Jurnal Ekonomi Pembangunan
Volume 20 (2): 205-224, December 2022
P-ISSN: 1829-5843; E-ISSN: 2685-0788

Research article

Linkages between Sectors and Regions in the Aceh Economy

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Article Info: Received: 27 August 2022; Accepted: 29 December 2022; Published: 31 December 2022

Abstract: This study analyzes the economy of Aceh not only based on the linkage between industries but also based on the linkage between regions. The analysis used forward linkages and backward links to determine the leading sectors in Aceh. The data used is secondary data from Indonesia's 2016 Inter-Regional Input Output (IRIO) based on domestic transactions at producer prices. The data is sourced from Statistics Indonesia. The study results show that the key sectors in Aceh are Electricity and Gas and Manufacturing. These sectors have the highest spreading power (backward linkage) and sensitivity (forward linkage) because they are in the first quadrant. In addition, inter-regional linkage analysis shows that the final demand shock in Aceh has a large output impact on DKI Jakarta, North Sumatera, and Riau. On the other hand, the economy of Aceh was affected by the final demand shock from several provinces on the island of Sumatra, namely North Sumatera, Bengkulu, West Sumatera, Jambi, and Sumatra Selatan. The policy implications that can be applied to increase labor skills and management in leading sectors will have a multiplier effect on other sectors and the cooperation between provinces in a special economic zone.

Keywords: IRIO, Aceh, backward linkage, forward linkage

JEL Classification: R10, R11, R15

Abstrak: Kajian ini menganalisis perekonomian Aceh tidak hanya berdasarkan keterkaitan antar industri tetapi juga berdasarkan keterkaitan antar wilayah. Analisis menggunakan keterkaitan ke depan dan keterkaitan ke belakang untuk menentukan sektor unggulan di Aceh. Data yang digunakan adalah data sekunder dari Inter-Regional Input Output (IRIO) Indonesia tahun 2016 berdasarkan transaksi domestik dengan harga produsen. Data tersebut bersumber dari Badan Pusat Statistik Indonesia. Hasil kajian menunjukkan bahwa sektor unggulan di Aceh adalah Listrik dan Gas serta Manufaktur. Sektor-sektor tersebut memiliki daya sebar (backward linkage) dan sensitivitas (forward linkage) yang paling tinggi karena berada pada kuadran pertama. Selain itu, analisis keterkaitan antar daerah menunjukkan bahwa guncangan permintaan akhir di Aceh memiliki dampak output yang besar di DKI Jakarta, Sumatera Utara, dan Riau. Di sisi lain, perekonomian Aceh dipengaruhi oleh guncangan permintaan akhir dari beberapa provinsi di Pulau Sumatera, yaitu Sumatera Utara, Bengkulu, Sumatera Barat, Jambi, dan Sumatera Selatan. Implikasi kebijakan yang dapat diterapkan untuk peningkatan keterampilan dan manajemen tenaga kerja di sektor unggulan akan memberikan multiplier effect pada sektor lain dan kerjasama antar provinsi dalam kawasan ekonomi khusus.

Kata kunci: IRIO, Aceh, keterkaitan ke belakang, keterkaitan ke depan

How to Cite:
Jannah, M., & Junaidi, E. (2022). Linkages between Sectors and Regions in the Aceh Economy. *Jurnal Ekonomi Pembangunan, 20*(2), 205-224. DOI: 10.29259/jep.v20i218492

1. INTRODUCTION

Economic development refers to a set of plans and policies aiming at raising people's living standards, providing job possibilities, ensuring equitable income distribution, and enhancing regional economic links (BPS Aceh, 2021). To attain this goal, integrated planning between sectors

(industry) and regions (provinces) is required to optimize economic development outcomes. It is important to evaluate the element of inter-sectoral linkages because the development of a sector needs the involvement of other sectors, both as input providers and/or as end users of the sector's output. As a result, progress in one area is impossible to achieve without the help of other sectors. Meanwhile, inter-regional connections are critical since not all the inputs required to produce outputs are available inside the areas. This is owing to a scarcity of resources within the region. As a result, other regions must be capable of supporting it.

In the second quarter of 2021, Aceh has the second lowest GRDP growth rate. Aceh barely grew by 2.56 percent when Indonesia's growth rate jumped by 7.07 percent. As a result, Economic growth of Aceh must be accelerated to stay ahead with the COVID-19 pandemic. The acceleration of economic growth cannot be separated from efforts to develop the production sector in Aceh and strengthen regional relations with neighboring provinces to advance the Aceh economy. This can be accomplished by focusing on policies that promote the growth of leading sectors, such as sectors with both backward and forward linkages, as well as policies for collaborating with other provinces that have a significant impact on economy of Aceh. This aims to improve the performance of Aceh's economic sectors so that they can have a multiplier effect on the Gross Regional Domestic Product (GRDP).

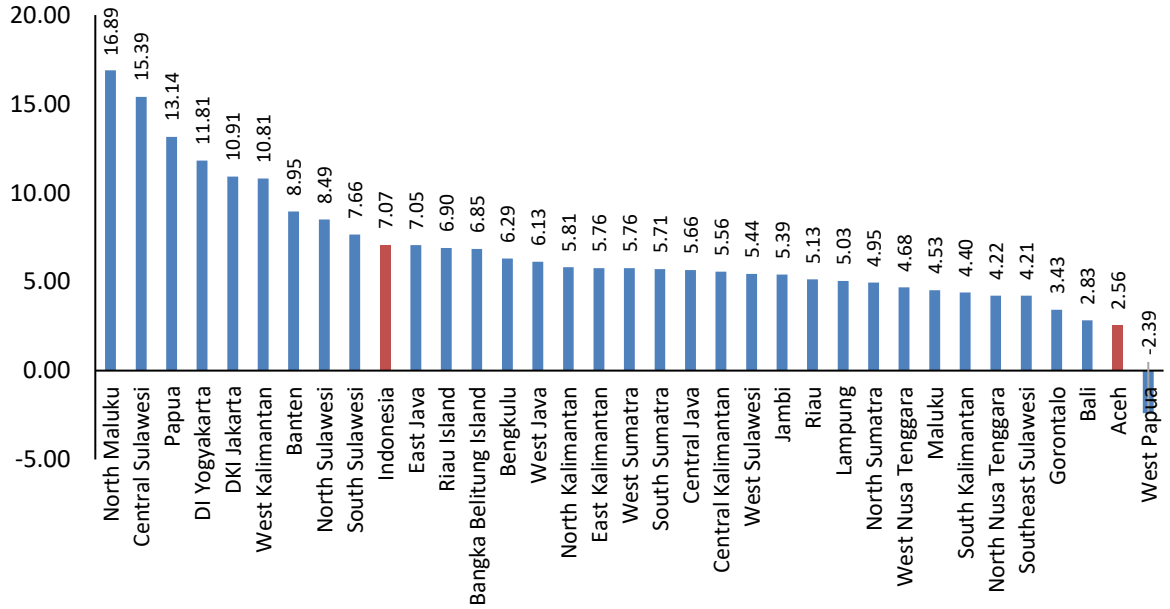

Figure 1. GRDP growth at constant prices 2010 by province in Quarter II-2021 (y-on-y)
Source: Statistics Indonesia-BPS (2021)

The IRIO of Aceh analysis can be used to examine the economic structure, namely the linkages that exist between different economic sectors as well as inter-regional trade relations. The government of Aceh can use the study of inter-sectoral linkages, inter-regional linkages, and analysis of leading sectors as a basis for planning and policymaking about the economic development strategy's direction. Changes in the economic structure of a region can be used to track the economic development of a country. The Input-Output (I-O) model is one of the quantitative models that may be used to describe a region's economic structure in detail. The relationship or linkages between sectors can be described using the ordinary I-O model. In practice, an area's economic activity is fueled through linkages with other regions. The I-O model was extended into an Inter-Regional Input-Output model, also known as the Interregional Input Output (IRIO) model, to describe inter-regional linkages. The economy's structure is depicted in a specific time and static in the I-O and IRIO models.

