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Identification of Leading Sectors of the Economy in Yogyakarta Using the Input-Output Method: Linkage Analysis of 17 Sectors by Business Field

Muhammad Rifqi Fadhillah[a], Fausti Widayanti[a], Dian Wahyudi[a]

[a]*UIN Sunan Kalijaga Yogyakarta, Indonesia*

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Abstract: The Special Region of Yogyakarta (DIY) is one of the provinces in Indonesia whose economy is dominated by the Manufacturing Industry; Agriculture, Forestry, and Fisheries; Accommodation and Food Services; Information and Communication; and Construction. To determine the leading sectors, it is necessary to analyze linkage indices, as leading sectors are those with high dispersion indices, which are capable of driving economic activity. Therefore, this study uses the Input-Output analysis method to identify sectors with high linkage dispersion indices. The study utilizes the 2016 Yogyakarta Input-Output Table and analyzes the linkage values of potential sectors. Potential sectors are selected from 17 business fields out of a total of 52 industrial sectors. The analysis results show that the three sectors contributing the most output are Manufacturing Industry (Rp38,461 billion), Transportation and Warehousing (Rp30,615 billion), and Construction (Rp22,915 billion). The Transportation and Warehousing sector has the highest forward linkage of 1.822, indicating significant potential in driving the output of other sectors. On the other hand, the Public Administration, Defense, and Mandatory Social Security sector records the highest backward linkage of 1.602. The Manufacturing Industry sector has a backward linkage value of 1.515 and a forward linkage value of 1.750, while the Electricity and Gas Supply sector records respective values of 1.521 and 1.632. With high forward and backward linkage indices, these two latter sectors fall into the leading quadrant and have strong potential as the main drivers of DIY's economy.

Keywords: *Leading Sector; Input-Output Method; Linkage Coefficient*

Introduction

The Special Region of Yogyakarta (DIY) is one of the provinces in Indonesia whose economy is dominated by five main business sectors: Manufacturing Industry; Agriculture, Forestry, and Fisheries; Accommodation and Food Services; and Construction. Based on data from the Central Statistics Agency (BPS) of Yogyakarta in 2016, the Manufacturing Industry was the dominant sector, contributing 13.21% to the Gross Regional Domestic Product (GRDP) (Suryono & Pafrida, 2017).

A sector can be categorized as a leading sector if it is capable of driving economic activities and enhancing the welfare of other sectors in terms of production, exports, and employment (Sianturi et al., 2022). According to the Input-Output Table report by BPS, leading sectors are those with high linkage values, namely backward linkage and forward linkage. Therefore, this study aims to analyze the industrial sectors in the Yogyakarta region that have the potential to become leading sectors (Mastiani et al., 2025).

There are several methods that can be used to analyze leading sectors in a region (Negara & Putri, 2020), and one of them is the Input-Output (IO) Table analysis method (Astuti & Maysaroh, 2020). The IO Table is a development of the Inter-Regional Input-Output (IRIO) Table that illustrates the

*Corresponding Author
muhammad.fadhillah@student.uin-suka.ac.id (M.Fadhillah).
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economic transaction activities of goods and services between economic sectors and between regions. The IO Table also describes how economic sectors are interconnected in carrying out economic activities (Asni et al., 2021).

Several studies have used the IO Table to analyze the economic sectors of a region. Here are some examples of studies using the IO Table analysis method. Simanjuntak & Anggara (2022) conducted an IO Table analysis to identify leading sectors in East Kalimantan Province. Their analysis concluded that three major contributing sectors to East Kalimantan's economy are Agriculture, Forestry and Fisheries , Mining and Quarrying; and Manufacturing Industry. The Water Supply, Waste Management, and Recycling sector had the highest output multiplier across all economic sectors in East Kalimantan. The Electricity and Gas Supply, as well as the Water Supply, Waste Management, and Recycling sectors, were identified as leading sectors to enhance the region's economic output.

