Leading sector analysis in West Kotawaringin Regency, Central Kalimantan Province, Indonesia

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Abstract. The balance between economic, social, and environmental aspects should be fulfilled in the planning of sustainable regional development. The main engine of regional economic development is the leading sector, which is characterized by strong linkage between forward and backward sectors. This research is intended to analyze leading sectors in West Kotawaringin Regency, Central Kalimantan Province. The data used is the 2012 IO (Input-output) table, analyzed using the Input-Output analysis method. Result of the research indicates that the leading sectors of West Kotawaringin Regency are agriculture; transportation and communication; trade, hotel and restaurant; and processing industry. As for the 48 sector groups, for the agricultural sector are rubber, wood, and oil palm; transportation and communication sector are river, lake and harbor transportation, sea transportation, and air transportation; trade, hotel, and restaurant sector is hotels and restaurants followed by trade. The manufacturing sector is the processing and preservation, the building wood and the sawmill industry.

Keywords: Input-Output, Intersector Linkages, Leading Sector

1. Introduction

The goal of sustainable development is not only to meet the needs of the current generation but should also consider the adequacy of resources for future generations \[1\]. This concept is reflected in the concept of Sustainable Development Goals (SDGs). This sustainable development can be translated into three pillars, which cover economic, social and environmental aspects \[2\]. The indicators of success are increase of growth and income, reduction of inequality and preservation of the environment. SDG's targets are realized through the functioning of the development sector \[3\]. Each region has a different number or type of sector but generally characterized by leading and non-leading sectors \[4\]. Sector optimization arises from economic transformation that provides added value, due to intersector linkages \[5\]. The intersector linkages are analyzed to see the characteristics of the sectors which are the main engine of development. The sector is known as the leading sector. \[6\] analyzed the leading sectors of all districts in Central Kalimantan Province using the Location Quotient (LQ) method and Klassen Typology. The data used is the Gross Domestic Product (GDP) of 2003-2007.

The three leading sectors in West Kotawaringin Regency were agriculture, industry, transportation, and communication. The LQ method is only able to calculate the magnitude of each sector in contributing output but does not illustrate the intersector linkages. Input-Output (IO) analysis is a useful tool in assessing structural changes in the economy \[7\]. For example, the IO model is used to estimate the impact of environmental policies on the economy \[8\]. Similar research was also carried out by several researchers, such as \[9,10,11,12,13,14\]. Linkages between sectors are important in

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regional development, besides institutions, natural resources, and locations [15]. The objective of this study is to determine the leading sectors in West Kotawaringin Regency.

2. Methodology
The analysis used is the input-output (IO) analysis. These results will be used in modeling the development of leading sector-based areas in West Kotawaringin Regency.

2.1. Study Area
The study was located in West Kotawaringin Regency, Central Kalimantan Province. Geographically, it is located at 01° 19' 00" - 03° 36' 00" N and 110° 25' 00" - 112° 50' 00" E, with an area of 10.759 km².

2.2. Interdependency between sectors
The IO table of West Kotawaringin Regency in 2012 consists of two types, there are 48 and 9 sectors. All sectors are linked through the intersectoral relations table. The important variables of IO are output, intermediate input, primary input, final demand, import, and export. Output is the value of the production of goods produced by all sectors. Intermediate input is the input used by sector's goods in production activities. The primary input is a remuneration given to the factor of production. Final demand includes consumption, fixed capital formation, stock changes, import, and export. From the IO table, balanced equations can be formulated as indicated in equations (1) and (2).

Row (Number of productions):

$$\sum_{j=1}^{n} x_{ij} + f_i = X_i \quad \forall i = 1, \ldots, n$$

Column (Number of Inputs):

$$\sum_{i=1}^{n} x_{ij} + v_j + m_j = X_j \quad \forall j = 1, \ldots, n$$

where: \(x_{ij}\)=good/service flow from sector i to sector j; \(f_i\)=total of final consumption; \(v\)=added values; \(m_j\)= import; \(X_i\)=production volume; and \(X_j\)=number of inputs. The inter industrial flow is transformed to be coefficient of intersector linkages as seen in equation (3).

$$a_{ij} = \frac{x_{ij}}{X_j}$$

Unifying equations (1) and (3) produces equation (4) as follow:

$$\sum_{j=1}^{n} a_{ij} X_j + f_i = X_i \quad \forall i = 1, \ldots, n$$

Equation (4) is arranged in matrix notation as seen in equation (5).

