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Analysis on The Linkages and Multiplier Effects of The Upstream Oil and Gas Sector on Indonesia's Economy Using The Input-Output Method

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ABSTRACT - The aim of this study is to analyze the role of the upstream oil and gas sector within Indonesia's economy in terms of its linkages to other sectors and the multiplier effects it produces. The input-output (IO) analysis method is applied by calculating the total, backward, and forward linkage index and multiplier effect index values of the upstream oil and gas sector. Building upon a previous study using the 2005 BPS IO Database updated in 2010 (2005 IO), this study used the 2010 IO Database released by BPS in 2015 (2010 IO) and the 2016 IO Database released in 2021 (2016 IO), processing the data using Python-based software. Based on calculations using the 2010 IO Database, 93 sectors had linkages to the upstream oil sector and 104 to the upstream gas sector, whereas the 2016 IO Database identified 96 sectors with linkages to the upstream oil sector and 113 to the upstream gas sector. Simulated calculation and analysis results revealed an increase in the total (backward and forward) linkage index values of the upstream oil and gas sector, from 3.8801 to 4.0826 for the upstream oil sector and from 3.1256 to 3.3940 for the upstream gas sector. With regard to multiplier effects, simulated calculation results also pointed toward an increase in total multiplier index values, from 6.1855 to 7.8943 for the upstream oil sector and from 4.9828 to 6.5630 for the upstream gas sector. The increase in the national upstream oil and gas sector's total multiplier index correlates with an increase in linkages between the upstream oil and gas sector and other sectors in Indonesia's economy as a whole, both backward and forward. Analysis results showed that the greater the multiplier index reported by a sector with linkages to the upstream oil and gas sector, the greater the total multiplier index produced in the upstream oil and gas sector.

Keywords: linkage, multiplier effect, index, upstream oil and gas sector, indonesia's economy, input-output.

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INTRODUCTION

The upstream oil and gas sector plays a crucial role in Indonesia's economy, not only as a source of state revenue but also as an economic driver in the broader context (Mardiana et. al 2024). However, measurements and analyses of the importance of the upstream oil and gas sector to Indonesia's economy have largely focused on how it directly contributes to state revenue in the State Budget. Less attention has been given to measuring and analyzing the upstream oil and gas sector's role as an economic driver for Indonesia in the broader context, and studies on this subject are relatively limited.

Previous studies that are relevant to this topic include: Analysis of the Economic Contribution and Multiplier Effect of the Upstream Oil and Gas Industry on the National Economy (ReforMiner Institute 2011), and Oil and Gas, Banking, and the National Economy (ReforMiner Institute 2013). One of the studies, which employed input-output (IO) analyses based on the 2005 IO Database updated in 2010, identified linkages between the upstream oil and gas sector and 129 out of 185 economic sectors, with a backward linkage index of 0.6369 and forward linkage index of 3.8253. Through these linkages, the multiplier effect on the national economy is calculated through an index value of 3.71.

Over time, developments and changes have occurred, both in the upstream oil and gas sector and Indonesia's other economic sectors. In (Rakhmanto 2024), it became known that the average oil and gas production rates at the national level had decreased by around 3.06% and 1.87% per year in 2013-2023. During the same period, national gas consumption grew by an average of 1.44% per year, while Indonesia's economic growth fluctuated between -2.07% and 5.56% per year (BPS 2024). Both the oil and gas sector and the national economy as a whole have experienced structural and statistical changes. The National IO data used as the basis for calculations and linkage analyses between sectors was also updated through the 2010 IO Database (published in 2015 by BPS) and 2016 IO Database (published in 2021 by BPS). The 2005 IO Database does not distinguish between the upstream oil sector, the upstream gas sector, and the geothermal sector. The 2010 IO Database and the 2016 IO Database both separate the upstream oil sector from the upstream gas sector, and combine the upstream gas sector and the geothermal sector into one. To better accommodate and analyze the developments and changes that have occurred, it is both relevant and necessary to update the index values reflecting the backward and forward linkages, as well as the multiplier effect of the upstream oil and gas sector on Indonesia's economy on the basis of more recent data.

