Consequently, the existence of large backward and forward linkages, without further information, does not imply that the particular sector can be considered as driver of the economy. A second criterion, which is based on multipliers, must be established. For example, the value added multiplier measures the direct and indirect impacts on total value added that are potentially generated by each additional unit of the final demand for a particular sector. Therefore, to be labeled as an importance sector, besides having large linkages to pass on growth impulses, a sector also needs to generate its own growth impulses.

Backward linkages are derived from the Leontief inverse matrix while the forward linkages are calculated from the Ghosh inverse matrix. They can be represented as follows;

$$B_i = \left(\frac{(1/n)\Sigma_i l_{ij}}{(1/n^2)\Sigma_i \Sigma_j l_{ij}} \right) \text{ for backward linkages} \quad (11)$$

$$F_i = \left(\frac{(1/n)\Sigma_i b_{ij}}{(1/n^2)\Sigma_i \Sigma_j b_{ij}} \right) \text{ for forward linkages} \quad (12)$$

where l_{ij} indicates an element of the Leontief inverse matrix and b_{ij} represents an element of the Ghosh inverse matrix. Ghosh model is a supply-driven model, where value added and imports are the exogenous variables, while the final demands are the endogenous variables. It provides an alternative interpretation that relates to sectoral gross production to the primary inputs, that is, to a unit of value entering the inter-industry system at the beginning of the production process. Technically, the supply-driven model operates by 'rotating' or transposing the vertical (column) view of the input-output model to a horizontal (row) view. The Ghosh model can be summarized as follows,

$$\mathbf{x'} = \mathbf{i'\hat{x}B} + \mathbf{d'} = \mathbf{x'B} + \mathbf{d'} \quad (13)$$

where $\mathbf{i'\hat{x}} = \mathbf{x'}$, $\mathbf{B(B} = \mathbf{\hat{x}^{-1}Z)}$ represents the output coefficient matrix and **d'** is the vector of primary inputs (i.e. value added and imports). Each element of the matrix output coefficient shows the delivery z_{ij} of commodity sector i to sector j per unit of the seller's output. The solution for (13) is

$$\mathbf{x'} = \mathbf{d'(I - B)^{-1}} = \mathbf{d'G} \quad (14)$$

DATA SOURCES

Morrissey (2014) classifies data into three types. Type 1 data is the data that is in the public domain. Type 2 data is the data that is publicly collected but is not released into public domain. Type 3 data is the data that is not publicly available in the public domain. In our case, construction of a new input-output table for a region demands for a disaggregated data on total output, intermediate consumption and final demand for each sector. In Malaysia, this type of data falls under Type 2 data. Therefore, some of the data used in this study has been officially requested from the authorities, the DOSM.

In this study, there are four types of data used. Firstly, we utilize the latest national input-output table in 2010 base-year that published by the DOSM (2014). The input-output table consists of 124 sectors and classified according to the 2008 Malaysia Standard Industrial Classification (MSIC). Monetary flows in the input-output table is transformed into national input-output coefficient, a_{ij}^N. Since the latest input-output table is used for 2010 base-year, the rest of the data are also collected for the same base-year.

The second dataset used is value added by sectors for Malaysia, Terengganu and Pahang. Data for value added is published by DOSM (2015) for 10 broad sub-sectors. This is the "best" level of disaggregation that is available and further disaggregation of the sub-sectors is constrained by the data. Value added for Malaysia, Terengganu and Pahang are used to estimate SLQ by providing information on V_i^T/V^T and V_i^N and V^N.

The third dataset used is the annual firm reports that compiled by the Companies Commission of Malaysia (CCM). This dataset is required to separate Crude Oil and Natural Gas industry from the Mining and Quarrying sector, and to breakdown Petroleum Refinery industry from the Manufacturing sector. In the input-output table there are two oil and gas industriesCrude Oil and Natural Gas (upstream) and Petroleum Refinery (downstream) while the value added is published only at aggregated industry (e.g. only mining industry without separating between crude oil and gas industry and other mining industries). Table 3 shows the classifications of these two industries. It should be mentioned here that we are unable to estimate Crude Oil and Natural Gas industry for the states of Terengganu and Pahang because of lower degree of reliability for the CCM-manufacturing dataset. Exclusion of Crude Oil and Natural Gas may have marginal effects because most of the activities in Kerteh and neighboring cities involve petroleum refinery activities.