Indriani & Mukhyi (2013) conducted a study using the IO Table analysis method to identify leading sectors in Indonesia's economy. Their findings showed that out of 36 sectors with high backward linkage indices, the Oil and Fat Industry had the highest. Among 26 sectors with high forward linkage indices, the Trade Sector ranked the highest. They identified 13 key or leading sectors in Indonesia, including Trade, Chemical Industry, Fertilizer and Pesticide Industry, Other Services, Construction, Machinery and Electrical Equipment Industry, Other Food Industry, Land Transport, Electricity, Gas, and Clean Water, Rubber and Plastic Goods Industry, Livestock, and Paper and Paper Product Industry. In total, 25 sectors were found to play an important role in increasing the income of the Indonesian people.

Meanwhile, Sutrisno (2021) used the IO Table and LQ (Location Quotient) analysis methods to identify leading sectors and simulate development policy scenarios for Indonesia's economy. The results indicated that the Financial Institutions and Insurance sector was a basic sector, along with Electricity, Water Supply, and the Manufacturing sector. The study also found that a sector's large output does not necessarily result in large intermediate inputs to other sectors. A policy simulation was conducted on government policy in Cilegon, focusing on economic analysis using injections (including effects) through household consumption. The findings highlighted the need for government intervention to maintain economic stability.

This study focuses on identifying leading sectors in the Yogyakarta region using the 2016 Yogyakarta Input-Output Table. In general, the study aims to identify the leading sectors in Yogyakarta through IO Table output analysis and the dispersion index of linkage values.

Literature Review and Hypothesis

The data used in this study is secondary data, specifically the Input-Output (IO) Table of Yogyakarta for the year 2016, based on the 2021 fiscal year (Asni et al., 2021). Essentially, the IO Table consists of three quadrants. Quadrant I describes the transactions of goods and services used by producers in each industry. Quadrant II illustrates final consumption in the transaction of goods and services. Quadrant III represents the gross value added generated by each industry. The IO Table is classified into 17 sectors out of a total of 52 industrial sectors, based on the classification by field of business. To provide an overview of the IO Table, Table 1 presents an example consisting of the following three quadrants:

Table 1. Three-Quadrant Input-Output Table

Industry Sector	Output Allocation			Final demand	Ouput Totals
	Insdustry 1	Insdustry 2	Insdustry n		
Input Antara		Quadrant I		Quadrant II	
Insdustry 1	$X_{1.1}$	$X_{1.2}$	$X_{1.n}$	f_1	X_1
Insdustry 2	$X_{2.1}$	$X_{2.2}$	$X_{2.n}$	f_2	X_2
Insdustry n	$X_{n.1}$	$X_{n.2}$	$X_{n.n}$	f_n	X_n

*Corresponding Author

muhammad.fadhillah@student.uin-suka.ac.id (M.Fadhillah).

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Primary input	Quadrant III		
	V_1	V_2	V_n
Jumlah Input	X_1	X_2	X_n

Source: IO Tables BPS Yogyakarta 2016

In Table 1, Quadrant I shows how the output of an industry sector is allocated to each demand sector. The rows of the table show the allocation of intermediate inputs to fulfill the demand of each industry sector, while the columns show the usage of intermediate inputs to meet the needs of each sector (Leontief, 1986).

The variable X in Quadrant I, when viewed in matrix form, holds two meanings depending on whether it's read by row or column. For example, X1.2, when read by row, means the amount that industry 1 supplies to fulfill the demand of industry 2. When read by column, it means the amount of input that industry 2 receives from industry 1. Based on the IO Table above, the following equation can be formed:

$$\text{Rows} = \sum_{j=i}^{n} X_{ij} + f_i = X_i \quad \text{and Columns} = \sum_{i=j}^{n} X_{ij} + V_j = X_j$$

Where Xij is the input value from sector *i* to sector *j*; fi is the final demand value of sector *I*; Vj is the total value of primary input to sector *j*; Xi is the total output plus the total final demand value of sector *I*; Xj is the total input value plus the total primary input of sector *j*.