Literature Review

The relationship between energy included therein oil and gas and the economy is a frequent topic of discussion among experts. Some economists argue that economic growth drives energy consumption, while others contend that energy consumption itself is the cause of economic growth. One of the theories developed to explain the role of energy in the economy was presented by (Stiglitz 1974) and (Tahvonen & Salo 2001). These scholars developed economic models to explain how energy influences economic growth by simulating both renewable and non-renewable energy needs. Energy is vital to economic growth because the primary factor of production is energy (Stern 1999).

Referring to (Partowidagdo 2009) and (Yusgiantoro & Luky 2018), energy consumption is heavily influenced by the development and structural changes in the economy. An economy with a predominant structure based on extractive sectors generally requires relatively low energy support. In contrast, an economy dominated by the industrial and services sectors requires significantly greater energy support or supply. In Indonesia's economy, the relationship between the energy sector oil and gas in particular and economic development tends to be in a reciprocal and proportional correlation (Notonegoro 2013). The oil and gas sector in Indonesia in particular has a strategic role in national development (Ainuddin & Muhammad 2021).

The economic impact of energy including the oil and gas sector on the national economy can be categorized into direct impact, indirect impact, and induced impact, which are related to the economic changes occurring in a region or country (Baumann et al. 2002). Economic impact refers to the effect of economic activities on a region or national scope resulting from the presence of a program or project (Sumardjoko 2013). Environmentally friendly use of oil and gas provides many benefits for local communities and has a positive impact on the national economy (Sunarjanto D. et. al 2017). The economic impact can be assessed through business output, economic value added, total gross domestic

product, individual income, and employment opportunities, which serve as indicators of economic development goals (Weisbrod 2017).

METHODOLOGY

This study is a quantitative in nature by carrying out calculations and analyses of secondary statistical data (Kothari, 2004).The method used in this study is the input-output (IO) analysis, as also applied in an earlier study. This study builds upon a previous study using the 2005 BPS IO Database updated in 2010. This study used the 2010 IO Database released by BPS in 2015 and the 2016 IO Database released in 2021, while the data were processed using Excel and Python-based software.

Leontief (1986) stated that the IO analysis is a method that systematically measures the reciprocal relationships between various sectors in a complex economic system. As one of the quantitative approaches widely used in economic analyses, the IO analysis method is used in this study because it meets the study's objective of measuring the linkage index between the upstream oil and gas sector and other economic sectors, as well as the multiplier index based on the multiplier effect generated on Indonesia's economy.

Several limitations of this study are as follows: 1). The analysis is static in nature, which means it cannot directly describe the dynamics of changes that occur; 2). It assumes a fixed and linear relationship between input-output; 3). And it depends on the availability of data, including its classification, which is not always in accordance with actual conditions. For example, in this study, the upstream geothermal sector is included as part of the upstream natural gas sector.

The general equation of the IO analysis, which represents the flow of goods from sector i to sector j, is denoted as zij. The total output of sector i is denoted as Xi, and the total final demand of sector i is Yi. This relationship can be expressed as follows:

$$Xi = zi1 + zi2 + zi3 + ... + zin + Yi \quad (1)$$

Leontief (1986) further developed the input-output analysis into matrix operations, known as the technology matrix, which is as follows:

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & & & \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \quad (2)$$

However, the matrix operation formula cannot illustrate the sequence of influences from one sector to another (Muchdia, 1999). Therefore, a multiple analysis is needed to trace the chain of influence from one sector to other sectors and households in the economy. This chain of influence is referred to as the multiplier or multiplier effect index.