Several research studies have been performed in Aceh to examine inter-sector linkages and the multiplier effect on the economy. According to Abdullah et al. (2014), using the Aceh Input Output Table in 2006 to analyze the level of inter-sectoral linkage and determine the leading sector in Aceh,

the leading sectors in first quadrant that have the spreading power and degree of sensitivity i.e the mining sector, oil and gas industry, coffee sector, rice, livestock and their products, food industry, beverage and tobacco industry, and urea fertilizer and basic chemicals industry. Rosmika (2020) using the Input Output Table of Aceh to analyze the linkage and output multiplier, the highest output multiplier is manufacture of food, beverage, and tobacco.

Additionally, Hirawan & Nurkholis (2008) used IRIO data from 1995 and 2000 to examine the inter-sectoral and inter-regional linkages of all Indonesian provinces, including Aceh. Study by Nurkholis & Brodjonegoro (2003) used the IRIO model with 1999 data to examine the influence of fiscal decentralization on the economy between regions in their study. Then, Luhur et al. (2014) used the 2020 IRIO table data in this study to examine the relation of the marine affairs and fisheries sector between Indonesia's main island regions. Nurlina (2018) used the 2005 Input Output Table in this research to determine the relationship between the fisheries sub-sector and other economic sectors in Aceh. Furthermore, using GRDP data based on constant prices for the 2010 base year for the period 2012 to 2016. Study by Najmi (2017) analyzes and identifies the potential sectors of the economy in Aceh so that they can be used as leading sectors that are advanced and developing. In their study, Nurlina et al. (2019) use the GRDP to examine the leading sectors in the Eastern Aceh region from 2010 to 2016. The study by Maulana & Jamal (2016) analyzes the most superior sector in Aceh for 9 sectors. The results show of the basis sectors in Aceh are the Manufacture of Oil and Gas Refinery Products, the Land Transport, and the Manufacture of Metal, Machinery and Equipment. Rozana et al. (2019) in the study focuses on analyzing the role of the agricultural sector in the Aceh Province economy structure. This study used Input-Output Tables of 1998, 2006 and 2012. The results of the study shown that the agricultural sector has an important role in the Aceh Province Economy Structure, as evidenced by the increase in output throughout the year.

BPS and Agency for Regional Development (*Badan Perencanaan Pembangunan, Penelitian dan Pengembangan Daerah*/BAPPEDA) in West Sulawesi (2019) studied the province's Input Output table in 2016, which included economic development through leading agricultural commodities, industrialization strategies, and the impact of Regional Revenues and Expenditure Budget (*Anggaran Pendapatan dan Belanja Daerah*/APBD) on output. Tenrini (2013) used the Input Output Table analysis to continue the study to evaluate regional development planning in Bangka Belitung Island in 2005. Study by Isdiana & Aminata (2019) conducted a study to examine on Indonesia's exports to APEC countries through maritime transportation. The findings reveal that Indonesia's GDP per capita, QPI, CPT, economic distance, and REER have a significant effect on the volume of its exports via maritime transportation modes. Meanwhile, trading partner countries' changing GDP per capita has a negative and insignificant effect. Fitria & Rizki (2018) used data from 2001 to 2016 to examine the impact of realized spending on economic growth in Aceh, finding a significant positive relationship between capital expenditures and economic growth. Adyaharjanti and Hartono (2016) used the Input-Output Table 2010 and the Miyazawa model in their study to examine the effect of tourist expenditure on the Indonesian economy. According to the author's knowledge, economic analysis of Aceh using the IRIO table has not been widely researched. Using the IRIO model, Arman et al. (2016) examine the economic linkages between the islands of Sulawesi, East Java, and East Kalimantan with the regional economy. North Sulawesi, Central Sulawesi, and Gorontalo were grouped as Other Sulawesi Province, while the provinces of West Sulawesi and South Sulawesi were grouped as South Sulawesi. The findings revealed that the economic linkages in the four regions showed that East Java had greater benefits, but the economic performance and growth had a minor spillover effect in Sulawesi and Kalimantan.

Firmansyah et al. (2015) in the study focuses on the Manufaturing Sector on the economy in Jambi, where the Manufacturing Sector has the largest direct forward linkage and direct backward linkage is the Manufacture of Fertilizer, meanwhile the simulation injection of direct expenditure economic growth that relatively larger than indirect expenditure. In their study, Mushlih et al. (2018) analyzed the pattern of economic landscape of economic in East Java using input-output tabel during the period 2000 to 2015 with the Multiplier Product Matrix (MPM). The study by Widyawati (2017) result with the input-output Indonesia 2018 showed that the manufacturing sector and electricity, gas, water sector had forward linkage to the agricultural sector. Furthermore, the

electricity, gas, water sector; and the building sector have backward linkages to the agriculture sector. Subanti & Hakim (2009) in their research to study the economy in Southeast Sulawesi show the basic sectors are agriculture; construction; transportation and communication; and the service sector.

Several studies from other countries have been adopted in this study. The study by Guilhoto, Sonis, & Hewings (1999) analyze the matrix for inter-regional input-output systems ini Brazilian Economy using Miyazawa's concepts of left and right multipliers. Xing (2017) on the study showed that the competition and collaboration between industrial sectors using global industry strongest relevant network model with inter-country I-O Table. Study by Meng & Yamano (2017) developed a new framework for measuring domestic linkages to global value chains by embedding a target country's domestic interregional input-output tables into the OECD inter-country Input-Output model. Another study by Sim et al. (2007) developed a modified interregional input-output (IRIO) table especially inter-country with the economy's link using the Chenery-Moses model.

Through analyzing the economy, the research previously stated only focused on the linkages between sectors. In fact, changes in the economy have an impact not only on its province, but also on neighboring provinces. The inter-regional import-export mechanism allows the inter-regional economy to depend on each other. Aceh imports goods and services from other provinces for use in the production process and final demand, while also exports goods and services to be used as production inputs or final demand by other provinces. As a result, this study will look at the economy of Aceh not only from the perspective of industry, but also from the perspective of provinces. The Inter Regional Input Output (IRIO) framework can be used to conduct a linkage analysis between provinces.

The study focuses on what are the leading sectors in Aceh that contribute to improving the province's economy. In addition, an in-depth analysis of inter-regional economic influences is interesting to find out which provinces have contributed to influencing and being affected by the economic conditions of Aceh. So that, the study aims to determine whether business sector has a Power Dispersion Index or forward linkage and a Degree of Sensitivity Index or backward linkage impact level above the average (>1), based on the 2016 IRIO Table analysis in Aceh. The other focus is to find out how Aceh links with other provinces in terms of managing the Aceh economy.

2. RESEARCH METHODS

The data used in this research were sourced from publication and dynamic tables published by BPS. The data and variables collected are as follows: (i) Input-Output Table 2016 of Aceh, 17x17 sectors; (ii) Input-Output Table 2016 of Aceh, 52x52 sectors; and (iii) Inter-Regional Input Output Table 2016, 52x52 sectors and 34 province. The Interregional Input-Output (IRIO) model is a development of the regional Input-Output (I-O) model. The main aspect in this model is the measuring and modeling of the interdependence of economic activities separated into multiple sectors in one region with other regions. The national IRIO data or tables are basically a combination of I-O tables for all of the regions. Tables of inter-regional trade transactions connect all of these regions' I-O tables to each other. The flow of commodities from one area to another is depicted in this table of inter-regional trade transactions. As a result, exports and imports from one region to another can be examined in this table of inter-regional trade transactions. The term export or import for trade transactions between regions is referred to as interregional trade (Lab. Ilmu Ekonomi FEUI, 2005).