$$AX + f = X$$

By simply manipulating equation (5), the following relationship is obtained:

$$(I-A)^{-1} f = X$$

Matrix \((I-A)^{-1}\) called Leontief inverse, contains information about how an increase in production of one sector will cause the development of other sectors. Matrix \((I-A)^{-1}\) is given a notation B (a set of crosssector linkage coefficients) so that it becomes like in equation (7).

$$(I - A)^{-1} = B = \begin{bmatrix}
{a_{11}} & {a_{12}} & {a_{13}} & {a_{14}} & {a_{15}} & {a_{16}} \\
{a_{21}} & {a_{22}} & {a_{23}} & {a_{24}} & {a_{25}} & {a_{26}} \\
{a_{31}} & {a_{32}} & {a_{33}} & {a_{34}} & {a_{35}} & {a_{36}} \\
{a_{41}} & {a_{42}} & {a_{43}} & {a_{44}} & {a_{45}} & {a_{46}} \\
{a_{51}} & {a_{52}} & {a_{53}} & {a_{54}} & {a_{55}} & {a_{56}} \\
{a_{61}} & {a_{62}} & {a_{63}} & {a_{64}} & {a_{65}} & {a_{66}} \\
\end{bmatrix}$$
2.3. Multiplier effect
The correlation coefficient does not show the effect of one sector to another. Multiplier analysis can trace this effect. Output multipliers describe the condition if there are changes in exogenous variables, affecting the increase in output across sectors. The income multiplier is used to see the effect of changes in a sector’s final demand on income. There are two types of income multipliers, namely type 1 and type 2, with formulas in equations (8) and (9).

Revenue multipliers type 1 = \frac{v(I - A)^{-1}}{v} \tag{8}

Income multipliers type 2 = \frac{v(I - A^*)^{-1}}{v} \tag{9}

Where v=value added of wages per total output; (I-A)^{-1}=Leontief; and (I-A^*)^{-1}=the new Leontief.

2.4. Determination of leading sectors
IO data is processed following several stages:

1. Arrangement in the form of matrix A (dimensions 48 x 48 and 9 x 9).
2. Arrangement of the identity of matrix I (matrix dimensions 48 x 48 and 9 x 9).
3. Calculation of the matrix (I-A).
4. Calculation of the inverse matrix (I-A) or (I-A)^{-1} or called as Leontief matrix.
5. Calculation the Index of Forward Linkage (IFL) and Index of Backward Linkage (IBL) between sectors and Total of Linkage Index (TLI) = Σ (IFL + IBL)

3. Result and Discussion
3.1. Analysis of leading sectors and intersector linkages
The linkages aspects discussed are direct forward and backward linkages, direct and indirect forward and backward linkages, and multiplier effect.

3.1.1. Direct forward and backward linkages. Direct forward linkage illustrates the magnitude of the influence from one particular sector to another sector that uses some of the output per unit of total demand directly. Direct backward linkage shows the direct influence of a sector in providing intermediate inputs for the needs of the sector per unit total demand. Table 1 shows the four sectors that have the largest IFL, namely the transportation and communication sector, the trade, hotel and restaurant sector, the agricultural sector, and the manufacturing industry sector. The four sectors that have the largest IBL are the transportation and communication sector, the trade sector, hotels and restaurants, the agricultural sector and the manufacturing industry sector. This shows that the strong direct influence of the four sectors in providing intermediate input. The largest TLI from the four sectors is the transportation and communication sector (1.99), the trade, hotel, and restaurant sector (1.74), the agricultural sector (1.50), and the manufacturing sector (1.43).

| Nr | Sector name          | Direct linkages |
|----|----------------------|-----------------|
|    |                      | IFL R | IBL R | TLI R |
| 1  | Agriculture          | 0.34369 | 3 | 1.16027 | 3 | 1.50396 | 3 |
| 2  | Mining and excavation| 0.05261 | 8 | 1.00971 | 9 | 1.06232 | 9 |
| 3  | Processing industry  | 0.33141 | 4 | 1.10218 | 4 | 1.43360 | 4 |
| 4  | Electricity and clean water | 0.14764 | 6 | 1.04235 | 6 | 1.18999 | 6 |
| 5  | Building             | 0.07349 | 7 | 1.02942 | 7 | 1.10290 | 7 |

Table 1. Direct forward and backward linkages in 9 sectors.
Classification of sector types using IO data in 48 sectors is also carried out to find out type of business of the leading sectors. The results are shown in table 2. Of the 48 sectors, the sectors that have high TLI are the agriculture sector (oil palm, timber and rubber). The transportation and communication sector, the sea transportation sector has TLI=2.67, followed by the river, lake, and crossing transportation sector and the air transportation sector. The trade, hotel and restaurant sector shows that TLI trade is greater than hotels and restaurants.