According to (Perwitasari & Sari 2013), the IO analysis includes a sectoral linkage analysis and multiplier analysis. The IO analysis consists of three parts, which are:

Performance analysis

Which consists of the contribution of output, final demand, and intermediate inputs

Output multiplier analysis:

$$X=(I+A+A^2+A^3+...).F \quad (3)$$
$$X=(I-A)^{-1}.F$$

X = output/supply
(I-a) -1 = multiplier matrix, often denoted as Ma
I = identity matrix
A = input coefficient matrix
F = final demand

Structure analysis

Which includes forward linkages and backward linkages, as well as the analysis of changes in the economic structure by comparing the Multiplier Product Matrix (MPM).

$$BL_j = \sum_{i=1}^{n} xij \dashrightarrow IBL_j = \sum_{i=1}^{n} xij \,/\, \left(\frac{\sum_{i=1}^{n} xij}{n^2}\right)$$
$$FL_i = \sum_{j=1}^{n} xij \dashrightarrow IFL_j = \sum_{i=1}^{n} xij \,/\, \left(\frac{\sum_{i=1}^{n} xij}{n^2}\right) \quad (4)$$

BLj (Backward Linkage) = the increase in economic output when the final demand of sector j increases by 1 unit.

FLi (Forward Linkage) = the increase in the output of sector i when the final demand of all sectors increases by 1 unit.

Multiplier analysis

Which includes the output multiplier, income multiplier, and employment multiplier. The employment multiplier is needed to illustrate the growth of new job opportunities because of increased final demand in a sector, which can be calculated using the following equation:

$$Ej=\Sigma an+1jni=1aij \quad (5)$$

Ej = employment multiplier for sector j

$an+1j$ = labor ratio of sector j

aij = Element of the inverse Leontief matrix ($(I-1)-1$

A similar analysis applies to the multipliers for import requirements, product taxes, wages/salaries for labor, and business surplus.

West & Jensen (1980) explained there are several types of impacts when changes occur in sector i. These impact types include the initial impact, direct impact, indirect impact, spillover impact, total impact, and overflow impact. Furthermore, (West & Jensen 1980) also developed a formula to calculate the multiplier effect based on these impact types as follows:

RESULT AND DISCUSSION

The 2010 IO and the 2016 IO both use the same IO table dimensions of 185 x 185 (sector/product). They also classify upstream oil and gas activities under the mining and excavation sector (sector code 17). Linkages between Indonesia's upstream oil and gas sector and other economic sectors are summarized in Table 2 and Table 3 below, based on simulated calculations carried out on two available IO databases, namely 2010 IO and 2016 IO.Table 2. Number of Sectors with Linkages to the Upstream Oil and Gas Sector (2010 IO).Source: Simulated calculations and analysis.

The above tables show a change (increase) in the total number of sectors linked to the upstream oil and gas sector. The 2010 IO Database identified 93 sectors with linkages to the upstream oil sector and 104 to the upstream gas sector, whereas the 2016 IO Database identified 96 sectors with linkages to the upstream oil sector and 113 to the upstream gas sector. The two tables above also demonstrate changes in the number of input supplier sectors and output user sectors for the upstream oil and upstream gas sectors, as identified by both the 2010 IO Database and 2016 IO Database.

Table 1
Formula for the multiplier effect based on impact types

Type of Impact	Output	Income
Initial Impact	1	P_1
Direct Impact	$\sum a_{ij}$	$\sum a_{ij}P_1$
Indirect Impact	$\sum g_{ij}-1-\sum a_{ij}$	$\sum g_{ij}P_i-P_i-\sum a_{ij}P_i$
Consumption Spillover Impact	$\sum(g^*_{ij}-g_{ij})$	$\sum(g^*_{ij}P_i-g_{ij}P_i)$
Total Impact	$\sum g^*_{ij}$	$\sum g^*_{ij}P_i$
Overflow Impact	$\sum g^*_{ij}-1$	$\sum g^*_{ij}P_i-P_i$

Note: a_{ij} is the direct input coefficient, g_{ij} is the open Leontief inverse coefficient, g^*_{ij} is the closed Leontief inverse coefficient and P_i is the household income coefficient.