The intermediate transaction matrix is also known as the Z matrix, which describes transactions between sectors and between regions. Thus, the Z diagonal matrix describes transactions between sectors in the same region. For example, $Z^{11\ 11}$ is a transaction matrix between sectors in Aceh. Meanwhile, Z's off-diagonal matrix is a transaction matrix between a sector in one region other sectors in another region. For example, matrix $Z^{11\ 94}$ is a transaction matrix between sectors from Aceh and Papua, where Aceh is the producer and Papua is the consumer. If expressed as Z_{ij}^{ab}, it can be interpreted as the quantity of sector output in the region that is used as input by sector j in region b.

Table 1. Intermediate transaction matrix in Indonesian IRIO Table 2016 by 34 Provinces and 52 Industries

Province	Industry	11. Aceh				...		94. Papua		
		1	...	52	...	...	...	1	...	52
11. Aceh	1	$Z_{1\ 1}^{11\ 11}$	...	$Z_{1\ 52}^{11\ 11}$	...	...	...	$Z_{1\ 1}^{11\ 94}$	...	$Z_{1\ 52}^{11\ 94}$
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	52	$Z_{52\ 1}^{11\ 11}$	...	$Z_{52\ 52}^{11\ 11}$	...	...	...	$Z_{52\ 1}^{11\ 94}$	...	$Z_{52\ 52}^{11\ 94}$
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
94. Papua	1	$Z_{1\ 1}^{94\ 11}$	...	$Z_{1\ 52}^{94\ 11}$	...	...	...	$Z_{1\ 1}^{94\ 94}$	...	$Z_{1\ 52}^{94\ 94}$
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	52	$Z_{52\ 1}^{94\ 11}$	...	$Z_{52\ 52}^{94\ 11}$	...	...	...	$Z_{52\ 1}^{94\ 94}$	...	$Z_{52\ 52}^{94\ 94}$

Source: Oosterhaven & Hewings (2014)

The IRIO table, like the I-O table, has a final demand matrix for each region and a primary input matrix for each region. The Final demand consists of household consumption expenditure, non-profit institutions serving households (*Lembaga Non Provit Rumah Tanggah*/LNPRT) consumption expenditure, general government consumption expenditure, gross fixed capital formation (*Pembentukan Modal Tetap Bruto*/PMTB, changes in inventories and export of goods and services. Meanwhile, the primary inputs consist of labor compensation, gross operating surplus (including mixed income) and taxes minus subsidies on other production. The basic formula for the inter-regional input-output model with 34 provinces and 52 industries can be calculated from the IRIO Table, namely:

$$X_i^{Aceh} = \sum_{j=1}^{52} z_{ij}^{11\ 11} + \cdots + \sum_{j=1}^{52} z_{ij}^{11\ 94} + Y_i^{11} \quad (1)$$

and so on until:

$$X_i^{Papua} = \sum_{j=1}^{52} z_{ij}^{94\ 11} + \cdots + \sum_{j=1}^{52} z_{ij}^{94\ 94} + Y_i^{94} \quad (2)$$

where, X is the quantity of output and Y is the quantity of final demand.

The IRIO model can analyze the leading sectors through backward and forward linkage analysis, output multiplier, labor multiplier, income multiplier, and other methods similar to the I-O model. In I-O, the transaction effect is intraregional effect, because it is only in a certain area. Intraregional transactions can also be examined using the IRIO model.

The interregional effect and interregional feedback effect, which are not recognized in the I-O model, are the differences between the IO table and the I-O model. Inter-regional transactions cause these two types of effects. The intraregional effect, as defined by the IRIO model, is the effects of changes in exogenous factors in one sector on other sectors in the same area. The impact of changes in exogenous variables in other areas on a sector in a specific location is known as the interregional effect. The interregional effect is often referred to as the interregional spillover effect because it describes the linkages and interactions between regions. Changes in exogenous factors in the region itself are causing increases in output in other locations, which will eventually lead to changes in final demand in the region. This condition is referred to as the interregional feedback effect.

2.1. Technical Coefficient

The technical coefficient or also known as the intermediate input coefficient can be defined as the number of inputs required from each sector to produce one unit of output in a particular sector.

This coefficient is obtained by dividing each cell entry in quadrant I by the total output in each column. The domestic technical coefficient is denoted by α_{ij} formulated with the following formulation:

$$\alpha_{ij} = \frac{z_{ij}}{z_j} \tag{3}$$

where, b_{ij} is the technical coefficient of sector j originating from domestic production (without imports) sector i, z_{ij} is input between sector j originating from domestic production (without imports) sector i, and z_j is output of sector j.

According to Sonis and Hewings (1992), the most important assumption in the Input-Output theory proposed by its creator Wasily Leontief was the assumption of constancy of direct input coefficients. The technical coefficient is assumed to be unchanged so that it is said to be a fixed measure of the relationship between output and input or in other words a sector uses inputs in a fixed proportion. The entire technical coefficient can be presented in the technical coefficient matrix (A). If $\alpha_{ij}^{11} \epsilon A_{11}$; $\alpha_{ij}^{22} \epsilon A_{22}$; $\alpha_{ij}^{12} \epsilon A_{12}$; and $\alpha_{ij}^{21} \epsilon A_{21}$ then the inter-industry flows matrix can be ilustrated in a block matrix form as follows:

$$A = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \tag{4}$$

where, A_{11} and A_{22} are the inter-industry flows in the region, while $\boldsymbol{A_{12}}$ and $\boldsymbol{A_{21}}$ are the inter-industry flows between region 1 and region 2.

2.2. Multiplier Analysis

Based on the Leontief inverse matrix, it can be used to calculate the multiplier of output and gross value added (GVA). The relationship between output and final demand can be described as follows.

$$X = (I - A)^{-1} F \tag{5}$$

where, X is column vector of output multiplier, I is identity matrix, and A is input coefficient matrix. F is column Vector of Final Demand and $(I - A)^{-1}$ is the multiplier matrix.

Meanwhile, the relationship between output and gross value added (NTB) can be described as follows.

$$V = \tilde{v}\, X \tag{6}$$

where, V is gross value added matrix, $\tilde{v}$ is diagonal matrix of gross value added coefficient, and $X\ is\ (I - A)^{-1} F$ or column vector of output multiplier.

2.3. Hirschman-Rasmussen Index

A relatively popular method to do a comparative analysis of the economic structures of different regions is through the classification of existing sectors into key sectors and non-key sectors. The basic concept behind these classification is by measuring backward linkages (a demand pull concept) and forward linkages (a supply push concept) as developed by Hood and Rasmussen (1956), and also Hirschman (1958). A sector is classified as a key sector if the growth effect in this sector is greater than the average growth effect of all the other sectors on the economy of the country (Hewings, 1982). Two commonly used indices are as follows:

2.3.1. Power of Dispersion Index

The power of dispersion analysis describes how a sector's demand affects other production sectors. The total distribution power shows the impact of one unit of final demand in a sector on overall economic growth. Backward linkage is measured by the number of dispersion power.

$$BL_j = \frac{\sum_{i=1}^{n} b_{ij}}{\left(\frac{1}{n}\right)\sum_i \sum_j b_{ij}} \quad (7)$$

where, BL_j is power of Dispersion Index of sector-*j*, n is number of sectors and b_{ij} is Leontief inverse matrix element $(I - A)^{-1}$ row i column j.

The value of the quantity BL_j can be one, more than one, or less than one. The dispersion power of sector *j* is equal to the average dispersion of all economic sectors if α_j = 1. Meanwhile, if $BL_j > 1$, sector *j*'s dispersion power is more than the average dispersion of all economic sectors, and opposite, if $BL_j < 1$, sector *j*'s dispersion power is lower than the average economic sector.