**Table 2. Direct forward and backward linkages in 48 sectors.**

| Nr | Sector name                          | IFL           | IBL           | TLI           | R |
|----|-------------------------------------|---------------|---------------|---------------|---|
| 1  | Agriculture                         | 1.02897       | 0.98963       | 2.01860       | 4 |
| 2  | Mining and excavation               | 0.56975       | 0.88663       | 1.65638       | 9 |
| 3  | Processing industry                 | 1.03878       | 1.10006       | 2.13883       | 3 |
| 4  | Electricity and clean water         | 0.86222       | 0.96990       | 1.83216       | 6 |
| 5  | Building                            | 0.79912       | 1.07981       | 1.87897       | 7 |
| 6  | Trade, hotel and restaurant         | 1.25795       | 0.97920       | 2.23717       | 2 |
| 7  | Transportation and communication    | 1.44437       | 1.10655       | 2.55089       | 1 |
| 8  | Financial institutions and rent      | 0.96923       | 1.00787       | 1.97710       | 5 |
| 9  | Other services                      | 0.76878       | 0.99304       | 1.76182       | 8 |

Source: Processed data results.
Note: IFL = Index of Forward Linkages; R= Ranking; IBL = Index of Backward Linkage; TLI = Total of Linkage Index

**Table 3. Direct and indirect forward and backward linkages in 9 sectors.**

| Nr | Sector name                          | IFL           | IBL           | TLI           | R |
|----|-------------------------------------|---------------|---------------|---------------|---|
| 1  | Agriculture                         | 1.08977       | 0.98693       | 2.07670       | 4 |
| 2  | Mining and excavation               | 0.76975       | 0.88663       | 1.65638       | 9 |
| 3  | Processing industry                 | 1.03878       | 1.10006       | 2.13883       | 3 |
| 4  | Electricity and clean water         | 0.86222       | 0.96990       | 1.83216       | 6 |
| 5  | Building                            | 0.79912       | 1.07981       | 1.87897       | 7 |
| 6  | Trade, hotel and restaurant         | 1.25795       | 0.97920       | 2.23717       | 2 |
| 7  | Transportation and communication    | 1.44437       | 1.10655       | 2.55089       | 1 |
| 8  | Financial institutions and rent      | 0.96923       | 1.00787       | 1.97710       | 5 |
| 9  | Other services                      | 0.76878       | 0.99304       | 1.76182       | 8 |

Source: Processed data results.
Note: IFL = Index of Forward Linkages; R= Ranking; IBL = Index of Backward Linkage; TLI = Total of Linkage Index
3.1.2. Direct and indirect forward and backward linkages. Forward direct and indirect linkages describe the magnitude of the influence of a sector, directly or indirectly, on other sectors that use the output of that sector. Backward direct and indirect linkages indicate the degree of change due to an increase in the unit demand for the end of a particular sector to other sectors that provide input to that sector. The results can be seen in Table 3 and Table 4. Table 3 shows the output of the transportation and communication sector having TLI=2.55. Other sectors that use the most output from this sector are the trade, hotel and restaurant sector (11.04%), the agricultural sector (1.7%), and the construction sector (1.08%).

Table 4 shows the business sectors that have a major role in the transportation and communication sector are river, lake and harbour transportation, followed by land and sea transportation, while the communication business sector plays a less role. The second leading sector is trade, hotel, and restaurant. The output of this sector is widely used for the benefit of the agricultural sector (8.99%), the transportation and communication sector (5.73%), and the manufacturing sector (2.73%). The third largest is the manufacturing sector. The output of the manufacturing sector is widely used for the agricultural sector (11.41%), the trade, hotel and restaurant sector (4.9%), and the transportation and communication sector (4.78%). The types of businesses that play a major role in creating output in this sector are the vegetable oil industry, the wood, bamboo and rattan industries, and the sawn timber and wood preserving industries. The agriculture sector ranks fourth at 2.08. The output from the agriculture sector is widely used for the transportation and communication sector (3.98%), the trade, hotel, and restaurant sector (3.54%), and the manufacturing sector (3.24%). The types of commodities included in the agriculture sector are rubber, wood and palm oil.