Table 2
Number of sectors with linkages to the upstream oil and gas sector (2010 IO)

2010 IO	Input Supplier Sectors	Output User Sectors	Total
Upstream Oil	69	24	93
Upstream Gas and Geothermal	71	33	104

Source: Simulated calculations and analysis

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Table 3
Number of sectors with linkages to the upstream oil and gas sector (2016 IO)

2016 IO	Input Supplier Sectors	Output User Sectors	Total
Upstream Oil	79	17	96
Upstream Gas and Geothermal	83	30	113

Source: Simulated calculations and analysis

Table 4
Upstream oil and gas sector linkage index

Sector	Backward Linkage Index		Forward Linkage Index		Total Linkage Index	
	2010 IO	2016 IO	2010 IO	2016 IO	2010 IO	2016 IO
Upstream Oil	0.9514	0.7463	2.9287	3.3363	3.8801	4.0826
Upstream Gas and Geothermal	0.7538	0.7625	2.3718	2.6315	3.1256	3.3940

Source: Simulated calculation results

The increase in the total number of sectors linked to the upstream oil and gas sector is directly proportional to the increase in the total linkage index of the upstream oil and gas sector, which encompasses linkages to the input supplier sectors (backward linkage index) and the output user sectors (forward linkage index). The simulated calculations of these findings are summarized in Table 4 below.

Table 4 shows an increase in the total linkage index values of the upstream oil and gas sector, from 3.8801 to 4.0826 for the upstream oil sector, and from 3.1256 to 3.3940 for the upstream gas sector. Meanwhile, the backward linkage index value of the upstream oil sector experienced a decrease, dropping from 0.9514 to 0.7463. However, this decline was still smaller than the increase of 2.9287 to 3.363 in the forward linkage index.With regard to multiplier effects, simulated calculations using the 2010 IO Database and 2016 IO Database also pointed toward an increase in total multiplier index values, from 6.1855 to 7.8943 for the upstream oil sector and from 4.9828 to 6.5630 for the upstream gas sector. While the total multiplier index increased, the value of the backward multiplier index for the upstream oil sector declined from 1.5167 to 1.4431. Still, the increase in the forward multiplier index was greater, rising from 4.6689 to 6.4513. Results of multiplier index calculations are summarized in Table 5.

Tables 4 and 5 show a consistent pattern in the upstream oil and gas linkage index values and total multiplier index values. Changes and shifts in the linkage between the economic sector and others directly correlate with its multiplier effect on the economy.

The calculations resulted in no anomalies. They indicate the presence of changes and shifts in linkages between the upstream oil and gas sector and other sectors within the economy. In this regard, further simulated calculations and analyses identified changes (differences) in the contributing sectors and the portion of their inputs to the upstream oil and gas sector. Tables 6 and 7 below present the 15 sectors that contribute the largest percentage of inputs to the upstream oil and gas sector.

Based on the percentage of inputs each sector provided to the upstream oil and gas sector in the 2010 IO and 2016 IO databases, Tables 6 and 7 reveal changes and shifts in linkages between the upstream oil and gas sector and the input supplier sectors. For example, inputs contributed by the oil and gas mining

services sector to the upstream oil sector increased from 5.03% to 24.34%, and from 8.02% to 18.44% to the upstream gas sector. The rise in inputs from the oil and gas mining services sector exhibits stronger linkages between this particular input supplier sector and the upstream oil and gas sector. In other words, based on the database used, backward linkages between the upstream oil and gas sector and oil and gas mining services as an input supplier sector increased over the analyzed time frame.

In the case of forward linkages with output sectors, further results from simulated calculations and analyses identified changes and shifts in inter-sectoral linkages based on an assessment of the percentage of upstream oil and gas outputs allocated to these sectors. Tables 8 and 9 below present the calculation results for the 15 sectors with the highest percentage of output allocations from the upstream oil and gas sector to other sectors, according to the 2010 IO and 2016 IO databases.