2.3.2. Degree of Sensitivity Index

The degree of sensitivity analysis is an analysis that describes the ability of a sector to supply other production sectors. The number of degrees of sensitivity shows how the final demand for each sector of the economy impacts the production of output in that region. Forward linkage is measured by the number of degrees of sensitivity.

$$FL_i = \frac{\sum_{j=1}^{n} b_{ij}}{\left(\frac{1}{n}\right)\sum_i \sum_j b_{ij}} \quad (8)$$

where, b_{ij} is Leontief inverse matrix element $(I - A)^{-1}$ row i column j; FL_i: Degree of Sensitivity Index of sector i, and n is number of sectors.

The value of $FL_i > 1$ indicates that sector *i* has a higher degree of sensitivity than the average sensitivity degree of all sectors. The value of $FL_i < 1$ indicates that sector *i*'s degree of sensitivity is lower than the average sensitivity degree of all sectors, while the value of $FL_i = 1$ indicates that sector *i*'s degree of sensitivity is equal to the average sensitivity degree of all sectors.

3. RESULTS AND DISCUSSION

3.1. Economic Overview of Aceh

According to the United Nations (2018), the Input Output Tables show separately the consumption of domestically produced and imported goods and services as the resources and also show the links between final uses and intermediate uses of goods and services defined as Uses. Table 2 shows the resources and uses for goods and services in economy of Aceh. This table provides information on the resources of goods and services in Aceh, as well as the allocation for their use. Aceh gets 73.99 percent of its goods and services through domestic production, with the remainder imported from neighbouring provinces and abroad. The percentage of products from other provinces is relatively high, at 23.90 percent. Meanwhile, foreign products amounted for 2.11 percent of total production. In the uses side, Aceh use the intermediate demand for 31.17 percent, household consumption for 28.34 percent, gross fixed capital formation (*Pembentukan Modal Tetap Bruto* [PMTB]) for 16.80 percent, government expenditure for 10.54 percent, and non-profit institution serving households (NPISH) Consumption for 0.87 percent.

This result is inline with the economic structure by expenditure GDRP of Aceh in 2016 and 2020 where the structure of Aceh's economy is still dominated by household consumption, then GFCF becomes the second-largest component. While government consumption expenditure is the third-largest component distribution. The component of Consumption Expenditure for Non-Profit

Institutions Serving Households has a small role (Badan Pusat Statistik Provinsi Aceh, 2021). Aceh also has a higher export component of 11.38 percent, which is made up of exports to other provinces (10.92 %) and exports to other countries (0.46 %). Based on the percentage of exports and imports, Aceh has more intense export and import trade links with other provinces than with other countries.

Table 2. The Goods and Services Account of the Economy in Aceh

Uses		**Resources**	
Description	**%**	**Description**	**%**
Intermediate Demand	31.17	Domestic Output	73.99
Household Consumption	28.34	Imports from Other Province	23.90
Non-Profit Institution Serving Households (NPISH) Consumption	0.87	Foreign Imports	2.11
Government Consumption	10.54		
PMTB	16.80		
Inventory Change	0.91		
Exports to Other Province	10.92		
Foreign Exports	0.46		
Total	**100.00**	**Total**	**100.00**

Source: Input Output Tables of Aceh, 2016

3.2. Output Structure

Output of Aceh is the value of production (including goods and services) produced by economic sectors of Aceh. It may be recognized which sectors make a major contribution output formation in Aceh by knowing the amount of output created by each sector. Figure 2 reports the ten sectors in Aceh with the highest output in 2016.

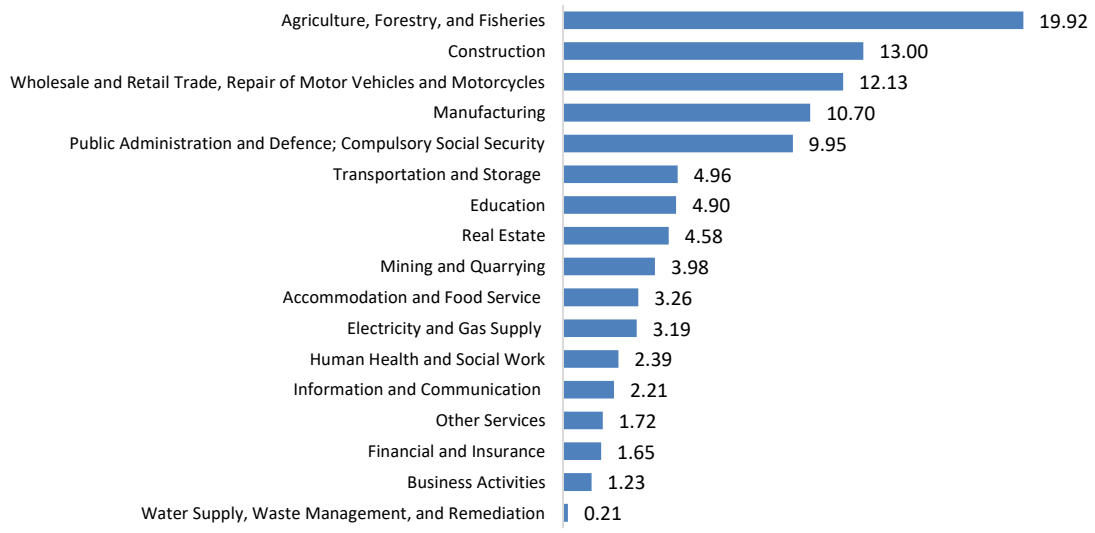

Figure 2. The ratio of output of Aceh in 2016 based on 17 industry (%)
Source: IRIO Table of Indonesia for 2016 (Authors calculation)

Figure 2 reports the industry with the largest proportion according to the output structure are the Agriculture, Forestry and Fisheries which have an output value of Rp. 46.31 trillion with a percentage of 19.92 percent, followed by the Construction with a percentage of 13.00 percent; Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles with a percentage of 12.23 percent; Manufacturing with a percentage of 10.70 percent and in fifth place is the Public Administration and Defence; Compulsory Social Security with a percentage of 9.95 percent. The Agriculture, Forestry, and Fisheries make up a sizable portion of the entire output in Aceh, indicating that they have largest contribution the province's overall output. The results are inline with the previous study by Rozana, Zakiah and Agus (2019) which shows that the agricultural sector has the

greatest output among the other 13 sectors. Agriculture had an important role in the Aceh economic structure.

3.3. Gross Value Added (GVA) Structure

The economy of Aceh is mainly supported by the Agriculture, Forestry and Fisheries (26.47 percent); Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles (14.51 percent), Public Administration and Defence; Compulsory Social Security (9.92 percent), Construction (9.75 percent) and Manufacturing (6.81 percent) (Figure 3). In total, the five industry provide 67.46 percent of Aceh's economy. The agricultural sector's largest contribution shows the importance of agriculture as the main economic activity. Besides being large in the creation of output, this sector was also capable of producing relatively large added value. This result inline with Rozana, Zakiah and Agus (2019) which shows that agriculture was the largest sector in creating value added. The Agriculture Sector was able to produce relatively large added value because in addition to meeting domestic needs, this sector is also able to export most of its output. (Rozana Zakiah and Agus, 2019).