Table 4. Direct and indirect forward and backward linkages in 48 sectors.

| Nr | Sector name | In 9 sectors | In 48 sectors | IFL | IBL | TLI | R |
|----|-------------|--------------|---------------|-----|-----|-----|---|
| 1  | Agriculture | Rubber       | 0.33415       | 1.11373 | 1.44788 | 1 |
|    |             | Palm oil     | 0.20001       | 1.06275 | 1.26276 | 3 |
|    |             | Wood         | 0.18494       | 1.08000 | 1.26494 | 2 |
| 2  | Transportation and communication | Sea transportation | 0.19837 | 1.06552 | 1.26389 | 3 |
|    |             | Air freight   | 0.24300       | 1.10412 | 1.34712 | 2 |
|    |             | River, lake and harbor transportation | 0.38241 | 1.09883 | 1.48124 | 1 |
| 3  | Trade, hotel and restaurant | Perdagangan | 0.13996       | 1.04680 | 1.18676 | 2 |
|    |             | Hotel dan restoran | 0.38152 | 1.11046 | 1.49198 | 1 |
| 4  | Processing industry | Processing and preservation industry | 0.69688 | 1.18579 | 1.88267 | 1 |
|    |             | Wood sawn industry | 0.44525 | 1.26923 | 1.71448 | 3 |
|    |             | Wood building industry | 0.53393 | 1.24418 | 1.77811 | 2 |

Source: Processed data results
Note: IFL = Index of Forward Linkages; R= Ranking; IBL = Index of Backward Linkage; TLI = Total of Linkage Index

3.2. Multiplier effect
The multiplier effect is a total impact due to outside influences in various types of economic activity. In IO, the multiplier effect is calculated from the Leontief inverse matrix. The size of the multiplier depends on how far and how intense the economic interactions are between sectors.

3.2.1. Multiplier impact of output. The total output multiplier is obtained from the sum of the direct and the indirect output multiplier. Table 5 shows that the three sectors that have the highest total output multiplier are the trade, hotel and restaurant sector, the manufacturing industry sector, the financial institutions’ sector, leasing and business services, and other services sectors. The trade, hotel
and restaurant sector uses the demand for goods and services from its own sector to meet its production and consumption inputs of 78.08%. Other supported sectors are the agriculture sector (8.99%), transportation and communication (5.73%), the manufacturing sector (2.73%). The manufacturing sector can meet its production and consumption inputs of 74.08%, and output from this sector can support the transportation and communication sector (3.98%), the trade, hotel, and restaurant sector (3.54%) and the manufacturing sector (3.24%).

3.2.2. Multiplier impact of income. Type 1 income multipliers show changes in the value of both direct and indirect output caused by an increase in output from all sectors. Type 2 income multipliers reflect effects on drivers of income change. The impact describes the role of household consumption in calculating income. Type 1, type 2, and induced income multipliers are calculated using IO data in 9 sectors. Table 6 shows four sectors with the highest type 1 income multipliers, namely the manufacturing sector, the transportation and communication sector, the agricultural sector, and the trade, hotel, and restaurant sector. This indicates that these sectors can be a mainstay in increasing people’s income. Also, the induced of the income of these sectors can increase output through increased consumption due to increased income from the four affected sectors.

**Table 5.** The multiplier effect of output in 9 sectors.

| Nr | Sector name                  | Direct linkages | IFL  | R  | IBL  | TLI  | R  |
|----|-------------------------------|-----------------|------|----|------|------|----|
| 1  | Agriculture                   |                 | 0.07449 | 5  | 1.02478 | 6  | 1.09927 | 6  |
| 2  | Mining and excavation         |                 | 0.07020 | 6  | 1.01574 | 7  | 1.08594 | 7  |
| 3  | Processing industry           |                 | 0.21251 | 2  | 1.07318 | 2  | 1.28569 | 2  |
| 4  | Electricity and clean water   |                 | 0.10914 | 3  | 1.03052 | 5  | 1.13966 | 5  |
| 5  | Building                      |                 | 0.03460 | 8  | 1.00870 | 8  | 1.04330 | 9  |
| 6  | Trade, hotel and restaurant   |                 | 0.33415 | 1  | 1.11373 | 1  | 1.44788 | 1  |
| 7  | Transportation and communication |            | 0.05149 | 7  | 1.01419 | 1  | 1.06568 | 8  |
| 8  | Financial institutions and rent |               | 0.20001 | 3  | 1.06275 | 3  | 1.26276 | 3  |
| 9  | Other services                |                 | 0.13086 | 4  | 1.05007 | 4  | 1.18093 | 4  |