Finally, we utilize Household Income Survey (HIS) to estimate employment by sectors for Terengganu and Pahang. HIS is a multi-purpose household survey that is conducted to gather detailed information on income and some outlays of households, taking demographic characteristics across socio-economic groups into

TABLE 3. Classification of Crude Oil and Natural Gas, and Petroleum Refinery sectors

Sectors	MSIC	Descriptions
Crude Oil and Natural Gas	06101	Extraction of crude petroleum oils
	06102	Extraction of bituminous or oil shale and tar sand
	06103	Production of crude petroleum from bituminous shale and sand
	06104	Processes to obtain crude oils
	06201	Production of crude gaseous hydrocarbon (natural gas)
	06202	Extraction of condensates
	06203	Draining and separation of liquid hydrocarbon fractions
	06204	Gas desulphurization
	06205	Mining of hydrocarbon liquids, obtain through liquefaction or pyrolysis
	09101	Oil and gas extraction services activities provided on a fee or contract basis
	09102	Oil and gas field firefighting services
Petroleum Refinery	19100	Manufacture of coke oven products
	19201	Manufacture of refined petroleum products
	19202	Manufacture of bio-diesel products

account. The HIS contains labor force characteristics of household members are mainly used for disaggregating the employment by sectors. Data for employment is used to calculate employment coefficient which in turn used to derive employment multiplier.

RESULTS AND DISCUSSION

This paper examines the economic impacts of the oil and gas industry in the states of Terengganu and Pahang by using the regional input-output model. The database for the development of regional input-output model is given by the RIOT that estimated by using the simple location quotient (SLQ). The SLQ is derived based on the value added, which is the "best" available and reliable dataset at state levels in Malaysia.

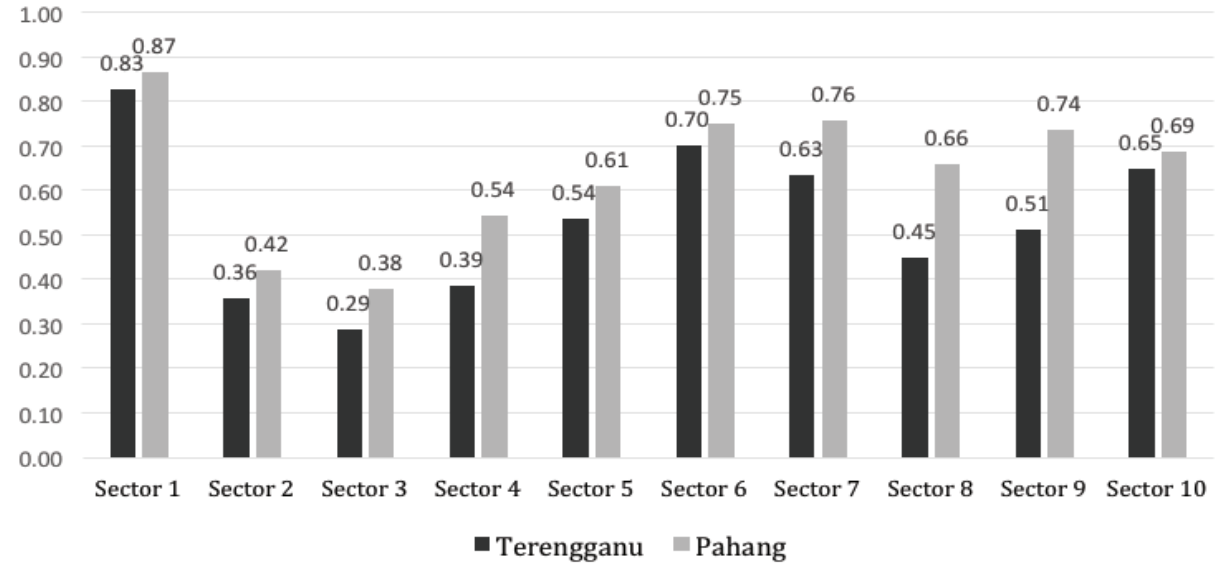
Let us first discuss the multiplier impacts on value added and employment of all industries in both states. Results for the multiplier impacts are summarized in Figure 1 for value added and Figure 2 for employment.