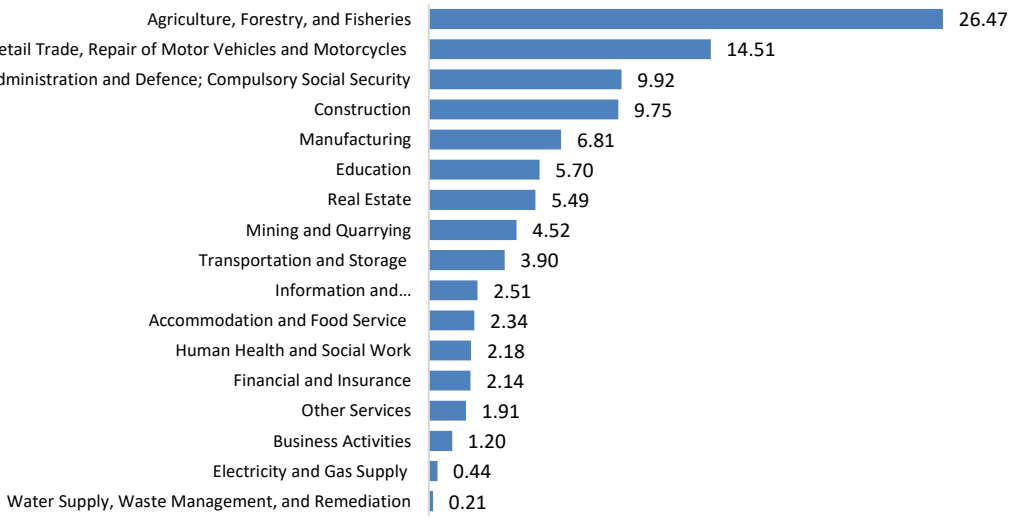

Figure 3. The GVA value contribution of Aceh in 2016 based on 17 Sectors (%)
Source: IRIO Table of Indonesia for 2016 (Authors calculation)

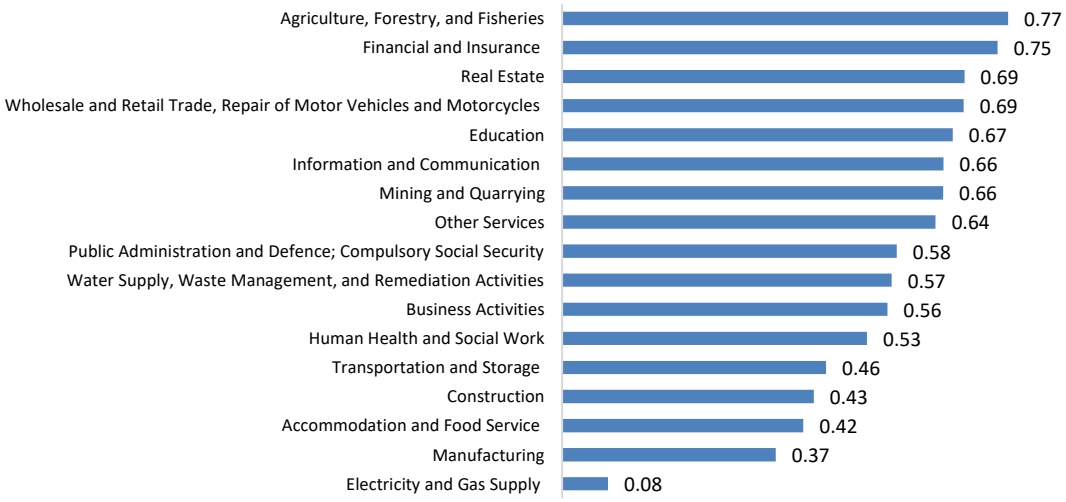

Figure 4. The GVA ratio of each sector in Aceh Province
Source: IRIO Table of Indonesia for 2016 (Authors calculation)

Figure 4 presents the GVA ratio for each sector in Aceh. The agriculture, forestry and fisheries have the largest GVA ratio, which is 0.77. It means that from 100 outputs of agriculture, forestry and

fisheries can create 77 percent of primary income, the form of wages and salaries for workers, taxes for the government, and business surplus for enterprises. Then, followed by financial and insurance which was 0.75; real estate of 0.69; and wholesale and retail trade; repair of motor vehicles and motorcycles were 0.69. The electricity and gas supply has the smallest GVA ratio, which was 0.08. It means that from 100 percent output of the electricity and gas supply can create 8 percent of primary income.

3.4. Export Destinations in Aceh

Based on Indriyani and Munim (2022), inter-regional dependence can be studied further from the IRIO Table. The composition of exports and imports of a province can involve other provinces in Indonesia, and from abroad to fulfill their needs. The output produced by a province is used to support the economy of other regions through exports. Aceh export destinations are shown in Figure 5. Aceh exports more than half of its products (56.47%) to North Sumatera. Agricultural products, especially those from seasonal and annual plantation crops, account for most Aceh exports to North Sumatera. The closeness of North Sumatera to Aceh is one of the reasons that Sumatra Utara is Aceh's major export destination. Aceh export destination is directed to DKI Jakarta by 12.06 percent with the main products exported are products from agriculture, especially agricultural products for seasonal horticultural crops, annual horticulture crops, and others. The results of Indriyani & Munim (2022), regarding the export destinations of North Kalimantan Province using the 2016 IRIO table also show that North Kalimantan's largest exports were destined abroad by 44.51 percent, followed by East Kalimantan by 18.28 percent, where East Kalimantan was a province that bordering North Kalimantan. This is in line with this study where Aceh's largest export is destined for North Sumatra, which is a bordering province of Aceh.

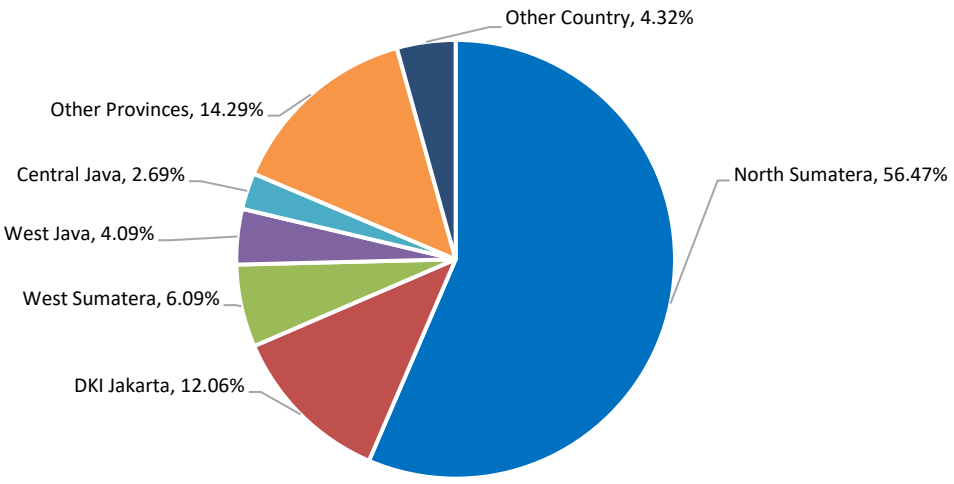

Figure 5. Aceh province export destination to regions in Indonesia
Source: IRIO Table of Indonesia for 2016 (Authors calculation)

Besides North Sumatera, the province on Sumatera Island that Aceh exports to is West Sumatera, which has 6.09 percent. Products that are exported to the West Sumatera are the products of the manufacturing, especially in the manufacture of food products and beverages. Besides DKI Jakarta, Aceh also exports mining products to Java Island, specifically West Java (4.09%) and Central Java (2.69%) in the form of mining products, especially oil, gas, and geothermal mining. In addition to exporting to other provinces in Indonesia, Aceh also exports 4.32 percent to abroad in the form of products from the manufacturing, especially products from the manufacture of chemicals and pharmaceuticals and botanical products.

3.5. Region Origin of Import to Aceh

There are occasions when a province needs products from other provinces to fulfill raw material and public consumption needs if the goods/services required are not accessible within the province or are available but at a considerably higher price. Imports from other provinces or from abroad will be used to meet the province's demands. Aceh also imports 94.55 percent of its needs from other provinces and 5.45 percent from outside the country. This indicates that Aceh imports more from other provinces in Indonesia than from abroad.