The IO Table has an input structure that shows the value of goods and services in an industry sector required to produce output. Using the information in Quadrants I and III, one can calculate the input coefficient matrix, also known as the Leontief Coefficient. The Leontief Coefficient equation is written as follows:

$$A_{ij} = \frac{X_{ij}}{X_j}$$

A_{ij} = *Leontief Coefficient*/ Coefficient of industry i input by industry j
X_{ij} = Use of industry i input by industry j
X_j = total output of industry j

In macroeconomic models, this leads to the concept of a Multiplier Matrix or Leontief Multiplier. The multiplier analysis is used to explain the causal impact of the change in one variable on other variables. To perform this multiplier analysis, matrix A from the input coefficients is required, which is then subtracted from the identity matrix (I), and the multiplier matrix is defined as the inverse of this result. The mathematical equation for the multiplier matrix can be written as:

$$B = I - A \text{ , and } L = (I - A)^{-1}$$

B = Multiplier matrix
I = Value of identity matrix
A = value of the coefficient input matrix
L = Matrix inverse

To determine the leading sectors, key sectors need to be identified for analysis. Leading sectors are those that have a high degree of inter-sectoral linkage in the production process. These sectors are

*Corresponding Author
muhammad.fadhillah@student.uin-suka.ac.id (M.Fadhillah).
https://doi.org/10.14421/bie.2025.041-04

identified through backward linkage and forward linkage analysis. Mathematically, the linkage analysis can be expressed as follows:

$$BL(i)_j = \sum_{i=1} I_{ij} \text{ and } FL(i)_i = \sum_{j=1} I_{ij}$$

BL(i) = *backward linkage* analysis value for industry j
FL (i) = *backward linkage* analysis value for industry i
I_{ij} = value in the *Leontief inverse* matrix

The linkage calculation is carried out using the inverse matrix of the Leontief coefficient in Microsoft Excel. Then, to identify sectors with high potential, a classification is applied to the linkage values, Backward Linkage (BL) > 1.5, Forward Linkage (FL) > 1.5.

Results

Descriptive Statistics Test Results

The economy generated by the Yogyakarta region in 2016 reached 222,871 billion rupiah. In terms of growth, the economic value that year increased by 0.1% compared to the previous year, with economic growth reaching 4.95%.

Based on the analysis of the Input-Output (IO) Table, it was found that industrial sectors playing a significant role in Yogyakarta's economy are referred to as leading sectors. Leading sector analysis can be conducted using sectoral linkage values. A leading sector has the highest total backward linkage and total forward linkage.

The 2016 Yogyakarta IO Table illustrates inter-sectoral linkages and allows for analysis based on multiplier values to determine the leading sectors. The Yogyakarta 2016 IO Table contains a classification of 52 x 52 sectors, but this classification was summarized into 17 sectors based on business fields.

Table 2 presents the results of the input-output analysis based on these 17 business sectors that have the potential to become leading sectors. It also includes the total output, sectoral income, and average number of workers.

Table 2. Results of IO Table Analysis Based on 17 Business Sectors

Industry Sector	Code	Output Total (Million)	Income (Billion)	Average Number of Worker (Thousand)
Agriculture, Forestry, and Fisheries	A	17.301.730,13	11.456,17	415,93
Mining and Quarrying	B	922.317,06	593,16	11,00
Manufacturing Industry	C	**38.461.085,55**	14.547,35	363,71
Electricity and Gas Supply	D	2.493.804,55	141,79	2,54
Water Supply, Waste Management, and Recycling	E	342.041,54	114,76	7,10
Construction	F	**22.915.646,58**	10.286,73	144,53

*Corresponding Author
muhammad.fadhillah@student.uin-suka.ac.id (M.Fadhillah).
https://doi.org/10.14421/bie.2025.041-04

Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	G	16.006.436,53	9.297,75	445,03
Transportation and Warehousing	H	**30.615.087,62**	6.248,79	82,90
Accommodation and Food and Beverage Services	I	22.419.547,84	11.255,1	209,76
Information and Communication	J	13.670.438,52	8.957,49	24,49
Financial and Insurance Services	K	6.056.379,22	4.334,78	28,99
Real Estate	L	7.471.085,06	7.800,51	4,04
Business Services	MN	5.432.159,57	1.115,85	51,65
Public Administration, Defense, and Mandatory Social Security	O	10.387.059,65	9.217,11	75,54
Education Services	P	15.413.337,67	9.010,14	139,02
Health Services and Social Activities	Q	6.347.172,54	2.759,86	46,56
Other Services	RSTU	6.615.716,93	2.824,99	129,40