Based on the percentage values of allocated outputs from the upstream oil and gas sector in the 2010 IO and 2016 IO databases, Tables 8 and 9 above reveal changes and shifts in linkages between the upstream oil and gas sector and output user sectors. As an example, in the oil sector, the basic chemicals (excluding fertilizer) sector reported an increase in output allocations, up from 6.98% to 21.02%. In the gas sector, the output allocation for the electricity sector increased from 10.83% to 34.25%. These increases reflect the rising forward linkages between the upstream oil and gas sector and these two user sectors, resulting in relative shifts and changes in the forward linkages of the upstream oil and gas sector to other user sectors.

Table 5
Upstream oil and gas sector multiplier Index

Sector	Backward Multiplier		Forward Multiplier		Total Multiplier	
	2010 IO	2016 IO	2010 IO	2016 IO	2010 IO	2016 IO
Upstream Oil	1.5167	1.4431	4.6689	6.4513	6.1855	7.8943
Upstream Gas and Geothermal	1.2016	1.4744	3.7811	5.0885	4.9828	6.5630

Source: Simulated calculation results

Table 6
Linked sectors to upstream oil and gas with the largest input contribution by percentage (2010 IO)

Sector Code	Sector	Input to Oil Sector	Sector Code	Sector	Input to Gas & Geothermal Sector
39	Gas and Geothermal	20.50 %	39	Gas and Geothermal	58.69%
38	Oil	18.12 %	51	Oil and Gas Mining Services	8.02%
150	Electricity, Gas, Drinking Water, and Communication Buildings & Installations	7.07%	175	Professional, Scientific, and Technical Services	7.42%
171	Insurance Services	6.94%	150	Electricity, Gas, Drinking Water, and Communication Buildings & Installations	4.12%
175	Professional, Scientific, and Technical Services	6.74%	170	Financial Banking Services	2.96%
51	Oil and Gas Mining Services	5.03%	176	Leasing and Business Support Services	2.76%
52	Mining and Excavation Services	4.90%	171	Insurance Services	1.96%
95	Refined Oil and Gas Products	3.05%	164	Accommodation	1.42%
170	Financial Banking Services	2.94%	161	Air Freight Services	1.34%
176	Leasing and Business Support Services	2.78%	177	General Government Services	1.09%
177	General Government Services	2.73%	172	Pension Fund Services	0.81%
161	Air Freight Services	1.62%	159	Sea Freight Services	0.72%

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Table 6 (Continued)
Linked sectors to upstream oil and gas with the largest input contribution by percentage (2010 IO)

Sector Code	Sector	Input to Oil Sector	Sector Code	Sector	Input to Gas & Geothermal Sector
168	Telecommunication Services	1.39%	95	Refined Oil and Gas Products	0.71%
130	Other Machinery and Equipment	1.27%	131	Motor Vehicles (Excluding Motorcycles)	0.59%
92	Paper and Cardboard Goods	1.23%	153	Other Buildings	0.53%

Source: Simulated calculations and analysis

Table 7
Linked sectors to upstream oil and gas with the largest input contribution by percentage (2016 IO)