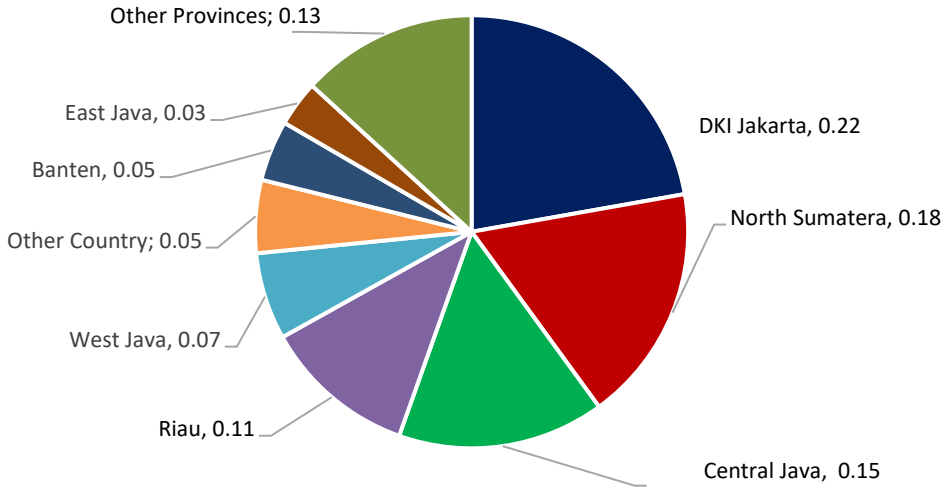

Figure 6. The region origin of product import to Aceh Province
Source: IRIO Table of Indonesia for 2016 (Authos calculation)

Aceh's imports mainly depend on regions in Java, such as DKI Jakarta (22.21 percent), Central Java (15.45 percent), West Java (6.50 percent), Banten (4.52 percent) and East Java (3.41percent). Aceh's imports from Java accounted for 54.08 percent of Aceh's total imports. Aceh's imports from North Sumatera and Riau are also quite large at 17.77 percent and 11.48 percent. The substantial contribution of North Sumatra to Aceh's imports is due to the proximity of the region North Sumatera to Aceh, making access and transportation costs easier and cheaper than in other provinces. Aceh imports from other countries to fulfill its needs, accounting for 5.45 percent of Aceh's total imports.

Aceh imports for the purposes of the production process (intermediate inputs) can be divided according to industry in Table 3. Industry in Aceh are generally still dependent on domestic output. However, several industry such as Information and Communication and Transportation and Storage are more than 40 percent dependent on imports. In terms of final demand (Table 3), household consumption needs at 38.20 percent came from imported goods, where most of the imports came from outside the island of Sumatera.

Table 3. Source of input by industry in Aceh

Code	Description	Source of Intermediate Input (%)				
		Domestic	Import Foreign	Import in Sumatra Island	Import Outside Sumatra Island	Total
A	Agriculture, Forestry and Fishing	71.38	0.53	17.42	10.67	100.00
B	Mining and Quarrying	79.87	0.65	8.31	11.18	100.00
C	Manufacturing	77.38	1.04	12.51	9.07	100.00
D	Electricity and Gas	72.12	0.24	18.98	8.66	100.00
E	Water supply, Sewerage, Waste Management and Remediation Activities	75.85	0.51	9.19	14.44	100.00
F	Construction	66.42	0.69	20.92	11.98	100.00
G	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	76.87	0.55	8.32	14.26	100.00
H	Transportation and Storage	48.83	0.90	36.69	13.58	100.00
I	Accommodation and Food Service Activities	81.60	0.23	12.25	5.91	100.00
J	Information and Communication	47.78	1.78	6.25	44.20	100.00
K	Financial and Insurance Activities	59.42	1.40	8.19	30.99	100.00
L	Real Estate Activities	76.76	0.91	4.70	17.63	100.00
MN	Business Activities	60.87	0.90	14.12	24.11	100.00
O	Public Administration and Defence; Compulsory Social Security	62.33	1.62	10.21	25.84	100.00
P	Education	62.11	2.02	16.80	19.07	100.00
Q	Human Health and Social Work Activities	69.40	1.08	11.57	17.96	100.00
RSTU	Other Services Activities	63.98	2.38	12.46	21.18	100.00

Source: IRIO Table of Indonesia for 2016 (Authos calculation)

Table 4. Source of final demand in Aceh

Description	Source of Final Demand (%)				
	Domestic	Import from Foreign	Import from Other Provinces in Sumatra Island	Import from Other Provinces Outside Sumatra Island	Total
Household Consumption	61.80	0.87	12.30	25.03	100.00
LNPRT Consumption	77.20	0.95	1.49	20.36	100.00
Government Consumption	95.14	0.42	0.76	3.69	100.00
Gross Fixed Capital Formation	75.87	4.77	3.70	15.66	100.00

Source: IRIO Table of Indonesia for 2016 (Authos calculation)

3.6. Backward and Forward Linkage

Hirawan and Nurkholis (2008) explain that sectors that have a backward linkage index and a forward linkage index greater than 1 together, then the sector is referred to as a key sector. Sectors that have forward linkages show that these sectors are able to encourage increased production in other sectors that use inputs from these sectors. As a result, sectors with forward linkage can move the economy together with the output it produce. Meanwhile, a sector with backward linkage demonstrates its ability to support an increase in the output of other sectors whose output is used as an input by the sector. Sectors that have backward linkages can move the economy in terms of the inputs it needs to produce output.