Source: IO Table BPS Yogyakarta 2016

Based on Table 2, the three industrial sectors with the highest ratio of total output value are: the manufacturing industry sector, the transportation and warehousing sector, and the construction sector. The manufacturing industry, with a total output of 38,461 billion rupiah, contributed 17.25% to the total output. The transportation and warehousing sector, with a total output of 30,615 billion rupiah, contributed 13.7%, and the construction sector, with a total output of 22,915 billion rupiah, contributed 10.28% to the total output.

Conversely, the three industrial sectors with the lowest ratio to total output value are: water supply, waste management, and recycling; mining and quarrying; and electricity and gas supply. The water supply sector had an output value of 342 billion rupiah, contributing 0.1% to the total output. The other two sectors—mining and quarrying, and electricity and gas supply—contributed 0.4% and 1%, respectively, to the total output.

However, these values alone do not determine whether a sector is considered a leading sector. A sector is identified as a leading sector through linkage analysis, specifically backward linkage and forward linkage. The results of the backward and forward linkage analysis are presented in Table 3.

Based on the analysis in the table below, the sector with the highest backward linkage value is Public Administration, Defense, and Mandatory Social Security, with a value of 1.602. This indicates that if there is an increase in demand of 1 unit, the total input to this sector will increase by 1.602 units. Meanwhile, the sector with the highest forward linkage value is the Transportation and Warehousing sector, with a value of 1.822. This indicates that if the output of this sector increases by 1 unit, it will increase the total output across all sectors by 1.822 units.

*Corresponding Author

muhammad.fadhillah@student.uin-suka.ac.id (M.Fadhillah).

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Table 3. Results of Backward Linkage and Forward Linkage Analysis

Industry Sector	**Code**	**Linkage Analysis**	
		Backward Linkage	**Forward Linkage**
Agriculture, Forestry, and Fisheries	A	1,137	1,472
Mining and Quarrying	B	1,239	1,079
Manufacturing Industry	C	1,515	1,750
Electricity and Gas Supply	D	1,521	1,632
Water Supply, Waste Management, and Recycling	E	1,240	1,012
Construction	F	1,383	1,229
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	G	1,234	1,475
Transportation and Warehousing	H	1,377	**1,822**
Accommodation and Food and Beverage Services	I	1,451	1,354
Information and Communication	J	1,350	1,582
Financial and Insurance Services	K	1,164	1,297
Real Estate	L	1,217	1,287
Business Services	MN	1,363	1,318
Public Administration, Defense, and Mandatory Social Security	O	**1,602**	1,097
Education Services	P	1,242	1,050
Health Services and Social Activities	Q	1,335	1,045
Other Services	RSTU	1,293	1,164

Source: Excel Process

*Corresponding Author

muhammad.fadhillah@student.uin-suka.ac.id (M.Fadhillah).

https://doi.org/10.14421/bie.2025.041-04

A leading industry is one that can drive a region's economy and create prosperity for other sectors. Through production activities, exports, and job opportunities, a leading sector has the potential to grow more effectively due to supporting factors. Theoretically, a leading sector is one that has a high linkage value (Asni et al., 2021). To identify whether a sector has the potential to become a leading one, a linkage quadrant mapping is used, as shown in Figure 1 below:

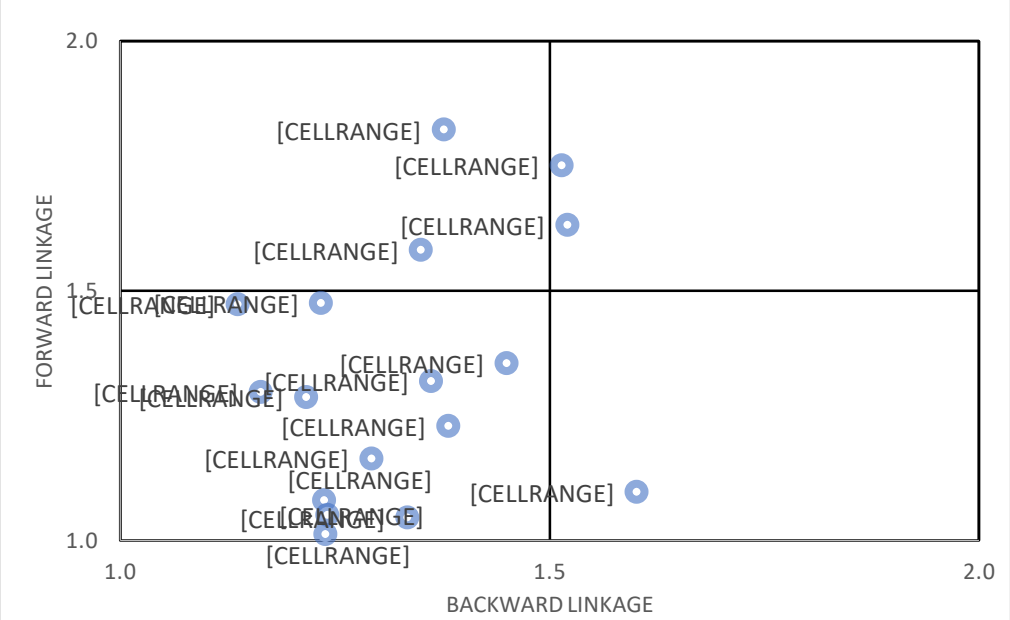

Figure 1. Linkage Quadrant Mapping Index Backward Linkage (BL) and Forward Linkage (FL)

Based on the figure above, quadrant I (BL >1.5 and FL >1.5) is the quadrant with the highest degree of backward and forward linkages, classifying it as the leading sector quadrant. There are two sectors that meet the classification in quadrant I, namely the Manufacturing Industry Sector (Code C) and the Electricity and Gas Supply Sector (Code D). This indicates that both sectors have the potential to be leading sectors in boosting the economy of the Yogyakarta region.

Meanwhile, the Transportation and Warehousing Sector (Code H), which has a high forward linkage value, is in quadrant II (FL > 1.5), meaning that this sector depends on other sectors but generates high output for other sectors. In contrast, the Public Administration, Defense, and Mandatory Social Security Sector (Code O), which has a high backward linkage value, is in quadrant III (BL > 1.5), meaning that this sector has a weakness in generating high output but does not depend on other sectors.

In light of these findings, it is hoped that the local government of Yogyakarta will pay more attention to the leading sectors, as the potential of these sectors can improve the economy, particularly in creating job opportunities. Based on Table 2, the average number of workers in the leading sectors, especially the Electricity and Gas Supply Sector, is 2,540 people. This becomes a factor that must be considered, as the great potential of this sector is not being utilized optimally.

Conclusion, Limitations, and Suggestions

There are three sectors that contribute significantly—over 10%—to the economy of the Yogyakarta region: the Manufacturing Industry Sector, the Transportation and Warehousing Sector, and the Construction Sector. These sectors generate high output; however, based on the linkage index, the sectors that have the potential to become leading sectors are the Manufacturing Industry Sector and the Electricity and Gas Supply Sector.

*Corresponding Author

muhammad.fadhillah@student.uin-suka.ac.id (M.Fadhillah).

https://doi.org/10.14421/bie.2025.041-04

Based on the linkage analysis, the Transportation and Warehousing Sector has the highest forward linkage value and the potential to generate high output, but it is highly dependent on other sectors. Similarly, the Public Administration, Defense, and Mandatory Social Security Sector has the highest backward linkage value, meaning it is not dependent on other sectors, but it does not have the potential to generate high output.

Therefore, the Manufacturing Industry Sector and the Electricity and Gas Supply Sector are the ones with the highest potential to enhance the economic output of the Yogyakarta region because they have a broad linkage index and generate high output.

The government can utilize these leading sectors when formulating economic policies, particularly in creating job opportunities. The Electricity and Gas Supply Sector has the lowest average number of workers compared to other sectors.

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*Corresponding Author

muhammad.fadhillah@student.uin-suka.ac.id (M.Fadhillah).

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