Value added multiplier measures the economy-wide impacts on value added as a result of an increase in one Ringgit of final demand for a particular industry. For example, for every *Ringgit* increase in final demand of Petroleum Refinery (Industry 3) in Terengganu generates RM0.29 value added for the entire economy of the state. There are two the most remarkable findings can be observed in Figure 1. First, results show that the value added multipliers for all industries in the state of Terengganu are lower than that of in the state of Pahang. The large differences are found for Banking and Financial services in which the value added multiplier in the state of Terengganu is 47% lower than that of the state of Pahang. Second, results indicate that the capacity of Petroleum Refinery in the state of Terengganu for generating value added is relatively lower (0.29 vs. 0.38). Explanation for these two remarkable findings is the differences in the level of economic integration that revealed by the inter-industry linkages. It seems to be that Petroleum Refinery industry in the state of Terengganu is less integrated with other sectors compared to the state of Pahang. This argument can be simply validated by separating the multiplier effects into direct and indirect effects in Table 4 and Table 5.

For the Petroleum Refinery industry, the direct and indirect effects can be explained below.

1. The direct effects of Petroleum Refinery industry measure how one Ringgit increase in the gross output of this industry has impacted on the gross output in the industry itself and in other industries (because output of industries are supplied as inputs to Petroleum Refinery).
2. The indirect effects capture how the increase in output of industries are supplied as inputs to Petroleum Refinery has impacted their own industries and other industries along their production chains (because they also need inputs that produced by other industries in order to support the increase in output of Petroleum Refinery).

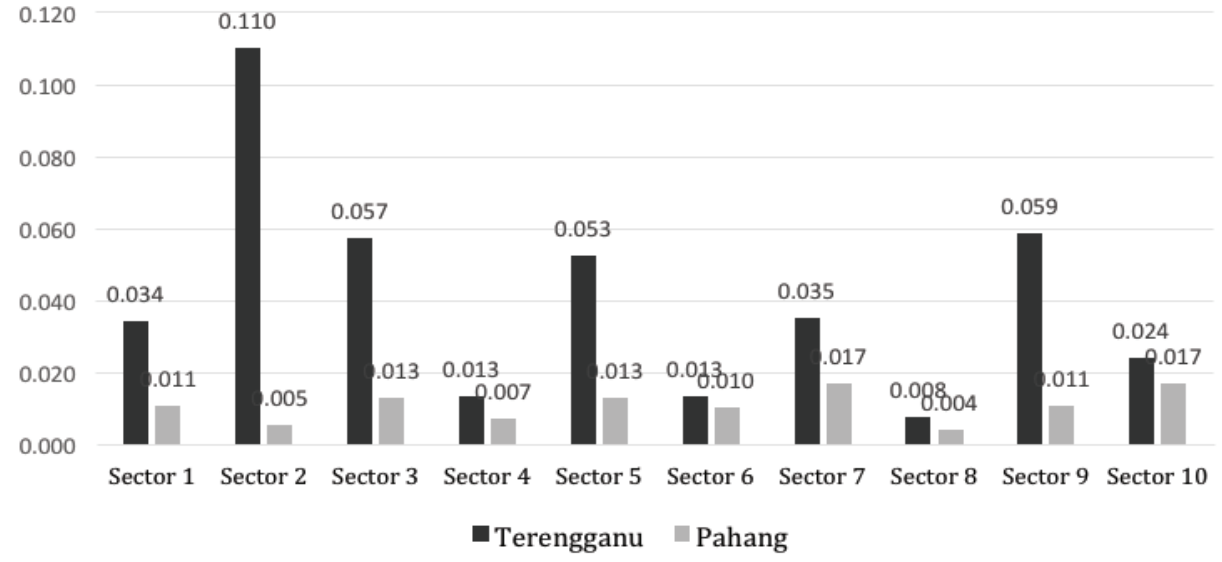
If the Petroleum Refinery industry has higher degree of economic integration with other sectors, the multiplier that contributed by the indirect effects is considerable.



Notes: Sector 1= Agriculture and forestry; Sector 2 = Mining and quarrying; Sector 3 = Petroleum refinery; Sector 4 = Manufacturing; Sector 5 = Building and construction; Section 6 = Utilities, transportation and storage, and information and communication; Sector 7 = Wholesale and retail trade, hotels and restaurants; Sector 8 = Banking and financial services; Sector 9 = Private services; and Sector 10 = Government services.