Sector Code	Sector	Input to Oil Sector	Sector Code	Sector	Input to Gas & Geothermal Sector
51	Oil and Gas Mining Services	24.34%	39	Gas and Geothermal	24.73%
176	Leasing and Business Support Services	7.18%	51	Oil and Gas Mining Services	18.44%
39	Gas and Geothermal	6.63%	176	Leasing and Business Support Services	6.73%
170	Financial Banking Services	5.19%	153	Other Buildings	6.00%
95	Refined Oil and Gas Products	4.98%	128	Motor Starters	5.21%
128	Motor Starters	4.63%	96	Basic Chemicals (Excluding Fertilizer)	4.53%
173	Other Financial Institution Services	4.29%	170	Financial Banking Services	3.67%
153	Other Buildings	3.70%	38	Oil	3.03%
159	Sea Freight Services	3.68%	173	Other Financial Institution Services	2.84%
171	Insurance Services	3.64%	145	Electricity	2.55%
96	Basic Chemicals (Excluding Fertilizer)	3.54%	174	Real Estate Services	2.19%
177	General Government Services	3.46%	131	Motor Vehicles (Excluding Motorcycles)	2.06%
160	River, Lake, and Crossing Transport Services	2.92%	95	Refined Oil and Gas Products	1.85%
145	Electricity	2.91%	158	Land Transport Services Excluding Rail Transport	1.79%
161	Air Freight Services	2.34%	149	Residential and Non-Residential Buildings	1.61%

Source: Simulated calculations and analysis

Table 8
Linked sectors to upstream oil and gas with the largest output allocations by percentage (2010 IO)

Sector Code	Sector	Oil Sector Output Allocation	Sector Code	Sector	Natural Gas & Geothermal Sector Output Allocation
95	Refined Oil and Gas Products	68.96%	95	Refined Oil and Gas Products	48.77%
96	Basic Chemicals (Excluding Fertilizer)	8.98%	145	Electricity	10.83%
37	Coal and Lignite	7.33%	38	Oil	9.98%
38	Oil	6.24%	39	Gas and Geothermal	9.29%
104	Other Chemical Products	2.32%	96	Basic Chemicals (Excluding Fertilizer)	5.82%
97	Fertilizer	1.86%	146	Natural and Artificial Gas Products, Steam and Hot Water Supply, Cold Water and Ice Supply	4.19%
94	Other Non-Metallic Goods	1.73%	115	Non-Iron Base Metal	3.74%
110	Plastic Goods	1.35%	114	Iron and Steel	3.13%
105	Pharmaceutical Products	0.95%	120	Other Metal Goods	1.04%
109	Other Rubber Goods	0.12%	117	Metal Building Materials	0.92%
175	Professional, Scientific, and Technical Services	0.05%	94	Other Non-Metallic Goods	0.87%
162	Transportation Support Services	0.04%	110	Plastic Goods	0.62%
145	Electricity	0.03%	112	Clay, Ceramic, and Porcelain Goods	0.60%
176	Leasing and Business Support Services	0.02%	119	Kitchenware, Carpentry Tools, Household and Office Furniture From Metal	0.06%
174	Real Estate Services	0.01%	116	Metal Casting Goods	0.04%

Source: Simulated calculations and analysis

Table 9
Linked sectors to upstream oil and gas with the largest output allocations by percentage (2016 IO)

Sector Code	Sector	Oil Sector Output Allocation	Sector Code	Sector	Natural Gas & Geothermal Sector Output Allocation
95	Refined Oil and Gas Products	74.57%	145	Electricity	34.25%
96	Basic Chemicals (Excluding Fertilizer)	21.02%	95	Refined Oil and Gas Products	28.75%
98	Synthetic Resin, Plastic Materials, and Synthetic Fibers	1.47%	97	Fertilizer	8.19%
97	Fertilizer	1.07%	39	Gas and Geothermal	7.43%
104	Other Chemical Products	0.73%	146	Natural and Artificial Gas Products, Steam and Hot Water Supply, Cold Water and Ice Supply	6.55%
39	Gas and Geothermal	0.71%	96	Basic Chemicals (Excluding Fertilizer)	3.65%
38	Oil	0.41%	112	Clay, Ceramic, and Porcelain Goods	2.25%
99	Pesticide	0.01%	38	Oil	1.84%
51	Oil and Gas Mining Services	0.00%	111	Glass and Glassware	1.67%
110	Plastic Goods	0.00%	114	Iron and Steel	1.58%
105	Pharmaceutical Products	0.00%	98	Synthetic Resin, Plastic Materials, and Synthetic Fibers	1.26%
162	Transportation Support Services	0.00%	113	Cement	0.58%
176	Leasing and Business Support Services	0.00%	116	Metal Casting Goods	0.57%
146	Natural and Artificial Gas Products, Steam and Hot Water Supply, Cold Water and Ice Supply	0.00%	115	Non-Iron Base Metal	0.55%
102	Soap and Cleaning Agents	0.00%	130	Other Machinery and Equipment	0.32%