Source: Processed data results

Note: IFL = Index of Forward Linkages; R= Ranking; IBL = Index of Backward Linkage; TLI = Total of Linkage Index

**Table 6.** Multiplier impact of income in 9 sectors.

| Nr | Sector Name                      | Income multiplier | Type 1 | R  | Type 2 | Induced |
|----|----------------------------------|-------------------|--------|----|--------|---------|
| 1  | Agriculture                      | 1.56157           | 3      | 0.13853 | 1.42304 |
| 2  | Mining and excavation            | 1.18078           | 9      | 0.27779 | 0.90299 |
| 3  | Processing industry              | 1.62065           | 1      | 0.21297 | 1.40768 |
| 4  | Electricity and clean water      | 1.22822           | 7      | 0.18654 | 1.04168 |
| 5  | Building                         | 1.31431           | 5      | 0.22579 | 1.08852 |
| 6  | Trade, hotel and restaurant      | 1.37797           | 4      | 0.28167 | 1.09630 |
| 7  | Transportation and communication | 1.58936           | 2      | 0.22809 | 1.36127 |
| 8  | Financial institutions and rent   | 1.28328           | 6      | 0.30432 | 0.97896 |
| 9  | Other services                   | 1.20018           | 8      | 0.37564 | 0.82454 |

Source: Processed data results

Note: IFL = Index of Forward Linkages; R= Ranking; IBL = Index of Backward Linkage; TLI = Total of Linkage Index
Table 7 shows the impact of income multipliers for each sector/type of business. The agricultural sector, agricultural commodities in the form of rubber, wood, and palm oil are the biggest contributors to increasing income, respectively. The transportation and communication sector, the communication business sector contributed the most, followed by the river, lake, port and sea transportation business sectors. In the trade, hotel and restaurant sector, the hotel and restaurant business sector are more dominant in supporting the increase in labor income compared to trade.

| Nr | Sector Name                      | Type 1 | R  | Type 2 | Induced  |
|----|----------------------------------|--------|----|--------|----------|
| 1  | Agriculture                      |        |    |        |          |
|    | Rubber                           | 1,71697| 1  | 0,22534| 1,49164  |
|    | Palm oil                         | 1,39452| 3  | 0,04107| 1,35345  |
|    | Wood                             | 1,60414| 2  | 0,10278| 1,50136  |
| 2  | Transportation and communication |        |    |        |          |
|    | Sea transportation               | 2,12687| 2  | 0,20860| 1,91827  |
|    | Air freight                      | 1,60075| 3  | 0,26777| 1,33298  |
|    | River, lake and harbor transportation | 2,64725| 1  | 0,20852| 2,43873  |
| 3  | Trade, hotel and restaurant      |        |    |        |          |
|    | Perdagangan                      | 1,14034| 2  | 0,29455| 0,84579  |
|    | Hotel dan restoran               | 2,08524| 1  | 0,17783| 1,90741  |
| 4  | Processing industry              |        |    |        |          |
|    | Processing and preservation industry | 2,85138| 1  | 0,33441| 2,51697  |
|    | Wood sawn industry               | 2,03745| 3  | 0,25195| 1,78550  |
|    | Wood building industry           | 2,32117| 2  | 0,17510| 2,14606  |

Source: Processed data results, R: Ranking

4. Conclusion

The leading sectors in Kotawaringin Barat Regency are the agriculture sector; transportation and communication; trade, hotel and restaurant; and processing industry. In the agriculture sector, the leading sectors are rubber, palm, wood and palm oil. In the transportation and communication sector, the leading sectors are river, lake, and harbor transportation, sea transportation and air transportation. In the trade sector, hotels and restaurants that are the leading sectors are hotels and restaurants and trade. The processing industry sectors that are superior are the processing and preservation industry, the building wood industry, and the sawmill industry.

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