FIGURE 1. Value added multiplier for every *Ringgit* of final demand

Results in Table 4 and Table 5 also decompose the contribution of the multiplier by specific industries. Results in both tables are linked to both Figure 1 and Figure 2. Figure 1 indicates for every *Ringgit* increase in final demand of Petroleum Refinery industry in Terengganu generates RM0.29 value added for the entire economy of the state. The first column of Table 4 decomposes these RM0.29 according to industries. Out of RM0.29, RM0.18 or 63% are contributed by Mining and Quarrying industry, RM0.07 or 24% generated by its own industry and so on. Next two columns decompose the total multiplier into direct and indirect effects. For



Notes: Sector 1= Agriculture and forestry; Sector 2 = Mining and quarrying; Sector 3 = Petroleum refinery; Sector 4 = Manufacturing; Sector 5 = Building and construction; Section 6 = Utilities, transportation and storage, and information and communication; Sector 7 = Wholesale and retail trade, hotels and restaurants; Sector 8 = Banking and financial services; Sector 9 = Private services; and Sector 10 = Government services.

FIGURE 2. Employment multiplier for every thousand *Ringgit* of final demand

TABLE 4. Direct and indirect multiplier effects for Terengganu

Industries	Value added			Employment		
	Total	Direct	Indirect	Total	Direct	Indirect
1. Agriculture and forestry	0.001	0.000	0.001	0.000	0.000	0.000
2. Mining and quarrying	0.181	0.180	0.002	0.056	0.055	0.001
3. Petroleum Refinery	0.070	0.001	0.069	0.000	0.000	0.000
4. Manufacturing	0.004	0.002	0.001	0.000	0.000	0.000
5. Building and construction	0.000	0.000	0.000	0.000	0.000	0.000
6. Utilities, Transportation and Storage, Information and Communication	0.007	0.004	0.002	0.000	0.000	0.000
7. Wholesale and Retail Trade, Hotels and Restaurants	0.018	0.016	0.002	0.001	0.001	0.000
8. Banking and financial services	0.006	0.004	0.002	0.000	0.000	0.000
9. Private services	0.000	0.000	0.000	0.000	0.000	0.000
10. Government Services	0.000	0.000	0.000	0.000	0.000	0.000
Total multiplier	0.287	0.207	0.079	0.057	0.056	0.001

TABLE 5. Direct and indirect multiplier effects for Pahang

Industries	Value added			Employment		
	Total	Direct	Indirect	Total	Direct	Indirect
1. Agriculture and forestry	0.092	0.062	0.030	0.001	0.001	0.000
2. Mining and quarrying	0.005	0.004	0.002	0.000	0.000	0.000
3. Petroleum Refinery	0.071	0.001	0.071	0.009	0.000	0.009
4. Manufacturing	0.076	0.051	0.026	0.001	0.001	0.000
5. Building and construction	0.003	0.001	0.001	0.000	0.000	0.000
6. Utilities, Transportation and Storage, Information and Communication	0.037	0.016	0.021	0.001	0.000	0.000
7. Wholesale and Retail Trade, Hotels and Restaurants	0.059	0.037	0.022	0.001	0.001	0.001
8. Banking and financial services	0.035	0.012	0.023	0.000	0.000	0.000
9. Private services	0.001	0.000	0.000	0.000	0.000	0.000
10. Government Services	0.000	0.000	0.000	0.000	0.000	0.000
Total multiplier	0.379	0.184	0.195	0.013	0.003	0.010

example, out of RM0.29 total value added generated by the Petroleum Refinery industry in the entire economy, 72% or RM0.21 are generated through the direct effects while the rest of 28% or RM0.08 are contributed by the indirect effects.

Comparing results in Table 4 and Table 5 clearly provides an indication for the lower level of economic integration between Petroleum Refinery industry and the rest of the industries (as measured by the indirect effects) in Terengganu than in Pahang. In an economy, circulation does matterthe more integrated of the industries is the more economic circulations. This weak structural explains why value added multiplier in the state of Terengganu is lower than the state of Pahang. In Pahang, the direct effects only explain 49% of the multiplier while the rest of 51% are contributed by the indirect effects.