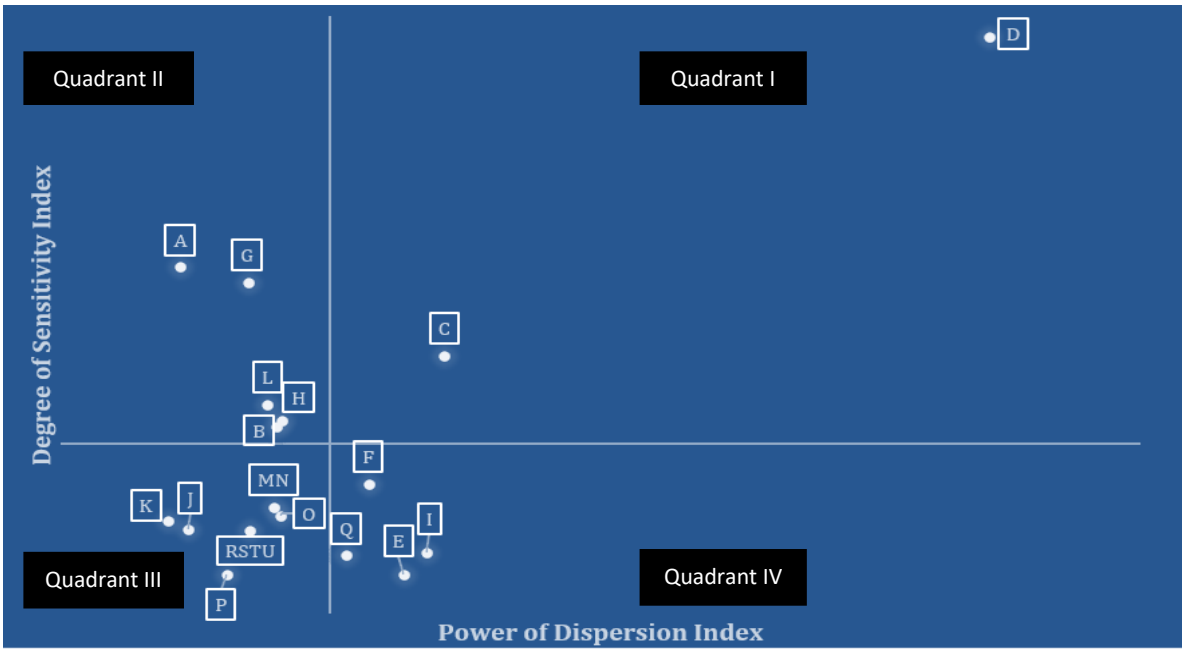

Figure 7. Power of Dispersion Index and Degree of Sensitivity Index Plots by Industry in Aceh
Note: A: Agriculture, Forestry and Fisheries; B: Mining and Quarrying; C: Manufacturing; D: Electricity and Gas; E: Water supply, Sewerage, Waste Management, and Remediation Activities; F: Construction; G: Wholesale and Retail Trade; Repair of Motor; Vehicles and Motorcycles; H: Transportation and Storage; I: Accommodation and Food Service Activities; J: Information and Communication; K: Financial and Insurance Activities; L: Real Estate Activities; MN: Business Activities; O: Public Administration and Defence; Compulsory Social Security; P: Education; Q: Human Health and Social Work Activities; RSTU: Other Services Activities
Source: IRIO Table of Indonesia for 2016 (Authos calculation)

The forward linkage is measured by the degree of sensitivity index. Meanwhile, the backward linkage is measured by the power of dispersion index. The larger the degree of sensitivity index and the power of dispersion index, the greater the ability of the sector to drive the economy. The sector in the first quadrant is a sector that has the Power of Dispersion Index and Degree of Sensitivity Index value of more than one so that the sector can be categorized as a leading sector because it has a great ability to drive the economy.

Figure 7 presents a quadrant plot based on the power of dispersion index and degree of sensitivity index for each category of industry. The results of the analysis show that the electricity and gas supply (D), and the manufacturing (C) are the main industries in Aceh. Pruitichaiwiboon (2011) explains that the electricity output is distributed as the final demand. Electricity is used in the production process of power plants. Therefore, electricity is an important input as fuel to start the machine or for lighting in the production process. On the other hand, all institutions, which is companies, households, government, and NPISH also need electricity for their daily activities and operations. From this, it can be understood why electricity is categorized as a leading sector, due to high demand because it is needed by all institutions or sectors.

Meanwhile, agriculture, forestry and fisheries are in quadrant two, where the degree of sensitivity index number is greater than one, but the power of dispersion index number is less than one. This demonstrates that Agriculture, Forestry and Fisheries in Aceh which was the largest contribution in output and GVA of Aceh are capable of driving sectors that utilise their outputs as production inputs. However, agriculture, forestry, and fisheries have not optimally pushed the production of other sectors whose outputs agriculture, forestry and fisheries utilize as inputs.

The study by Widyawati (2017) result with the input-output Indonesia 2018 showed that the manufacturing sector and electricity, gas, water sector had forward linkage to the agricultural sector. Thus, if there is incrincreasethe key sector Aceh which is manufacturing sector and electricity, can also increasing the agriculture, forestry, and fisheries, because agriculture, forestry and fisheries is used the electricity and manufacturing sector as an input in the process of production.

Table 6 shows the results, which show that the manufacture of food products and beverages and the manufacture of chemicals and pharmaceuticals and botanical products, have a degree of sensitivity index and power of dispersion index of greater than 1 or are in first quadrant. As a result, the two industries are leading sectors with significant potential to drive the economy, namely, the ability to drive production from other sectors that use the output of the industrial sector as production inputs to drive the economy from the input side.

Table 6. Degree of sensitivity index and power of dispersion index by manufacturing in Aceh

Industry	Code	DSI	PDI	Quadrant
(1)	(2)	(3)	(4)	(5)
Manufacture of coal & refined petroleum products	I-12	0,69	0,58	3
manufacture of food products & beverages	I-13	1,24	1,17	1
Manufacture of tobacco products	I-14	0,69	0,87	3
Manufacture of textiles; & wearing apparel	I-15	0,76	1,22	2
Manufacture of leather & related products & footwear	I-16	0,69	1,11	2
Manufacture of wood & products of wood, cork, articles of straw, & Plaiting materials	I-17	0,93	1,04	2
Manufacture of paper & paper products, printing & reproduction of recorded media	I-18	0,71	1,14	2
Manufacture of chemicals and pharmaceuticals and botanical product	I-19	1,31	1,08	1
Manufacture of rubber, rubber products and plastics products	I-20	0,73	1,00	3
Manufacture of other non-metallic mineral products	I-21	0,87	1,19	2
Manufacture of basic metals	I-22	0,69	1,13	2
Manufacture of fabricated metal products, computer, & optical products, & electrical equipment	I-23	0,88	1,13	2
Manufacture of machinery and equipment	I-24	0,69	1,14	2
Manufacture of transport equipment	I-25	0,69	1,16	2
Manufacture of furniture	I-26	0,72	1,09	2
Other manufacturing, repair and installation of machinery & equipment	I-27	0,76	1,18	2

Source: IRIO Table of Indonesia for 2016 (Authors calculation)

There are differences in the results of this study compared to previous studies. Based on table 6, the largest DSI (forward linkage index) is manufacture of chemicals and pharmaceuticals and botanical products, while the largest PDI (backward linkage index) is manufacture of textiles; and wearing apparel. Meanwhile, based on research of Abdullah et al. (2014), using Table I-O Aceh 2006, the results show that the largest DSI is manufacture of food products and beverages and the largest PDI is manufacture of urea fertilizer and basic chemicals. The comparison between this research and previous research by Abdullah et al. (2014), there was a shift in the sector that had the greatest forward linkage index, from Manufacture of Food Products and Beverages in 2006 to Manufacture of Chemicals and Pharmaceuticals and Botanical Products in 2016. This shows that in 2006 the Manufacturing of Food Products sector and Beverages is a sector that can provide the highest increase in output if Manufacture of Food Products and Beverages is used as an intermediate input. Then, in 2016, the sector shifted to the second rank among industrial sectors. While the first rank is occupied by Manufacture of Chemicals and Pharmaceuticals and Botanical Products. This shows that the Manufacture of Chemicals and Pharmaceuticals and Botanical Products sector can provide the highest increase in output if the Manufacture of Chemicals and Pharmaceuticals and Botanical Products is used as an intermediate input.

Additionally, there was also a shift in the sector which had the greatest backward linkage index from the Manufacture of Urea Fertilizer and Basic Chemicals in 2006 to the Manufacture of Textiles; and Wearing Apparel in 2016. This shows that in 2006 the Manufacture of Food Products and Beverages sector was a sector that could provide increased output to the industry whose role was to provide intermediate inputs for that sector. Meanwhile, in 2016, the Manufacture of Urea Fertilizer and Basic Chemicals was a sector that could provide increased output to the industry whose role was to provide intermediate inputs for the sector.

3.7. Multiplier Analysis

The output multiplier is generated from the sum of the columns in the Leontief inverse matrix $(I - A)^{-1}$. This output multiplier is specified in the IRIO model as a response to change in exogenous variables (final demand) in one or all sectors in one or all regions. The response to these changes will later be reflected in the economy's impact on all sectors (due to inter-regional linkages). (Hirawan & Nurkholis, 2008). Malba & Taher (2016) explain that the output multiplier shows the magnitude of the impact that occurs on output when there is an increase in final demand (either in the form of investment or others) in each sector. The data of Aceh's Input Output Table can be used to generate output multipliers for Aceh by summing the columns (for each sector and region) in the Leontief inverse matrix, as shown in Figure 9 below.