Source: Simulated calculations and analysis

Such changes or shifts in backward or forward linkages correlate with changes in the total multiplier index values of the upstream oil and gas sector. In this context, an increase in the national upstream oil and gas sector's total multiplier index value is brought about by increased linkages between the upstream oil and gas sector and other sectors in Indonesia's economy as a whole, both in the backward and forward direction. The greater the multiplier index of a sector with linkages to the upstream oil and gas sector, the greater the total multiplier index of the upstream oil and gas sector produced. In this context, simulated calculations and analyses identified more sectors that exhibit strong linkages to the upstream oil and gas sector with large multiplier index values. Among these sectors are the electricity sector and the basic chemicals (excluding fertilizer) sector, which have a multiplier index value of 10.8752 and 15.3582, respectively. Further research to determine the multiplier index values of other sectors with considerably strong linkages to the oil and gas sector would produce a more complete picture of these sectors' contribution toward multiplier effects created by the upstream oil and gas sector on Indonesia's national economy.

CONCLUSION

The conclusion and recommendation derived from the simulated calculations and analyses conducted in this study are as follows: 1). The total number of sectors with identified linkages to the upstream oil and gas sector has changed (increased). The 2010 IO Database identified 93 sectors with linkages to the upstream oil sector and 104 to the upstream gas sector, whereas the 2016 IO Database identified 96 sectors with linkages to the upstream oil sector and 113 to the upstream gas sector; 2). The increase in the total number of sectors linked to the upstream oil and gas sector is directly proportional to the increase in the total linkage index of the upstream oil and gas sector, which encompasses linkages to input supplier sectors (backward linkage index) and output user sectors (forward linkage index). In this regard, there was an increase in the total linkage index values of the upstream oil and gas sector, from 3.8801 to 4.0826 for the upstream oil sector and from 3.1256 to 3.3940 for the upstream gas sector; 3). With regard to multiplier effects, simulated calculation results using the 2010 IO Database and 2016 IO Database also pointed toward an increase in total multiplier index values, from

6.1855 to 7.8943 for the upstream oil sector and from 4.9828 to 6.5630 for the upstream gas sector; 4). Changes and shifts in the linkages between the upstream oil and gas sector and other sectors were also observed. Such changes or shifts in backward or forward linkages correlate with changes in the upstream oil and gas sector's total multiplier index values; 5).The increase national upstream oil and gas sector's total multiplier index correlates with an increase in linkages between the upstream oil and gas sector and other sectors in Indonesia's economy as a whole, both backward and forward; 6). The greater the multiplier index of a sector with linkages to the upstream oil and gas sector, the greater the total multiplier index of the upstream oil and gas sector produced. In this context, the electricity sector and the basic chemicals (excluding fertilizer) sector have strong linkages to the upstream oil and gas sector, as evident from their large multiplier index values of 10.8752 and 15.3582, respectively; 7). Further research to determine the multiplier index values of other sectors with considerably strong linkages to the oil and gas sector is needed to produce a more complete picture of these sectors' contribution to the upstream oil and gas sector's multiplier effects on Indonesia's national economy.

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GLOSSARY OF TERMS

Symbol	Definition	Unit
IO	Input Output	
BPS	Indonesia's Central Agency of Statistics	
2005 IO	BPS IO Database 2005 published in 2010	
2010 IO	BPS IO Database 2010 published in 2015	
2016 IO	BPS IO Database 2016 published in 2021	
MPM	Multiplier Product Matrix	
BL	Backward Linkage	
FL	Forward Linkage	

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