Next, we present the estimated employment multiplier for the states of Terengganu and Pahang in Figure 2. The employment multiplier can be interpreted in a similar way of the value added multiplier. For an increase in a thousand *Ringgit* of final demand for the Petroleum Refinery industry generates 0.06 jobs in Terengganu and 0.01 jobs in Pahang. To be more meaningful, we may for example interpret the multiplier for every million *Ringgit* increases in final demand. In that case, there are 57 jobs are created in the economy of Terengganu and 13 jobs in Pahang for every 1 million *Ringgit* increases in final demand of Petroleum Refinery. Although value added multiplier is lower in Terengganu, the employment multiplier is higher. This implies that production of Petroleum Refinery in the state of Terengganu is relatively more labor-intensive whereas more capital-intensive observed in the state of Pahang.

Detailing the results in Table 4 and Table 5 provides two interesting observations. First, job creation in Terengganu is 98% generated from the Mining and Quarrying industry (essentially Crude Oil and Natural Gas industry). This can be explained by the fact that the extraction of oil and natural gas is concentrated in Terengganu and thus it has extraordinary impacts to the economy. The second observation is similar to the value added, where the indirect effects are dominant in Pahang while in direct effects are major forces in Terengganu.

So far, we have discussed the multiplier effects of Petroleum industry in the states of Terengganu and Pahang. The multiplier only provides information regarding the size of the effects without giving the information on the extent to which the 'size' can stimulate growth of other industries. An industry may have large multiplier effects, but that does not inform the policy makers, whether that industry is passively receiving impulses from other sectors or actively sending impulses to other sectors. Thus, the additional measures that we needed are the backward and forward linkages. Backward and forward linkages measure the level of dependencies between intermediate input purchases and intermediate input sales for a given sector. Table 6 shows the estimated backward and forward linkages in Terengganu and Pahang.

If the values for both forward and backward linkages are greater than one for a particular sector, it implies that the industry plays a significant role in regional economic development by supporting (forward linkages) as well as boosting (backward linkages) other industries. Based on the results in Table 6, we can observe that Petroleum Refinery, Utilities, Transport and Communication, and Banking and Financial services are the key sectors for the state of Pahang. Growth of these three sectors has large capacity in boosting and supporting other industries. In Terengganu, only one industry, that is, Utilities, Transport and Communication is considered to be the driver of the regional economy. Thus, this observation supports our expectation that the economy of Pahang is more diversified than that of Terengganu.

In Terengganu, Petroleum Refinery industry plays an important role in boosting other sectors through backward linkages only but less important for forward linkages. This implies that Petroleum Refinery products that produced in the state of Terengganu are mostly exported to neighboring regionin our case is the state of Pahang. More economic activities related to petroleum refinery and support services are outsourced to the state of Pahang and as a consequent of this, Pahang is more benefited from the existence of the oil and gas industry in Terengganu.

Despite the usefulness of analyses provided in this paper, it is fair to mention that results are to some extent hardly to compare with other studies for a verification. Our literature survey indicates that studies on economic impacts of petroleum industry at regional economies are not only scarce in Malaysia but also in the Southeast Asian region. Broadly, the following two evidences may be used as a verification for our analysis.

First, comparing value added data in the states of Pahang and Terengganu in Appendix 1 provides a consistent results with our value added multiplier. Data in Appendix 1 and value added multiplier consistently show the domination of Pahang compared to Terengganu. Value added for the state of Pahang is 58% higher than that of Terengganu while value added multiplier for the former is 32% larger than the latter. Second, the value added of mining and quarrying industry (proxy for petroleum industry) contributes only 0.15% in Terengganu compared to 1.07% in Pahang.

Second, we compare value added and employment multipliers generated by the petroleum industry between Pahang and across states in the US economy. PricewaterhouseCoopers (2017) has decomposed the value added and employment multipliers into the direct and indirect effects, making the analyses are comparable with our case. Overall, both studies show consistent results