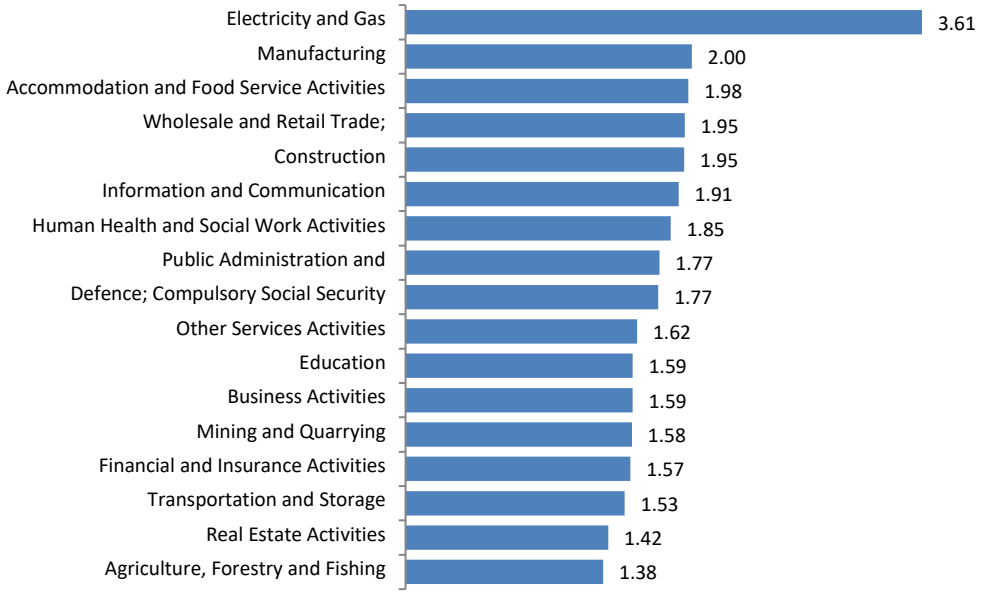

Figure 8. The output multiplier of Aceh Province
Source: Input Output Table of Aceh in 2016, (Authors calculation)

The highest output multiplier of Aceh in 2016 were Electricity; Manufacturing and Accommodation and Food Service Activities. While the smallest output multiplier is Agriculture, Forestry, and Fisheries. The output multiplier for sector Electricity, which is 3.61, indicates if the final demand from this sector has increased by one million rupiah, the total output of all sectors in the economy will increase by 3.61 million rupiah. Based on Hirawan & Nurkholis (2008), by using analyzes of I-O Aceh 2005 shows that the highest output multiplier is Construction, while based on Rosmika (2011) using the Input Output Table of Aceh to analyze the linkage and output multiplier, the highest output multiplier is manufacture of food, beverage, and tobacco. While based on this research, the highest output multiplier is electricity. Thus, if Aceh increases the output generated from electricity, then it can increase Aceh's economy significantly. The government suggests that the program equalizes electricity consumption to remote and outermost areas, which can increase the output output generated from electricity.

3.8. Analysis of Interregional Linkages

Based on Hirawan & Nurkholis (2008), interregional effect is defined as the effect of an increase in output that occurs in an area as a result of a change in one unit of final demand from a sector in another area. Thus, economic changes in Aceh will have an impact not only on Aceh's economy, but also on the economies of other provinces, and vice versa.

Figure 9. Output Multiplier to Other Provinces due to Final Demand Shock in Aceh
Source: IRIO Table of Indonesia for 2016 (Authors calculation)

Figure 10 shows how the final demand shock in Aceh affected output in other provinces. If there was increasing in the final demand of Aceh, it will affect increase of other provinces output. The final demand shock in Aceh had a large output impact to DKI Jakarta, North Sumatera, Riau, Banten, West Java and East Java. DKI Jakarta was the province that benefited the most when there was a final demand shock in Aceh. If final demand in Aceh increases by Rp. 1000, then output in DKI Jakarta increases by Rp. 68.47.

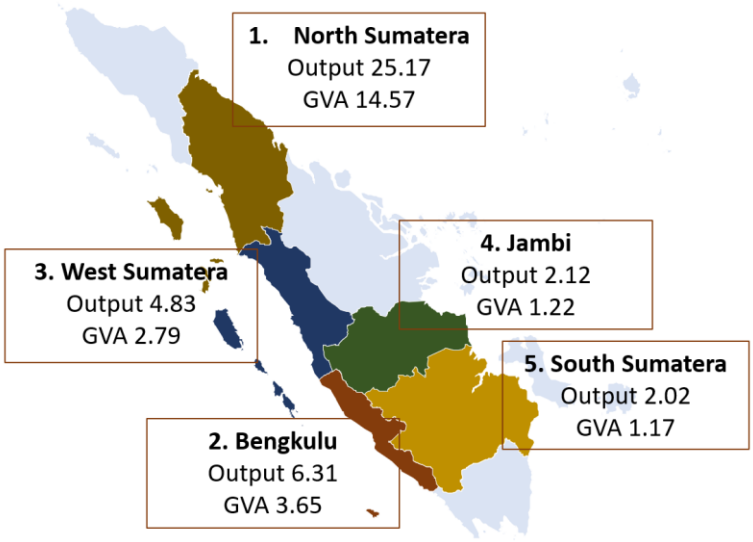

Figure 10. Output multiplier to Aceh due to final demand shock in other provinces
Source: IRIO Table of Indonesia for 2016 (Authors calculation)

Economic changes in Aceh can also be caused by final demand shocks in other provinces. Figure 10 shows the output impact to Aceh due to final demand shocks in other provinces. The largest output impact to Aceh occurred when there was a final demand shock in North Sumatera. If final demand in North Sumatera increases by Rp. 1000, then output in Aceh increases by Rp. 25.2. The next largest output impact to the Aceh is from North Sumatera, Bengkulu, West Sumatera, Jambi and South Sumatera. This result implies that the greatest economic changes in Aceh is depend on the province in the Sumatera Island, which is still on the same Island with Aceh.

4. CONCLUSIONS

The main industry with the largest share of output in Aceh are agriculture, forestry and fisheries; construction; wholesale and retail trade; manufacturing; and public administration. In

total, the five industry provide 65.71 percent of Aceh's economy. The electricity and gas supply and manufacturing, are major industry in Aceh when it comes to the relationship between industry. This demonstrates that the The electricity and gas supply and manufacturing needs to be optimized in order to drive the Aceh's economy. The final demand shock in Aceh had a large output impact to DKI Jakarta, North Sumatera, and Riau Provinces. The biggest output impact to Aceh due to final demand shocks in other provinces occurred when there were final demand shocks in North Sumatera, Bengkulu, West Sumatera, Jambi and South Sumatera.

Based on the results of the study, several suggestions can be made by the Aceh government in order to improve its economy. First, to encourage the optimization of Agriculture, Forestry and Fisheries dan Construction which have a large share of the Aceh economy to become a leading sector. Second, leading sectors such as the Electricity and Gas Supply and Manufacturing can be a booster to improve Aceh's economic performance after affected by the COVID pandemic. Finally, the provinces of North Sumatera, Bengkulu, West Sumatera, Jambi and South Sumatera are provinces that have the greatest output impact and GVA for Aceh, so it is necessary to increase economic synergy with these regions. Policy implications can be intended for Manufaturing and Electricity sector, because it is the key sector in the Aceh. The policy implication based on the result of this result is as follows: (1) Program to equalize electricity consumption to remote and outermost areas; (2) Programs to increase the skills of industrial workers, etc; and (3) Inter-regional work programs for the Sumatran region such as forming a special Sumatran economic zone etc.

ACKNOWLEDGEMENT

The authors would like to thank Directorate of Production Accounts of BPS-Statistics Indonesia for knowledge sharing related to scientific paper.

Conflicts of Interest: The authors declare there is no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

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