TABLE 6. Backward and forward linkages for Terengganu and Pahang

Industries	Pahang		Terengganu	
	Backward	Forward	Backward	Forward
1. Agriculture and forestry	0.910	0.800	1.026	0.913
2. Mining and quarrying	0.720	0.908	0.727	1.066
3. Petroleum Refinery	1.087	1.018	1.157	0.660
4. Manufacturing	1.087	0.846	1.013	0.929
5. Building and construction	1.154	0.771	1.240	0.816
6. Utilities, Transportation and Storage, Information and Communication	1.108	1.724	1.242	1.018
7. Wholesale and Retail Trade, Hotels and Restaurants	0.967	0.903	0.920	1.303
8. Banking and financial services	1.029	1.852	0.840	1.980
9. Private services	1.019	0.614	0.807	0.666
10. Government Services	0.919	0.564	1.028	0.649

for the contribution of direct effect to the value added and employment multipliers. For the value added multiplier, the direct effect contributes 54% in the case of US economy while it explains 49% for the state of Pahang. For employment multiplier, the direct effect indicates 34% in the case of US economy and in the state of Pahang it shows 23%. For both economies, the direct effect dominates about half of the value added multiplier and it explains about one-thirds of the employment multiplier.

CONCLUSIONS

This paper examines impacts of petroleum production in Kemaman, Terengganu on value added and employment for the states of Terengganu and Pahang. Regional input-output model that developed by using the simple location quotient, has been used as the main methodology in this paper. Results are consistent with our expectation that the state of Terengganu does not benefit largely from the oil and gas industry but contributes more to the economic diversification for the state of Pahang.

The lower economic impacts of petroleum industry to the state of Terengganu can be validated based on the following measures. First, the value added multiplier for the Petroleum Refinery sector in Terengganu is relatively lower than that of Pahang although the main operation of petroleum industry is located in Kemaman, Terengganu. Second, the economy of Terengganu is less diversified and less integrated than that of Pahang. The multiplier decomposition analysis and linkages justify that growth of Petroleum Refinery sector in Terengganu only benefits its own sector and associated with very low spillover effects to other industries in the state. This is contrast to Pahang in which the Petroleum Refinery is more integrated with other industries and as a consequent of this, it promotes the economic diversification.

There are two explanations can be suggested to understand the lower impacts of Petroleum Refinery industry to economy of Terengganu. First, most of the forward activities and services such as port facilities and transportations are outsourced to other regions in particular the state of Pahang. Distances between Kemaman and Gebeng are much closed to each other and these factors are economically feasible and viable for the outsourcings. Second, Petroleum Refinery industry is essentially capital-intensive production and utilizes highly skilled labors (which most of the labors are come from other states). In addition to that, most of the outputs are destined for export demand. Consequently, the economic benefits to the local economies are expected to be lower and to some extent may create economic distortions to the local economies such as higher prices for goods and services.

It is also important to mention two main methodological limitations in this study because our analysis and data does not measure everything perfectly. First, this study is unable to provide explicit impacts of oil and gas industry for the specific localities such as Gebeng, Kemaman and Dungun. Due to data reliability and availability, our analysis is able to examine the impacts at macro level, which is at state level. Second, data availability also limits the analysis to focus on Petroleum Refinery industry only and we are unable to analyze specifically the impacts of Crude Oil and Natural Gas industry. Extending the analysis for Crude Oil and Natural Gas industry is possible to be considered for future studies because data for this industry at regional level may be obtained by establishing proper institutional arrangement that includes the state government, DOSM and other main stakeholders.

NOTES

1 Includes crude oil and natural gas, and petroleum refineries.

2 Final demand for investment includes gross fixed capital formation and change in stock.

3 Input-output model involves matrix operations. For clarity, matrices are indicated by bold, upright capital letters; vectors by bold, upright lower case letters and scalar by italicized lower case letters. Vectors are columns by definition, so that row vectors are obtained by transposition, indicated by a prime (e.g. $\mathbf{x}'$). A diagonal matrix with the elements of vector x on its main diagonal and all other entries equal to zero are indicated by a circumflex (e.g. $\hat{\mathbf{x}}$). A summation vector is represented by **i**.

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APPENDIX 1: Value added for the states of Pahang and Terengganu in 2010 (RM million, in 2010 constant prices)

Industries	Pahang	Terengganu
1. Agriculture and Forestry	10,068	2,633
2. Mining and Quarrying	387	35
3. Manufacturing	8,147	8,256
4. Building and Construction	943	813
5. Utilities, Transportation and Storage, Information and Communication	1,716	4,269
6. Wholesale and Retail Trade, Hotels and Restaurants	5,643	2,220
7. Banking and Financial Services	1,949	846
8. Private Services	3,470	839
9. Government Services	3,537	2,845
Total Economy	35,860	22,756

Source: Department of Statistics Malaysia (2017)